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Public procurement of innovation for obtaining complex defense systems

Encomiendas tecnológicas de innovación para obtener sistemas complejos de defensa

Abstract: This paper aims to analyze the Public Procurement of Innovation (PPI) model applied to complex defense systems acquisition processes, the opportunities generated by this type of contracting as well as its legal security. The research included literature and document review, considering the literature that addresses the process of obtaining defense products in Brazil, since PPI could benefit the national defense industrial base in the development of technological solutions capable of replacing options provided by the international market, which historically have been subject to restrictions and embargoes by countries that have control over sensitive technologies. The study demonstrated that despite the possibility provided by the legislation, few processes for defense systems acquisition have relied on PPI, until now. The research allowed us to conclude that due to the complexity of a process of complex defense systems acquisitions, the full use of PPI will only be possible through the elaboration of an internal regulation by the Ministry of Defense detailing the process to be followed when contracting a product through a PPI approved by the Audit Institutions.

Keywords: Public Procurement of Innovation. PPI. Acquisition. Complex Defense Systems.

Resumen: El presente artículo tiene como objetivo analizar el modelo de compras públicas por Encomiendas Tecnológicas (ETEC) aplicadas a la obtención de sistemas complejos de defensa, las oportunidades generadas a partir de este tipo de contratación, así como la seguridad jurídica en emplearlas. La investigación se ha desarrollado por medio de revisión bibliográfica y documental, a la luz de la literatura que aborda el proceso de obtención de productos de defensa en Brasil, ya que las ETEC podrían beneficiar a la base industrial de defensa nacional en el desarrollo de soluciones tecnológicas capaces de sustituir opciones suministradas en el mercado internacional, las cuales, históricamente, son blanco de restricciones y embargos por parte de los países detentores del control de tecnologías sensibles. El estudio demuestra que a pesar de las posibilidades de emplear las ETEC, que dispone la legislación brasileña, pocos procesos para obtener sistemas de defensa se han realizado por medio de ese mecanismo de compras públicas, durante el periodo contemplado por esta investigación. El estudio ha permitido, también, llegar a la conclusión que en función de la complejidad de ese proceso, la plena utilización de las ETEC solo será posible por medio de la elaboración de una reglamentación interna del Ministerio de Defensa, aprobada por los órganos de control y con los debidos detalles que se deben seguir durante la contratación de un producto de defensa (PRODE).

Palabras-clave: Encomiendas Tecnológicas. ETEC. Obtención. Sistemas Complejos de Defensa.

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1 Introduction

The acquisition of Defense Products (DEPRO) is a complex activity because it includes cutting-edge technologies, requires significant financial resources and, generally, is undertaken in a context of technological uncertainties, export and technological restrictions and budgetary unpredictability. When procurement is related to Complex Defense Systems, which for the most part includes Strategic Defense Products (SDP)[1], the decisions become even more complex, since they can impact other expressions of National Power.

The term "system", according to Blanchard and Blyler (2016), is a complex combination of resources (human, material, equipment, hardware, software, facilities, data, information, services, etc.) integrated in order to meet a specified operational requirement. Also, according to these authors, a system is designed for a specific function, or a series of functions, with the purpose of satisfying an identified need. This concept is based on the concepts defended by Bertalanffy (1977), considered the creator of the General Systems Theory (GST), which describes them as a set of mutually inter-linked units.

Mitchell (2009) clarifies that a complex system is a system with a large number of interacting agents that exhibit non-trivial and self-organized behavior. The author also considers that such systems involve sophisticated processes of information and adaptation via learning or evolution. Complementing this definition, Oliveira (2009) adds that complex systems are products developed in order to meet specific demands and, therefore, require a high capacity for integrating knowledge and skills. (OLIVEIRA, 2009).

A defense system, on the other hand, is considered complex when it has a long production cycle, high unit cost, complex interfaces and intense engineering demand (HOBDAY, 1998). Examples of complex defense systems are military aircraft, submarines, armored combat vehicles, missiles, satellites and their subsystems, among others.

The process of procuring defense products according to the Ministry of Defense is the system for acquiring DEPRO, jointly or not, based on military capabilities and its relevance to the national interests (BRASIL, 2018a).

In Brazil, defense products are obtained through the procurement process[2], the rules of which are defined by the Law 8.666 / 93 and its subsequent amendments. This law seeks to assure fair competition among the bidders in the public sector, impartiality of judgment and the guarantee of selection of the most advantageous proposals for the goods and services demanded by the government agencies. However, some peculiarities of acquiring defense products, such as the lack of solutions in the domestic market, the need

1 Strategic Defense Product is "any DEPRO that, due to technological content, difficulty of acquisition or indispensability, is of strategic interest for national defense" (BRASIL, 2018a, p. 1).

