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BRAZILIAN SCIENTIFIC PRODUCTION ON INNOVATION IN THE DEFENSE SECTOR

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SUMMARY

The aim of the study was to map the profile of scientific research on defense innovation in Brazil, highlighting the main national journals that host articles of this nature. Journals in the area of Political Science, International Relations and Defense (Area 39) were evaluated. Methodologically, a bibliometric study limited to a period from 1991 to 2020 was carried out, in which the laws of Lotka, Bradford and Zipf were applied. The result pointed out that from 2011 there was an exponential and sustainable growth of articles related to innovations in the defense sector. It was also observed that among the journals in the area that most welcome works related to the theme are those linked to the graduate programs of military schools. Finally, in the set of publications analyzed, there is a central nucleus of journals that, although not specialized in innovation topics, host most of the articles published with this content.
Keywords: Defense Innovation; military innovation; innovation culture.

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INTRODUÇÃO

The defense industry plays an important role in the Brazilian economy. According to information from the Federal Government, the defense industrial base was responsible for 4.78% of the Brazilian Gross Domestic Product in 2020, surpassing the performance of sectors such as civil construction, agriculture and oil extraction (NÓBREGA, 2021). As highlighted by Moreira (2011), the sector, in addition, is responsible for a significant portion of jobs.

As in so many other industries, innovation capability is critical to the defense sector. It is the innovations that guarantee advantages for a belligerent force against its adversaries, modifying the relations of combat power that can even lead to unpredictable results in wars (MURRAY, 1996, 1997; CORREIA, 2008). The lack of innovative capacity can even lead to the crystallization of military doctrine[4] of a country, which will impair its ability to defend itself (BARROS, 2022).

The concept of innovation is quite broad. According to the Organization for Economic Cooperation and Development (OECD), innovation is "the implementation of a new or significantly improved product (good or service), or a process, or a new marketing method, or a new organizational method in business practices, workplace organization, or external relations" (OECD, 2005, P.55). Applied to the defense sector, it is defined as the implementation of a defense product (good or service), a process, a marketing method or an organizational method, new or significantly improved, that is capable of considerably changing the way military power is organized, prepared and employed (FRANCO AZEVEDO, ALVES DE BORBA, de ARAÚJO, 2021).

In Brazil, the military innovation process is in a context of disjointed actors that have little productivity and, in this sense, low impact on national military power (CUNHA; AMARANTE, 2011; FRANCO-AZEVEDO, 2018). Despite this scenario, the Brazilian innovation sector in defense[5] it has struggled

4 Military doctrine is a set of diverse knowledge, such as norms, concepts, beliefs and values, which, combined, enable the Armed Forces to organize, prepare and act in the fulfillment of their missions (Barros, 2022).

5 Starting from the vision of systemic and sectoral innovation of authors such as Freeman and Soet (1982), Malerba (2002), Nelson and Winter (2004) and Kline and Rosemberg (2009), Franco-Azevedo (2013, P.61) groups the actors involved in the "set of activities and interactions, consolidated in a process that involves the creation, development, use and diffusion of technological and non-technological innovations" of this sector in what it calls the Defense Sector Innovation System (SIS-Def).

to grow.

In recent years, as shown by the figures of the Department of Defense Products (SEPROD) of the Ministry of Defense[6], it was observed several initiatives aimed at integrating knowledge and actors in the sector.

Thus, considering the importance of innovations for the development of the defense industry and for the increase of military capabilities, the present work sought to map the profile of scientific research on defense innovation in Brazil, highlighting the main national journals that host defense articles and that address the theme of innovation in the sector.

For this, methodologically, a bibliometric study was carried out, limited to a period from 1991 to 2020, in which the laws of Lotka (1926), Bradford (1976) and Zipf (2012) were applied. As Araújo (2006) highlights, bibliometrics has as its central point an objective evaluation of scientific production and, therefore, helps the work in understanding patterns and behaviors of the field. It is also worth noting that, in order to enable the research, the study was directed to evaluate only the productions present in journals in the area of Political Science, International Relations and Defense.

