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Contributions of the Brazilian Army's strategic programs to the national defense industrial base policy

Contribuciones de los programas estratégicos del Ejército Brasileño a la política de base industrial de la defensa nacional

Abstract: The objective of the article is to evaluate the contributions of the Army's Strategic Programs to the objectives of the National Defense Industrial Base Policy (PNBID). The research used a quantitative method, which involved collecting evaluations by experts, applying the Hierarchical Analysis Process (AHP), and confirming the results through statistical tests. Programs with a more technological bias confirmed the greatest contribution to PNBID, with emphasis on the ASTROS Program, while the Sports, Education and Culture Program obtained the lowest score, as expected by the Authors. The research has practical implications when evaluating the Army's Strategic Programs in light of the objectives of the recent Policy. As it is a public policy, the actors involved need to be accountable to society and improve their management, generating knowledge and learning for future decision-making processes. The research innovates by applying AHP and statistical tests to analyze public policy.

Keywords: Portfolio of Strategic Programs; Brazilian Army; AHP; PNBID; defense industry.

Resumen: El objetivo de este artículo es evaluar las contribuciones de los programas estratégicos del Ejército a los objetivos de la Política de Base Industrial de la Defensa Nacional (PNBID). Este estudio utilizó el método cuantitativo, que implicó recopilar valoraciones de expertos, aplicar el Proceso de Análisis Jerárquico (AHP) y confirmar los resultados mediante pruebas estadísticas. Los programas con un sesgo más tecnológico confirmaron la mayor contribución a la PNBID, con destaque para el Programa ASTROS, mientras que el Programa de Deporte, Educación y Cultura obtuvo la menor puntuación, como esperaban los autores. Este estudio tiene implicaciones prácticas al evaluar los programas estratégicos del Ejército a la luz de los objetivos de la política reciente. Al tratarse de una política pública, los actores involucrados deben rendir cuentas ante la sociedad y mejorar su gestión, generando conocimiento y aprendizaje para futuros procesos de toma de decisiones. Este estudio innova al aplicar AHP y pruebas estadísticas para analizar la política pública.

Palabras clave: Portafolio de Programas Estratégicos; Ejército Brasileño; AHP; PNBID; industria de defensa.

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1 INTRODUCTION

The purpose of this research is to evaluate the contributions of the Brazilian Army's strategic programs to the objectives of the National Defense Industrial Base Policy (PNBID – *Política Nacional da Base Industrial de Defesa*). The PNBID is recent, having been published in Decree No. 11.169, of August 10, 2022, guaranteeing the competitiveness and autonomy of the Defense Industrial Base (BID – *Base Industrial de Defesa*), in strategic technologies that are indispensable to national defense (Brasil, 2022). The PNBID established six objectives, summarized here: (1) to stimulate the production of knowledge and the generation of intellectual property by institutions involved in research, development and innovation in the field of defense goods and services; (2) to encourage the integration of actions relating to science, technology and innovation as a factor inducing the productive development of the BID; (3) encourage the continued training of human resources for the BID; (4) reduce external dependence for defense goods and services; (5) improve the technological quality of defense goods and services produced and developed in the country; and (6) increase the competitiveness of the BID in order to expand exports of defense goods and services produced and developed in the country (Brasil, 2022).

The assessment proposed here is relevant in a number of ways. Firstly, most of the Armed Forces' strategic programs date from well before the PNBID, and their conceptual bases were brought together in the first edition of the National Defense Strategy (Brasil, 2008). In this sense, verifying the alignment between the objectives of the recent policy and the current strategic programs sheds light on the various sectors of the government, industry, and academia when it comes to outlining strategic actions, indicators, and metrics, which normally stem from a public policy, but which is still lacking in relation to the PNBID. Moreover, this research anticipates and assists the Ministry of Defense (MD) in its efforts to identify the strategic programs that are most in line with each objective of the PNBID, given that its results were generated based on standardized questionnaires, answered voluntarily by experts from the Single Force itself. As this is a public policy, the actors involved need to be accountable to society and improve their management, generating knowledge and learning for future decision-making processes (Simões, 2006, 2018). Finally, the methodological approach model suggested here for the analysis confirms the usefulness of the Analytic Hierarchy Process (AHP) for decision support processes in defense problems, following a trend evidenced in the scientific literature.

At the national level, it is possible to highlight the applications of the AHP in Biluca, Aguiar and Trojan (2020), who studied waste management in military units; Balian (2018) e Martins (2018) associated the AHP with the SWOT matrix to diagnose fish supply logistics in the 2nd Military Region; Baptista et al. (2017) analyzed sports infrastructure in the Army; Borges and Gavião (2023) analyzed government relations in the latest version of the Navy's Strategic Plan (PEM-2040); Salgado et al. (2023) evaluated a sample of polar research vessels in support of the Brazilian Antarctic Program; Maêda et al. (2021) explored AHP with TOPSIS to evaluate aircraft for the Navy; Madeu, Pellanda and Passos (2021) prioritized technologies based on the number of patents. Internationally, Gomes and Romão (2017) explored the AHP to prioritize naval projects for the Portuguese Navy in Simplício; Han, Sung and Chou (2016) evaluated modes of transportation between Taiwan and other regional islands; Michaeli et al. (2014) used AHP

to analyze weapons systems and their links; Kim and Lim (2021) analyzed the combat capability of South Korean frigates; Wiejak, Grzelak and Mroczek (2023) evaluated the mobility of Polish logistics vehicles and Radovanović et al. (2021) combined AHP with VIKOR to select unmanned aircraft in Serbia.

After this introductory section, in Section 2, this article looks at the history of BID regulation, which materializes the country's initiatives to develop the defense industry in all its different forms. This is followed in Section 3 by a brief review of the literature on BID and the Army. Section 4 presents the Army's strategic programs; Section 5 details the quantitative methodology explored, based on the Analytic Hierarchy Process and hypothesis testing. Finally, Section 6 concludes this research.

2 NORMATIVE HISTORY ON THE DEFENSE INDUSTRY

The National Defense Policy (PDN)[1], approved by Decree No. 5.484 of June 30, 2005, can be considered a milestone in the regulation of the BID. PDN-2005 mentioned the "defense industry" in three passages of the text, emphasizing its development to "reduce technological dependence and overcome unilateral restrictions on access to sensitive technologies", to include "the mastery of dual-use technologies [...] to achieve secure and predictable supply of defense materials and services" and it encourages that the "regional integration of the defense industry, like Mercosur, should be the subject of measures that promote mutual development, the expansion of markets and the achievement of strategic autonomy" (Brasil, 2005a, our translation).

Still within the context of the PDN, Normative Order No. 899 of the MD, of July 19, 2005, approved the National Defense Industry Policy (PNID). The general objective of the document was to strengthen the BID, as well as establishing specific objectives aimed at raising awareness in society, seeking to reduce external dependence, expanding the acquisition and mobilization capacity of the national industry, and improving the technological quality of strategic products. It is worth noting that the PNID already determined that the Secretariat for Logistics and Mobilization (SELOM) would be responsible for "coordinating the preparation of the resulting strategic actions, as well as preparing the work program, with an annual assessment, containing goals and deadlines" (Brasil, 2005b).

The Brazilian National Defense Strategy (END – *Estratégia Nacional de Defesa*), approved by Decree No. 6.703 of December 18, 2008, focused defense planning on medium and long-term strategic actions. The END paid special attention to the defense industry, placing its reorganization as the second of three structuring axes of the strategy (Brasil, 2008). It also defined three strategic technological sectors, considered decisive for national defense: space, cyber, and nuclear. The END represented an important milestone in the development of policies aimed at BID, as it established the objective of strengthening the sector, with priority given to promoting the training of human resources and the dominion over national technological mastery.

1 PDN-2005 originated in 1996, even more concisely than similar documents today and without explicitly addressing the defense industry (Brasil, 1996). After its revision in 2012, the PDN was renamed the National Defense Policy (PND), including quadrennial revisions, in accordance with Complementary Law No. 97 of June 9, 1999 (Brasil, 2020).

