Reindustrialization Plan Using the DPSIR and TOPSIS Methods

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Abstract

(De)industrialization is a phenomenon that affects the economic development of developed and developing countries. However, there is a lack of studies that evaluate strategies to promote the industrialization of a country through the information of industry experts. Objective: this article aims to develop a reindustrialization plan based on strategies to increase the relative participation of Brazilian industry in the Gross Domestic Product (GDP) in order to mitigate the Brazilian deindustrialization process. Method: the method used was DPSIR (Driving Forces, Pressures, State, Impacts, and Responses) in order to map information from specialists directly involved in the theme of industrial development in the areas of economics, public law, scientific research, public management, and private management. In addition, the TOPSIS method was used to prioritize the specialists' responses in order of urgency of implementation. Findings: the main result of this work revealed the strategies that should be prioritized to promote the country's industrialization. Novelty: this research served as a basis for the elaboration of the Brazilian Reindustrialization Plan, presented at the end of the article.

1- Introduction

Manufacturing is the main engine of technical progress, raising the standard of living of the population through increased income and productive investment. This reinforces the idea that manufacturing production is a relevant development strategy to promote the prosperity of a nation. Morceiro [1] and Fries et al. [2] state that Brazil envisioned and experienced a period of growth in the share of the manufacturing industry in the Gross Domestic Product (GDP) between the 1930s and 1980s. However, after the 1980s, the Brazilian economic situation was deteriorated by the inflationary scenario. Thus, in the last 30 years, there has been a considerable drop in the relative participation of the industrial sector in the Brazilian economy [3].

Several studies have indicated that the Brazilian economy is going through a process of deindustrialization [3-6], where industry has lost share in GDP in recent years. According to Fries et al. [2], this deindustrialization occurred due to the reduction of public investments (in the form of subsidies and public policies to promote industrial development) and private investments in industrial sectors of the most varied segments, putting the country in a situation of loss of international competitiveness. The low investments are reflections of obstacles and inefficiencies in the three spheres: government, companies, and universities (precisely the spheres that make up the so-called triple helix). These obstacles come from ineffective public policies, poor management, lack of planning, and lack of strategic vision, among several other factors [2].

Suzigan & Furtado [7] argue that industrial policy aims to promote economic development by stimulating strategic sectors, innovation, and coordination between different economic instruments. They emphasize the need for clear

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policies, innovation, and a new institutional organization. The policy adopted by the government between 2003 and 2006 had positive aspects, such as the emphasis on innovation and clear targets, but also identified several weaknesses, such as incompatibility with macroeconomic policy, inconsistencies between economic instruments, deficiencies in the infrastructure and in the science, technology, and innovation system, as well as the lack of coordination and political will. To develop an effective industrial policy, Suzigan & Furtado [7] argue that it is essential to ensure compatibility with macroeconomic policy, coordinate economic instruments in a coherent manner, strengthen the infrastructure and innovation system, and ensure a firm political commitment. This theme was discussed by Tavares [4], who stated that there were major failures in the continuity and coordination of industrial policies over the years, in addition to the lack of a long-term strategy and solid policies, which caused fragmentation and lack of effective and real direction in the rise of Brazilian industry. Mazzucato [8] argues that the State should be seen as an active agent in the economy, capable of directing economic growth through innovative and inclusive public policies. The author proposes a new approach to public policy that emphasizes the importance of collaboration between the public and private sectors to promote innovation and ensure that the benefits of economic growth are widely distributed. Mazzucato [8] suggests that redefining the role of the state can lead to more balanced and sustainable development, reducing economic inequalities and promoting social well-being through the creation of new markets and development opportunities.

In this context of the entrepreneurial state brought by Mazzucato [8], research shows that developed countries are increasingly implementing industrial policies. van Neuss [9] are the ones who bring this research, and state that the implementation of industrial policies is vital to enhance the economic development of a country for several reasons, such as: (i) promoting the reindustrialization and modernization of the industrial sector; (ii) foster technological innovation in strategic sectors; (iii) addressing market failures, such as limited financial support for long-term projects and sectors requiring higher initial investment; iv) to create quality jobs; (v) increase economic resilience by strengthening national production chains with less dependence on imports in strategic sectors; — to encourage the use of regulations, public procurement and public-private partnerships as industrial policy instruments; and (vii) encourage the use of green technologies, leading the country to sustainable development and a low-carbon economy. Also, according to van Neuss [9], these reasons explain why there is a growing movement among developed countries (such as the US, China, and others) to adopt and expand industrial policies as a way to address contemporary economic challenges, promote innovation, and ensure economic competitiveness on the global stage, which clearly addresses the research gap regarding industrial policies identified in this article.

Several studies (authors cited at the end of this paragraph) show that Latin America, in general, has not developed effective industrial development plans, much less efficient and long-term industrial policies. Latin America had, and in many cases still has, its economic base based on the export of commodities, to the detriment of manufactured goods with higher added value. Making a comparison, in Brazil it is not much different. The country has failed to develop a competitive and sophisticated industry in various sectors. The dependence on imported technology and inputs, combined with the lack of investments in research and development, has compromised the innovation capacity and competitiveness of the national industry. In addition, there were failures in the continuity and coordination of industrial policies over time, leaving a gap that motivated the elaboration of this research. The absence of a long-term strategy and consistent policies has resulted in fragmentation and the lack of effective direction in the promotion of Brazilian industry [9-11].

Thus, the research problem of this article stems from the loss of relative participation of the industrial sector in the Brazilian GDP and the scarcity of a plan to mitigate the deindustrialization process in Brazil. To solve this research problem, the objective of this research is to present strategies in order to increase the relative participation of the manufacturing industry in the national GDP. To assist in achieving the objectives of this research, the DPSIR method was the method chosen because it is focused on the identification of final objectives and intermediate objectives, in addition to collaborating strongly with the definition of the criteria that will be adopted in decision-making [12]. In addition, Bell [13] states that the DPSIR aims to analyze the interconnections between environment and society, structuring the problem to be analyzed in a coherent and cohesive way, in addition to using a methodology that is easy to understand for non-specialists in the area of problem structuring methods.

This study contributes to the industrial policy literature in several aspects. First, industrial policy studies have focused on building a theoretical basis, but there is a lack of investigations with primary or quantitative data, leaving scientific gaps [14]. In this sense, this article contributes by presenting strategies for industrial development from the perspective of specialists in the areas of economics, public management, private administration, and public law and researchers, all with expertise in the area of economic development, who agreed to participate in the research through questionnaires. Secondly, this work innovates by applying the DPSIR and TOPSIS methods in the context of the formulation and prioritization of strategies to enhance industrial development. This is because the DPSIR method is relevant, as it focuses on intermediate and final objectives and contributes to the structuring of the problem of deindustrialization in such a way that the connections between the actors are interrelated, generating a virtuous cycle. The DPSIR was the method chosen because it is more focused on the identification of final objectives and middle objectives, in addition to collaborating strongly with the definition of the criteria that will be adopted when making decisions. Other PSM methods could be used, such as SWOT (Strengths, Weaknesses, Opportunities, and Threats, which means Strengths, Weaknesses, Opportunities, and Threats, respectively) and SAST (Strategic Assumption Surfacing and Testing), among others, but

they require constant contact and involvement of specialists in each phase of the structuring of the method, something very difficult for this research due to the scarce time that the specialists have to participate more actively [12]. Therefore, the DPSIR is a method that has greater adherence to the theme of this research, collaborating objectively and coherently in the construction of proposals for solutions to the factors that led to the process of deindustrialization in Brazil, in order to mitigate this process and maximize the participation of industry in the GDP, considering the policies, perceptions, and experiences mentioned above.

In addition, once the real need to prioritize the experts' answers after the application of the DPSIR method was identified, the TOPSIS method was used, which compares criteria and unitary alternatives, working as a technique that evaluates the proximity of the ideal solution and classifies them by the geometric distance of this ideal solution, prioritizing them [12]. Once the real need to prioritize the experts' answers after applying the DPSIR method was identified, the search for the Multi-Criteria Decision Analysis (MCDA) method that would allow this prioritization to be possible was set out. Among the most used MCDA methods, brought by Marttunen [12], the methods that use the pair-by-pair comparison technique of the alternatives cannot be used because the alternatives, called responses to the DPSIR, are incomparable in this research, as they are incompatible with each other, thus making it impossible to apply the MCDA methods that work with pair-by-pair comparison. Therefore, because of the above, the method that solves the problem faced here is the TOPSIS method, which compares criteria and unitary alternatives, acting as a technique that evaluates the proximity of the ideal solution, and classifies them using the geometric distance of this ideal solution, prioritizing them [12].