Within this proposal, the article is divided into sections, in which the theoretical and methodological references that supported the research work are initially presented. Then, the results of the analysis of the collected data are presented, which were: (i) number of articles published related to the theme per year (II) number of articles published related to the theme per Journal, (III) institution with the highest production on the theme; (IV) recurrent themes in the area; and, finally, the (V) productivity of authors in the field. Finally, the conclusion sought to establish a clearer view of scientific publications on the subject, performing a joint and integrated data analysis.

THEORETICAL FRAMEWORK

Bibliometrics is a quantitative and statistical technique for measuring the production and dissemination of scientific knowledge. This emerged at the beginning of the century as a symptom of the need for the study and evaluation of scientific production and communication activities, and the term "bibliometrics" was created by Otlet in 1934 in hisTraité de Documentation" (ARAÚJO, 2006). The methodology strives for objectivity and brings important tools for analysis

6 Available in https://www.gov.br/defesa/pt-br/centrais-de-conteudo/noticias/defesa-supera-1-5-bilhao-de-dolares-em-exportacoes-em-2021

and understanding of the current scenario of a particular field of knowledge. As highlighted by Price (1976, p. 39),

> Leaving aside value judgments, it seems clear the importance of having a distribution that informs us about the number of authors, works, countries or journals that exist in each category of productivity, utility or whatever else we want to know (PRICE, 1976, p.39).

Bibliometric analysis techniques are already commonly used for the purpose of evaluating and measuring scientific activity itself, such as identifying key topics, most important works and authors in a given area, or also to identify aspects of research evolution, such as the need for studies of new topics or the obsolescence of scientific fields (FRASCARELI, PIMENTEL, 2012).

This work aligns with the definition of Ikpaahindi (1985), who understands that bibliometrics is a generic term that describes a series of techniques that seek to quantify the process of written communication. These techniques have been used in the identification of the most productive authors, in the identification of paradigms in science, in the Fusion and fission of scientific disciplines and in the identification of the most productive journals in different fields, etc.

It is a quantitative approach in the area of Information Science that aims to analyze bibliographic data (MACIAS - CHAPULA, 1998; MARICATO, 2010). In this perspective, it provides indicators that help in the understanding of patterns and behaviors of an area of knowledge by allowing to explore, organize and analyze large masses of data (DAIM et al.., 2008).

Among the fundamental theorists of bibliometrics are Alfred J. Lotka; Samuel C. Bradford and George K. Zipf. These authors have developed studies of great relevance to the area, because they were able to establish mathematical patterns that contribute to the analysis. Such was the impact of their productions that, nowadays, the three authors are considered founders of the laws of bibliometrics.

Lotka in 1926 established Lotka's law or, as it is also known, the inverse square law. The law is used to evaluate the productivity of researchers and to identify the most developed research centers in each area or field of knowledge. This law proposes that a restricted number of researchers produce a lot in a certain area of knowledge, while a large volume of researchers produces little (ALVARADO, 2009). Thus, Lotka (1926) uses the premise that the total of scientists

who produce "n" contributions in a scientific branch can be represented by 1/n2 of the authors who present a single contribution. Therefore, approximately 60% of authors in a field produce only one article in their entire academic life (CHUNG; COX, 1990; ALVARADO, 2009).

Since 1926, many studies have sought to investigate the productivity of authors in different disciplines. By December 2003, approximately 390 works had been produced criticizing, replicating and/or reformulating Lotka's law (URBIZAGASTEGUI, 2008). Despite the amount of research, studies have conflicting results on the validity of this law. In this context, studies have been developed in order to improve Lotka's law. Voos (1974), for example, asserts that the correct one for the application of the law would be an exponent of n = 3.5, and not of inverse square n = 2, to provide a good fit to the empirical data. Schorr (1974) proposed an exponent of n = 4, stating that, for the case of information science, academic production would follow an inverse quadruple power law. Bogaert, Rousseau and Van Hecke (2000) propose that Lotka's law could be seen as a power law, which uses an inverse exponential scale related to the number of articles per author to determine the productivity of the area. According to the authors, taking exponent 2 as a reference, areas with a higher exponent would be less productive, while those with a lower exponent would be more productive (MACHADO JR et al.., 2016). In summary, it can be stated that both the scope and applicability of Lotka's law (1926) are still limited and that alternative formulations that better fit the observed data are in the process of research.