2 Due to the specificity, the hiring of Defense Products may also occur through the waiver of bidding or unenforceability. Among the reasons that justify the waiver of bidding are International Agreements, cases related to National Security (Decree No. 2,225, 1997) and products related to research and development (BRASIL, 1993).

for technological development and the presence of technological risk, demand a more specific approach under the national legislation (Department of Defense Industry, 2011).

In the context of diverse difficulties, not only the defense sector, but all the other public sectors, that deal with the acquisition of high technological content equipment, needed changes in the legislation to enable new ways of procurement, especially those involving research and development of products. It is in this scenario that the Innovation Procurement option appears.

The Procurement of Innovation (PPI) is a type of public procurement under which a public agency or entity may contract a research, development or innovation service to solve specific technical problems (BRASIL, 2018b). This option involves a contractual link that has the characteristic of technological development and risk. The development process can be carried out by an individual company or by a consortium of companies.

The aforementioned public procurement modality represents, therefore, the consolidation of a series of adaptations in the legislation that deals with technology, innovation and tax incentives, making it necessary to analyze its possibilities and the legal apparatus necessary for its effectiveness. In this sense, this article aims to analyze the public procurement model by PPI applied to obtaining complex defense systems, the opportunities generated from this type of contracting, as well as the legal security in their employment.

To make this goal feasible, the methodology employed consisted of exploratory documentary research of the main laws that define the theme, such as the New Legal Regulatory Framework for Science, Technology and Innovation, Decree no. 5.798 / 2006, called the "*Lei do Bem* (Law of Good)", Law 10.973 / 2004, which provides for the use of PPI, the Air Force Command Guidelines, which deal with the Aeronautics Systems and Materials Life Cycle (DCA 400-6), among others. Public documents of the Brazilian Space Agency (AEB) were also raised, such as technical notes and preliminary studies, in order to identify the main practices adopted by the Agency in procurement processes carried out through PPI. In addition to document analysis, a bibliographic review related to technological innovation was carried out to identify the use of PPI in public contracts in the national defense sector, in addition to an approach on complex defense systems, the particularities applicable to acquisitions in the defense sector, and the possible embargoes to which this sector is subjected.

This article is divided into five sections. Following the introduction, the second section reviews the changes in the legislation on technological innovation, with emphasis on the legal aspects and the possibilities provided by PPI. The third section deals with complex defense systems already obtained in Brazil through PPI, as well as the main obstacles to the adoption of this type of contracting by the Singular Forces. The fourth section presents a PPI initiative carried out by the Brazilian Space Agency (AEB), related to the acquisition of a navigation system, the results of which can contribute to learning about the topic, mainly for use in purchasing processes carried out

by Brazilian Armed Forces. Finally, in the last section, the conclusions of the analysis of technological orders within the defense sector are summarized.

2 Innovation and public procurement of innovation: legal aspects and opportunities

According to Dosi (1988), innovation refers to the search, discovery, experimentation, development, imitation and adoption of new products, new production processes and new forms of organization. For Longo and Moreira (2013, p. 9), innovation results from a "process that involves interactions between science, technology, research, experimental development, basic industrial technology, engineering and other activities that occur inside, outside and between companies". According to the authors, the innovation process depends on several factors, such as public policies, formal regulatory framework and usual practices of organizations, suppliers and, in a broader aspect, of society in general.

In the same sense, Freeman (1995) observes that the innovation process is permanent and irreversible, especially in the firm's environment, since the absence of innovation may imply its disappearance. Despite this, the author also highlights the importance of thinking about innovation as part of a *national innovation system*, linked to scientific, technological and industrial policy.

According to the Organisation for Economic Co-operation and Development (OECD), technological innovation is a set of scientific, technological, organizational, financial and commercial measures, including investment in new knowledge, which are intended to lead to the realization of technologically new and or significantly improved products and processes (ORGANIZAÇÃO PARA A COOPERAÇÃO E DESENVOLVIMENTO ECONÔMICO, 2002). In a more restrictive concept, Decree no. 5.798/2006, which regulated the so-called Law of Good, defines technological innovation as:

> The conception of a new product or manufacturing process, as well as the addition of new features or characteristics to the product or process that lead to incremental improvements and effective gain in quality or productivity, resulting in greater competitiveness in the market (AGBI, 2020, Our translation).

Therefore, technological innovation is related to the design of a new product or process not yet known, with characteristics different from those existing in a given institution. It is also related to the aggregation of new functionalities, requiring the characteristics of innovative products to be substantially improved or to lead to incremental improvements, and generate advantages and benefits for the institution (AGBI, 2020).

Also, in the Oslo Manual, innovation is defined as the implementation of a new or significantly improved product, process, organizational or business method. The innovation activities would be the scientific, technological, organizational, financial and commercial stages that lead to the increase in these products or processes (ORGANIZAÇÃO PARA A COOPERAÇÃO E DESENVOLVIMENTO ECONÔMICO, 2005).

