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OVERVIEW OF THE EVALUATIONS OF INNOVATION AND TECHNOLOGY TRANSFER PROGRAMS: ANALYSIS BASED ON STRATEGIC DOCUMENTS OF THE MINISTRY OF DEFENSE OF BRAZIL

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Joel Eloi Belo Junior [1], Clarissa Stefani Teixeira[2], Irineu Afonso Frey[3].

ABSTRACT

This article presents a bibliographic and documentary analysis of the evaluation practices employed in the processes of innovation and technology transfer, considering three distinct sets of strategic documents. The article aims to contribute to the specialized literature, offering valuable insights for academics, policy makers and practitioners involved in the innovation ecosystem. The first set of documents highlights the flaws in small business incentive programs, pointing to the urgent need to review and improve current metrics. In the Brazilian scenario, the focus is on the evolution of technological compensation policies, underlining the importance of developing robust indicators that effectively measure the effectiveness and impact of these policies. In addition, the global analysis reveals a dynamic repositioning in the power of scientific and technological innovation, suggesting the creation of new indicators that are in line with the current complex dynamics of Science and Engineering. The study emphasizes the need for multidimensional and adaptable evaluation methods, which are essential for the formulation of well-founded public policies and for the strategic allocation of resources in research and development activities.

Keywords: Innovation Evaluation. Technology Transfer. Strategic Indicators.

[1] Graduate Program in Intellectual Property and Technology Transfer for Innovation - Corresponding author
Federal University of Santa Catarina – UFSC – Florianópolis/SC – Brazil
Master's student in Intellectual Property and Technology Transfer for Innovation at the Federal University of Santa Catarina
Contribution: A, B, C, D, E
Email: belojr27@gmail.com
Orcid: https://orcid.org/0000-0002-5386-481X
Lattes: http://lattes.cnpq.br/1376524148385999

[2] Graduate Program in Intellectual Property and Technology Transfer for Innovation - Author and reviewer
PhD in Production Engineering from the Federal University of Santa Catarina
Contribution: A, B, C, D, E
Federal University of Santa Catarina – UFSC – Florianópolis/SC – Brazil
Email: clastefani@gmail.com
Orcid: https://orcid.org/0000-0003-1362
Lattes: http://lattes.cnpq.br/6668948766545628

[3] Graduate Program in Intellectual Property and Technology Transfer for Innovation - Author and reviewer
PhD in Production Engineering from the Federal University of Santa Catarina
Contribution: A, B, C, D, E
Federal University of Santa Catarina – UFSC – Florianópolis/SC – Brazil
E-mail: irineu.inova@gmail.com
Orcid: https://orcid.org/0000-0002-7731-3406
Lattes: http://lattes.cnpq.br/1971038997895602

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INTRODUCTION

International trade in defense products is a pillar of the global geopolitical and economic structure, representing a strategic sector that encompasses the production and transfer of advanced military technologies (CORRÊA, 2017). The international market, with its complex dynamics, significantly impacts global security and strategic alliances (CARVALHO, 2021). This impact is often driven by economic factors, as seen in the relationship between war, military power, and economic dynamics (MATOS, 2018).

Currently, this sector faces a transition period marked by disruptive innovations, which are transforming defense companies into more efficient and collaborative entities, although the adoption of a robust intellectual property culture remains a persistent challenge (BELLAIS, 2006; 2017; BLOM, 2014; DOMBROWSKY, 2009; HALL, 2009).

In the midst of these transformations, Commercial, Industrial and Technological Compensation Agreements, or *offsets*, emerge as essential compensatory practices, especially for developing economies seeking advances in their industrial and technological capabilities (DA SILVA, 2019; MAYAMONE, 2019). However, the debate on the effectiveness and economic rationality of defense policies, including those , is intense and contentious, with divergent positions between critics and defenders (FEVOLDEN; TVETBRÅTEN, 2016). *Offsets*

In the United States, despite criticism, the remains an established practice, with the Bureau of Industry and Security (BIS) annually assessing its impacts on defense trade (BIS, 2018). In Brazil, the supervision of Compensation Agreements by COMAER (Air Force Command) reflects the attempt to align these practices with the national innovation strategy, although the lack of consistent innovation indicators reveals gaps in the monitoring and evaluation of results (BRASIL, 2020b). *Offsets*

This article analyzes the approaches to evaluation in innovation and technology transfer in the defense sector, considering the contemporary dynamics and guidelines that guide this critical field.