Samuel C. Bradford, in turn, deals with the relevance of journals in a particular branch of knowledge (BRADFORD, 1976). His law, the law of dispersion (or Bradford's law) was constructed from research in the medical field conducted by Hill Bradford and other researchers at the American Medical Research Council. This tool makes it possible, by measuring the productivity of journals: "establish the core and areas of dispersion on a given subject in the same set of journals" (VANTI, 2002, p.153).

According to Bradford (1976), the most prolific journals on a topic supposedly have more marked quality or relevance. This premise can be verified by ordering the journals in descending order of productivity and then separating them into three groups, each containing about 1/3 of the total number of articles (ANDRES, 2009). The first group, also called the central core, should, in theory, concentrate a small number of journals, which will be the most productive; the second, a larger number of journals with intermediate productivity and, finally, the last Zone will present a high number of journals with low production. The number of journals in each zone should grow in an exponential proportion,

proportional to 1 : n : n2, which makes literature review papers increasingly difficult to cover all published articles, due to the number of publications in the peripheral region.

Finally, Zipf's law focuses on measuring the frequency of the appearance of words in various texts, in order to generate an ordered list of terms of a particular discipline or subject (VANTI, 2002). This law uses the principle of least effort (EGGHE, 1991; ZÖRNIG, ALTMANN, 1995), through which certain words are taken to represent consensual ideas in an area of thought. Thus, information is organized according to its relevance, and can be, for example, evaluated as trivial or filtered as noise (QUONIAM et al., 1998).

METHODOLOGICAL PROCEDURES

The methodological procedure used in this work consists of a bibliometric analysis (VANTI, 2002) whose objective is to map the profile of scientific research on defense innovation in Brazil. A total of 95 articles on Defense Innovation published in the period 1991-2020 in journals with classification were mapped in March 2021 Qualis higher than B2 (quadrennium 2013-2016), in the capes assessment area

- Political science and International Relations, present in the research platforms CAPES, Google Scholar, observing those that contain the following keywords: innovation, Innovation, Defense, Defense, Defence, War, War, Military, Military, Strategy, Strategy and that they had objectives related to the researched topic.

In order to operationalize the collection of said terms, the software was used publish or perish. In total, more than 928 articles with the cited keywords were collected, however, only 99 were published in the period 1991-2020 in journals with Qualis classification higher than B2 (quadrennium 2013-2016), in the evaluation area CAPES-Political Science and International Relations. It should also be noted that not all articles raised by the system contained the keywords described above in their body or had objectives related to the theme. In this sense, there was a need to categorize the articles into green, yellow and red. Articles with adherence to the theme were categorized in green. The articles in yellow have the keywords, but need a second opinion to conclude whether it contains content related to Defense Innovation and, finally, articles that do not adhere to the theme were categorized in red. The analysis was subjective and had the help of experts in the field. A total of 67 articles were categorized in Green, 28 articles in yellow and 4 articles in red. To assess whether there is adherence, only the title

and abstract were considered.

Finally, 95 articles were considered adherents to the theme of Defense Innovation. These manuscripts were analyzed quantitatively, according to the following typologies: (I) evolution of publications; (II) Journal in which the article was published; (III) institution of the authors; (IV) keywords of the articles and (V) authorship characteristics. The use of these typologies aimed to reach the following variables: (i) number of articles published related to the topic per year (II) number of articles published on the topic per Journal (III) institution with the highest production on the topic; (IV) recurring themes in the area; and, finally, the (V) productivity of authors in the field.