Despite being an easy concept to understand, the application of the concept to the reality of companies can be more complex. When the sector that produces goods and services for National Defense is considered, this complexity tends to be even greater. Azevedo (2018), who divides innovations between technological and non-technological, defines innovation in the Defense sector as the implementation of a product (good or service), or of a new or significantly improved process, marketing or organizational method, that are capable of altering the organization, preparation and use of military power.

Still regarding innovation in the defense sector, Brazil modified the legislation that deals with the subject, in order to foster national technological development and encourage the Industrial Defense Base (IDB). This participation of Brazil is also due to the need to turn national products, developed through investments in Research, Development and Innovation (RD&I), more competitive in an increasingly fierce market.

In Brazil, the policy of tax incentives was instituted in 1994, with the Industrial Technological Development Program (PTDI)[3], the objective of which was to stimulate private sector investment in the area of research and innovation, in order to enable the creation of new processes and products or to improve their characteristics, in order to increase the level of competitiveness of Brazilian companies, through tax incentives destined to the technological qualification of the industry (FORMIGONI et al., 2009).

Despite the relevance of the PTDI, the emergence of new market demands required the State to pass other laws in order to improve the incentives that promote national capacities for technological innovations and Research and Development (R&D), as seen in Figure 1.

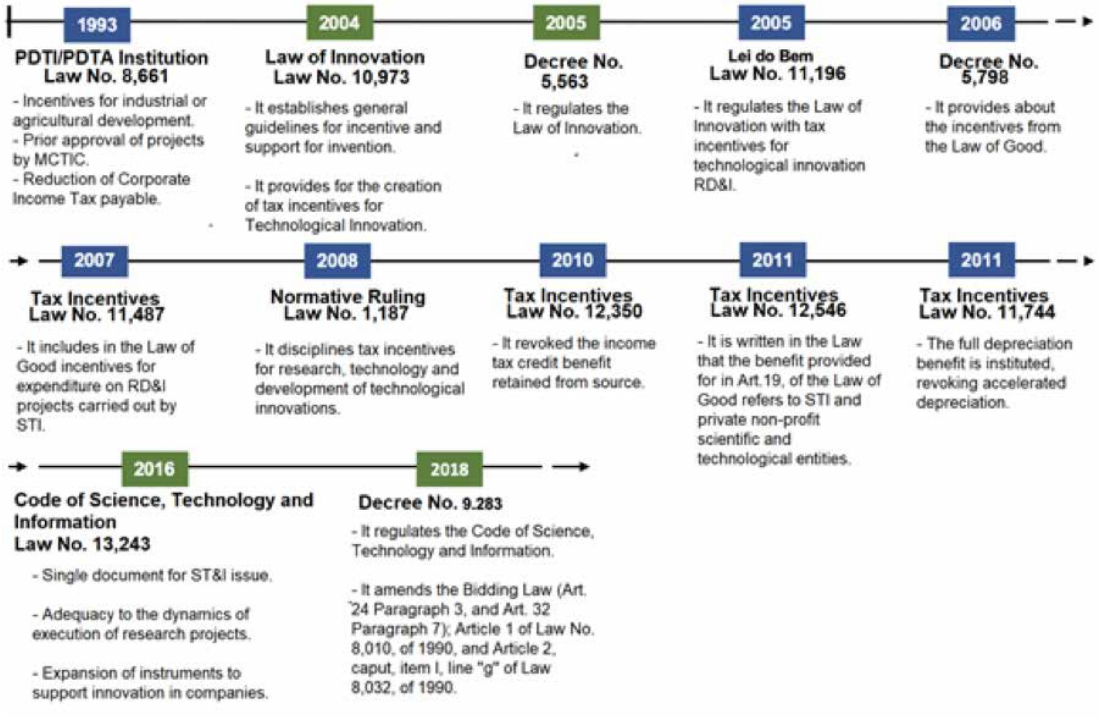
Despite the importance of the aforementioned legislation, it is worth highlighting the relevance of the New Legal Regulatory Framework for Science, Technology and Innovation[4]. This legislation changes important rules and aims to facilitate the creation of a more dynamic innovation environment in Brazil. This Law seeks to favor the innovation environment by promoting scientific and technological activities, considering them strategic for economic and social development; promoting cooperation and interaction among public entities, among the public and private sectors and among companies themselves; for stimulating innovation activity in companies and in Science and Technology Institutions (STI); and by simplifying procedures for the management of science, technology and innovation projects and adopting control for results in its evaluation (SEBRAE, 2020).

For the defense sector, that works with complex systems which operate on the frontier of existing technology, this New Regulatory Framework may bring advances by including measures to stimulate innovation in companies, such as Innovation Procurement (PPI).

3 The PDTI was instituted by Law 8,661, of June 2, 1993, which provides for tax incentives for the technological training of industry and agriculture, and provides other measures.

