SOCIOECONOMIC ANALYTICS

A Multi-Criteria Composite Index for Evaluating Economic Development

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Abstract

The development of a region is a process that challenges public managers regardless of the political spectrum in which it is inserted. The real development needs to be reflected in the population, with the logical consequence of improving their social indicators. The use of decision support tools aims to provide a better visualization of which paths each decision maker must follow to achieve their goals, and in the present study we sought to achieve this focus by applying the PROMETHEE II multi-criteria method to analyze and ponder the economic variables that most impact the development process of the states of northeastern Brazil, together with the elaboration of a composite indicator. This correlation of themes is not found in depth in the regional scientific literature. However, ultimately, the study provides an important visualization for measuring the criteria that most significantly impact the reality of each state, mainly because the analysis was applied in a region historically known for its economic difficulties, yet which possesses unique strengths and opportunities within the national territory.

Keywords

Development, Northeast, Multicriteria Analysis, PROMETHEE.

1. Introduction

Economic and social development has always presented as a paradigm and urban center's attempt of getting organized throughout history. For Brazil, this discussion has been relevant since its discovery in 1500. The development history of Brazil can be divided into three big cycles: The State and territorial integration cycle, The Cycle of Nation and Development, and, The Cycle of Democracy and Social Justice (Bresser Pereira, 2012). The first concerns the construction of a basis called modern Brazil, with the establishment and pacification of republicans conflicts attributed to the construction of the Brazilian state, composed of the multiple extractivist cycles (coffee, sugarcane, rubber, and sugar, for example); the wave of Asian and European migration; and slavery abolition along with the lack affirmative policies towards the previously enslaved population and society, which brings up the basis of one of the most relevant national paradigms: inequality.

The second cycle was from the beginning of the 30s to the end of the 70s. This is where the search for the construction of development projects and the strong presence of the industry became characterized by the substitution of imports along with the emergence of a bold working class, with labor rights and an industrial bourgeoisie that benefited from the incentives of national industrialization programs. A historical period characterized by several institutional and political crises, but in which the so-called “national developmentalism” was successful in leveraging economic indicators. The country had a "mercantile-agrarian-exporting" economy until the end of the 20s, which was replaced by an industrialization process that reached 26% of GDP in 1960 from 12.5% in 1929. On the other hand, economic growth was not reflected in advances in social indicators (Cano,2017).

Among the various factors, the international oil crisis, and the change in international monetary policies, along with the rise in long-term interest made the old model obsolete and the country entered the so-called third cycle, which is characterized by the search for the strengthening of civil society after the 1988 constitution re-democratization to the present days.

Three pacts that characterize this third cycle stand out: the "democratic-popular pact of 1977", which corresponds to the joining of forces for the end of the dictatorial regime; "the dependent liberal pact of the year 1990", which encompasses the search for the end of the dictatorship, of the inflationary crisis, and the stabilization of the currency; and the “popular democratic pact” from the 2000s, with the advances of social policies (Bresser Pereira,2012) , the expansion of the image of the country's interests facing the world and the search for a new form of national development now with the presence of other factors not present in previous discussions, such as how to democratize and expand this development to all social classes and the presence of environmental factors in the discussions.

Throughout the various historical moments with different forms, characteristics, and objectives, it was observed that the seek for national development was not homogeneous in all regions of the country (Bresser Pereira, 2012). The trade surpluses of extracted products from the northeast were used to finance imports from south-central regions along with their forms of industrialization, during what was previously called the nation and development cycle (Campolina, 2009).

In this quote, Furtado refers to the first development manner of the northeastern region, the export centered in the coastal region. However, that depended on factors that came from the periphery, which today we call the interior of the states. Just as Brazil has centralized its development throughout history in the South and Southeast region, the Northeast region has also centralized its development process in different ways, concentrating on its coastal regions due to factors like colonization background, climate, and geographical conditions.

The present study arises with the intention of, through operational research and financial engineering tools, measuring which possible paths or factors are directly linked to the region's development process with the use of the PROMETHEE II multi-criteria method. This will also produce knowledge concerning the characteristics and challenges of this process, especially in the Northeast; along with the elaboration of a composite indicator of non-compensatory nature that translates the socioeconomic wealth of the region into comparative measures.

2. Literature Review

For the construction of the present study, it is necessary to approach some concepts and indicators that relate to economic and social development, along with the analysis parameters that involve the process of multicriteria models.

2.1- Economic, Social, and Environmental Development

Development is an important category for any society and over time has undergone several changes. From the perception of wealth based on the accumulation of precious metals in the 15th century to contemporary conceptions of development, it composes of complex concepts that can comprise the process of achieving the greater good for society, either wealth, prosperity, technical progress, economic growth, well-being, sustainability, among others (De Souza, 2017).

The concept of development was closely linked to those of “modernization” of Western societies, established in the 20th century after the second world war with the Marshall Plan, in the historical scenario of the cold war and the capitalist-socialists clash (Ferreira, 2017). At the end of the war, its results involved economic, political, and historical factors faced by all countries, such as unemployment and misery (Sunkel, 1988).

In the first generation called mainstream development (1945-1970), development took place only through the impulse of economic growth through strong industrialization and state investment. That ended up suffering a counterpoint from the emergence of neoclassical economics through Friedman and the " Chicago Boys," who had to connect to the transition from the Fordist to post-Fordism production system affirming what came to be known as neoliberalism after the so-called "Washington Consensus," who defended the "invisible hand" of the market with little presence of the state in economic decisions within export-induced industrialization (Ferreira e Raposo, 2017) . Furtado (1961, p.19) argues that development is not a simple matter of increasing the supply of goods or accumulating capital, it has a meaning, it is a set of responses to the project of self-transformation of human collectivity.