The data collection of the first variable, which focuses on the set of journals, was performed manually according to the dates present in the article header. The second variable focused on measuring the productivity of journals in the area, therefore, the collection was carried out according to the data provided in the article itself. Sought if you use such a perspective of analysis to contemplate Bradford's law of dispersion of periodicals. The third variable, related to the authors ' institution, seeks to elucidate which region and which institution has the highest productivity in the area of Defense Innovation. In order to achieve this objective, the authors ' institutions of association were verified during the period of publication of the manuscript. This information was collected according to the data available in the article itself. In the manuscripts that did not describe the institutional link of the author, we opted for the manual search of the institution of each author on academic curriculum websites. This process may generate some inconsistency between the actual institution of each author and the classification adopted in the analysis, considering that these external sources do not bring the exact date of the beginning and end of the linkage.

For the data collection of the fourth variable, which analyzes the keywords of the articles, we chose to table the terms indicated as keywords in the body of the article. A keyword tabulation limit has not been set. Some journals, for example, limit 3 keywords to a maximum. In this research, all terms presented as keywords were recorded. In this mister, the fact that 14 articles analyzed did not have keywords stands out. All this effort seeks to contemplate Zipf's law or law of minimum effort or even law of frequency of words (GUEDES; BORSCHIVER, 2005).

Finally, the last variable analyzes the productivity of the authors in the area. For this, the sum of the articles produced by each author identified in the area was carried out, in order to identify their total productivity. It should be noted that, as some articles are produced by more than one author, the total of the

sum of the number of articles produced per author will necessarily be greater than the total number of articles searched. This data was used to verify the adherence of the area to Lotka's law, based on the formula: given several authors "A" who publish only one article in the studied area, the number of authors "N" who publish "n" articles will be proportional to the inverse of the square of "n", that is, N = A x 1/n2 (LOTKA, 1926). The data were collected according to the information contained in the articles.

DATA ANALYSIS

Initially, the evolution of publications throughout the analyzed period (1991-2020) was mapped. Figure 1 shows the number of articles on Defense Innovation, published in journals with Qualis higher than B2 (quadrennium 2013-2016) in the evaluation area CAPES Political Science and International Relations (CP, RI, Def).

Graph 1-evolution of production on Defense Innovation in the area of CP, IR and Def.

Source: prepared by the authors

The first work that met the search criteria of the research is from 1991 and authored by Gilda Maria Teixeira Uflacker entitled: The Evolution of the subject of Science and Technology in ESG. From that year, only in 1993 there was another published work on innovation in defense. The second period analyzed (1996-2000) was the one with the lowest production, corresponding to 1.05% of the total observed. Graph 1 also shows the exponential growth in the last 9 years, representing 85.2% of total production. The most productive year related to the

theme was 2018, with 17 articles (17.9%) tabulated.

The second stage of the analysis focused on measuring the productivity of journals in the area. A total of 17 (seventeen) journals were raised with records of articles adhering to the theme studied. Applying the precepts of Bradford's law to the collected data, we find a model as described in Table 1. In this table it is possible to verify that there is a large concentration of articles in the first four journals of the area. It is also possible to observe the small number of journals that publish the subject. The two facts make the division of publications into groups more complex, as suggested by Bradford's law (1976), given that the movement of some journals has a great impact on the distribution of the number of articles.

Table 1 - distribution of journals in groups according to Bradford's law

Periódico	Nº de artigos	Grupo	Nº de artigos no grupo	Nº de periódicos no grupo	% de artigos no grupo	% de periódicos no grupo
Revista da Escola de Guerra Naval	20	1	38	2	40%	11,76%
Coleção Meira Mattos	18					
Revista Superior de Guerra	15	2	30	2	31,58%	11,76%
Revista Brasileira de Estudos Estratégicos	15					
Revista Política Hoje	6	3	27	13	28,42%	76,47%
AUSTRAL: Brazilian Journal of Strategy and International Relations	6					
Revista Brasileira de Estudos de Defesa	3					
Carta internacional	2					
Meridiano 47	2					
Brazilian Journal of Political Economy	1					
Conjuntura Internacional	1					
Contexto Internacional	1					
Mediações	1					
Revista Brasileira de Ciências Sociais	1					
Revista Brasileira de Gestão e Desenvolvimento Regional	1					
Revista de Estudos Internacionais	1					
Revista Sul-Americana de Ciência Política	1					