In 2012, the Ministry of Defense published the *Livro Branco de Defesa Nacional* [White Book on National Defense], which boosts the concept of transforming the sector, with the aim of strengthening the capabilities of the Armed Forces and fostering economic growth. To achieve this vision, the document outlined the creation of the Defense Articulation and Equipment Plan (PAED), Annex B of the document, and the restructuring of the Defense Industrial Base (BID). The PAED aimed to restore the operational capacity of the Armed Forces, guarantee the acquisition of defense equipment, and strengthen teaching, research, and education in the sector, through 35 projects by the Single Forces, for a time horizon of 20 years (Brasil, 2012a).

Another important measure for the defense sector was the publication of Provisional Measure No. 544 of September 29, 2011, converted into Law No. 12,598 of March 22, 2012, which stipulated special rules for purchases, contracts and the development of defense products and systems, as well as rules to encourage the strategic defense area. Among the measures contained in the law is the Special Tax Regime for the Defense Industry (RETID), with the aim of stimulating defense companies by exempting them from certain contributions (Brasil, 2012b). It also established the concepts of Defense Product (PRODE – *Produtos de Defesa*); Strategic Defense Product (PED – *Produto Estratégico de Defesa*); and Defense System (SD – *Sistema de Defesa*) (Brasil, 2012b).

Despite important government initiatives, it is important to note that, until the creation of Decree No. 11.169, of August 10, 2022, there was no specific National Policy for the BID, which centralized the strategic guidelines aimed at promoting the defense industry, covering the points dealt with in previous legislation. In fact, the PNBID involved other sectors of the Public Administration in the discussion, standardization, and engagement of the defense theme in a direct way, such as the Ministries of Economy and Science and Technology, and indirectly, the Ministry of Education.

3 3. THE BRAZILIAN DEFENSE INDUSTRIAL BASE: A REVIEW OF THE LITERATURE

Initially, searches were carried out on the world's two main research databases, Clarivate Web of Science and Elsevier Scopus, which bring together tens of thousands of international journals that follow the strictest criteria for publishing scientific articles (Zhu; Liu, 2020; Pranckutė, 2021; Asubiaro; Onaolapo; Mills, 2024). The preliminary results generated the results in Table 1.

Table 1- Search in the main journal index databases

Clarivate Web of Science (access on Jun. 24, 2024)		
Search metadata	**Search keywords**	**Number of publications**
Abstract	"defense industry" OR "defense industrial base" OR "defense industry" OR "defense industrial base"	678
Connector: AND		
Abstract	Brazil OR Brazilian	6
Connector: AND		

(to be continued)

Table 1- Continuation

Clarivate Web of Science (access on Jun. 24, 2024)		
Search metadata	**Search keywords**	**Number of publications**
Abstract	Policy OR Army	2
Elsevier Scopus (accessed June 24, 2024)		
Search metadata	Search keywords	Number of publications
Title, Abstract and Keywords	"defense industry" OR "defense industrial base" OR "defense industry" OR "defense industrial base"	4476
Connector: AND		
Title, Abstract and Keywords	Brazil OR Brazilian	44
Connector: AND		
Title, Abstract and Keywords	Policy OR Army	20 (18 articles and 2 books)

Source: prepared by the authors, 2024.

The two articles found in the Web of Science database deal, respectively, with the performance of companies in Ecuador's defense industry, with some comparison to Latin American countries (Lorenzo; Cárdenas; Calderón, 2023); e Avila (2023) investigates the history and trajectory of ENGESA in Brazil, from 1974 to 1990.

The wider range of results on the Scopus database led to a survey of bibliometric indicators for this sample of 18 scientific articles and two books, which combine the keywords indicated, as shown in Tables 2 and 3.

Table 2- Names of journals and books from the main search

Name of Journal or Book	Type	Total
Defense and Security Analysis	Article	2
Jane's Defence Weekly	Article	2
Aviation Week and Space Technology	Article	1
Brazil-Africa Relations in the 21st Century: From Surge to Downturn and Beyond	Book	1
Comparative Strategy	Article	1
Culture and Defence in Brazil: an inside look at Brazil's Aerospace Strategies	Book	1

(to be continued)

Table 2- Continuation

Name of Journal or Book	Type	Total
Defence and Peace Economics	Article	1
Defence Studies	Article	1
Espacios	Article	1
International Journal of Product Lifecycle Management	Article	1
Jane's Defence Industry	Article	1
Journal of Aerospace Technology and Management	Article	1
Journal of Technology Management and Innovation	Article	1
Latin American Politics and Society	Article	1
Revista Brasileira de Ciências Sociais	Article	1
Revista Científica General Jose Maria Cordova	Article	1
Revista Ibérica de Sistemas e Tecnologias de Informação	Article	1
World Review of Science, Technology and Sustainable Development	Article	1

Source: prepared by the authors, 2024.

Table 3- Affiliation of the authors of the main search

Author affiliation	Number of Publications
Universidad Simón Bolívar	3
Pontifícia Universidade Católica do Paraná (PUC-PR)	2
University of New Mexico	2
Escola Superior de Guerra (ESG)	1
Instituto Tecnológico da Aeronáutica (ITA)	1
Universidade da Força Aérea (UNIFA)	1
Instituto de Pesquisa Econômica Aplicada (IPEA)	1
Escola Brasileira de Administração Pública e Empresas (FGV-EBAPE)	1
Universidade de Campinas (Unicamp)	1
Universidade Federal do Rio Grande do Sul	1
Unicentro – Paraná	1
Centro Universitário UniAtenas – Minas Gerais	1
Academia de Defensa Militar	1
Université du Québec à Trois-Rivières	1
Empresa Eléctrica Quito	1
Instituto Universitário de Lisboa (ISCTE-IUL)	1
Universidade de Brasília (PPEE – Engenharia Elétrica)	1
Technological Management and Innovation Agency	1

(to be continued)

Table 3- Continuation

Author affiliation	Number of Publications
University of Central Florida	1
The University of Manchester	1
Universidad de Fuerzas Armadas-ESPE	1

Source: prepared by the authors, 2024.

Of these 20 publications filtered from the Scopus database, it is worth highlighting those that developed some analysis of public policies directly aimed at the defense industry, or made mention of programs or projects of the Brazilian Army, which are the main objects of this study. Ribeiro et al. (2023) analyzed the challenges and opportunities in using SISFRON, seeking to leveraging dual-use technological innovations and increasing information sharing between the armed forces, public security, and private companies, through bibliographic and documentary research with open sources and documents from the Brazilian Army. Vieira, Schmoller and Bravo (2022) developed a case study with the Army's mortar development project to analyze product lifecycle management, focusing on traceability and the reuse of requirements during the product development process. Fernandes et al. (2020) analyzed the triple helix model and open innovation in the Brazilian Army, as models of research cooperation to generate innovation. With a similar focus on the triple helix model, Silva and Olavo-Quandt (2019) identified the existing technology parks in the headquarters of the Brazilian Army's military regions, based on the premise that these habitats are capable of forming governance hubs for technological innovation.

For a specific search for scientific articles published in Portuguese, a survey was carried out in the Directory of Open Access Journals (DOAJ), using the keywords "indústria de defesa" or "base industrial de defesa." Table 4 shows the 16 scientific articles found.

Table 4- Search for articles in the DOAJ database

Authors	Title of Scientific Article	Journal	Analysis of the PNBID or its objectives?	Analysis of BA projects?
Cardoso; Oliveira (2024)	*A indústria de defesa e seus aspectos socioeconômicos* [The defense industry and its socioeconomic aspects]	Revista ESMAT	No	No
Avila (2023)	*Por dentro da Engesa-Engenheiros Especializados, 1974–1990: Armas, negócios e inserção internacional de uma empresa brasileira* [Inside Engesa-Engenheiros Especializados, 1974-1990: Weapons, business and international insertion of a Brazilian company]	Latin American Research Review	No	Partially
Farias Júnior; Lemos (2021)	*Os Impactos Econômicos da Política Nacional de Defesa e da Estratégia Nacional de Defesa na Base Industrial de Defesa do Brasil* [The Economic Impacts of the National Defense Policy and the National Defense Strategy on Brazil's Defense Industrial Base]	Revista Agulhas Negras	No	Yes (Guarani)

(to be continued)