4 Law No. 13,243, of 2016, provides for incentives for scientific development, research, scientific and technological training and innovation and was regulated by Decree No. 9,283, of 2018.

Figure 1 - Legislation focused on technological innovation



Source: Adapted from ABGI (2018).

2.1 Public procurement of innovation and the legal security of the process

Due to the difficulties related to the access to sensitive technologies, especially those intended for the space and defense sectors, a viable alternative for countries such as Brazil is the autochthonous development of technological solutions[5] through national research, in order to circumvent their current technological dependence (ANDRADE; SANTOS, 2018).

According to Longo and Moreira (2018), sensitive technology is the one that gives rise to sensitive products and/or has dual use, such as space and nuclear technologies. According to the authors, sensitive technologies are controlled by one country, or a group of countries, who consider that "one should not give access to it to other countries, for a certain time, hypothetically for security reasons".

In this scenario, although PPI is a possibility available for the search for solutions to technological problems that involve national interests, some actions must be taken by the contracting public agencies in order to guarantee legal security of the entire process.

One of the major problems faced in processes of defense products acquisition through development is to obey the same rite, defined for other government contracting, established in Law 8.666/93 (Department of Defense of Industry, 2011). This legislation demands, in the initial

5 Technological solution is the application of a technology or know-how aimed at meeting the needs of creating / modifying / improving a product or process of companies or institutions (ALBUQUERQUE et al., 2015, p. 250).

phase of the process, a sequence of acts that do not contemplate some factors directly related to purchasing defense products, such as technological risk.

In this context, public bodies find it very difficult to both acquire the product appropriate to their needs, and to comply with all the procedures provided for in the legislation in force. These procedures, despite requiring time, human and material resources, are necessary to guarantee legal security of an Innovation Procurement process.

Surrounding this issue, the Public Sector Bidding and Contracts Law requires the contracting entity to describe the technical-operational requirements of the object/item to be acquired so that stakeholders are fully able to identify the nature of the existing technical problem, as well as envisage the product, service or innovative process required. The difficulty of this task is in the description of the technical specifications of the object to be developed, due to the complexity of the research, development and innovation activity or because it involves innovative solutions not available on the market.

In sum, the contracting public body must describe the technical-operational needs in such a way that allows stakeholders to identify the nature of the technical problem. In practice, the more complex the system ordered, the more difficult it becomes to describe the requirements for it and the greater the technological risk involved.

The existence of technological risk is one of the main characteristics of PPI. It is the possibility of failure in the development of a solution, resulting from a process the result of which is uncertain due to the technical-scientific knowledge restricted to the time when the decision to purchase the product was made.

In order to ensure the lawfulness of the procedures, the consultations, the responses of potential contractors and all other documents related to PPI should be attached to the contracting process, except for the cases in which information of an industrial, technological or commercial nature must be kept confidential (BRASIL, 2018b).

Furthermore, in order to maintain legal record, the legislation establishes that the contracting public administration body or entity may create, by decision of its highest authority, a technical committee of specialists to assist the institution in defining the object of the order, in choosing the future contracted party, in monitoring contract implementation and in the other functions provided for in the Decree No. 9283/2018. It is, therefore, a feasibility study to be carried out by a group of specialists of various fields/areas. This study, provided for in a few legal acts[6] on the acquisition of defense products, consists of a thorough examination of the planning carried out so far, checking the consistency of its structure, its coherence with the intended objectives and the reliability of the data obtained (BRASIL, 2007).

Another factor of legal certainty for the process is the determination of the minimum acceptable parameters for receiving the product, service or process related to the order. In short, it is a precise definition of the technical, logistical and industrial requirements for the PPI in question.

6 The Aeronautics Command Directive (DCA 400-6) deals with the Aeronautics Systems and Materials Life Cycle, which ranges from the product design phase to the disposal phase (BRASIL, 2007).

The conclusion of the PPI contract also requires that the contracting public body must acquire the product with the most advantageous contracting conditions. Legislation requires transparent negotiation, with the relevant documentation attached to the contracting process records, with the exception of any information of an industrial, technological or commercial nature that must be kept confidential. Furthermore, the choice of the contractor considers the highest probability of achieving the result intended by the contractor, and not necessarily the lowest price or cost. In this case, the public administration will be able to use, as factors of choice, technical competence, management capacity, previous experiences, the quality of the project presented and other significant evaluation criteria of the contractor (MONTEIRO, 2020).

An additional factor for the legal guarantee of the process is the need for prior approval of the specific project prepared by the contractor. This project must contain a work plan and financial schedule, compliance with the objectives to be achieved by the PPI, the requirements that allow the application of the methods and means indispensable for verifying the progress of the project at each stage, in addition to other elements established by the contracting party. Prior analysis can be carried out by the technical committee of experts established by the contracting public body.