Source: prepared by the authors

From the analysis of the data presented in Table 1, it is observed that the general principle of Bradford's law (1976)-few journals present many articles while many journals present a small amount – is confirmed in the area. It is analyzed that there is a central nucleus formed by two journals that publish 40% of the articles in the area, followed by a second group, also formed by two journals that publish 31% of the articles and, finally, a third group of 13 journals that publish 28% of the articles.

Despite meeting the general principle of Bradford's law (1976), as previously highlighted, the distribution presented in Table 1 does not have the characteristic of exponential growth expected by the theory among the number of journals in each group. In view of this, and taking into account the observations made in the previous paragraphs, it was decided to adjust the distribution of journals among the groups. Table 2 below shows this new distribution, in which the first two journals of Group 3 were elevated to Group 2. Although this contradicts the number of articles predicted for each group (about 32 articles), this adjustment was chosen because the journals moved had the same number of published articles, a number two to six times higher than that of the other publications in Group 2.

Table 2 - distribution of journals in adjusted groups

Periódico	Nº de Artigos	Grupo	Nº de artigos no grupo	Nº de periódicos no grupo	% de artigos no grupo	% de periódicos no grupo
Revista da Escola de Guerra Naval	20	1	38	2	40,00	11,76
Coleção Meira Mattos	18					
Revista Superior de Guerra	15	2	42	4	44,21	23,53
Revista Brasileira de Estudos Estratégicos	15					
Revista Política Hoje	6					
AUSTRAL: Brazilian Journal of Strategy and International Relations	6					
Revista Brasileira de Estudos de Defesa	3	3	15	15	15,79	64,71
Carta internacional	2					
Meridiano 47	2					
Brazilian Journal of Political Economy	1					
Conjuntura Internacional	1					
Contexto Internacional	1					
Mediações	1					
Revista Brasileira de Ciências Sociais	1					
Revista Brasileira de Gestão e Desenvolvimento Regional	1					
Revista de Estudos Internacionais	1					
Revista Sul-Americana de Ciência Política	1					

Source: prepared by the authors

The result of the adjustment provided a greater approximation between the difference in the number of articles between groups 1 and 2 (going from 8.42% to 4.21%), and improving the growth ratio between groups (from 1:1:6.5 to 1:2:2.75). However, there is also a reduction in number of existing articles in Group 3, which now has 15.79% of the articles published by 64.71% of the journals. By observing the behavior of the data collected, based on the perspective presented by Machado Jr et al. (2016) from the fact that articles are usually submitted to a specific group of journals and that with the growth of the theme other scientific journals begin to accept them with focus, it can be inferred that the research area on defense innovation is still in an expansion process, having constituted a central core of publications, and that it has been expanding to other publications in the area.

The third part of the analysis sought to establish the most productive institutions in the subject. For this purpose, the institutions were classified in a decreasing way of publication quantity, according to the researcher's link, or the researchers when there was co-authorship, at the time of submission. The result of this effort can be seen in Table 3.