Table 4- Continuation

Authors	Title of Scientific Article	Journal	Analysis of the PNBID or its objectives?	Analysis of BA projects?
Fonsêca; Vasconcellos (2021)	*A indústria de defesa brasileira na era da guerra irregular* [The Brazilian defense industry in the era of irregular warfare]	Coleção Meira Mattos-Revista das Ciências Militares	No	No
Nabuco; Costa; Meireles (2021)	*Análise sobre a participação do comércio internacional da indústria de defesa na balança comercial brasileira* [Analysis of the share of international trade in the defense industry in Brazil's trade balance]	Revista Principia	No	No
Oliveira et al. (2021)	*Encomendas tecnológicas em processos de obtenção de sistemas complexos de defesa* [Technological orders in the procurement of complex defense systems]	Coleção Meira Mattos-Revista das Ciências Militares	No	No
Bello; Figueiredo; Almeida (2020)	*Acumulação de capacidades tecnológicas inovadoras na indústria de defesa em economias emergentes: a experiência dos projetos REMAX e TORC30 no Exército Brasileiro* [Accumulation of innovative technological capabilities in the defense industry in emerging economies: the experience of the REMAX and TORC30 projects in the Brazilian Army]	Cadernos EBAPE.BR	No	Yes (REMAX and TORC30)
Dall'Agnol (2020)	*Análise de programas de defesa de alto custo e longo prazo* [Analysis of high-cost, long-term defense programs]	Coleção Meira Mattos-Revista das Ciências Militares	No	No
Gonçalves; Ferreira (2020)	*O papel das parcerias estratégicas para o desenvolvimento da Base Industrial de Defesa brasileira* [The role of strategic partnerships for the development of the Brazilian Defense Industrial Base]	Coleção Meira Mattos-Revista das Ciências Militares	No	Yes (Guarani)
Alves et aal. (2018)	*Investimentos na indústria de defesa do Brasil e da Argentina: os avanços e recuos dos gastos militares no século XXI* [Investments in the defense industry in Brazil and Argentina: the progress and setbacks of military spending in the 21st century]	Coleção Meira Mattos-Revista das Ciências Militares	No	No
Leite; Studart (2018)	*Negociações entre governos na exportação de produtos de defesa* [Negotiations between governments on the export of defense products]	Coleção Meira Mattos-Revista das Ciências Militares	No	No
Silvestre; Ávila (2016)	*Entre armas leves e a regulamentação internacional: para que lado o Brasil dirige uma política pública?* [Between small arms and international regulations: which way is Brazil steering public policy?]	Revista Brasileira de Políticas Públicas e Internacionais	No	No
Borlina (2015)	*A desminagem humanitária como instrumento político da diplomacia brasileira* [Humanitarian demining as a political tool for Brazilian diplomacy]	Coleção Meira Mattos-Revista das Ciências Militares	No	No

(to be continued)

Table 4- Continuation

Authors	Title of Scientific Article	Journal	Analysis of the PNBID or its objectives?	Analysis of BA projects?
Dagnino (2008)	*A revitalização da indústria de defesa brasileira: uma contribuição ao processo decisório* [The revitalization of the Brazilian defense industry: a contribution to the decision-making process]	Carta Internacional	No	No
Dagnino; Campos Filho (2007a)	*Análise sobre a viabilidade de revitalização da Indústria de Defesa brasileira* [Analysis of the feasibility of revitalizing the Brazilian Defense Industry]	Brazilian Business Review	Defense industry policies in general	No
Dagnino; Campos Filho (20072007b)	*A revitalização da indústria de defesa brasileira: análise da alternativa Cooperação Sul-americana/européia* [Revitalizing the Brazilian defense industry: an analysis of the South American/ European cooperation alternative]	Revista Vértices	No	No

Source: prepared by the authors, 2024.

4 BRAZILIAN ARMY'S STRATEGIC PORTFOLIO

In 2008, with the approval and publication of the END, the Army Commander ordered the Brazilian Army General Staff (EME) to prepare a plan to meet the demands of the END, including the projects of interest to the Force in terms of articulation and equipment. Once this planning had been completed, the 7th Sub-Chief/EME identified the need for a structure in the Army that could evaluate, propose, coordinate, and integrate actions and efforts in order to effectively make it possible to carry out the Army's projects, which have large-scale characteristics associated with technological and financial complexity. In 2010, the Special Management and Projects Office (AEGP) was created, focusing on four projects: Guarani, SISFRON, Anti-Aircraft Defense and OCOP (Brasil, 2023).

In 2012, Ordinance No. 134-EME established the Army Projects Office (EPEx), based on the AEGP, to supervise, coordinate, and control the management of the Army's strategic projects, including those derived from the acquisition, modernization, and development of defense products defined by the EME, plan and coordinate institutional relations actions of interest, supervise, and coordinate related contracting activities and manage the processes related to the Army' strategic projects (Brasil, 2023).

The general objective of the 13 programs that make up the Army's Strategic Portfolio is to provide the Land Force with new operational capabilities, with a view to fulfilling its constitutional mission of defending society, contributing to increasing its deterrent capacity by projecting power in the military, scientific, technological, and economic fields. In addition to its primary mission, its indirect benefits include the enhancement of the human dimension, the promotion of social peace, job creation, increased research, development, and innovation.

4.1 Armored Forces

The Army's strategic Armored Forces program aims to obtain wheeled and tracked armored vehicles, as well as their component subsystems, such as weapons and communications systems, helping to transform the Motorized Infantry into Mechanized Infantry, modernize the Mechanized Cavalry and the Armored Infantry and Cavalry. The Program fosters research, development, and innovation in the country for various solutions in defense and security products, such as the various versions of the wheeled armored vehicle family and the modernization of wheeled and tracked vehicles, as well as technological remotely controlled weapons systems and command and control systems. (Brasil, 2023).

4.2 Astros

Beginning in 2012 and scheduled to end in 2031, the ASTROS program includes research, development and innovation projects, the acquisition and modernization of ASTROS vehicles and the construction of facilities for military organizations. The strategic ASTROS program, in addition to inducing the transformation of the Brazilian Army, participates in national development insofar as, in line with the National Defense Policy and the National Defense Strategy, it fosters BID, enables the generation of more than 7,000 direct and indirect jobs in the areas of civil construction and science and technology, reducing technological differences that inflict considerable disadvantages on the maintenance of national interests (Brasil, 2023).

4.3 Integrated Border Monitoring System (SISFRON)

The general objective of the Integrated Border Monitoring System (SISFRON – *Sistema Integrado de Monitoramento de Fronteiras*) is to provide the Brazilian Army with the necessary means to monitor and control the Brazilian land border, with the support of sensors, decision-makers and operators and other technological means that guarantee an agile and secure flow of reliable and timely information, in order to enable the exercise of command and control at all levels of the Land Force's operations, according to its constitutional purpose (Brasil, 2023).

Among its specific objectives, SISFRON must (1) provide adequate physical and logical structures for the command and control cycle at all levels of the decision-making process, including appropriate links for communications between all echelons, with transmission capacity compatible with the assigned mission and with the possibility of operating as a network, as established in the National Defense Strategy; (2) integrate with the Land Force Command and Control System, whose central body is the Land Operations Command, as well as enabling integration between Forces and agencies; (3) enable integration between the Land Force's combat functions; (4) prepare Land Force combatants to operate in an environment of high technological complexity, adapting them to expanded situational awareness and the concept of network-centric warfare; (5) consolidate national training in Monitoring, Surveillance, Reconnaissance, and Intelligence Systems, mobilizing the Defense Industrial Base and national

integrating organizations, in order to ensure technological independence in the maintenance, expansion and permanent updating of the System; (6) cooperate with government actions in promoting activities of interest to national defense, public security, social and economic development (Brasil, 2023).

4.4 Aviation

The program's objectives are: (1) to complete the structure of the Aviation System, updating it in line with the Army's strategic transformation concepts; (2) to diversify the origin of the aircraft fleet, reducing dependence on a single manufacturer; (3) to acquire attack aircraft capable of carrying out offensive combat, reconnaissance and security missions, adding greater deterrence, survival and situational awareness capabilities; (4) to renew and modernize the existing fleet, using its operational capacity, due to the technical obsolescence of military equipment over time; (5) to increase the Brazilian Army's deterrence and aeromobility capacity by modernizing the "Fennec" Weapons System; (6) to update the organizational framework; (7) to increase the capacity for rapid response; (8) to integrate with the Brazilian Airspace Coordination and Control Systems; (9) to increase the combat power of the Land Force; (10) to increase the flexibility, adaptability, modularity, elasticity and sustainability of Army aviation; (11) to reduce the cost of preparing crews; (12) to increase the level of flight safety, speeding up training and learning processes with consequent savings in air resources, by implementing simulators for different types of aircraft. (Brasil, 2023).