Thirdly, this article contributes to the formulation of strategies for the promotion of industrial policy in Brazil. It should be noted that this type of strategic formulation can corroborate future studies in other developing countries, such as India and South Africa, which also lack strategic plans for the industrial area, filling a historical gap in the world scientific literature regarding the reindustrialization plan of emerging countries [15].

This article is structured in 5 topics in addition to this introduction. Topic 2 critically reviews the bibliography on deindustrialization in the world and in Brazil. Topic 3 introduces the DPSIR and TOPSIS methods. Topic 4 discusses the results and applications of the methods in this article. Finally, topic 5 discusses the final considerations and contributions of this article.

2- Deindustrialization

The objective of this section is to contextualize the process of deindustrialization in its influencing variables and its nuances.

2-1- Deindustrialization in the World

According to Rodrik [16], in developed countries, deindustrialization was due to the loss of the share of industrial employment in total employment, but it was not due to the loss of the share of industry in the GDP, showing that there was a mature deindustrialization. The author cites the United States, where the share of manufacturing employment in total employment has fallen steadily since the 1950s, falling from about 25 percent to less than 10 percent today. However, the participation of industry in the GDP has remained constant in this period, corroborating the fact of mature deindustrialization that occurred there and in other developed countries, such as England, Japan, Germany, and, more recently, China [16, 17].

Basically, there are three patterns of deindustrialization in the world: (i) what occurred in developed countries, where there was a strong drop in the share of industrial employment in relation to the total, but a constant participation of industry in the GDP; (ii) what happened in Asian countries, where there was an increase in the share of industrial employment in relation to the total and an increase in industry in the GDP; and (iii) what happened in Latin American and African countries, where there was a drop in employment and industrial participation in GDP [16].

Observing industrialization from the point of view of late industrialization, Oliveira [17] states that the countries considered late industrialization (USA, Germany, and France) progressed based on the commercialization of surpluses produced by industries, initially English and later national, since these countries soon learned to produce domestically the goods that were previously imported from England, thus generating the desired industrialization, with qualified personnel for this. This author also emphasizes that the financing of industrialization in these countries was mostly through state investments and also via investment banks, mainly in Germany, where banks made large contributions of capital credit to industries. Therefore, the process of late industrialization reproduced the British productive structure, thus giving rise to national capitalisms similar to English capitalism, which allows Germany, France, and the USA to be placed in the same set of late industrializations [17, 16].

Oliveira [17] also states that this was the first wave of late industrialization. The second wave occurred during the Great Depression, between 1873 and 1896, and had Russia and Japan as precursors, with others following. At the same time, the Second Industrial Revolution took place, with the advent of electricity in factories, heavy chemistry, and

combustion engines. According to Kim & Kwon [18], the protectionism preached by traditionalists to actually protect their industries against the globalization of production is actually harmful to the national economy because it increases production costs, which make production and job maintenance unfeasible. Protectionism is a strategy that turns against the economy in a short time [18]. Also, according to Kim & Kwon [18], neoliberals advocate that *offshoring* leverages the economy, as it allows developing countries to increase their employment rates in industry (by having lower labor costs), while developed countries would be able to deliver cheaper and more competitive products to the globalized world, also allowing the latter to dedicate more time to research and development of new products and technologies, therefore, adding greater value to the items produced. Tavares [4] and Kim & Kwon [18] warn that, for neoliberalism to work, it is necessary to reduce state intervention in the market as much as possible, including some neoliberal economists, such as Howard Pack and Kamal Saggi, who maintain that industrial policies are unnecessary when operating in a globalized and free trade market.

Kim & Kwon [18] state that in the United States, *offshoring* has brought jobs and technologies (knowledge) to producing countries, leaving a gap in terms of learning and innovation. According to the aforementioned authors, the opposite occurred in South Korea, which had an increase in domestic employment and industrial capacity with a focus on technology and the knowledge-oriented economy, not on inputs. And this difference can be based on the focus given in South Korea to knowledge and investment in the development of collaborative innovation networks (composed of real and effective partnerships between universities, companies, and governments) [18]. South Korea's recipe for success was, as Kim & Kwon [18] report, the government's investment, in the form of a political priority, from the 2000s onwards, in the construction of an industrial ecosystem focused on innovation, through the creation of research and development funds for government institutes for the promotion and production of innovation that, in collaboration with private companies, produced new technologies, thus creating the Korean Collaborative Innovation Network. In the United States, while the government granted simple research and development tax credits and direct financial support to individual companies (usually large corporations), the Korean government focused on innovative industrial networks and research consortia, involving universities, companies (small and medium-sized, first), and the government itself [18].

China, on the other hand, has achieved rapid growth since its economic reform and market opening in 1978, lifting more than 700 million people out of poverty in the country. Since joining the World Trade Organization (WTO) in 2001, China has seen many factories moving there in search of lower manufacturing costs as well as a good supply of capital and technology through knowledge, consecrating its comparative advantages [19]. However, according to previous studies [20-22], until the fifteenth century, China had the highest per capita income in the world and many technological innovations (for the time), and even though it lost this position of highest per capita income in the world to Europe in 1500, it still held the largest national product until the beginning of the nineteenth century.

Masiero & Coelho [23] and Nolan [24] reinforce that, between 1980 and 1990, China created an industrial policy based on the opening of the market, but with regulation and control by the state, ensuring that what was planned was in fact fulfilled. And, from the 1990s onwards, there was a more dynamic opening of the Chinese economy, and in 2001, the entry of China into the WTO, which gave greater strength and strengthened the Chinese export economy, modifying many economic structures of countries impacted by Chinese industrial power. To get an idea of the size of China's investment in export manufacturing, it invested heavily in research and development, so much so that by 2007 there were 1.7 million jobs in the R&D sector, more than 80% of which were scientists and engineers, more than there were at the time in Japan. United Kingdom, France, and Germany combined [23, 24].

According to van Neuss [10], in Latin America there was an industrialization process based on the development of industries based on intensive labor and the civil construction industry. According to him, a common fact in Latin American countries is that most began their deindustrialization process in the 1980s, prematurely, when industry did not reach its peak of technological development, generating considerable impacts on unemployment and the income of the economically active population in general. This has led the economies of these countries to focus their efforts on primary areas, such as mining, extractivism, and agriculture, leading Latin America to reprimarize its economies. In fact, one of the causes was the effect of globalization on the world and on economies that were not prepared enough to compete at global levels with the world's largest exporters. A similar movement was experienced by countries in Africa [10].

Additionally, it is important to bring here the concept of how Dutch disease occurs. According to Corden [25], Dutch disease is an economic phenomenon that occurs when the discovery or exploitation of natural resources, such as oil, natural gas, minerals, or even an expanding economic sector, results in negative consequences for a country's economy.

Corden [25] reports that Dutch disease usually manifests itself through three main mechanisms: (1) appreciation of the local currency; (2) deindustrialization; (3) "income effect" (with the exploitation of natural resources, the country experiences a significant increase in income and profits, which can lead to a general increase in wages and production costs in other sectors of the economy).

Kaldor [26] states that the problems of taxation and economic development are interconnected. According to him, the tax potential of a country depends on administrative efficiency, income distribution, use of resources, and the political will to implement effective policies. Taxation plays a key role in promoting economic development.

Deindustrialization has been analyzed in recent research, mainly regarding the return of regionalization and deglobalization [27] and the different nuances of deindustrialization in countries around the world [28].

2-2- Deindustrialization in Brazil

Furtado [3] and Tavares [4] point out that Brazil's economic development was strongly influenced by a model of industrialization and import substitution, based on the belief that growth could be achieved through domestic production and the reduction of external dependence, which led to a period of intense industrial activity and increased domestic production of manufactured goods.

There was then protectionism in the national industry through high import tariffs and restrictions on imports of manufactured products. These policies aimed to foster domestic production and stimulate the growth of the industrial sector. However, these measures had limitations, since the Brazilian industry faced difficulties in competing with imported products in terms of quality and cost [3, 4, 5, 6, 29].

Tavares [4] argues that Brazilian industrial policy was marked by a series of State interventions in the economy, with the aim of promoting industrialization and boosting economic growth. She points out that the State played a central role in the formulation and implementation of these policies, through the creation of tax incentives, subsidies and protection for national industry. The economist points out that one of the main strategies adopted in the Brazilian industrial policy was the substitution of imports. Through high import tariffs and trade restrictions, the country sought to stimulate domestic production and reduce external dependence. Tavares [4] recognizes that this strategy had some success in boosting industrialization in Brazil, allowing the growth of key sectors of the economy. But she points out that, despite the advances, the country has not been able to develop a competitive and sophisticated industry in several sectors. The economist argues that the dependence on imported technology and inputs and the lack of investments in research and development were factors that hindered the innovation capacity and competitiveness of the national industry. In addition, there was a failure in the continuity and coordination of industrial policies over time, the lack of a long-term strategy and consistent policies led to fragmentation and lack of effective direction in the promotion of Brazilian industry [4].