Table 3-number of articles by institution

Instituição	Quantidade
Escola de Comando e Estado-Maior do Exército (ECEME)	20
Universidade Federal Fluminense (UFF)	14
Escola de Guerra Naval (EGN)	13
Escola Superior de Guerra (ESG)	10
Universidade Federal do Rio Grande do Sul (UFRGS)	6
Instituto Militar de Engenharia (IME)	5
Universidade da Força Aérea (UNIFA)	5
Universidade Federal de Pernambuco (UFPE)	4
Agência de Gestão e Inovação Tecnológica (AGITEC)	3
Universidade Estadual de Campinas (UNICAMP)	3
Universidade Estadual Paulista (UNESP)	3
Universidade Federal do Rio de Janeiro (UFRJ)	3
PPGRI San Tiago Dantas UNESP - UNICAMP - PUC-SP	2
Academia Militar das Agulhas Negras (AMAN)	1
Centro de Avaliações do Exército (CAEx)	1
Centro de Instrução Almirante Graça Aranha (CIAGA)	1
Centro Universitário FEI	1
Centro Universitário La Salle (UNILASALLE)	1
Departamento de Ciência e Tecnologia do Exército Brasileiro (DCT)	1
Faculdade Damas da Instrução Cristã	1
Fundação Getúlio Vargas (FGV)	1
Instituto de Ensino e Pesquisa (Insper)	1
Instituto de Pesquisa Econômica Aplicada (IPEA)	1
Instituto Nacional da Propriedade Industrial (INPI)	1
Pontifícia Universidade Católica – MG (PUC-MG)	1
Pontifícia Universidade Católica – PR (PUC-PR)	1
Universidade Complutense de Madrid (UCM)	1
Universidade de Brasília (UNB)	1
Universidade de São Paulo (USP)	1
Universidade de Taubaté (UNITAU)	1
Universidade de Vassouras	1
Universidade Federal de Minas Gerais (UFMG)	1
Universidade Federal de Santa Catarina (UFSC)	1
Universidade Paulista (UNIP)	1
Universidade Regional do Cariri (URCA)	1
Total	**113**

Source: prepared by the authors

As can be seen in Table 3, the most productive institutions with more than 10 articles published on the subject are: the Army Command and General Staff School (ECEME), the Fluminense Federal University (UFF), the Escola de Guerra Naval (EGN) and Escola Superior de Guerra(ESG). It should be noted that, among them, the military institutions that have graduate programs in topics related to Defense and National Security stand out[7]. The exception is the UFF, a civil entity that has a high percentage of publications in the field of innovation in the defense segment. It is believed that the result is related to the Postgraduate Program in Strategic Defense and Security Studies (PPGEST) that the institution promotes and that was authorized by CAPES in December 2007, which has Master's and doctoral classes.

Another important analysis carried out concerns the region of the country in which production on defense innovation is concentrated. More than 84% of the productions come from institutions based in southeastern Brazil. The South represents the second region with the highest production, meaning more than 7.1% of the articles, most of which come from the Federal University of Rio Grande do Sul. Institutions in the Northeast then accounted for 5.4% and the Midwest 2.7%. Finally, using the temporal and spatial clipping of this research, it is found that the northern region does not include any publication related to the theme. It is believed that the result may be related to institutions that have graduate programs related to Defense and National Security, which are concentrated in the Southeast and South.

Regarding the analysis of the keywords most used by the authors in their articles, only 245 keywords were raised. This result is justified by the number of articles that did not have the type of characterization, that is, keywords (14 articles, which represents 14.7% of the observed universe). Figure 1 presents, in the form of a word cloud, the most frequently used terms, on a larger scale, and the least frequently used terms, on a lower scale. For the preparation, the principles of Zipf's law were used.

7 The Army Command and General Staff School has the Postgraduate Program in Military Sciences of the Meira Mattos Institute (PPGCM-IMM) and the Escola de Guerra Naval promotes the Postgraduate Program in Maritime Studies. Both programs have Master's and Doctoral courses aimed at civilians and military personnel.

Figure 1-keyword frequency cloud

Source: prepared by the authors

It can be observed that the term defense Industrial Base was the most recurrent with 19 appearances (7.7%). The list with the most used keywords is complemented by the terms Innovation (16), National Defense (12), Technology (10), Brazil (7), Defense Logistics (7), Budget (6) and, finally, International Arms Market (5). The other terms added low frequencies of use, varying between 1 and 4 uses. This fact can be explained by Zipf's law, since it is possible to evaluate the presence of the principle of least effort, through which the authors selected the most adherent terms to the journals that initially opened space for the theme seeking greater adherence of their manuscripts in the universe of research platforms.