4.5 Anti-aircraft defense

The program's objectives are: (1) to recover and obtain low and medium altitude Anti-Aircraft Defense (AAD) capability, respectively, modernizing the Military Organizations (MO) that make up the Land Force's AAD and generating benefits for defense, by mastering critical anti-aircraft defense technologies, contributing to the structuring of the Land Force for broad spectrum combat, increasing the capacity to defend strategic structures, contributing to airspace monitoring, increasing interoperability between the Single Forces, contributing to the expansion of exchanges and partnerships with the national scientific-technological sector and strengthening the BID (Brasil, 2023).

4.6 Cybernetics

A sector of strategic importance for National Defense, the cyber sector was introduced within the scope of the Land Force, with the Cyber Defense Center as the body in charge of coordinating and integrating the efforts of the vectors dedicated to this field of action. The program currently has six structuring projects, with the aim of creating cyber capacity in the Army. These structuring projects are currently being carried out by Military Organizations linked to the sector, such as the Military

Engineering Institute, the Army Communications and Electronic Warfare Command, the Army Systems Development Center, the Army Integrated Telematics Center, the Army Intelligence Center, and the Cyber Defense Center itself. It meets the demands and provides increased capabilities directly to more than 50 MO specifically linked to the area, as well as providing defense for the operational and strategic networks that serve all the OM of the Land Force. (Brasil, 2023).

4.7 Lucerne

The program began in 2014 with the aim of providing the Brazilian Army with a new structure for the Army Intelligence System (SIEx), with a view to impacting decision support processes by integrating intelligence analysis structures with those for obtaining data from various sources. As a result of the Program, the 6th Military Intelligence Battalion (6th BIM) was set up in the Western Military Command, the teaching of military intelligence within the Army's educational establishments was improved, information and communications technology for various military intelligence structures was perfected and the construction of the Army's new Military Intelligence School began (Brasil, 2023).

4.8 Achieving the Full Capability of our Force (OCOP)

The program originated in the Operational Capacity Recovery Project (RECOP – *Projeto de Recuperação de Capacidade Operacional*), which began in 2013, and is the only strategic program that covers the Force as a whole. The benefits to be achieved with the implementation of this program are: increasing the operational readiness of the Land Force; increasing the deterrent capacity; contributing to the protection of society; and strengthening the BID. The program was structured with the aim of maintaining permanent operational capability and contributing to the BID, seeking to fill the Land Force's capability gaps by obtaining and modernizing its systems and materials for military use and defense products. (Brasil, 2023).

4.9 Protected Amazon

In line with the objectives set out in the PND and END, the Protected Amazon Strategic Program seeks to expand the Military Land Capacity of the Amazon Area Commands (Amazon Military Command and Northern Military Command) and the operational capacity of the Amazon border strip. To this end, the program seeks to: (1) build, reorganize, restructure, adapt, and rearticulate the MO and Special Border Platoons; (2) revitalize and propose the maintenance of the MO's energy, treated water and basic sanitation systems; (3) revitalize and propose the maintenance of the infrastructure of the MO, military villages, transit hotels, schools, hospitals and medical posts, moorings and/or river ports and airstrips; (4) build and propose the maintenance

of National Residential Properties (PNR); and (5) implement other structuring actions that bring social well-being and quality of life to the military family (Brasil, 2023).

4.10 Sentinel of the Homeland

The *Sentinela da Pátria* (Sentinel of the Homeland) strategic program is a set of sub-programs, projects, and complementary actions aimed at implementing, reorganizing, adapting, and improving the structure of the Land Force's Military Organizations in all the strategic areas of the National Territory. The program continues the efforts to rearticulate the Land Force, previously included in the Army's Strategic Restructuring Plan, with the main objective of providing better conditions for fulfilling the Brazilian Army's constitutional missions.

The Sentinel of the Homeland program is transversal to other Army strategic programs and projects, in relation to the deployment, transformation, and repositioning, by transfer of headquarters, of Military Organizations, either due to the addition of fractions (increase in personnel) or due to a change in nature (with a significant change in the number of vehicles and equipment used) (Brasil, 2023).

4.11 Military Operating System Modernization Program

It is a strategic structuring program that contributes to the modernization of the Land Military Operational System and the improvement of information technology governance, contained in the following strategies of the Army's Strategic Plan, which include increasing the Land Force's rapid response capacity, improving preparedness, increasing the effectiveness of employment and improving the Army's Command and Control System (Brasil, 2023).

4.12 Land Military Logistics System

The current logistics reality is fundamentally based on road transport and the standardization of logistics support structures and organizations, and there is still no Logistics Information and Management System to enable knowledge of the real and timely situation of logistics needs. In line with the new doctrinal orientation, the organization of a new logistics system based on information technology is envisioned, with a focus on adopting a peace structure that resembles that of conflict/war.

The new system must be effective in predicting, providing, maintaining, and reversing the means and services needed to carry out logistics functions in the various employment situations, in order to achieve the necessary logistical readiness, and all these concepts must already be aligned with the new doctrinal concept now being experimented with.

The benefits to be achieved by implementing the program are: rationalization; adaptation and modernization of logistics structures and organizations; sustaining strategic and tactical

mobility; updating military land logistics doctrine; improving logistics management; operational integration and military land logistics with the other Single Forces; and integration into national logistics (Brasil, 2023).

4.13 Strategic Program of the Army Education, Culture and Sports System (PENEC)

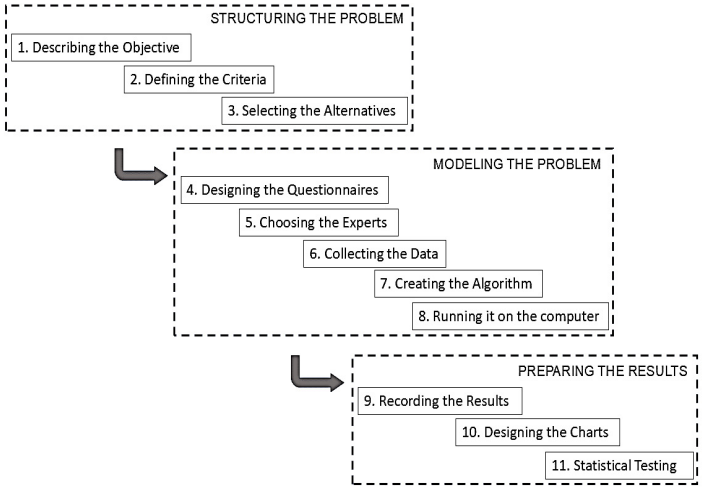
The implementation of PENEC was justified by the need to establish the Army's Education and Culture System based on the competencies of the military professional of the knowledge era, capable of developing the new competencies needed to perform the jobs arising from the transformation process of the Force, observing the characteristics of the new generation, using technology to the advantage of the teaching-learning process, offering greater professional qualification (including through continuing education) and allowing the development of critical thinking and a culture of innovation.

The changes to be implemented in this strategic program aim to improve the system, maximizing the development of new competencies, with a greater focus on the training of career officers and sergeants and on the preparatory and assistance education applied in the Military College System (Brasil, 2023).

5 METHODOLOGY

The approach to the problem involved the steps shown in Figure 1.