2.2 Opportunities generated by the public procurement of innovation

The main opportunity generated by the PPI is facilitation of the interaction between the purchaser and the supplier, since it offers the possibility to waive public bidding. However, to make this interaction feasible, a contract is required between the parties that establishes the object, the physical-financial schedule and the rules that define intellectual property rights (BRASIL, 2018b).

PPI also allows public administration bodies and entities to directly hire Scientific, Technological and Innovation Institutions (STI), public or private, or even non-profit private entities or companies, either alone or in consortia, focused on research activities, provided that they have recognized technological training in the sector.

PPI's objective is, therefore, to carry out research, development and innovation activities that involve technological risk, to solve a specific technical problem or obtain an innovative product, service or process (BRASIL, 2018b).

In view of the difficulties involved in the development of complex defense systems, the legislation began to consider the existence of technological risk during the process. According to the regulatory decree[7], technological risks are related to the "possibility of failure to develop a solution, resulting from a process in which the result is uncertain due to insufficient technical and scientific knowledge at the time when the decision to perform the action is made" (BRASIL, 2018b, p. 2).

In the case of contracts where the object involves technological risk, the Public Procurement of Innovation admits that the product obtained by the contract may be different from the one desired, due to the existing technological uncertainty. In addition, this new legal provision allows the contract to be discontinued due to technical or economic infeasibility observed during its development.

7 Decree No. 9,283, of 2018, requires incentives to encourage innovation and scientific and technological research in the productive environment, with a view to technological training, the achievement of technological autonomy and the development of the national and regional productive system.

Another possibility generated by PPI is the inclusion of the costs of activities that precede the introduction of the solution, product, service or innovative process to the market. Thus, the manufacture of prototypes; gradual delivery, e.g. initial designs as proof of concept, tests and demonstration; and the construction of the first designs on a commercial scale once the interest of the contracting public body in the supply of these items is confirmed, may be a part of the object of the contract.

The New Regulatory Framework under review has a direct impact on the public sector entities that promote research and development activities and execute contracts based on Article 24 of Law 8.666/93, since this new legislation removes the need to carry out a public bidding to contract goods, supplies, services and works in cases where the object of the contract is linked to research projects and duly approved by the Administration, thus offering legal certainty for the actors involved.

In a technical note published by the Brazilian Space Agency (AEB) (AGÊNCIA ESPACIAL BRASILEIRA, 2020c), it is clear that PPI only applies in cases where there are no solutions available on the market, for the problem that the government aims to solve through contracting (AGÊNCIA ESPACIAL BRASILEIRA, 2020a). This consideration is important because PPI becomes an option to be used only in very specific cases. It is, therefore, an exception among the contracting instruments made available by the Brazilian legislation, since it presupposes the assumption of a significant portion of technological risks by the government.

It should be noted that when seeking technological solutions, even though options are available on the market, the possibility of restrictions and embargoes by the countries that own the technology should be considered. In the space and defense sector, as an example, the Missile Technology Control Regime (MTCR), of which Brazil is a signatory, affected the development of national satellite launch vehicles (LONGO; MOREIRA, 2018). Such embargoes can mean delays and, in more extreme situations, even the abandonment of related activities (SANTOS, 1996).

However, given the importance of PPI for the acquisitions that involve technological risks, the need for control mechanisms causes difficulties in the application of the legislation in question, which in practice restricts the use of the PPI modality by Brazilian public agencies.

3 Complex defense systems acquisition and public procurement of innovation

The possibility of making public purchases in Brazil through a Public Procurement of Innovation has existed since the enactment of Law No. 10.973/2004[8]. This possibility favors complex defense products acquisition due to several factors, including the option of developing a technological solution not yet available on the market.

8 PPIs are provided for in art. 20 of Law No. 10,973 / 2004, as amended by Law No. 13,243 / 16 and regulation given by Decree No. 9,283 / 2018. According to item XXXI of art. 24 of Law 8.666 / 1993, ETEC are exempted from the bidding process (RAUEN, 2019, p. 7).

However, despite the options made available by the PPI, few processes for obtaining defense products through PPR have been implemented by the Armed Forces (AF) until the present moment. According to Barbosa and Rauen (2019), only on five occasions the AF carried out procurement processes using this legal provision, as seen in Table 1.

Table 1 – Public procurement of innovation undertaken by the Brazilian Armed Forces

Date	Contractor	Supplier	Object	Contract value (Current R$)
12/06/10	Army Technological Center	Orbisat	Specialized technical services for the technological updating of five low-altitude anti-aircraft defense radars (Radio Target Monitoring System Based on Radio Frequency Emission - SABER M60)	2,973,000.00
08/21/14	Brazilian Army Research, Development and Innovation Support Foundation	CPqD	Specialized technical services related to the R&D modeling services of a waveform module for use in the high frequency range (HF)	4,580,000.00
11/04/14	Brazilian Army	Hidromec	Hiring of services for the development of the Integration Platform for the Radio Project Defined by Defense Software (RDS-Defense), vehicular version	2,399,895.00
12/07/18	Brazilian Navy	Instituto de Pesquisas Energéticas e Nucleares	Development of technologies for accelerating laser protons for nuclear applications	14,860,000.00
09/20/19	Brazilian Army	Opto	Thermal imaging monocle R&D service LOOK (OLHAR)	2,879,204.45

Source: Adapted from Barbosa and Rauen (2019).