Bacha & Bolle [30] state that the future of Brazilian development depends primarily on the integration between the primary, secondary and tertiary sectors, in a collaborative, innovative and efficient network. The authors also state that Brazil is going through a process of deindustrialization with characteristics of a Dutch disease, especially after the 1990s, but that it is reversible with efficient public policies.

Figure 1 shows the share of industry in the Brazilian GDP, from 1947 to 2021. In 1985, industry participated in the Brazilian GDP with 48% of the value added, the highest value in the historical series. After the opening of the Brazilian economy in the 1990s, this share of industry in the GDP fell precipitously, remaining stable (but low) between 1996 and 2013 at 26%, on average. After 2013, the share of industry in the GDP continued to fall, reaching 21.1% in 2017, the worst mark since the beginning of the series. Between 2014 and 2016, GDP fell by 8%. The industry closed 2021 with a share of 23.6% of GDP, a slight recovery [31, 32]. It clearly indicates a process of deceleration of Brazilian industry. However, it is also important to note that Brazil is the 13th country in participation in the world production of the manufacturing industry, with 1.48% of the world industrial production. By way of comparison, China holds the first place with 24.83% and the United States the second place with 16.27% of the world's industrial production [32].
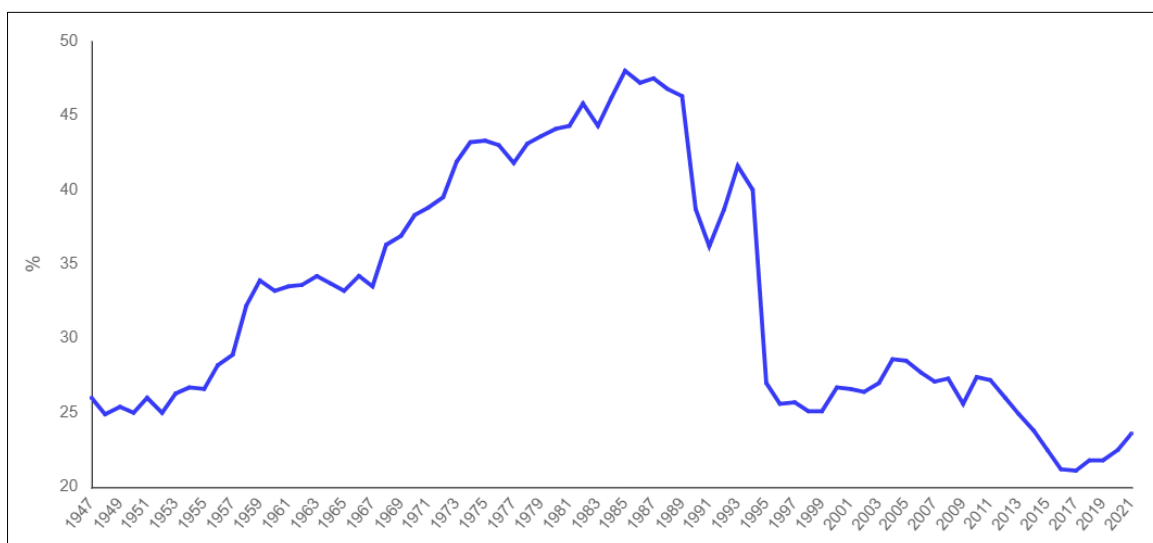

Figure 1. Industry's share of GDP, from 1947 to 2021

In a literature review in the Web of Science, Scopus and Scielo databases to survey the factors that led to the process of deindustrialization in Brazil, and after analyzing the articles, the main factors that led to the process of deindustrialization in Brazil, according to the authors researched, are listed in Table 1.

Table 1. Main factors that led to the process of deindustrialization in Brazil

Factor	Description	Reference
1	Public policies to promote sectors in which Brazil already had a certain competitive advantage, such as agriculture, mining, and civil construction, to the detriment of other sectors of the economy.	[33-35]
2	Full and multilateral liberation of free trade in the 1990s	[36]
3	Overvaluation of the exchange rate	[37-40]
4	Outsourcing of manufacturing activities to service provider sectors	[41, 42]
5	Migration of industry and employment to countries where production costs are lower	[42]
6	Low industrial investment rate	[42]
7	Increased commodity exports, generating financial dependence	[3, 25, 33-35, 40, 43, 44]
8	High interest rates	[45-48]
9	Inability to coordinate government policy	[47, 48]
10	Products from China at extremely competitive prices	[5, 6, 19, 29, 49-51]
11	High tax burden	[5, 6, 26, 29]

3- Research Method

This research is characterized by a qualitative and quantitative approach using the DPSIR and TOPSIS methods, and the research used an experience survey with a qualitative approach, in which interview questionnaires applied to specialists in the area of industrial development are used to better understand the problem analyzed. In this research, the experience *survey* has an exploratory character, as it aims to obtain a new view of the problem, from different perspectives [52]. In order to apply the DPSIR and TOPSIS methods, a *survey* was used with questions based on the aforementioned methods. In addition, it uses a systematic review of the literature to survey the published research and identify the state of the art on the subject, addressing and allowing the identification of the main factors that led to the process of deindustrialization in Brazil according to researchers in the area [52, 53].

To this end, the inclusion criteria for the choice of the specialists participating in this research are: belonging to the areas of Economics, Public Law, Scientific Research, Public Management or Private Management; economists working for at least 5 years in the private sector or in agencies linked to economic development; lawyers specializing in public law; professors-researchers in public universities in the area of economics; public managers (current or former minister, secretary, superintendent or other leadership position in public agencies linked to economic development); and directors, superintendents or other leadership positions in private companies in the manufacturing segment.

The selected intentional sample considered a total of 170 guests, with the effective return of 21 participating responding experts (representing 12.35% of the total) in the first questionnaire, 280 guests and 19 responses in the second (representing 6.79%), and 290 guests and 8 responses in the third questionnaire (representing 2.76%), and in the end the necessary distribution of professionals by area was obtained. The profile of each of these invited experts was studied before the invitation to participate in the research was sent, strictly complying with the inclusion and exclusion criteria mentioned above.

Additionally, it is important to emphasize that the results of the research are divided into 3 phases: phase 1 with the application of Questionnaire 1, which dealt with the level of agreement of the experts regarding each of the factors that led to deindustrialization; during phase 2, Questionnaire 2 related to the DPSIR was applied with the experts; and phase 3 with the application of Questionnaire 3 related to the TOPSIS method and the prioritization of the most urgent strategies.

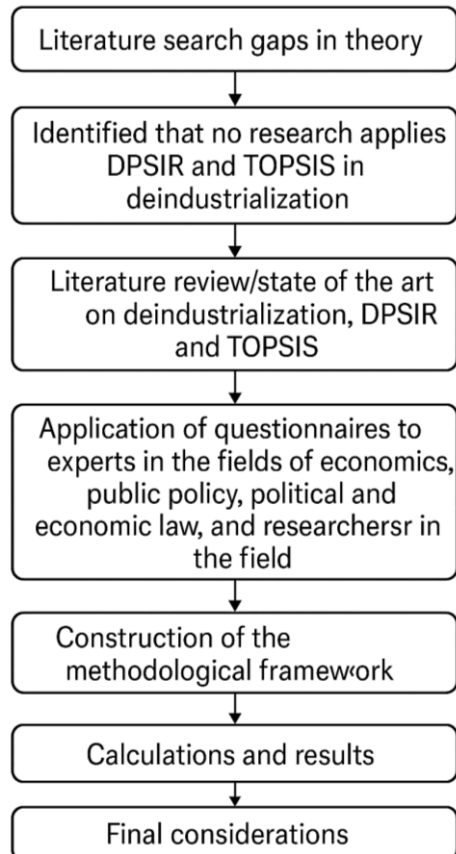Next comes Figure 2, which shows the workflow of the methodology process.