Figure 1- Methodology

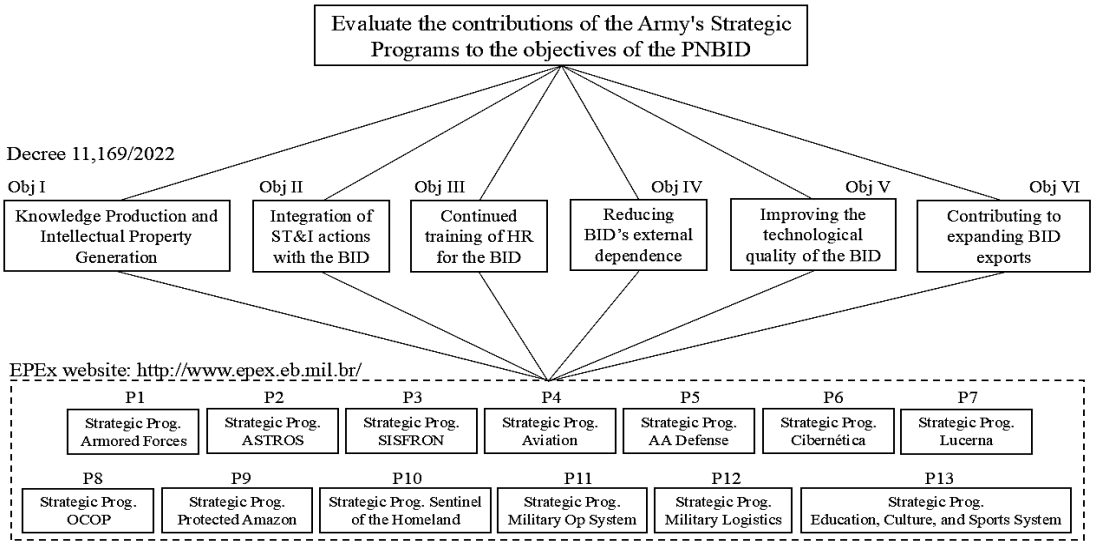


Source: prepared by the authors, 2023.

In structuring the problem, three stages were carried out: describing the objective, defining the criteria, and selecting the alternatives. The aim of the research is to evaluate the contribution of the Navy and Army Strategic Programs to the PNBID, whose relevance was described in the introduction to this article. The criteria chosen for this evaluation were the PNBID objectives

themselves and the alternatives to the respective programs. In this way, the following hierarchical trees defined the structure of the problem, as shown in Figure 2.

Figure 2- BA's hierarchical tree



Source: prepared by the authors, 2023.

There were four stages in modeling the problem: designing the questionnaires, choosing the experts, creating the algorithm, and running it on the computer. The questionnaires follow the usual structure of AHP models, including an initial section with information on the experts' qualifications. The remaining questions refer to pairwise evaluations of the criteria and strategic programs, which the expert judged at each hierarchical level. Due to the need to keep the text concise, the questionnaire was not included in the draft, but is available on request. A sample of experts from the Navy and Army was then prepared, with academic and career experience, including working or managing activities related to the respective strategic programs. Of the 21 volunteer specialists[2], nine have master's degrees and one has a doctorate. In addition, 57% have already had experience in managing some strategic program and only five specialists have not had the opportunity to work on them, although they come from postgraduate courses in the area of science, technology, and innovation (ST&I).

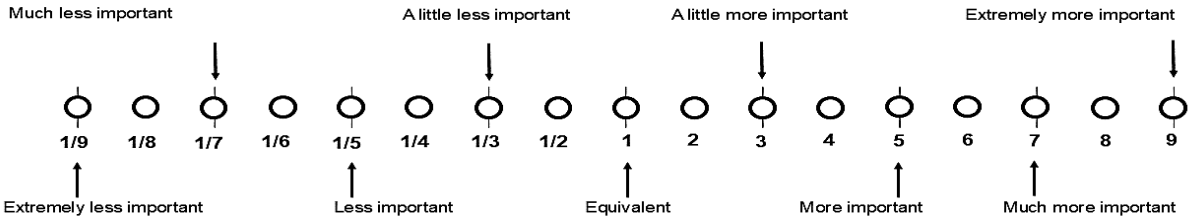
The data was collected from the response forms and recorded by the authors in an Excel spreadsheet, double-checking to avoid transcription errors. Spreadsheets with incomplete data and from experts with no experience in strategic programs, ST&I or the BID were discarded, and only those experts whose data qualified for analysis were kept.

After collecting the data, the AHP calculation algorithm was prepared to model the experts' evaluations. This process consists of a sequence of procedures to obtain the final weights of the strategic programs, whose highest value indicates the program deemed preferable by the

2 The experts consulted volunteered to take part in the survey and requested authorization from their Chiefs/Commanders to proceed with their answers. The preamble to the questionnaire specified the type of research, its purpose, and the methodology, and confirmed that the respondents would remain anonymous when this article was published.

sample of experts. The evaluations are based on a psychometric scale proposed by Saaty (1980) in which the expert compares the variables pair by pair and associates their judgment with a value on this scale (Figure 3). For example, if an expert believes that Criterion 1 is less important than Criterion 2, they would mark the value "1/5" on the answer sheet.

Figure 3- Saaty's 9-point scale



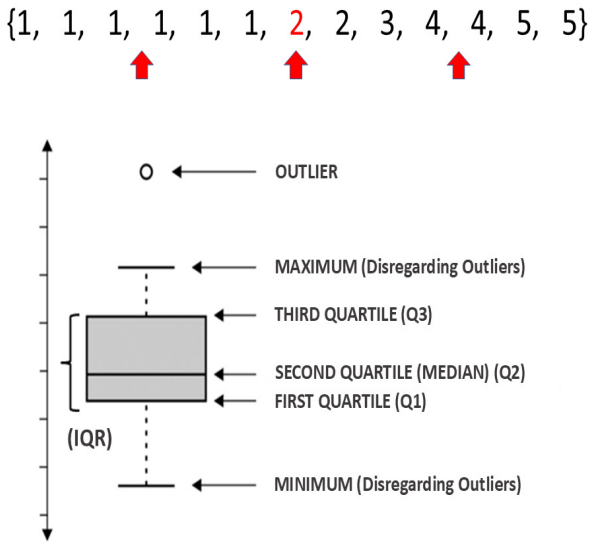
Source: adapted from Saaty (1980).

After completing the matrix of pairwise evaluations, a sequence of mathematical equations is applied to calculate the AHP, to obtain the weights of the criteria and strategic programs, as well as the Consistency Ratio (CR) of the evaluations. These procedures were detailed in Gavião and Kostin (2023). There are a number of techniques in the literature for calculating the AHP weights, the original proposal being based on linear algebra, known as the eigenvalue model. The equations used to calculate the results come from Liu and Lin (2016). The cut-off value considered for the CR is usually 10%, below which the expert's judgments are considered logically consistent.

In general, AHP requires considerable effort by the experts, as they have to carry out various evaluations, in proportion to the size of the hierarchical tree. There are numerous studies in the scientific literature that seek to reduce that effort. This research explored the approach of Gavião, Lima and Garcia (2021), which uses the logical principle of additive transitivity to limit the collection of data from experts. This principle was also referenced in Alonso et al. (2008, 2009) and Li et al. (2019). The computing was carried out in the R software.

Finally, the results were prepared, recorded in a spreadsheet, and exported for producing boxplot graphs, which graphically describe the set of responses and statistical tests to verify the significance of the differences in the results. Boxplot graphs are normally used when there is considerable dispersion in the sample values, using the results of the data's descriptive statistics as parameters, as shown in Figure 4. The basic structure of the graph consists of a rectangular box, a median (inside the box and symbolized by Q2), and whiskers, resembling the letter "T," representing the values between the box and the lower and upper limits of the data set. Values considered outliers are identified when they exceed 1.5 times the interquartile range (IQR), being below Q1 or above Q3.

Figure 4- Generic design of a boxplot



Source: adapted from Neto et al. (2017).

The visual information identified in the boxplot graphs can be confirmed using statistical tests. Given that the main aspect to check in the graphs are the medians, a non-parametric test should be applied to check whether the differences between the medians are significant or not. Non-parametric tests do not assume that the distributions being compared are normal, so they are useful alternatives when the assumptions of normality are not valid. They are called "non-parametric tests" since they do not estimate parameters for a model using a normal (or any other) distribution. In this context, the Wilcoxon test for two independent samples suits the problem (Siegel; Tukey, 1960).

In hypothesis testing, we generally consider a 95% confidence level to reject or not reject the null hypothesis. In this study, the null hypothesis assumes that the difference between the medians is not significant, and the opposite is true for the alternative hypothesis. After calculating the test, when the parameter called "p-value" is less than 0.05 (referring to the 95% level), the null hypothesis is rejected, and it is then acceptable to consider that the medians are different.