Analyzing Table 1, we infer that despite the possibilities provided by the PPI, Brazilian AFs made little use of this resource. Barbosa and Rauen (2019) mention that the fact that PPI is underused in the set of national technological development strategies is evident. In this sense, when analyzing the acquisition of complex defense products, the same conclusion can be drawn.

We also observe that there was no participation of the Air Force Command in any process of acquisition through PPI, despite the existence of projects, within the scope of this Command, directly aimed at the development of technological solutions. Despite being signed in 2009, the

KC-390 cargo aircraft development contract (Project KC-X)[9] is an example of defense products that could have been acquired through a PPI.

In complex projects like KC-X, the use of PPI would be a guarantee that possible problems in the development of the contracted solution would not cause conflicts between contracting and contracted entities. In the case of KC-X, as it was a project contracted through a bidding waiver, there was a risk that prototypes would not be produced according to the contractual rules, due to the technological risks existing in a complex activity such as the development of an aircraft.

PPI allows the utilization of variable forms of remuneration in contracting: fixed price, fixed price plus variable incentive remuneration, cost reimbursement without additional remuneration, cost refund plus variable incentive remuneration and cost refund plus fixed incentive remuneration (BRASIL, 2018b). These compensation options allow the existing technological risk to be shared between companies and the public administration, and make it possible to alleviate the difficulty of estimating a price for a solution still in the development stage.

In relation to the KC-X Project, it is important to note that fixed price contracting (or remuneration of the contracted company) was utilized, whereby all risks fall under the responsibility of the contracted company.

Although fixed price contracting seems advantageous to the contracting party, in practice, contracted companies tend to include all the uncertainty of the project in the price defined in the contract, which makes the project more expensive (BARBOSA; RAUEN, 2019). In this sense, the development of the two prototypes of the KC-390 cargo aircraft had an estimated cost of 5.9 billion reais. This cost for the development of the two freighter units is clearly quite high when compared to the value of the 28 aircraft planned for the KC-390 Project, which will cost around R$ 16.2 billion (BRASIL, 2020).

In addition, according to Barbosa and Rauen (2019), the legal instrument chosen for the development of the KC-X brought considerable risks to the company Embraer, since the non-enforceable bidding contracts do not provide for the existence of technological risks.

It should be noted that, despite the existence of the PPI modality for acquiring complex defense products, limited knowledge and experience of the federal government and the Armed Forces' legal body on the application of the aforementioned legislation (see the limited usage verified in Table 1), as well as the difficulty in defining the object of certain acquisitions under the PPI modality may prevent this option from being fully applied.

The difficulty in defining a defense product under a PPI is a relevant factor in determining whether to use this modality in the acquisition process. In this respect, the uncertainties related to technological risk, as a rule, are not the only relevant factors in the

9 The KC-X Project was aimed at the development of two prototypes of a military transport aircraft and in-flight refueling to complement and eventually replace the Brazilian Air Force's C / KC-130 aircraft in carrying out the logistical air transport missions, SAR (Search and Rescue) and in-flight refueling, among others. More broadly, the Project also aimed to promote the technological training of Aeronautics and the Brazilian aerospace industry and to increase the operational capacity of the Brazilian Air Force, through the development and subsequent acquisition of the KC-390 aircraft (BRASIL, 2018).

selection of the contracted company. In many cases, problems related to international embargoes, for example, can be of great importance when it comes to complex defense products, due to the strategic importance that these items have for national sovereignty (AGÊNCIA ESPACIAL BRASILEIRA, 2020b).

Regarding this type of impasse, the Ministry of Health, which is currently one of the main users of the PPI modality, realized the need to work together with other institutions[10] to resolve possible difficulties in understanding and applying PPI in solving problems related to the Ministries (BRASIL, 2017). In this sense, the promulgation of Decree No. 9.245[11], of December 20, 2017, was an important step in dealing with complex issues aimed at obtaining indispensable solutions in the area of Health.

If a parallel is made between the Ministry of Health and the solutions sought by the Armed Forces, it can be observed that the defense area needs to evolve in order to define procedures and establish more precise and standardized processes on the subject, in order to facilitate the work of professionals directly involved in the activities of acquiring complex defense systems.

According to Rauen (2014), central coordination allows not only efficiency and legal certainty, but also facilitates the analysis of processes related to public procurement of innovation. Thus, the drafting of internal regulations by the Ministry of Defense (MD), aimed at standardizing some procedures related to the PPI modality, could facilitate the acquisition of certain defense products using this modality. These new regulations may speed up the process and provide greater legal certainty for the bodies involved in the acquisition processes.