Figure 2. Worklow of the methodology process

3-1- The DPSIR Method

The vast majority of published works are in the environmental area, such as problems related to land use and occupation, tourism development, sustainability, and natural resource management, such as those found in Gupta [54] and Wu et al. [55], but, due to the essence of the DPSIR method, it is noted that its application is not limited to this field. However, the use of the DPSIR has been expanded because of two factors: (i) the DPSIR structures indicators linked to the political objectives that came from an environmental problem analyzed; and (ii) because it is simple and clear, the DPSIR attracts political actors when constructing causal relationships [56]. DPSIR has been used in recent research to support the creation of performance indicators interrelating society, economy and nature [57], and in research in industrial ecology [58].

The DPSIR can be understood as the economic and social developments (driving forces – D) that exert pressures (P) on the environment, consequently changing the state (S) of the environment, causing impacts (I) on the ecosystem, health and society in general, resulting in a response (R) from society that feeds back the driving forces, the state and/or the impacts through mitigation actions, adaptation or cure [59, 60].

Table 2. Main applications of the DPSIR in economic development issues in the world

No.	Authors	Title	Main applications
1	[55]	A systematic coupling analysis framework and multi-stage interaction mechanism between urban land use efficiency and ecological carrying capacity.	It presents a study on the unification of urbanization and economic efficiency through the efficiency of urban land use, enabling sustainable development.
2	[61]	Tourism circular economy: identification and measurement of tourism industry ecologization.	The authors propose an indicator system for assessing the greening of the tourism industry based on the DPSIR and make policy suggestions to improve the development of greening regional tourism.
3	[62]	Regional green development level and its spatial spillover effects: empirical evidence from Hubei province, China.	It used the DPSIR to measure the level of green development of a Chinese region, and brought policy proposals for development.
4	[9]	New indices system for quantifying the nexus between economic-social development, natural resources consumption, and environmental pollution in China during 1978–2018.	He used the DPSIR to propose a new Index System in order to investigate the link between socioeconomic complex, natural and environmental resources.
5	[63]	Research on the Evaluation of Real Estate Inventory Management in China.	It used DPSIR to integrate economic, social, and environmental factors to assess the performance of real estate inventory management in China.
6	[64]	Development Indicators and Soybean Production in Brazil.	It categorized the 30 largest soybean-producing municipalities in Brazil with the help of DPSIR to obtain ranking factors based on soybean's influence on the local economy, number of jobs generated by soybeans, and soybean's impact on the environment.

It is observed that no publication was found that related the DPSIR to deindustrialization. Another fact is that, even though there are applications of the DPSIR in development-related issues, they all consider the environment.

3-2- The Topsis Method

According to Hwang & Yoon [65], the creators of the TOPSIS method, which stands for *Technique For Order Preference By Similarity To Ideal Solution* , created the method to obtain the judgment that the chosen alternative needs to have the shortest distance from the ideal solution and as far as possible from the negative ideal solution. The logic is simple: imagine that each attribute has increasing (or decreasing) utility, which makes it easy to think that the ideal solution is composed of all the best achievable attribute values, and the negative ideal solution is the worst achievable attribute values [65]. We then have the alternatives classified in order of preference, from the most ideal to the least ideal. TOPSIS has been used in recent research on economics and sustainability, such as supporting the construction of water stress maps [66], in the development of sustainability indicators in thermodynamic assessments [67], among others.

The application of the method is carried out, sequentially, by calculating the weighted normalized decision matrix V of Equation 1, by determining the positive and negative ideal solutions of Equations 2 and 3, by calculating the separation measure of Equations 4 and 5, and by calculating the relative proximity of the ideal solution of Equation 6.

$$
V = \begin{bmatrix} v_{11} & v_{12} & \cdots & v_{1j} & \cdots & v_{1n} \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ v_{i1} & v_{i2} & \cdots & v_{ij} & \cdots & v_{in} \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ v_{m1} & v_{m2} & \cdots & v_{mj} & \cdots & v_{mn} \end{bmatrix} = \begin{bmatrix} w_1 r_{11} & w_2 r_{12} & \cdots & w_j r_{ij} & \cdots & w_n r_{1n} \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ w_1 r_{i1} & w_2 r_{i2} & \cdots & w_j r_{ij} & \cdots & w_n r_{in} \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ w_1 r_{m1} & w_2 r_{m2} & \cdots & w_j r_{mj} & \cdots & w_n r_{mn} \end{bmatrix} \tag{1}
$$

$$
A^* = \{(\max v_{ij} | j \in J), (min v_{ij} | j \in J') | i = 1, 2, \ldots, m\} = \{v_1^*, v_2^*, \ldots, v_j^*, \ldots, v_n^*\} \tag{2}
$$

$$
A^- = \{(\min v_{ij} | j \in J), (max v_{ij} | j \in J') | i = 1, 2, \ldots, m\} = \{v_1^-, v_2^-, \ldots, v_j^-, \ldots, v_n^-\} \tag{3}
$$

$$
S_i^* = \sqrt{\sum_{j=1}^n (v_{ij} - v_j^*)^2} \ , i = 1, 2, \ldots, m \tag{4}
$$

$$
S_i^- = \sqrt{\sum_{j=1}^n (v_{ij} - v_j^-)^2} \ , i = 1, 2, \ldots, m \tag{5}
$$

$$
S_i^- = \sqrt{\sum_{j=1}^n (v_{ij} - v_j^-)^2} \ , i = 1, 2, \ldots, m \tag{6}
$$

The symbols are: v is the vector resulting from the multiplication of the weight w by the ratio r; the matrix A is the maximum of the vector v such that j belongs to J, and is the minimum of the vector v such that j belongs to J row; i is the row and j the column; when it is the maximum vector, the matrix A is positive (*), and when it is the minimum vector, the matrix A is negative (-); S is the measure of separation from the ideal solution; and C is the result of the calculation of the relative proximity of the ideal solution.

After performing the calculations, the alternatives are classified in order of preference, from the most ideal to the least ideal.

3-3- The SWOT Method of Structuring Problems

The SWOT method has been widely used since the 1960s, due to its simplicity in application and its effective strategic approach, collaborating with organizations in the correct identification of Strengths, Weaknesses, *Opportunities and Threats (*hence the acronym SWOT). With the correct SWOT analysis, the organization can draw up more assertive and effective strategic plans, as it gives those involved the opportunity to understand their problems and their interconnection with the success factor of the strategic plan. It is important to emphasize that the SWOT analysis needs to be done from the perspective of the client or the stakeholder closest to the target of the analysis so that it is as realistic as possible, without personalities or deviations from the central focus [68, 69].

Also according to Phadermrod et al. [68], Strengths and Weaknesses are internal (controllable) factors, and can enhance (in the case of Strengths) or mitigate (in the case of Weaknesses) the characteristics of the company related to the achievement of the planned goals. Opportunities and Threats, on the other hand, are external factors, said to be uncontrollable because they depend on agents external to the company and its management, and which can

allow or disable organizations from fulfilling their missions. By performing this SWOT analysis, the organization is able to raise, in a structured way, its weaknesses and qualities, in order to be able to develop effective strategic plans.

4- Results and Discussion

4-1- Factors that Led to the Deindustrialization of Brazil

In this first phase of the survey with specialists, 170 questionnaires were sent, with an effective return of 24 answered. The majority, 44.4%, have a degree in Economics, and 83.3% have at least 16 years of experience in the area. The positions they held in their career were: analysts and managers of the private and/or public sector, directors of finance/investments/research, pro-rector, director of investment banking, university professors, consultants, course coordinator of an internationally renowned university, and director of a public agency at the federal level. Regarding the geographic distribution of the specialists, of the 24 respondents, 21 are from the southeast, 1 from the south and 2 from the midwest. And of these 24, 12 are from the private sector and 12 are civil servants. This demographic profile corroborates the *know-how* of the experts and gives credibility to the information collected. The questionnaires were sent to specialists from all Brazilian regions, both private and public, as it is not the objective of the latter to create biased samples. However, because the theme of the survey is extremely focused on industrial development, the specialists were chosen based on their experiences and backgrounds focused on this theme, which brought a limitation both in the number of respondents (they are professionals with managerial, strategic or research positions who have little time available to answer surveys) and in their geographical distribution (the vast majority of the responding specialists are from the southeast region).

The experts answered about their agreement with the eleven factors that led to the deindustrialization of Brazil, obtained through a literature review, obeying a 5-point Likert scale that varied from totally disagree to totally agree, passing through partially disagree, indifferent and partially agree. Table 1 shows the factors and their respective levels of agreement, according to the experts who participated in questionnaire 1 of the research, classified in descending order. The factors that had at least 50% agreement were considered to be factors that led to the deindustrialization of Brazil, where it is observed that eight factors (9, 6, 8, 11, 3, 10, 2 and 5) have this level of agreement among the experts. The purpose of this Table 3 is to validate the factors with the experts, in addition to ordering them by level of agreement, in order to proceed with the application of the other following questionnaires.