Finally, we sought to analyze the productivity of authors in the area, as indicated by Lotka's law (1926). It was observed that there are 124 authors in the area[8] and A Study Group[9] with research published in journals that followed the criteria of the present work. Within this universe, it was it is possible to measure that 3 authors published 4 Articles, 3 authors published 3 articles, 19 authors published 2 articles and 99 authors published only 1 article. Applying the

8 This number is higher than the number of studies analyzed (94) due to co-authored publications.

9 The study group was excluded from the calculation because it was not possible to define the number of associated researchers.

calculation proposed by Lotka (1926), we arrive at the results presented in Table 4, below:

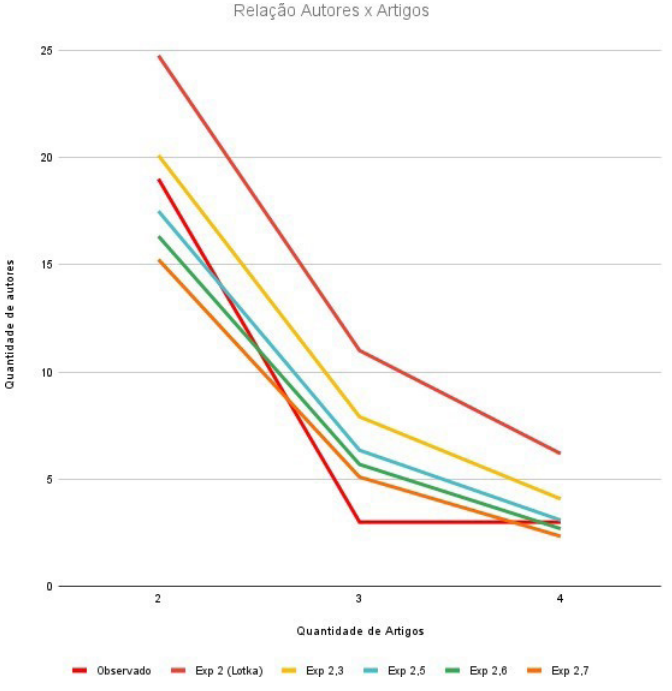
Table 4-analysis of productivity data according to Lotka's law

Nº de Artigos Publicados	**Nº de autores observados**	Exp 1,7	Exp 1,9	**Exp 2 (Lotka)**	Exp 2,1	Exp 2,3	**Exp 2,5**	Exp 2,6	Exp 2,7
1,00	**99**	99,00	99,00	**99,00**	99,00	99,00	**99,00**	99,00	99,00
2,00	**19**	30,47	26,53	**24,75**	23,09	20,10	**17,50**	16,33	15,24
3,00	**3**	15,29	12,28	**11,00**	9,86	7,91	**6,35**	5,69	5,10
4,00	**3**	9,38	7,11	**6,19**	5,39	4,08	**3,09**	2,69	2,34

Source: prepared by the authors

Graph 2 shows an extract of the data presented in Table 4. Exponents smaller than 2 and the point indicative of the number of authors who produced 1 article were removed in order to provide a better visualization of the most relevant data.

Graph 2-number of articles by author



Source: prepared by the authors

Using the exponent 2 in the formula N = A x 1/n2, as proposed by Lotka (1926) - data represented by the black line-an acceptable parity is observed with the data observed in the research

- red line-regarding the number of authors who Published 2 articles, but who start to distance themselves as the amount of articles written by the authors increases. However, when proceeding to the variation of the exponent, following the idea of power law of Bogaert, Rousseau and Van Hecke (2000), a better similarity of the exponent curve 2.5 (Green Line) is perceived, especially in categories 2 and 4 articles. Using the exponent 2 as a productivity reference, as proposed by the authors, it can be concluded that the field of Defense Innovation can be considered still unproductive or under development, which is in line with what was observed by the data analysis according to Bradford's law.