Furthermore, the creation of a more integrated and robust defense product procurement system, under the coordination of the MD, as stated by Longo and Moreira (2013), can be a fundamental option for the efficient and effective use of available financial resources, through consistent and feasible public procurement of innovation.

However, just as an example that corroborates the legal security of defense systems acquisition processes, it should be noted that the Air Force Command (COMAER) has already created, on other occasions, specific rules aimed at facilitating the understanding of legislation on public purchasing. One of these cases was the Ordinance No. 921/GC3[12], of September 2, 2004, which attributes competence and defines procedures for internal COMAER commissions to issue technical opinions aimed at justifying the waiver of bidding in the purchase of materials and equipment motivated by the need to maintain the standardization required by the logistical support structure of air and land resources.

10 Bodies that make up the so-called Executive Group of the Industrial Health Complex (GECIS), such as Casa Civil, MRE, Ministry of Finance, among others.

11 Decree No. 9,245, of 2017, institutes the National Policy for Technological Innovation in Health, regulating the use of the State purchasing power in contracts and acquisitions that involve strategic products and services for the Unified Health System within the scope of the Industrial Health Complex and provides for the Executive Group of the Industrial Health Complex and the Permanent Forum for Articulation with Civil Society.

12 Ordinance No. 921 / GC3, 2004, provides for an Internal Commission with the competence to examine and issue an opinion on the waiver of bidding for the purchase of materials and equipment used by the Air Force Command, except for materials for personal and administrative use, motivated by the need to maintain the standardization required by the logistical support structure of air and land resources.

4 The case of the public procurement of innovation undertaken by AEB

The Brazilian Space Agency (AEB) started an unprecedented project to acquire a technological solution based on a PPI. This project focused on contracting the development of an Inertial Navigation System (INS). The unprecedented nature of this AEB initiative is mainly due to the partnership with the Federal Audit Court (TCU) and representatives of the Federal Attorney General (AGU), the Federal Comptroller General (CGU), the Ministry of Science, Technology and Innovation (MCT) and the Institute for Applied Economic Research (IPEA).

According to AEB, the difficulty of inertial navigation systems acquisition has usually been an obstacle to Brazilian research and development activities. This is due to the embargoes imposed by international suppliers on products related to space and defense applications. Among these embargoes are the control regimes for the transfer of sensitive goods and technologies established by the countries that master this knowledge, such as the aforementioned *Missile Technology Control Regime* (MTCR)[13] led by G7 members.

In addition to the embargoes, other risks inherent to this activity are also common, among them, the restriction of the number of items supplied, the sale of technologically obsolete equipment, insufficient functional specifications for the desired mission, supply of items not customized to the intended application, among others (BRASIL, 2020).

In view of the presented scenario, AEB identified PPI as an instrument that has the potential to be used in contracting solutions for the space sector (BRASIL, 2020). Also according to this Agency, because of the unprecedented nature of the initiative and the lack of practical experiences in the space sector, there was a need for the participation of the Federal Court of Accounts (TCU) to accompany the process of public procurement of innovation in order to map and mitigate the risks encountered, to guarantee the correct application of the legislation and guarantee the compliance of the process. It should be noted that, as it is a new activity, the paradigm shift is relevant for both contracting agencies and control bodies (AGÊNCIA ESPACIAL BRASILEIRA, 2020a).

As previously mentioned, AEB chose a navigation subsystem as the object of the first PPI. According to the Agency, this type of navigation subsystem is usually represented by an Inertial System (INS)[14] operating in parallel with a positioning component by GNSS (*Global Navigation Satellite System*), as seen in Table 2. The complexity of the system is related to the fact that INS systems can have their position processing influenced by the inherent error of sensors, among others. Therefore, some problems may arise; for example, integration over time can propagate a positioning error during its trajectory.

13 The MTCR is a regime that works informally and member countries commit to develop an export system that inhibits, or even eliminates, the possibility of transferring sensitive items to countries that intend to develop missiles (SANTOS, 1995).

14 INS composes a navigation technique in which three-dimensional measurements of linear and angular acceleration are used to follow the position, orientation and speed of an object relative to a starting point. An INS detects changes in geographical position, in its speed (direction and magnitude), and in its orientation (rotation around an axis), from linear acceleration and angular speed applied to the vehicle. Thus, it is immune to external influences because it does not require external references after its initialization (AEB, 2020).