Table 3. Factors that led to the deindustrialization of Brazil and their levels of agreement ranked in descending order

	Factors that led to the deindustrialization of Brazil	Level of agreement
9	Inability to coordinate government policy	87.50%
6	Low industrial investment rate	83.33%
8	High interest rates	75.00%
11	High tax burden	66.67%
3	Overvaluation of the exchange rate	62.50%
10	Products from China at extremely competitive prices	58.33%
2	Full and multilateral liberation of free trade in the 1990s	50.00%
5	Migration of industry and employment to countries where production costs are lower	50.00%
1	Public policies to promote sectors in which Brazil already had a certain competitive advantage, such as agriculture, mining and civil construction, to the detriment of other sectors of the economy	37.50%
7	Increased commodity exports, generating financial dependence	33.33%
4	Outsourcing of manufacturing activities to service provider sectors	20.83%

4-2- Strategies to Reverse Deindustrialization in Brazil

In phase 2, the experts chosen to answer Questionnaire 2 – Application of the DPSIR are the same ones who answered Questionnaire 1. They answered five questions that contextualized the DPSIR in the evaluated scenario. The questions were, in full:

- Among the 8 factors that led to deindustrialization presented above, which do you think are the motivators, in fact, of Brazil's deindustrialization? (D);

- What pressures do these factors above trigger in the economic and industrial environment? (P);

- How was the environment where changes occurred caused by the pressures mentioned earlier by you? (S);

- What were the impacts generated by the pressures that occurred in the state, due to the factors that led to deindustrialization? (I);

- What are your proposals to reverse the process of deindustrialization in Brazil? (R).

Each phase of the DPSIR was called D for *Driven forces*, P for *Pressures*, S for *State*, I for *Impacts*, and R for *Responses*. For each item of the method belonging to each phase, a sequential number will be given along with the letter that represents its phase, such as D1, D2, and so on. The similar answers were grouped in Table 4 the result of the answers.

Table 4. Result of the application of the DPSIR to the specialists

D - *Driven forces*:
* Inability to coordinate government policy (D1);
* Low industrial investment rate (D2);
* High interest rates (D3);
* High tax burden (D4);
* Overvaluation of the exchange rate (D5);
* Products from China at extremely competitive prices (D6);
* Full and multilateral liberation of free trade in the 1990s (D7);
* Migration of industry and employment to countries where production costs are lower (D8).

P - Pressures:
* Lack of stimulus to domestic production and stimulus to imports of manufactured goods (P1);
* Retraction and lack of competitiveness and innovation (P2);
* Investments aimed much more at recomposing depreciated productive capital than at expanding industrial productive capacity (P3);
* The inability of government policy coordination causes pressures in the economic and industrial environment, since it does not articulate actions to improve infrastructure, incentives for industrial diversification and also to provide incentives for new companies (P4);
* Vicious cycle with low-skilled labor and reduction of job opportunities in medium and high-skilled occupations, moved to other countries (P5);
* Globalization (P6);
* Cost pressure and increased competition (P7);
* Instability and low profitability (P8);
* Low investment rate in the sector (P9);
* Import stimulus (P10);
* High production costs (P11);
* Stimulus to rentism (P12).

S - State:
* Unfavorable and uncompetitive business environment (S1);
* Lack of perspective and incentive to invest (S2);
* Pressured and strangled, where the strength of the brand is checked, to the detriment of the search for price (S3);
* Importing manufactured products and exporting commodities, causing job creation in sectors with lower added value and negative environmental impacts, since commodities are intensive in natural resources and generate the scale effect (S4);
* Migration of resources to the service sector (S5);
* Weak development of technological skills, especially those resulting from R&D efforts, in Brazilian companies, even in sectors of low technological intensity (S6);
* Most Brazilian regions have undergone a process of deindustrialization, with companies with obsolete machinery, indebtedness and seeking to face competition from parallel substitute products (made in China) (S7);
* External liberalization without strategic selective counterpart (S8);
* Unstable and unprofitable (S9);
* Below-average economic growth rates, unemployment and underemployment (S10).

I - Impacts:

* Low economic growth (I1);

* Low competitiveness of the national company (I2);

* Decrease in employment and revenue (I3);

* Low-skilled jobs (I4);

* Loss of knowledge (I5);

* Innovation policies more focused on credit than economic subsidy (I6);

* Unemployment in specialized sectors (I7);

* Closure of many companies in various sectors of the economy (I8);

* Reduction of investment in R&D by companies (I9);

* Increase in the weight of less qualified services (I10);

* Increase in the distance of technological skills dominated by Brazil in relation to the border (I11);

* Non-replacement of obsolete capital (I12);

* Aging of product lines, low quality and high costs (I13);

* Non-entry into Global Production Chains (I14);

* Lack of coordination between industrial and macroeconomic policies (I15);

* Drop in the level of sectoral income and fall in the level of national income (I16);

* Drop in investment in worker training (I17);

* Drop in workers' income (I18);

* Drop in the consumption of Brazilian industrialized products (I19);

* Retraction of the sector in the country (I20);

* Increase in informality and socioeconomic inequality (I21).

R - Responses:

* Simplification of the Tax System with VAT (Value Added Tax), reduction of taxes and rates (tax reform) (R1);

* Economic public policies that aim to develop areas of excellence and bring this to less privileged areas (R2);

* Institutional change, because economic decisions come from groups, from individuals who act according to the institutions defined by Douglass North, and individual behaviors as well (as long as this does not change, no policy will be in force beyond the years of each government and despite the existing formal rules and norms, policies need to be maintained beyond at least 4 years, regardless of what they are) (R3);

* Critical analysis of the technological constraints of industrial processes and manufactured products in relation to the international market, thus, based on the mapping from the analysis, establish lines of financing for research and development projects in conjunction with Universities and research centers to reduce the existing technological gap (R4);

* Increase the rate of industrial investment, with subsidized interest and other measures (e.g., economic subsidy) for sectors that generate more innovation in both products and processes, but ranging from basic industry to aerospace (R5);

* Well-conducted trade opening would help strengthen the industry (R6);

* Slightly devalued exchange rate, but without causing spurious competitiveness in Fernando Fajnzylber's terms (Fernando Fajnzylber was an important thinker for Latin American development and created ECLAC's new theoretical approach in the 1990s, which led to the project of "productive transformation with equity". His work had as its main objective to overcome the obstacles to economic growth and constant social exclusion in Latin America, seeking to create a development model that was less dependent and less exclusionary, while promoting economic growth and social equity. (R7);

* Investment in education at all levels (with emphasis on basic education), encouragement of technical courses (R8);

* Implementation of a planning agenda that takes into account the current Brazilian situation with its weaknesses and potentials (R9);

* Implementation of mechanisms for the collection and accountability of the beneficiaries of targeted public resources, as well as of the public agents responsible for the implementation of industrial policies (R10);

* Industrialization in niche opportunities (clear comparative advantages) seems to be a sustainable goal (R11);

* UNASUR Regional Block for GVC (global value chain) in South America with lower transport costs (R12);

* Map the industries and identify their challenges in recent years/decades, and at the same time, it is necessary to understand the process of changes in value chains around the world and the technological challenges that are currently presented, however, from this, it is necessary to establish a permanent dialogue channel with the sectors and industrial representatives to design a broader industrial policy and, at the same time, coordinated with other macroeconomic policies, aiming to ensure competitiveness and international partnerships for the national industry (R13);

* Concession of state-owned companies with gross fixed capital formation targets (R14);

* Facilitation of foreign direct investment (FDI) in sectors that generate employment and income, by companies that are committed to bringing international monetary resources for investment in the country (R15);

* Monetary policy and national infrastructure investment plan (R16);

* Continued progress in the labor reform (R17);

* Administrative reform (R18);

* Minimum income for the underprivileged (R19);

* Recovery of the macroeconomic tripod (fiscal responsibility, inflation targets, and floating exchange rate) (R20).

4-3-Prioritization of Actions: Application of TOPSIS

In phase 3, 290 questionnaires were sent (questionnaire 3) to specialists with expertise in the area of economic development, whether in the field of economic science, engineering, administration or law. 8 responses were obtained, since for this problem the questionnaire involved 160 questions, as a result of the TOPSIS method. It is important to emphasize the expertise of the experts who participated in this phase of the research, 6 were economists, 1 lawyer and 1

engineer, and most (6) had more than 16 years of experience. 6 are from the southeast region, 1 from the south region and 1 from the central-west region of Brazil.