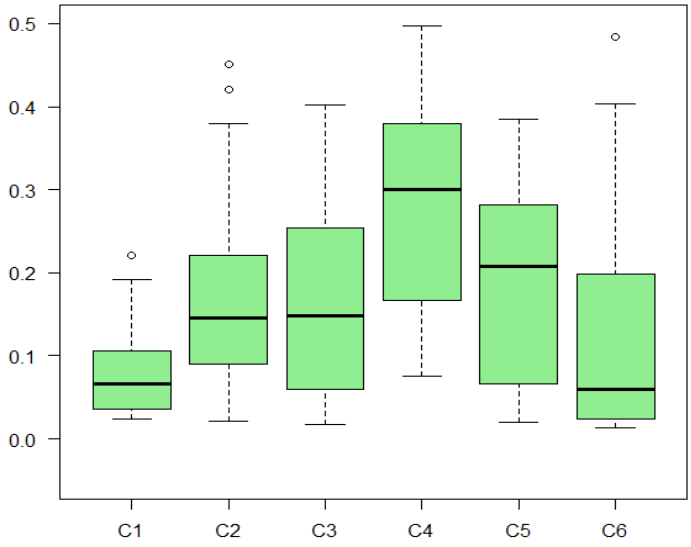
6 ANALYSIS OF RESULTS

The results of the analysis of the Army's questionnaires were segmented in order to verify and compare the programs' performance both in general and in each criterion.

6.1 Final weights of the Criteria

Figure 5 shows the results of the criteria evaluations, according to the parameters in Table 5 in the Appendix to this article.

Figure 5- Criteria weights (BA)



Source: prepared by the authors, 2023.

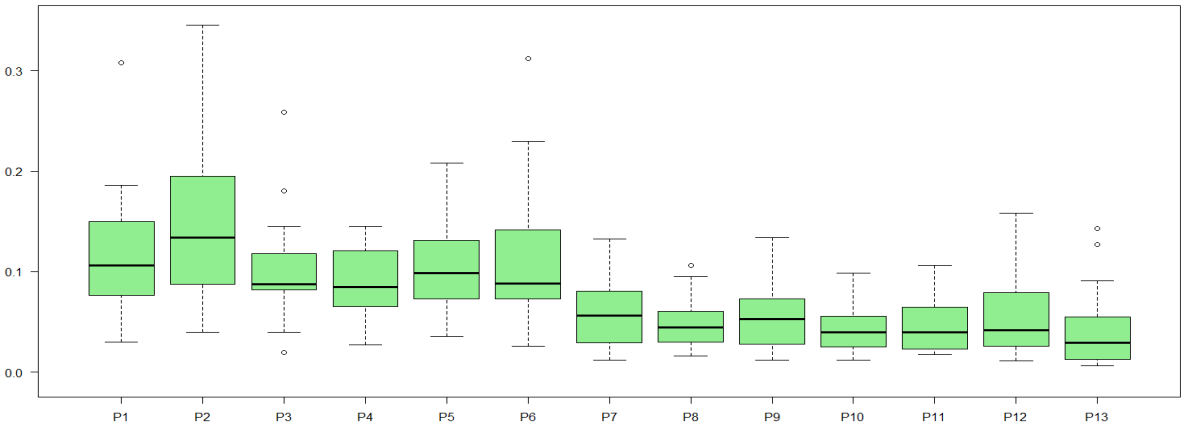
The graph shows that the median for Criterion 4 (Objective IV – reducing BID's external dependence) stood out had the highest value compared to the other medians. This higher result for Criterion 4 is also confirmed by the arithmetic mean, the Q1 and Q3 values and the experts' maximum evaluation. Next comes the median for Criterion 5 (Objective V – improving the technological quality of the BID), which also confirms the second highest arithmetic mean and Q3. Next, it is possible to consider a tie between the medians of Criteria 2 and 3 (Objective II – integration of ST&I actions with the BID and Objective III - continued training of HR for the BID). Criteria 1 and 6 (Objective I – knowledge production and intellectual property generation and Objective VI – contributing to expanding BID exports) have the lowest preference.

However, it is necessary to check whether the differences between the medians are statistically significant. Applying the Wilcoxon test to the results of C4 (the highest median in the sample) and C5 (second) (W = 318.5, p-value = 0.01416) rejected the hypothesis that this difference between medians is null. It is therefore possible to consider that C4 is indeed the most relevant PNBID objective for experts, as its values are statistically higher than those of the other criteria. The differences between C5/C3 (W = 241, p-value = 0.6148) and C5/C2 (W = 220.5, p-value = 1), on the other hand, are not statistically significant, so it is acceptable to consider them equivalent in the experts' preferences. Table 6, in the Appendix to this article, shows whether the statistical differences between the criteria are significant (answer "yes").

6.2 Final result of the Programs

Figure 6 describes the final results obtained from the program evaluations, according to the parameters in Table 7, in the Appendix to this article.

Figure 6- Final weights of the Programs (BA)



Source: prepared by the authors, 2023.

These results show that two groups were formed: Programs 1 to 6 obtained higher ratings than Programs 7 to 13. In fact, these are programs with more technical and industrial characteristics in their processes, and are thus discriminated by the experts.

To confirm the visual information in the graph, that the groups perform statistically differently, we compared the lowest scores in Group 1 (P3, P4 and P6) with the highest scores in Group 2 (P7 and P9). As there is a significant difference between these pairs (represented by "yes"), it is acceptable to assume that the experts considered Group 1 to be more relevant to PNBID than Group 2. The Wicoxon tests generated the following p-values in Table 8, in the Appendix to this article.

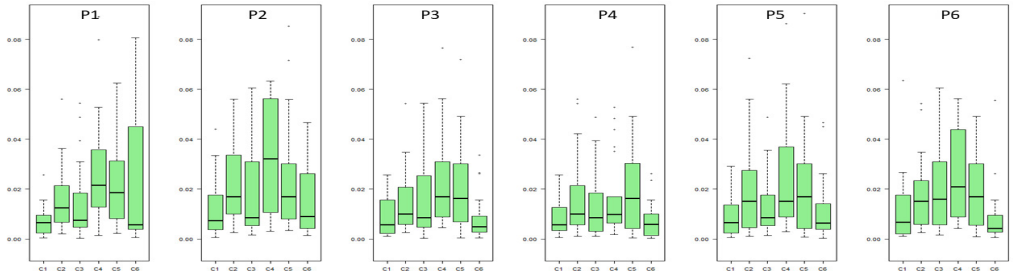
6.3 Results of the Criteria by Programs

Figures 7 and 8 describe the results of the criteria in each program, according to the parameters in Tables 9-11, in the Appendix to this article. The segmentation of P1-P6 and P7-P13 was due to the differences in performance between these groups, indicating that the former have greater potential to contribute to the objectives of the PNBID. In each graph of the programs, it is also possible to see the different scores per objective. For example, Strategic Program 2 (ASTROS), which was given the highest preference by the experts, received the highest score in Criterion 4, followed by Criteria 2 and 5, with lower scores in Criteria 1, 3, and 6. This shows that the experts consider there is evidence that the ASTROS Program's greatest contribution to the PNBID is through reducing the BID's external dependence (Objective IV).

Reducing BID's external dependence can be achieved by increasing the rate of nationalization of technologies relevant to strategic programs, which include systems, subsystems, or even simpler components of defense products. This reduction can also be guided by the level of technology transfer and installed capacity to develop the BID, in the

case of defense system imports, so that production and maintenance can be nationalized in a systematic and planned way.

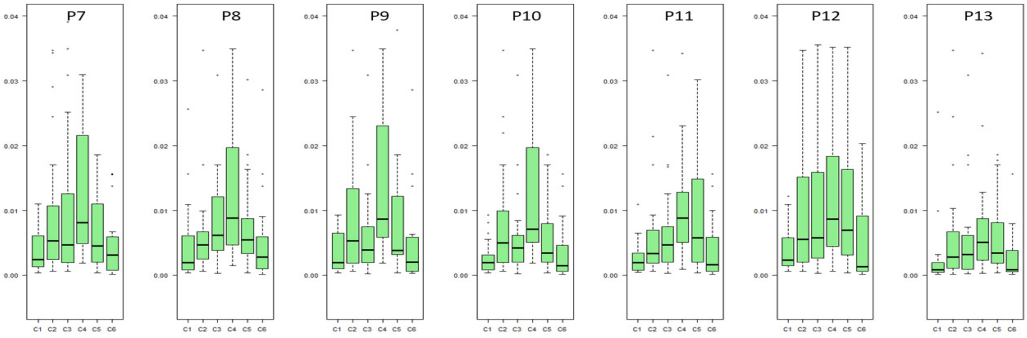
Figure 7- Weights of Programs 1 to 6 (BA)



Source: prepared by the authors, 2023.