METHODOLOGY

The research can be classified as applied, descriptive and mixed (quantitative and qualitative), according to the criteria of purpose, objective and nature, respectively. The methods used were bibliographic research and documentary research, to verify the knowledge already systematized on the subject. The documents were selected based on

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their strategic relevance and potential contribution to the understanding of different aspects of the evaluation of innovation programs.

A methodological approach based on clustering was used to analyze a set of carefully selected documents with a focus on the evaluation of impacts on Science, Technology and Innovation (ST&I). This approach allowed the categorization of the documents into three distinct clusters, each reflecting specific themes and evaluative approaches inherent to its nature and objectives.

Chart 1 shows the breakdown of the documents analyzed, specifying the type of document and the group considered.

Table 1 – Division of the documents analyzed

Clusters	**Document type**	**Title**
1	Small Business Programs	*Evaluation of the Small Business Innovation Research Program in Japan*
		Evaluation Revisited Improving the Quality of Evaluative Practice by Embracing Complexity
2	Public Policies	National Defense Strategy (END)
		Normative Ordinance No. 61/GM-MD
		Multi-year Plan Indicators Manual
3	Global Organizations / USA	Science and Engineering Indicators - *National Science Foundation (NSF)*
		Measuring Innovation - A New Perspective - Organisation for Economic Co-operation and Development (OECD)
		Overview of Evaluation Methods for R&D Programs

Source: Prepared by the author from the referenced documents (2024).

In the first *cluster*, the evaluation of programs applied to small businesses was considered: *Evaluation of the Small Business Innovation Research Program in Japan* and the document *Evaluation Revisited Improving the Quality of Evaluative Practice by Embracing Complexity*. The studies by Froehlich (2016) and Souza *et al.* (2023) demonstrate that the effective application of innovation programs can significantly alter the trajectory of small companies, leveraging their innovative capabilities to generate differentiation in the market. These studies argue that by empowering small businesses with the tools and resources they need to innovate, programs not only increase operational efficiency, but also push the boundaries of what is possible in terms of products, services, and business models.

The analysis of the second *cluster* brings the National Defense Strategy (END), which establishes a framework for Brazil's defense and security. These documents include guidelines for the preparation of the Armed Forces and a policy of industrial reorganization to keep technological advancement under national control. Normative Ordinance No.

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61/GM-MD, in particular, aligns with *offset policies* to boost the country's technological capacity, while the Manual of Indicators of the Multi-Year Plan offers a method to evaluate the effectiveness of the public policies implemented, essential for the progress of technological and industrial autonomy in the area of defense.

In the third group, the methodologies adopted by global organizations such as the NSF and the OECD are analyzed, as well as an evaluation of methods that have proven effective for managers of research and development programs in federal agencies in the United States.

RESULTS AND DISCUSSION

In this section, the analysis and interpretation of the data obtained will be presented. The research focused on the evaluation of impacts in Science, Technology and Innovation (ST&I) programs, using a methodological approach based on clustering. This technique allowed the categorization of the documents into three main clusters, each representing different themes and evaluative approaches that are essential to understand the nuances of the evaluation of innovation programs.

EVALUATION OF SMALL BUSINESS PROGRAMS *CLUSTER* 1 - APPLIED

a) *Evaluation of the Small Business Innovation Research Program in Japan*

The document includes the analysis of recent publications, which serve as a contemporary reference. Other support programs in Japan, such as ERATO and COI-NEXT, also emphasize the importance of disruptive innovations and collaboration between industry, academia, and government to achieve carbon neutrality and create new economic and social values. A study by Kumar and Singh (2023) analyzes various government support programs for small businesses, highlighting the importance of such programs for economic development and innovation, but also the ambiguities regarding their effectiveness, reinforcing the need for careful evaluation.

Analysis of the Small Business Innovation Research Program in Japan (Japanese SBIR) revealed that there was no significant difference in sales, employment, or patents between benefited and non-benefited companies, suggesting an incongruence between the incentives offered and the expected practical results. The regression models used in the evaluation of the programme indicate that, despite investments in R&D, no measurable competitive advantages were identified in the beneficiaries. This finding is in line with the

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considerations of Lerner (2011) who also did not observe significant improvements in sales and employment growth resulting from the program.