Table 2 – Basic components and parameters of the inertial system

Internal Components	*Interface Parameters*
An on-board computer (OBC1) and its software for processing signals emitted by inertial sensors	Total mass less than 5 kg
An on-board computer (OBC2) and respective software for positioning and integration data processing for trajectory definition, corrected by GNSS	Dimensions required to board as a payload on the VSB-30 rocket and modified versions, or on FTB and FTI training rockets
GNSS receiver	Own telemetry
A Mobile Measuring Unit (MMI) composed of inertial sensors (accelerometers and gyroscopes)	Energy source and own electrical network
Telemetry adapted to a ground reception system	-

Source: Adapted from Agência Espacial Brasileira (2020a).

The importance of PPI arises from the fact that this acquisition involves considerable risks, since the object of the contract is a product that is on the cutting edge of existing technology. Thus, according to AEB, to minimize the occurrence of problems during the ordering phases, all technical specifications and operating parameters will be reviewed and detailed by a technical committee of specialists.

Although space projects use the minimum Technology Readiness Level (TRL) 2 as a technological development metric, as occurred with the SISNAV[15] project, the Inertial Navigation System acquired through the public procurement of innovation modality will have its deliverable products divided into five phases. The first phase will start with a technology maturity index level 3, as shown in Table 3.

Table 3 – Inertial Navigation System phases.

Phase	Technology Readiness Level (TRL)	Deliverable Product
Phase 1	TRL 3	Engineering Project
Phase 2	TRL 4	Laboratory testing of components and interfaces
Phase 2	TRL 5	Integration and validation in relevant environment
Phase 4	TRL 6 e 7	Verification and integrated prototype demonstration
Phase 5	TRL 8 e 9	Complete prototype for flight qualification

Source: Adapted from AEB (2020a).

15 SISNAV is an inertial navigation system developed by the Aeronautics and Space Institute (IAE) for launch and suborbital vehicles (BRASIL, 2020).

The adoption of TRL 3 for the first phase of PPI undertaken by the AEB is a mitigating measure to increase the chances of success, considering that TRL 3 consists of obtaining documented analytical/ experimental results in order to validate the proof of concept (MANKINS, 1995).

The PPI undertaken by the AEB shows similarities to the R&D projects carried out within the scope of the Brazilian Armed Forces in relation to the object of the contracts, as is the case with the development of the KC-390 aircraft (Project KC-X), among other projects aimed at the acquisition of complex defense products. However, in the case of the KC-390, due to several factors, including the lack of specific legislation by the COMAER for the implementation of public procurement of innovation modality, at the time of conception of the project in question, the Air Force Command relied on two legal provisions, namely waiver and unenforceable bidding[16] (RIBEIRO, 2017).

5 Final considerations

This article analyzes the Public Procurement of Innovation (PPI) model applied to acquire complex defense systems, the opportunities generated by this type of contracting, as well as legal security in its use.

It is observed that despite the time elapsed between the publication of the New Legal Framework for Science, Technology and Innovation and its regulation, Brazilian public bodies have not yet shown significant adherence to the aforementioned legislation for defense systems acquisitions. This lack of adherence is possibly related to the limited knowledge on the details of the legislation and the fear of making mistakes in the interpretation of the current rules, which could imply the loss of public resources and its legal implications for the public servants.

Thus, for public bodies to make use of all the possibilities offered by the existing legislation, it is necessary to adopt measures that help public servants understand the rules in force in order to provide greater legal security to complex defense systems acquisition processes.

It should be noted that this type of acquisitions stand out due to their high costs, the importance of defense systems to the country, the complexity of the processes and the uncertainty in the success of the activity, especially when procurement involves the development of defense products. Due to these particularities, the processes of contracting complex defense systems require specific approaches that offer viable options for the public administration and enable the fulfillment of society's demands more efficiently.

The cases discussed in this paper include two processes for complex systems acquisition that followed different paths: the KC-390 Project and the Inertial Navigation System (INS). Although they are considered systems of outstanding importance for national sovereignty, and are successful R&D projects, it appears that the legal method used as the basis for the process of obtaining the INS, the Public Procurement

16 Public bidding waiver (Art. 24) and Bidding unenforceability (Art. 25), both of Law No. 8.666 / 1993.

of Innovation, is more suitable for contracts when object involves technological risks, mainly due to the existing uncertainties and the legal security provided to the managers involved.

The instrument used by the AEB shows that it is possible to overcome the difficulty in using PPI as an instrument for contracting technological solutions in order to meet public sector needs, while the legislation is not yet fully consolidated. It was also possible to identify that the lack of experience in AEB raised the need for the participation of a control body (TCU) as well as other organs of public administration, such as AGU, MCTI and IPEA, in all phases of the process in order to build the knowledge necessary for the appropriate use of the PPI and with the necessary legal certainty.

Following the example of the AEB, we suggest that the Ministry of Defense draw up internal regulations aimed at standardizing procedures related to PPI and including certain defense products in this type of contracting modality. This new regulation may speed up the process and provide greater legal certainty for the government bodies involved in the acquisition processes. Furthermore, a central coordination will possibly allow not only greater efficiency, but also facilitate the analysis of processes related to public procurement of innovation.

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