Of this group with the highest ratings, Program 2 (ASTROS), which had the highest mean and median, only differed significantly from Programs 3 (SISFRON) and 4 (Aviation), and was equivalent to the performance of Programs 1 (Armored Forces), 5 (AA Defense), and 6 (Cybernetics). These statistical results suggest a slight preference for Program 2 (ASTROS) in the group, with a balance between the others in terms of their contribution to the PNBID's objectives, as described in Table 11, in the Appendix to this article.

Figure 8- Weights of Programs 7 to 13 (BA)



Source: prepared by the authors, 2023.

Of this group of lower performers, there is an equivalence between the programs, with the exception of Programs 7 (Lucerne) and 8 (OCOP) in relation to 13 (Education, Culture, and Sport), which were the least preferred among the experts. The performance of

Program 13, in particular, confirmed the authors' expectations regarding the results of the survey, as it appears to be the program with the least potential to contribute to the PNBID's objectives, due to its ST&I-oriented nature. The statistical significance confirming the difference in performance ("yes" answer) between the pairs of programs is shown in Table 12, in the Appendix to this article.

7 CONCLUSION

This article sought to analyze the recent policy aimed at developing the BID, published in 2022. Although it still requires the development of a strategy that describes the actions, goals and indicators associated with its objectives, this research has provided the MD and the Brazilian Army with information on the adherence of their Strategic Programs to the PNBID.

Experts with experience in the Force's own projects were used, with sufficient qualifications to establish their preferences for the proposed questions. The quantitative methodology explored the AHP, an established method in scientific literature, along with statistical tests to verify the significance of the results. Boxplot graphs showed the preferences for the objectives of the PNBID and the Programs.

In the end, it was found that Objective IV (reducing BID's external dependence) had the highest value compared to the other medians, and in a prominent way, corroborated by the Wilcoxon test. This preference indicates that actions, targets, and indicators should focus on increasing the rate of nationalization of technologies relevant to strategic programs, which include systems, subsystems, or even simpler components of defense products. Reducing BID's external dependence can also be assessed by the level of technology transfer and installed capacity to develop BID, in the case of defense system imports, so that production and maintenance can gradually be nationalized.

The results also showed that the Strategic Programs Armored Forces, ASTROS, SISFRON, Aviation, and AA Defense were identified as having the greatest potential to contribute to the objectives of the PNBID. This allows EPEx to optimize its resources to initially focus on these projects, preferably based on the objectives that were identified as the strongest in each Program. The results also proved the initial expectation that the Education, Culture, and Sport Program had the least potential to contribute to the PNBID, due to its nature focused on industry, technology, and innovation.

This research can be continued by confirming the results with new rounds of data collection with groups of experts with different qualifications. In addition, it can provide input for the development of the strategy resulting from the PNBID, as it is still incomplete in terms of generating the expected results related to strengthening the BID.

8 ACKNOWLEDGEMENT

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9 APPENDIX. STATISTICS AND HYPOTHESIS TESTS

Table 5- Descriptive statistics of the criteria weights (Ba) (see Figure 5)

Criterion	Minimum	Q1	Median (Q2)	Mean	Q3	Maximum
C1	0.0240	0.0358	0.0658	0.0827	0.1061	0.2211
C2	0.0208	0.0900	0.1457	0.1777	0.2211	0.4515
C3	0.0176	0.0602	0.1477	0.1614	0.2543	0.4018
C4	0.0752	0.1669	0.3000	0.2757	0.3796	0.4977
C5	0.0205	0.0665	0.2075	0.1795	0.2816	0.3848
C6	0.0137	0.0243	0.0602	0.1230	0.1983	0.4846

Source: prepared by the authors, 2023.

Table 6-. Statistical significance of differences (BA)

Wilcoxon test (p-values)	C1	C2	C3	C4	C5
C1	xxx	0.008551 (yes)	0.06439 (no)	5.94e-06 (yes)	0.00921 (yes)
C2	xxx	xxx	0.7059 (no)	0.02355 (yes)	1 (no)
C3	xxx	xxx	xxx	0.006578 (yes)	0.6148 (no)
C4	xxx	xxx	xxx	xxx	0.01416 (yes)
C5	xxx	xxx	xxx	xxx	xxx

Source: prepared by the authors, 2023.

Table 7- Descriptive statistics of the programs' final weights (BA)

Strategic Program	Minimum	Q1	Median (Q2)	Mean	Q3	Maximum
Strat. Prog. 1	0.0299	0.0767	0.1059	0.1148	0.1501	0.3079
Strat. Prog. 2	0.0394	0.0873	0.1336	0.1446	0.1946	0.3453
Strat. Prog. 3	0.0196	0.0818	0.0873	0.0993	0.1182	0.2586
Strat. Prog. 4	0.0273	0.0653	0.0848	0.0875	0.1205	0.1449
Strat. Prog. 5	0.0352	0.0730	0.0987	0.1001	0.1314	0.2081
Strat. Prog. 6	0.0259	0.0730	0.0884	0.1101	0.1413	0.3119
Strat. Prog. 7	0.0118	0.0294	0.0562	0.0582	0.0806	0.1322
Strat. Prog. 8	0.0164	0.0300	0.0443	0.0504	0.0603	0.1059

Continue...

Continuation

Table 7- Continuation

Strategic Program	Minimum	Q1	Median (Q2)	Mean	Q3	Maximum
Strat. Prog. 9	0.0118	0.0280	0.0529	0.0516	0.0732	0.1336
Strat. Prog. 10	0.0118	0.0249	0.0398	0.0411	0.0556	0.0987
Strat. Prog. 11	0.0173	0.0228	0.0398	0.0445	0.0644	0.1059
Strat. Prog. 12	0.0115	0.0260	0.0415	0.0574	0.0795	0.1584
Strat. Prog. 13	0.0062	0.0128	0.0295	0.0404	0.0552	0.1430

Source: prepared by the authors, 2023.

Table 8- Statistical significance of differences (BA)

Wilcoxon test (p-values)	Group 1 (P1-P6)			Group 2 (P7-P13)	
	Strat. Prog. 3	Strat. Prog. 4	Strat. Prog. 6	Strat. Prog. 7	Strat. Prog. 9
Strat. Prog. 3	xxx	0.5544 (no)	0.7059 (no)	0.002845 (yes)	0.0001943 (yes)
Strat. Prog. 4	xxx	xxx	0.3082 (no)	0.009257 (yes)	0.0008117 (yes)
Strat. Prog. 6	xxx	xxx	xxx	0.001891 (yes)	0.0004085 (yes)
Strat. Prog. 7	xxx	xxx	xxx	xxx	0.6149 (no)
Strat. Prog. 9	xxx	xxx	xxx	xxx	xxx

Source: prepared by the authors, 2023.

Table 9- Descriptive statistics for Programs 1-6 (BA)

Program	Criteria	Minimum	Q1	Median (Q2)	Mean	Q3	Maximum
P1	C1	0.0004	0.0024	0.0065	0.0073	0.0094	0.0256
	C2	0.0021	0.0067	0.0124	0.0167	0.0214	0.0560
	C3	0.0002	0.0047	0.0075	0.0154	0.0184	0.0543
	C4	0.0015	0.0128	0.0216	0.0285	0.0357	0.0891
	C5	0.0022	0.0081	0.0186	0.0222	0.0313	0.0624
	C6	0.0006	0.0040	0.0058	0.0247	0.0450	0.1406

(to be continued)