Challenges encountered in the Japanese SBIR include the difficulty of transferring knowledge between universities and companies and an administrative segmentation that compromises the efficiency of the program, limiting the exchange between different ministries and government agencies. The system for selecting awardees also differs from the American model, which is apparently less structured and without the presence of specialized scientific advisors, which can affect the selection of truly innovative projects.

In addition, the study's temporal analysis, from 2006 to 2010, coincides with a period of economic recession in Japan, where the focus on traditional manufacturing began to show signs of exhaustion. The country's need to transition to a knowledge-based economy is a critical factor that may have influenced the effectiveness of the SBIR program. In this context, the recession can be partially attributed to the country's industrial structure, which is at an inflection point, needing to adapt to a new economic and technological reality.

The qualitative evaluation points to the need for innovation policies that foster technical competencies and innovative management, suggesting that such intangible competencies may take longer to be reflected in economic indicators. This suggests that traditional success metrics may not fully capture the benefits of programs like SBIR, especially in an economy that is seeking to transform its industrial base into more knowledge-intensive sectors.

In summary, the results suggest that while Japan's SBIR has not achieved a direct impact on traditional economic performance metrics, this does not rule out potential long-term positive effects that may arise from strengthening companies' technical and managerial capabilities. These findings highlight the complexity of assessing the effectiveness of innovation programs and the importance of developing indicators that can capture the long-term benefits of investments in intellectual capital and organizational innovation.

b) Evaluation Revisited: Improving the Quality of Evaluation Practice by Embracing Complexity

This report summarizes the discussions and presentations of the Conference 'Evaluation Revisited: Improving the Quality of Evaluation Practice by Embracing Complexity", which took place from 20 to 21 May 2010. It positions these discussions

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within international debates on the measurement of development outcomes, through insights and additional observations from several key evaluation events in 2010/2011, during which discussions from the May conference were shared.

At the conference, an understanding emerged that evaluating the effectiveness of innovation programs in small businesses needs to transcend traditional metrics, embracing both quantitative and qualitative methods. This allows you to capture the essence of innovation in its multifacets, addressing both the immediate impacts and the long-term consequences. In addition, the importance of ethical values and consideration of diverse stakeholder perspectives was emphasized, with examples such as *Oxfam America*'s approach, which highlights sustainable empowerment through a set of inclusive indicators. This holistic and evaluative approach is considered essential for an in-depth analysis of the effects of innovation support programs.

The objectives of the study included summarizing the key concepts, reflecting on the applicability of the *insights* gained, evaluating the conference through participatory methods, and analyzing the methods used in the study. The 'Discussion Overview' delves into the importance of adopting a systemic, integrated approach to evaluation, which goes beyond simple measurement and is dedicated to continuous learning and stakeholder engagement. Feedback collected through participatory methods such as voting and Survey Monkey survey underlined participants' approval of discussions that encourage a collaborative, learning-oriented assessment practice.

The article highlights the predominant use of qualitative methods, the sequence and dedication of time to each technique used, as well as the values and principles that guide the process. This approach underscores the challenges of committing to complex systematic changes, which are inherently difficult to quantify.

In addition, the complexity of ensuring sufficient funding for program components that generate indirect returns and the importance of developing skills to manage measurement and learning processes involving multiple levels and actors were highlighted. Simplistic managerial approaches, preferred by some workers and development managers, often underestimate the inherent complexity of innovative programs and can lead to an aversion to risk and adherence to tradition, as observed in the Ethiopian context.

EVALUATION OF PUBLIC POLICY DOCUMENTS *CLUSTERS* 2 -

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The analysis of the documents related to the National Defense Strategy (END) and related public policies reveals Brazil's strategic commitment to strengthening its technological autonomy and its Defense Industrial Base (BID). This commitment is reflected in the constant search for advances that are not limited to government cycles, but that extend through robust and long-term planning.

The documents point to a direction regarding the application of compensation policies, aiming at technological development critical to national sovereignty. The END, from its conception in 2008 to its subsequent versions, including the most recent one in 2020, persists in highlighting defense as an integral area of national development strategies, underlining defense not only as a means of protection, but also as a lever for technological and industrial development.