The experts were asked at what level (on the 5-point Likert scale) they agreed that a given answer solves a certain factor that led to deindustrialization. Afterwards, the average of the experts' votes was made by answer and factor, as shown in Table 5.

Table 5. Result of the averages of the experts' answers for each factor that led to deindustrialization

Expert Answers To Address These Factors	Inability to coordinate government policy (F1)	Low industrial investment rate (F2)	High interest rates (F3)	High tax burden (F4)	Overvaluation of the exchange rate (F5)	Products from China at Extremely Competitive Prices (F6)	Full and multilateral liberation of free trade in the 1990s (F7)	Migration of industry and employment to countries where production costs are lower (F8)
Simplification of the Tax System with VAT, reduction of taxes and rates (tax reform) (R1);	6.00	6.25	3.50	6.75	3.50	5.50	4.50	6.25
Economic public policies that aim to develop areas of excellence and bring this to less privileged areas (R2);	7.50	7.25	2.75	4.75	2.75	5.50	6.00	6.50
Institutional change, because economic decisions come from groups, from individuals who act according to the institutions defined by Douglass North, and individual behaviors as well (as long as this does not change, no policy will be in force beyond the years of each government and despite the existing formal rules and norms, policies need to be maintained beyond at least 4 years, regardless of what they are) (R3);	5.50	4.75	3.75	4.50	4.50	4.75	4.75	5.25
Critical analysis of the technological constraints of industrial processes and manufactured products in relation to the international market, thus, based on the mapping from the analysis, establish lines of financing for research and development projects in conjunction with Universities and research centers to reduce the existing technological gap (R4);	7.00	6.50	3.50	5.00	3.50	6.25	5.00	6.75
Increase the rate of industrial investment, with subsidized interest and other measures (e.g., economic subsidy) for sectors that generate more innovation in both products and processes, but ranging from basic industry to aerospace (R5);	6.25	7.00	3.75	4.75	4.00	5.00	5.50	5.75
Well-conducted trade opening would help strengthen the industry (R6);	5.00	4.00	3.50	3.25	3.25	3.25	4.50	3.75
The exchange rate was slightly devalued, but without causing spurious competitiveness in Fernando Fajnzylber's terms (Fernando Fajnzylber was an important thinker for Latin American development and created ECLAC's new theoretical approach in the 1990s, which led to the project of "productive transformation with equity". His work had as its main objective to overcome the obstacles to economic growth and constant social exclusion in Latin America, seeking to create a development model that was less dependent and less exclusionary, while promoting economic growth and social equity. (R7);	5.50	5.75	3.75	4.00	6.00	5.00	5.50	5.75
Investment in education at all levels (with emphasis on basic education), encouragement of technical courses (R8);	7.00	6.50	3.00	4.00	3.25	5.00	4.75	7.25
Implementation of a planning agenda that takes into account the current Brazilian situation with its weaknesses and potentials (R9);	7.75	7.75	5.00	6.00	6.00	6.75	6.50	7.50
Implementation of mechanisms for the collection and accountability of the beneficiaries of targeted public resources, as well as of the public agents responsible for the implementation of industrial policies (R10);	6.25	5.50	3.00	4.50	3.75	4.25	4.75	4.50
Industrialization in niche opportunities (clear comparative advantages) seems to be a sustainable goal (R11);	5.75	6.25	2.25	3.25	3.25	6.25	6.00	6.75
UNASUR Regional Block for GVC (global value chain) in South America with lower transport costs (R12);	5.00	5.25	2.50	3.75	4.75	6.25	6.00	6.00
Mapping the industries and identifying their challenges in recent years/decades, and at the same time, it is necessary to understand the process of changes in value chains around the world and the technological challenges that are currently presented, however, from this, it is necessary to establish a permanent dialogue channel with the sectors and industrial representatives to design a broader industrial policy and, at the same time, coordinated with other macroeconomic policies, aiming to ensure competitiveness and international partnerships for the national industry (R13);	6.75	7.25	3.25	4.25	5.25	7.25	6.25	7.00
Concession of state-owned companies with gross fixed capital formation targets (R14);	5.00	4.25	2.75	3.00	2.50	3.00	4.00	4.00
Facilitation of foreign direct investment (FDI) in sectors that generate employment and income, by companies that are committed to bringing international monetary resources for investment in the country (R15);	4.75	4.75	3.50	3.75	4.50	3.00	4.50	4.75
Monetary policy and national plan for investments in infrastructure (R16);	7.25	6.00	5.75	5.00	4.25	5.50	5.75	5.50
Continued progress in the labor reform (R17);	3.25	2.75	1.75	2.75	2.00	2.75	3.00	4.00
Administrative reform (R18);	3.50	2.75	2.75	3.50	2.50	2.25	3.25	3.75
Minimum income for the underprivileged (R19);	5.50	5.25	2.75	2.50	2.50	3.25	4.00	4.25
Recovery of the macroeconomic tripod (fiscal responsibility, inflation targets, and floating exchange rate) (R20).	3.75	4.00	3.25	4.75	4.25	3.25	3.75	3.75

Next, the step-by-step of the TOPSIS method was executed, constructing the normalized matrix, the weighted normalized, the positive and negative ideal solutions, the separation measure, the relative proximity of the ideal solution and the classification in order of preference, as shown in Table 6.

Table 6. Answers ranked in order of priority to solve the factors that led to the deindustrialization of Brazil after applying the TOPSIS method

Expert Answers To Address These Factors	Relative proximity of optimal solution (Ci*)
Implementation of a planning agenda that takes into account the current Brazilian situation with its weaknesses and potentials (R9);	0.8869
Monetary policy and national plan for investments in infrastructure (R16);	0.7142
Mapping the industries and identifying their challenges in recent years/decades, and at the same time, it is necessary to understand the process of changes in value chains around the world and the technological challenges that are currently presented, however, from this, it is necessary to establish a permanent dialogue channel with the sectors and industrial representatives to design a broader industrial policy and, at the same time, coordinated with other macroeconomic policies, aiming to ensure competitiveness and international partnerships for the national industry (R13);	0.6494
Critical analysis of the technological constraints of industrial processes and manufactured products in relation to the international market, thus, based on the mapping from the analysis, establish lines of financing for research and development projects in conjunction with Universities and research centers to reduce the existing technological gap (R4);	0.6046
Increase the rate of industrial investment, with subsidized interest and other measures (e.g., economic subsidy) for sectors that generate more innovation in both products and processes, but ranging from basic industry to aerospace (R5);	0.5957
Simplification of the Tax System with VAT, reduction of taxes and rates (tax reform) (R1);	0.5920
The exchange rate was slightly devalued, but without causing spurious competitiveness in Fernando Fajnzylber's terms (Fernando Fajnzylber was an important thinker for Latin American development and created ECLAC's new theoretical approach in the 1990s, which led to the project of "productive transformation with equity". His work had as its main objective to overcome the obstacles to economic growth and constant social exclusion in Latin America, seeking to create a development model that was less dependent and less exclusionary, while promoting economic growth and social equity. (R7);	0.5658
Economic public policies that aim to develop areas of excellence and bring this to less privileged areas (R2);	0.5549
Investment in education at all levels (with emphasis on basic education), encouragement of technical courses (R8);	0.5185
Institutional change, because economic decisions come from groups, from individuals who act according to the institutions defined by Douglass North, and individual behaviors as well (as long as this does not change, no policy will be in force beyond the years of each government and despite the existing formal rules and norms, policies need to be maintained beyond at least 4 years, regardless of what they are) (R3);	0.4912
UNASUR Regional Block for GVC (global value chain) in South America with lower transport costs (R12);	0.4617
Implementation of mechanisms for the collection and accountability of the beneficiaries of targeted public resources, as well as of the public agents responsible for the implementation of industrial policies (R10);	0.4560
Industrialization in niche opportunities (clear comparative advantages) seems to be a sustainable goal (R11);	0.4548
Facilitation of foreign direct investment (FDI) in sectors that generate employment and income, by companies that are committed to bringing international monetary resources for investment in the country (R15);	0.3896
Recovery of the macroeconomic tripod (fiscal responsibility, inflation targets, and floating exchange rate) (R20).	0.3407
Well-conducted trade opening would help strengthen the industry (R6);	0.3169
Minimum income for the underprivileged (R19);	0.3002
Concession of state-owned companies with gross fixed capital formation targets (R14);	0.2421
Administrative reform (R18);	0.1519
Continued progress in the labor reform (R17);	0.0407

It is observed that the priority answer, according to experts and after the application of the TOPSIS method, is R9, which says that to solve the factors that led to deindustrialization and thus mitigate the ongoing deindustrialization process, it is necessary to implement a planning agenda that takes into account the current Brazilian situation with its weaknesses and potentials. And so on, even the least priority, according to the same experts, which is R17, which says that to solve the factors that led to the deindustrialization of Brazil, it is necessary to continue advancing the labor reform.