Table 9- Continuation

Program	Criteria	Minimum	Q1	Median (Q2)	Mean	Q3	Maximum
P2	C1	0.0006	0.0036	0.0074	0.0123	0.0175	0.0441
	C2	0.0025	0.0099	0.0170	0.0213	0.0337	0.0560
	C3	0.0017	0.0053	0.0085	0.0184	0.0309	0.0605
	C4	0.0031	0.0106	0.0321	0.0393	0.0563	0.1423
	C5	0.0034	0.0081	0.0170	0.0238	0.0302	0.0852
	C6	0.0014	0.0042	0.0090	0.0295	0.0261	0.1922
P3	C1	0.0010	0.0023	0.0056	0.0091	0.0156	0.0256
	C2	0.0025	0.0059	0.0099	0.0193	0.0208	0.1044
	C3	0.0003	0.0047	0.0085	0.0160	0.0254	0.0543
	C4	0.0045	0.0089	0.0169	0.0270	0.0310	0.1109
	C5	0.0005	0.0069	0.0163	0.0194	0.0302	0.0719
	C6	0.0004	0.0028	0.0049	0.0084	0.0092	0.0337
P4	C1	0.0006	0.0034	0.0058	0.0079	0.0126	0.0256
	C2	0.0010	0.0058	0.0099	0.0170	0.0214	0.0560
	C3	0.0012	0.0031	0.0085	0.0185	0.0184	0.1099
	C4	0.0018	0.0064	0.0098	0.0167	0.0169	0.0527
	C5	0.0004	0.0043	0.0163	0.0196	0.0302	0.0769
	C6	0.0003	0.0014	0.0058	0.0079	0.0101	0.0261
P5	C1	0.0006	0.0024	0.0065	0.0087	0.0136	0.0292
	C2	0.0010	0.0046	0.0152	0.0201	0.0276	0.0724
	C3	0.0015	0.0053	0.0085	0.0142	0.0175	0.0488
	C4	0.0029	0.0089	0.0151	0.0255	0.0370	0.0863
	C5	0.0008	0.0043	0.0170	0.0203	0.0302	0.0904
	C6	0.0003	0.0040	0.0064	0.0114	0.0141	0.0467
P6	C1	0.0010	0.0021	0.0067	0.0117	0.0175	0.0635
	C2	0.0025	0.0059	0.0151	0.0231	0.0234	0.1479
	C3	0.0017	0.0058	0.0159	0.0203	0.0309	0.0605
	C4	0.0043	0.0089	0.0209	0.0277	0.0438	0.1061
	C5	0.0010	0.0055	0.0170	0.0182	0.0302	0.0491
	C6	0.0006	0.0028	0.0042	0.0090	0.0095	0.0555

Source: prepared by the authors, 2023.

Continuation

Table 10- Statistical significance of the differences in Group 1 (BA)

Wilcoxon test (p-values)	Strat. Prog. 1	Strat. Prog. 2	Strat. Prog. 3	Strat. Prog. 4	Strat. Prog. 5	Strat. Prog. 6
Strat. Prog. 1	xxx	0.1589 (no)	0.4064 (no)	0.1908 (no)	0.513 (no)	0.6781 (no)
Strat. Prog. 2	xxx	xxx	0.0455 (yes)	0.0079 (yes)	0.0591 (no)	0.1344 (no)
Strat. Prog. 3	xxx	xxx	xxx	0.5544 (no)	0.8405 (no)	0.7059 (no)
Strat. Prog. 4	xxx	xxx	xxx	xxx	0.4580 (no)	0.3082 (no)
Strat. Prog. 5	xxx	xxx	xxx	xxx	xxx	0.7341 (no)
Strat. Prog. 6	xxx	xxx	xxx	xxx	xxx	xxx

Source: prepared by the authors, 2023.

Table 11- Descriptive statistics for Programs 7-13 (BA)

Program	Criteria	Minimum	Q1	Median (Q2)	Mean	Q3	Maximum
P7	C1	0.0004	0.0013	0.0024	0.0037	0.0061	0.0110
	C2	0.0006	0.0024	0.0053	0.0098	0.0107	0.0347
	C3	0.0006	0.0020	0.0047	0.0103	0.0126	0.0391
	C4	0.0018	0.0049	0.0081	0.0204	0.0216	0.0859
	C5	0.0004	0.0020	0.0046	0.0071	0.0110	0.0186
	C6	0.0001	0.0007	0.0032	0.0069	0.0060	0.0555
P8	C1	0.0004	0.0009	0.0019	0.0048	0.0061	0.0256
	C2	0.0006	0.0025	0.0047	0.0083	0.0067	0.0517
	C3	0.0003	0.0038	0.0062	0.0084	0.0121	0.0309
	C4	0.0015	0.0047	0.0089	0.0141	0.0197	0.0527
	C5	0.0004	0.0034	0.0055	0.0095	0.0088	0.0491
	C6	0.0001	0.0010	0.0028	0.0054	0.0060	0.0286
P9	C1	0.0004	0.0010	0.0019	0.0053	0.0065	0.0465
	C2	0.0006	0.0019	0.0053	0.0103	0.0134	0.0542
	C3	0.0002	0.0020	0.0039	0.0060	0.0075	0.0309
	C4	0.0018	0.0059	0.0087	0.0167	0.0231	0.0593
	C5	0.0004	0.0032	0.0038	0.0086	0.0122	0.0379
	C6	0.0003	0.0006	0.0021	0.0047	0.0058	0.0286

(to be continued)

Table 11- Continuation

Program	Criteria	Minimum	Q1	Median (Q2)	Mean	Q3	Maximum
P10	C1	0.0004	0.0009	0.0019	0.0027	0.0031	0.0093
	C2	0.0006	0.0019	0.0050	0.0081	0.0099	0.0347
	C3	0.0002	0.0020	0.0042	0.0061	0.0062	0.0309
	C4	0.0018	0.0050	0.0071	0.0145	0.0197	0.0563
	C5	0.0004	0.0020	0.0034	0.0063	0.0080	0.0186
	C6	0.0001	0.0006	0.0015	0.0035	0.0046	0.0156
P11	C1	0.0005	0.0008	0.0019	0.0026	0.0034	0.0110
	C2	0.0006	0.0019	0.0034	0.0067	0.0070	0.0347
	C3	0.0003	0.0020	0.0047	0.0068	0.0075	0.0309
	C4	0.0009	0.0050	0.0089	0.0160	0.0128	0.0682
	C5	0.0004	0.0020	0.0058	0.0084	0.0148	0.0302
	C6	0.0001	0.0006	0.0017	0.0039	0.0058	0.0156
P12	C1	0.0006	0.0015	0.0023	0.0041	0.0058	0.0122
	C2	0.0006	0.0020	0.0055	0.0106	0.0152	0.0517
	C3	0.0003	0.0026	0.0058	0.0115	0.0158	0.0596
	C4	0.0006	0.0044	0.0087	0.0157	0.0183	0.0682
	C5	0.0004	0.0031	0.0069	0.0105	0.0163	0.0352
	C6	0.0001	0.0006	0.0014	0.0050	0.0092	0.0203
P13	C1	0.0002	0.0005	0.0009	0.0026	0.0019	0.0252
	C2	0.0002	0.0011	0.0028	0.0064	0.0067	0.0347
	C3	0.0002	0.0009	0.0032	0.0095	0.0062	0.0856
	C4	0.0003	0.0023	0.0051	0.0136	0.0088	0.0798
	C5	0.0004	0.0019	0.0034	0.0056	0.0081	0.0186
	C6	0.0001	0.0005	0.0008	0.0026	0.0038	0.0156

Source: prepared by the authors, 2023.

Table 12- Statistical significance of the differences in Group 2 (BA)

Wilcoxon test (p-values)	Strat. Prog. 7	Strat. Prog. 8	Strat. Prog. 9	Strat. Prog. 10	Strat. Prog. 11	Strat. Prog. 12	Strat. Prog. 13
Strat. Prog. 7	xxx	0.7153 (no)	0.6149 (no)	0.1704 (no)	0.3455 (no)	0.8111 (no)	0.0455 (yes)
Strat. Prog. 8	xxx	xxx	0.8999 (no)	0.2826 (no)	0.4064 (no)	0.8701 (no)	0.0407 (yes)
Strat. Prog. 9	xxx	xxx	xxx	0.242 (no)	0.501 (no)	0.8701 (no)	0.0804 (no)
Strat. Prog. 10	xxx	xxx	xxx	xxx	0.7153 (no)	0.2965 (no)	0.1866 (no)

(to be continued)

Table 12- Continuation

Wilcoxon test (p-values)	Strat. Prog. 7	Strat. Prog. 8	Strat. Prog. 9	Strat. Prog. 10	Strat. Prog. 11	Strat. Prog. 12	Strat. Prog. 13
Strat. Prog. 11	xxx	xxx	xxx	xxx	xxx	0.4811 (no)	0.1047 (no)
Strat. Prog. 12	xxx	xxx	xxx	xxx	xxx	xxx	0.0575 (no)
Strat. Prog. 13	xxx	xxx	xxx	xxx	xxx	xxx	xxx

Source: prepared by the authors, 2023.


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