FINAL REMARKS

Having as research object the sectoral studies of innovation, this work sought to map the profile of scientific research on defense innovation in Brazil, highlighting the main national journals that host defense articles and that address the theme. In this work, the journals in the area of Political Science, International Relations and Defense (Area 39) were evaluated. This delimitation was understood as necessary to enable the research and to allow some inferences that will be synthesized in these final considerations.

The research allowed to observe that, from 2011, there was an exponential and sustainable growth of articles related to innovations in the defense sector (Graph 1), published in area 39 of CAPES evaluation, considering journals with Qualis classification higher than B2. Among the journals in the area that most welcome works related to the theme are those linked to the graduate programs of military schools (Table 1), since they were the ones that hosted the first articles on the theme. It should be noted, however, that such journals are not especially dedicated to the theme of innovation, since they have a comprehensive and interdisciplinary scope.

From the application of Bradford's law (dispersion law) and Lotka's Law, important findings indicate that research related to the theme of innovation in the defense sector is in the process of expansion. In addition, in the set of publications analyzed, there is a central nucleus of journals that, although not specialized in the subject, host most of the articles published with this content. This fact allows us to infer that authors with an interest in publishing on the subject tend to seek other journals that can host works of this nature. Once this dynamic has been verified, it

is expected that, from now on, new journals, specialized in innovation, will begin to encourage submissions for researchers interested in the area of knowledge.

The research also allowed us to infer, with the application of Lotka's law, that the interest in the theme of innovations in the defense sector is not exclusive to researchers from military institutions. Although most of of the articles being written by researchers (military and civilian) from those institutions (Table 2), there is a significant number of articles submitted by researchers from civilian institutions such as in a short period of time: UFF, UFRGS, UFPE, UNICAMP, UNESP, USP, UFSC and others.

Another interesting point to note lies in the use of keywords by researchers. It was expected to find more frequent use of terms such as: innovation; defense; military; war; and strategy. Instead, it was found the use of expressions such as: defense industrial base; technology; Defense Logistics; budget; international arms market; and innovation. It is worth mentioning that the latter is the only keyword among those selected by the authors to carry out the research collection. This fact can be explained by Zipf's law, since it is possible to evaluate the presence of the principle of least effort, through which the authors selected the most adherent terms to the journals that initially opened space for the theme.

A final aspect that, although not within the scope of the research, also deserves to be highlighted is the fact that more than 90% of the production related to the theme originates from institutions located in the Southeast (84%), South (7.8%) and Northeast (5.2%), which demonstrates the importance of maintaining and expanding incentives for research in other regions of the country, as graduate programs have already been carrying out to some extent, with capes encouragement.

Finally, once the expansion of publications on innovation in the defense sector in area 39 has been verified, it is suggested that future work be carried out in other areas of CAPES evaluation, such as Administration, Engineering and Economics. It is believed that many researchers are directing their work towards such fields of knowledge.

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A PRODUÇÃO CIENTÍFICA BRASILEIRA SOBRE INOVAÇÃO NO SETOR DE DEFESA

RESUMO

O objetivo do estudo foi mapear o perfil das pesquisas científicas sobre a inovação de defesa no Brasil, destacando os principais periódicos nacionais que acolhem artigos deste cunho. Foram avaliados os periódicos da área de Ciências Políticas, Relações Internacionais e Defesa (Área 39). Metodologicamente, realizou-se um estudo bibliométrico limitado a um período de 1991 a 2020, no qual foram aplicadas as Leis de Lotka, Bradford e Zipf. O resultado apontou que a partir de 2011 houve um crescimento exponencial e sustentável de artigos relacionados às inovações no setor de Defesa. Também se observou que dentre os periódicos da área que mais acolhem os trabalhos relacionados à temática estão aqueles ligados aos programas de pós-graduação das Escolas Militares. Por fim, no conjunto das publicações analisadas, verifica-se um núcleo central de periódicos que, embora não especializados em temas de inovação, acolhem a maior parte dos artigos publicados com este teor.

Palavras-chave: Inovação de Defesa; Inovação Militar; Cultura de inovação.

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