Figure 3 is a flowchart summarizing the main components of DPSIR and how it sequentially connects and helps solve TOPSIS.
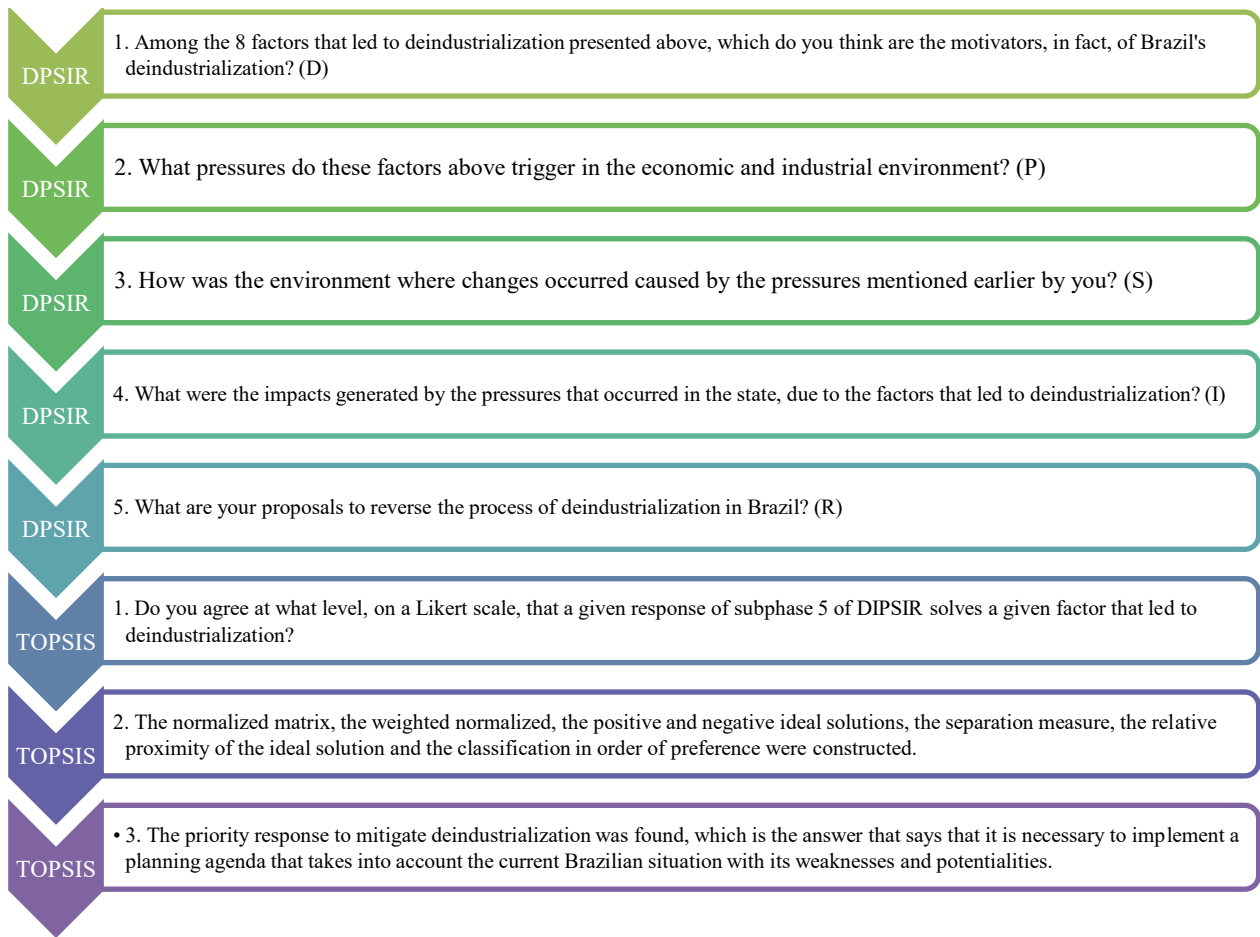
DPSIR 1. Among the 8 factors that led to deindustrialization presented above, which do you think are the motivators, in fact, of Brazil's deindustrialization? (D)

DPSIR 2. What pressures do these factors above trigger in the economic and industrial environment? (P)

DPSIR 3. How was the environment where changes occurred caused by the pressures mentioned earlier by you? (S)

DPSIR 4. What were the impacts generated by the pressures that occurred in the state, due to the factors that led to deindustrialization? (I)

DPSIR 5. What are your proposals to reverse the process of deindustrialization in Brazil? (R)

TOPSIS 1. Do you agree at what level, on a Likert scale, that a given response of subphase 5 of DIPSIR solves a given factor that led to deindustrialization?

TOPSIS 2. The normalized matrix, the weighted normalized, the positive and negative ideal solutions, the separation measure, the relative proximity of the ideal solution and the classification in order of preference were constructed.

TOPSIS • 3. The priority response to mitigate deindustrialization was found, which is the answer that says that it is necessary to implement a planning agenda that takes into account the current Brazilian situation with its weaknesses and potentialities.

Figure 3. Flowchart with the main components of DPSIR and how it connects and solves TOPSIS

4-4- Execution of the Swot Analysis Applied to the Current Industrial Segment

Now the research continues, identifying the strengths, weaknesses, opportunities and threats to the Brazilian industrial segment, having the SWOT methodology as a guide.

Table 7 shows: the country's Strengths (internal factors) that impact the Brazilian industrial segment, based on scientific publications by renowned researchers; the country's Weaknesses (taken from Table 1), or weaknesses (internal factors), that impacted the Brazilian industrial segment, based on the factors that led to the deindustrialization of Brazil, with a level of agreement equal to or greater than 50% of the experts interviewed, with the exception of factor 6 - Products from China at extremely competitive prices, which does not represent a weakness but a threat (external factor); the Opportunities (external factors), taken from the questionnaire applied to the specialists using the DPSIR method, in the Answers phase (last phase); and the Threats (external factors) taken from the questionnaire applied to the experts using the DPSIR method, in the Pressures phase.

Table 7. Application of the SWOT analysis applied to the current industrial segment in Brazil

Strengths	Weaknesses
1. Expressive Domestic Market: Brazil has one of the largest consumer markets in the world, driven by a population of more than 210 million inhabitants. This scale favors productive diversification and attracts investments [70];	1. Inability to coordinate government policy;
2. Abundance of Natural Resources: the availability of mineral, agricultural, and energy resources sustains sectors such as mining, steel, and bioindustries [71];	2. Low industrial investment rate;
3. Competitive Agroindustry: highlight in the production of ethanol from sugarcane and soybean complex, with tropicalized technology and global leadership [72];	3. High interest rates;
4. High-Tech Aeronautical Industry: Embraer consolidated Brazil as a global leader in regional aviation, with strong integration into the global value chain [73];	4. High tax burden;
5. Renewable Energy Matrix: the participation of renewable sources (hydroelectric, wind, biofuels) reduces industrial costs and meets environmental demands [74];	5. Overvaluation of the exchange rate;
6. Dynamic Industrial Clusters: regional concentrations (such as the automotive hub in São Paulo) promote synergies and reduce logistics costs [75];	6. Full and multilateral liberation of free trade in the 1990s;

7. Investments in Innovation and R&D: public policies (Lei do Bem, Finep) and university-company partnerships boost industrial innovation [76];	7. Migration of industry and employment to countries where production costs are lower.
8. Consolidated Automotive Sector: Brazil is one of the 10 largest vehicle producers in the world, with an integrated supply chain [77];	
9. Structural Chemical and Petrochemical Complex: Petrobras and hubs such as the Camaçari Complex ensure self-sufficiency in strategic inputs [78];	
10. Qualified Labor: technical institutions (SENAI, universities) train professionals for highly complex sectors [33].	