Strategic action AED-47, which focuses on achieving commercial, industrial and technological offsets (), illustrates an intentional approach to incorporating domestic industry into offsets arising from external procurement, mitigating vulnerabilities and fostering BID growth. The AED-45 and AED-46 strategies complement this effort, seeking to promote exports and increase local content in defense products, respectively. *Offsets*

However, there is a gap in the documentation that points to a systematic assessment of the long-term results of offsets, especially with regard to tangible social benefits, such as the generation and qualification of jobs in the aerospace industry and the impact on exports of defense products.

Normative Ordinance No. 61/GM-MD is a reflection of offset policies, outlining the fundamental principles for their application and evidencing the intention to strengthen Brazilian technological and industrial capacity. However, it is imperative that offset agreements are accompanied by strict oversight and that the criteria and performance indicators applied to the offset are well constructed and consistently monitored.

The Manual of Indicators of the 2020-2023 Multiannual Plan presents essential characteristics that public policy indicators must have, emphasizing the usefulness, validity, reliability, and availability of data. On the other hand, the manual also draws attention to the risks inherent in the use of indicators, including the possibility that they influence the reality they seek to measure, underestimate costs, and imperfectly represent reality.

The above considerations lead to the proposal that the indicators for monitoring and evaluating the offset policy be designed to reflect the complexity of the context in which

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they are applied, providing a reliable tool to measure success and direct the evolution of Brazil's defense and innovation strategy.

EVALUATION OF GLOBAL ORGANIZATIONS / USA *CLUSTERS*

a) Science and Engineering Indicators - *National Science Foundation (NSF)*

Analysis of the Science and Engineering Indicators paper reveals profound structural changes in the global Science and Engineering (S&E) landscape. Traditional S&E performance metrics are complemented by a qualitative consideration of trends, revealing an increasingly multipolar world of S&E. This phenomenon is not only quantifiable through investment in Research and Development (R&D) and academic publications, but also qualitatively observable in the rise of new centers of excellence and intensified international collaboration.

Developing *countries' "catching up"* in S&E signals a significant global transition driven by R&D investments and a more equitable distribution of high-tech skills. China, in particular, has demonstrated remarkable growth in R&D and S&E education, suggesting a reconfiguration of the balance of power in research and innovation.

Academic institutions in developed countries, while still leading in high-impact S&E and postgraduate education, now share the arena with northern European countries, which are emerging as prominent public research centres. The highly cited publications from these countries reflect their growing influence in the global S&E space.

Developments in the European Union, such as advances in Hungary, Poland and other nations, demonstrate an increase in contribution to global research. Specialization in S&E has become more pronounced in smaller economies such as Israel and Singapore, which now exhibit high rates of R&D intensity.

The report recognizes that the S&E landscape is in constant flux, where S&E activities are increasingly characterized by interconnection and collaboration across borders. The production and trade of high-tech goods, such as those found in the pharmaceutical and ICT industry in China, illustrate how economic development is influenced by investment in S&E.

However, intellectual property activities remain predominantly in developed economies, which still control most of the production and export of knowledge-intensive commercial services, patents, and intellectual property revenues.

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This dynamic landscape highlights the ongoing need for high-quality data to keep pace with ongoing changes. Recent data is likely to further illuminate the direction and magnitude of these changes, reflecting an ever-changing world where C&E operates within an interdependent and multifaceted global value chain.

The overview presented by NSF is deliberately non-exhaustive; it is designed to highlight information that provides insights into key trends shaping today's world of S&E and that will continue to alter the prevailing patterns of global activity in S&E. This scenario should not be interpreted as static, but rather understood as part of an integrated and dynamic world, linked by global infrastructures and interdependent processes that are constantly evolving.

b) Measuring Innovation – A New Perspective

Analyzing the Organisation for Economic Co-operation and Development's (OECD) document "Measuring Innovation: A New Perspective" requires a close examination of the propositions to improve the ability to measure innovations. Qualitative analysis suggests that, in order to meet the complexity and multidimensionality of innovation, it is imperative to develop indicators that better reflect the various facets of the phenomenon.

The OECD proposes that the effectiveness in measuring innovation is not only a technical issue, but also a strategic one, since the indicators chosen must be aligned with the goals of public policies. This underscores the importance of collecting robust and relevant data that can inform informed policy decisions and influence the distribution of resources. The emphasis is on overcoming the shortcomings of the current international measurement framework, which focuses on key areas to advance a forward-looking measurement agenda.

The document recognizes the need for more comprehensive data infrastructures and the integration of research and administrative data with economic indicators. This suggests that there is a gap between data collection and its application in political and economic contexts, indicating the need for better alignment between research data and broader strategic objectives of growth and development.

The objectives outlined in the study reflect the ambition to move beyond conventional indicators, creating a rich and nuanced narrative that can effectively guide innovation policies. The recognition of the remaining challenges in measuring innovation and the willingness to address these challenges indicate a commitment to continued advancement in this field.

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The "Measurement Agenda for Innovation" presented seeks to establish benchmarks to enable countries to monitor their progress against policy targets and promote international comparison. This focus on leading indicators is designed to transcend traditional metrics, offering a more detailed and diverse narrative of innovation.

Although methodological limitations are not explicitly listed, the OECD (2010) highlights the challenges and areas that require further development, suggesting a path towards indicators that more adequately capture regional impact and contributions to scientific and technological innovation policies.

It is concluded that, while the OECD Innovation Strategy (2010) offers fundamental guidelines to improve evidence-based innovation policies, the development of complementary indicators and a robust data infrastructure is crucial. Access to the full text of the online book through Source OECD is an initiative that reflects the organization's commitment to transparency and the dissemination of knowledge.

This examination underlines the importance of systematically addressing the challenges of innovation measurement and the need for a measurement agenda adapted to the rapidly changing and complex global innovation landscape.

c) Overview of Evaluation Methods for R&D Programs

The document prepared by the United States Department of Energy presents a complex approach to the evaluation of Research and Development programs, emphasizing the need to use a wide range of methods to capture the multiple impacts generated by these programs. The document's guidance is particularly relevant for evaluators seeking to understand not only the direct outcomes but also the broader ramifications of R&D in terms of collaboration, economic contributions, and social benefits.

The objectives are practical, aiming to provide evaluators of federal R&D programs with a compendium of evaluation methods that can be applied to improve the planning, implementation, and communication of program benefits, and to provide examples of successful applications of these methods in various organizations.

The peer review methodology is widely used as a means of assessing quality and relevance in research, however, the document points to the intrinsic limitations of this method, such as the dependence on the credibility of reviewers, which can introduce biases or flaws in the evaluation. Thus, the need for impartial reviewers and the difficulty in establishing criteria to evaluate truly innovative works are significant challenges.

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In addition, the paper underlines the relevance of methods such as network analysis and econometrics, which can offer more objective and quantifiable perspectives of the impact of R&D. *Spillover* analysis is particularly notable for its ability to identify how the benefits of a given R&D program can spread and benefit other areas of society and the economy.

However, there is an acknowledgment of limitations in generating data for retrospective impact assessment, which may restrict the understanding of the true scope of programs. Peer review is seen as insufficient for impact assessment without reliable results from other methods, suggesting that a more integrated approach is needed for effective evaluation.

The summary of the discussion reinforces the need for a careful alignment between the evaluation method and the desired unit of measurement. There is an emphasis on the careful selection of methods to be employed by R&D managers and on the importance of continuous development in estimating indirect effects, such as *spillovers*, which are crucial to understanding the broader impact of R&D programs.

Overall, the document offers a holistic perspective on the evaluation of R&D programs, highlighting both the strengths and limitations of current methods and suggesting directions for future advances. These considerations are fundamental to optimize the evaluation of R&D programs and ensure that the investments made are effectively contributing to the advancement of science, technology and society in general.

FINAL CONSIDERATIONS

This study highlighted the critical importance of a multidimensional and adaptive approach to evaluation in innovation and technology transfer, using as a reference the complex network of strategic documents and public policies of the Ministry of Defense. The analysis showed that technological sovereignty is fundamental in the national strategy, highlighting that the sustainability and innovation of the Defense Industrial Base (BID) are long-term imperatives that go beyond electoral cycles.

The documents analyzed, from the "Evaluation of the Small Business Innovation Research Program in Japan" to the "Overview of Evaluation Methods for R&D Programs", contribute valuable *insights*, highlighting the need to strengthen managerial and technical capacities and the development of indicators that capture long-term benefits, considering both immediate impacts, as well as lasting consequences. The emphasis on ethical values

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and consideration of diverse *stakeholder* perspectives, along with the classification of compensatory measures and precepts for project management, are identified as crucial elements in promoting technological and industrial autonomy, fostering a robust and globally integrated defense industry.