Opportunities	Threats
1. Establish funding lines for research and development projects in conjunction with universities and research centers to reduce the existing technological gap;	1. While Brazil lacks stimulus to domestic production, other countries foster industrial innovation;
2. Increase the rate of industrial investment, with subsidized interest and other measures (e.g., economic subsidy) for sectors that generate more innovation in both products and processes, but ranging from basic industry to aerospace;	2. Increased competitiveness of countries that previously did not have industrial tradition and economic power, such as South Korea, for example;
3. Carrying out a well-conducted commercial opening would help strengthen the industry;	3. In other countries, there are investments aimed at expanding industrial production capacity and policies strongly oriented towards the purchase of machinery and equipment, leading to the modernization of the production park;
4. Investment in education at all levels (with emphasis on basic education), and encouragement of technical courses;	4. While in Brazil the inability of government policy coordination causes pressures in the economic and industrial environment, since it does not articulate actions to improve infrastructure, incentives for industrial diversification and new companies, other countries, such as South Korea and India, do exactly the opposite;
5. Implementation of a planning agenda that takes into account the current situation of the Brazilian industrial segment with its weaknesses and potentials;	5. Other countries report that their technological changes have been transferred to knowledge-intensive sectors and the Brazilian economy has lagged behind in this process;
6. Industrialization in niches of opportunity (clear comparative advantages);	6. In other countries, there is an incentive for innovative activity, greater ease of planning and coordination between agents in the public and private sectors, a higher proportion of qualified labor and job opportunities in medium and high qualification occupations;
7. Develop a broader industrial policy and, at the same time, coordinated with other macroeconomic policies, aiming to ensure competitiveness and international partnerships for the national industry;	7. High competitiveness of imported products;
8. Facilitation of foreign direct investment (FDI) in sectors of the industrial segment strategically chosen as the greatest generators of innovation and income for the population.	8. Globalization;
	9. Pressure for lower costs and increased competition;
	10. Increase in the rate of investment in the industrial sector in other countries;
	11. In other countries, export stimulus;
	12. Pressures to lower the cost of production, curbing investments and improvements in the manufacturing industry;
	13. Products from China at extremely competitive prices.

With this, SWOT is applied, so that it is then possible to prepare a Plan for the Reindustrialization of Brazil.

4-5- Brazil's Reindustrialization Plan

From the strategies to maximize the participation of industry in the GDP and mitigate the deindustrialization process, using the DPSIR and TOPSIS methods, the Brazilian Reindustrialization Plan is created here, all actions to be carried out by the federal government, acting together with its ministries and political and economic scientists.

The actions to reverse the process of deindustrialization in Brazil, according to the specialists in industrial development participating in this research, and to start its reindustrialization come from the Opportunities phase of the SWOT previously applied, namely:

- Establish financing lines for research and development projects in conjunction with universities and research centers to reduce the existing technological gap. This type of action brings research institutes closer to the consumer market for research, with this consumer market being the direct beneficiary of the research, making the practical tasks of the triple helix more effective;

- Increase the rate of industrial investment, with subsidized interest rates and other measures (e.g., economic subsidies), for sectors that generate more innovation, both in products and processes, but covering everything from basic industry to aerospace. This action requires efforts to be made in strategic sectors that bring greater added value to the country's economy as a whole, generating benefits for practically all segments;

- Carry out a well-managed trade liberalization. In this action, it can be clearly seen that there was haste at the time when the government indiscriminately opened the market to the entry of manufactured products with higher added

value, which led to a drop in the national industry's share of GDP because it was not prepared to compete on an equal footing (quality and costs) with imported products;

- Investment in education at all levels (with emphasis on basic education) and incentives for technical courses. With this action, it is expected that new governments will focus on greater quality in the educational process, starting at the base, where many values and skills are built and transferred to the remaining levels of education, fostering transformative education, focused on quality results, not quantity;

- Implementation of a planning agenda that takes into account the current situation of the Brazilian industrial sector, with its weaknesses and potentialities. This action considers that political planning without considering weaknesses and potentialities is a mere waste of time. It is necessary to draw up plans with horizons longer than 10 years, where actions are outlined in key sectors, where Brazil can have a certain competitive advantage and can develop more prosperous results;

- Industrialization in opportunity niches (where Brazil presents clear comparative advantages). This action is in line with the previous one, where the focus should be on strategic sectors with greater added value and, additionally, which Brazil can masterfully improve;

- Develop a broader industrial policy that is coordinated with other macroeconomic policies, aiming to ensure competitiveness and international partnerships for the national industry. This action addresses the issue of international partnerships, public-private partnerships and the interconnection between them. With strong, strategic and vibrant partners, actions become more productive;

- Facilitate foreign direct investment (FDI) in sectors of the industrial segment strategically chosen as the greatest generators of innovation and income for the population. This last action corroborates the previous ones regarding focusing efforts on sectors of the economy that would boost the Brazilian industrial economy. It is necessary to join forces, yes, but more important than joining forces is knowing where strategic actions should go. Greater focus on activities that add value to GDP and less focus on commodities.

By implementing these eight actions, it is expected that the government will begin to observe improvements, in the medium and long term, in the participation of industry in the GDP, generating the reindustrialization of the country. Obviously, these results will only be felt over decades, and if they are in fact implemented by competent political actors focused on the industrial development of Brazil. There is no more room for populism and "chicken flights" (popular jargon to indicate that an action had a short trajectory and almost zero impact on the expected result). It is necessary that, regardless of the political party, the actors understand that industry is the great engine of the economy, and that it generates and distributes income and wealth to the population like no other sector. Therefore, investing in this Brazilian Reindustrialization Plan will only bring benefits to the country as a whole, including tax collection and improvement of the country in the ranking of the richest countries in the world.

4-6- Comparative Analysis of This Study with Previous Studies

It was observed that the strategic solutions proposed by the experts are in line with what the authors who came before this study presented in their research, mentioned in the previous chapters of this same article. These other researchers reported that there was a lack of planning that considered public policies to promote and enhance reindustrialization, so that industry would once again have a greater share of the country's GDP. The other strategies consider and corroborate the researchers cited in this article on the topic of deindustrialization and economic development through industry.

This leads us to believe that the research applied here with questionnaires to experts in the areas of economics, political and public law, administrators and engineers linked to research in industrial development was validated and substantiated by previous researchers, who, in isolation and not jointly, suggested almost the same strategies. There are no studies or research that used DPSIR and/or TOPSIS to develop strategies to mitigate the deindustrialization process faced by the country, so it is not possible to compare the final application of this research with other previously published research, corroborating the fact that this research is unprecedented, useful and original.

5- Conclusion

This study identified and prioritized strategic actions for Brazil's Reindustrialization Plan through the application of the DPSIR and TOPSIS methodologies. Based on expert assessments, three strategies emerged as priorities: (i) the development of a planning agenda that addresses Brazil's current context, including its structural weaknesses and potentialities; (ii) the reinforcement of monetary policy alongside a national infrastructure investment plan; and (iii) the mapping of industrial sectors to identify their long-term challenges, while analyzing global value chain transformations and technological demands. This third strategy also calls for the establishment of a permanent dialogue with industrial stakeholders to formulate a comprehensive and coordinated industrial policy aligned with broader macroeconomic strategies, with the goal of ensuring competitiveness and fostering international partnerships.

Although expert responses were concentrated in Brazil's Southeast region, where industrial activity is predominantly located, the findings are considered representative. The proposed strategies, if effectively implemented, possess strong potential to generate positive impacts on the national industrial sector and broader economy. This is particularly relevant given the manufacturing sector's capacity to generate income at scale, stimulate production networks, and contribute to foreign exchange generation, even in the current digital and technological age. Furthermore, the suggested strategies may serve as a reference for other developing nations experiencing similar deindustrialization challenges. By addressing structural barriers and promoting strategic agreement, these recommendations offer a pathway to economic revitalization and industrial resurgence. Finally, the research advances academic knowledge by introducing an innovative application of the DPSIR and TOPSIS methods in the context of industrial policy formulation. It sets a foundation for future studies focused on the practical implementation of strategic responses to deindustrialization and supports informed policymaking in emerging economies facing analogous economic dynamics.

6- Declarations

6-1- Author Contributions

Conceptualization, W.C. and R.M.S.; methodology, W.C. and R.M.S.; validation, W.C. and R.M.S.; formal analysis, R.M.S. and D.F.; investigation, W.C.; resources, R.M.S. and D.F.; data curation, R.M.S.; writing—original draft preparation, W.C.; writing—review and editing, W.C., R.M.S., and D.F.; visualization, R.M.S. and D.F.; supervision, R.M.S.; project administration, W.C.; funding acquisition, R.M.S. and W.C. All authors have read and agreed to the published version of the manuscript.

6-2- Data Availability Statement

Data sharing is not applicable to this article.

6-3- Funding and Acknowledgements

6-4- Institutional Review Board Statement

Not applicable.

6-5- Informed Consent Statement

Not applicable.

6-6- Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies have been completely observed by the authors.

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