Chart 2 shows some of the *insights* perceived in each document considered.

Chart 2 – *Insights* observed in the analyzed documents

Document	***Insights* in reviews**
Evaluation of the Small Business Innovation Research Program in Japan	- Strengthening of the technical and managerial capacities of the companies revealed in the documents analyzed.
Evaluation Revisited Improving the Quality of Evaluative Practice by Embracing Complexity	- Indicators developed to capture long-term benefits from investments in intellectual capital and organizational innovation are emphasized.
National Defense Strategy (END)	- The approach of the documents regarding the immediate impacts and the long-term consequences is notorious.
Normative Ordinance No. 61/GM-MD	- The emphasis on the importance of ethical values and consideration of the perspectives of diverse *stakeholders* is clearly valued.
Multi-year Plan Indicators Manual	- Documents establish a classification of countervailing measures, differentiating technological, industrial and commercial measures.
Science and Engineering Indicators – *National Science Foundation (NSF)*	- The precepts for prospecting, negotiating, implementing, monitoring and controlling projects are outlined.
Measuring Innovation – A New Perspective – Organization for Economic Co-operation and Development (OECD)	- The construction of indicators is based on the needs of decision-makers, a crucial aspect identified. - The regional impact and contributions to scientific and technological innovation policies.
Overview of Evaluation Methods for R&D Programs	- The significance of the indicators, and their maintenance over time, is a key point discussed.

Source: Prepared by the author from the referenced documents (2024).

The research revealed that the innovation program aimed at small businesses in Japan provided strengthening of technical and managerial capacities. This result suggests that focused interventions can significantly increase competence and competitiveness in the global market. The programs not only drive operational efficiencies, but also stimulate a substantial expansion in companies' innovative capabilities, highlighting the effectiveness of these initiatives in transforming the business landscape.

On the other hand, the document *"Evaluation Revisited: Improving the Quality of Evaluative Practice by Embracing Complexity"* highlights the need for indicators that capture the long-term benefits of investments in intellectual capital and organizational innovation. The approach that recognizes the complexity of evaluation practices contributes to the development of metrics that reflect the transformative and lasting effects of

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innovation programs, suggesting a methodological revision to incorporate broader and less tangible aspects.

In the context of the National Defense Strategy (END) and Normative Ordinance No. 61/GM-MD, the analysis emphasized the duality of impacts, considering both immediate and long-term consequences. The inclusion of ethical values and consideration of the perspectives of diverse *stakeholders* reinforce the importance of inclusive and ethical policymaking. These documents also outline a structured approach to national defense that integrates technological, industrial, and commercial issues under a cohesive policy.

The Manual of Indicators of the Multiannual Plan introduces a detailed classification of the compensation measures, differentiating them into technological, industrial and commercial categories. This segmentation is essential to accurately assess the impact of implemented policies and to understand how different types of offsets contribute to technological and industrial advancement.

Finally, the analysis of the documents of the *National Science Foundation (NSF)* and the Organization for Economic Cooperation and Development (OECD) emphasizes the construction of indicators adjusted to the needs of decision-makers. These precepts are vital for the prospection, negotiation and monitoring of Science, Technology and Innovation (ST&I) projects, evidencing the central role of indicators as tools for continuous evaluation and adjustment of innovation policies. The discussion on the maintenance of indicators over time, addressed in the document "Overview of Evaluation Methods for R&D Programs", highlights the need for evaluation systems that endure to capture the full impact of R&D investments.

These results reflect the complexity and multifaceted nature of evaluation practices in innovation, pointing to the need for a constant evolution of methodologies to effectively support the dynamics of scientific and technological innovation.

The convergence of the data suggests that a robust matrix of indicators, which reflects the multifaceted reality of innovation, can serve to stimulate technological development and international collaboration. The documents point to the need for improvements in evaluation methodologies and public policies informed by robust data and long-term strategic vision, considering the complexity of the domains analyzed. These considerations underline the continuing need to adapt public policies to technological and geopolitical developments, ensuring that evaluation practices and indicators used are as dynamic as the field they propose to foster. Thus, it is concluded that innovation and

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technology transfer strategies must be agile and multidimensional, ensuring alignment with the strategic objectives of defense and national development. *Insights*

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