At the end of the 20th century and the beginning of the 21st century, the sustainable development agenda gained support and attention after the ECO-92 conference held in Rio de Janeiro. The conference invoked an effort to share and encourage environmental responsibilities, seeking to change the negative impacts of development without an environmental vision on top of natural resources.

Sustainable development corresponds to the long-term social learning process, whose public policies must be guided by a national development plan, making it possible to achieve the greatest plurality of interested social actors (Bezerra, 2000). The definition of sustainable development is not about saving nature, but about internalizing strategies, thus adding new resources to enable economic growth and prosperity shared by all (Barter, 2012).

With frequent climate changes and irreversible effects caused by environmental devastation, the theme of sustainable development becomes an inherent part of the 21st century, where

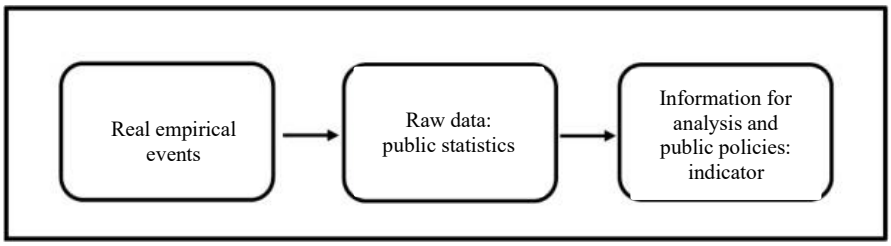
knowledge is important and necessary to design paths for social advances together with a historical look at the stages of evolution of thought. about development.

2.2 - Indicators Related to Development

The measurement of the development of a given region is necessary for future planning, and the use of indicators helps this measurement and consequently the interpretation of the scenario. An indicator corresponds to a measure that captures important data that relate to an activity, phenomenon, or situation and provides information that supports the decision-making process and guides the formulation of public policies and planning. Therefore, indicators assume the role of providing information for taking actions at strategic levels of public governance (De Souza, 2017).

From the academic perspective, the indicators correspond to an approximation between the explanatory models referring to social theory and the empirical evidence of the observed phenomena, thus providing the opportunity to deepen the studies on the changes that occurred in social environments and on the determinants of the phenomena that caused them. Differentiation can be made between social indicators, data, and information from public statistics, showing that the latter represents the occurrences or events of social reality, in its raw form, without contextualization or finalized pragmatics for its interpretation, in figure 1 it is represented the flowchart of the informational value aggregation process (Jannuzzi, 2003).

Figure 1: Data collection framework



Source: Adapted from Jannuzi(2003)

The IBGE classifies the indicators as follows:

1- Economic: They reflect the economic behavior of a country or region, they were the first to be produced, so they have a more consolidated theory.
2- Social: They are the ones that point out the well-being and quality of life of the population, we can highlight those related to health, education, work, income, and security.
3- Environmental: Refers to the progress made towards sustainable development.

There is a classification that divides the indicators from the perspective of the flow management of the implementation of programs, having great importance in the process of formulation and implementation of public policies since they separate the indicators according to their use in a different way in the management cycle (De Souza, 2017) . The Ministry of Planning, Budget, and Management (2010) performs the classification of indicators concerning the flow of implementation can be:

1- Input (input indicators): They have a direct relationship with the resources to be allocated, that is, with the availability of human, material, financial and other resources to be used by the government. Example: doctors/thousand inhabitants and per capita expenditure on education.

2- Process (throughput indicators): They represent the effort undertaken to obtain the results, measuring the level of use of the allocated inputs. Example: Percentage of attendance of a target audience and percentage of financial resources.

3- Output (output indicators): Measure the achievement of physical goals, and express the delivery of products or services to the target audience of the program. For example, the percentage of kilometers of road delivered, schools built and children vaccinated concerning the established targets.

4- Outcome indicators: They directly or indirectly express the benefits to the target audience arising from the actions undertaken in the context of the program and are particularly important in the context of public management. Example: Homicide rate and death rate.

5- Impact (Impact indicators): They have a comprehensive and multidimensional nature, about society as a whole and measure the effects of government strategies in the medium and long term. Example: Gini index and distribution of GDP per capita.

Another classification referring to indicators is related to performance evaluation, with focuses on the evaluation of allocated resources and the results achieved can be of the following nature (TCU, 2000):

Economy: Measure the expenses used in the acquisition of inputs such as materials, human and financial, necessary for the actions to produce the planned results, seeking to reduce costs without compromising the expected quality.

Efficiency: Measure related to productivity, that is, how much can be produced with the available means.

Efficacy: Indicates the degree to which the program achieves the planned goals and objectives, and analyzes whether these were achieved or exceeded.

Effectiveness: Measures the positive and negative effects in the way in which the reality undergoes intervention, that is, it points out if there were socioeconomic, environmental, or institutional changes resulting from the results obtained by the policy, plan, or program.

The Ministry of Planning, Budget, and Management (2010) highlights that for the implementation of a public policy, one or more indicators are used, correlating flow management and performance indicators. For the construction of the study, indicators that portray the reality of each state in the northeast region were chosen, they are gross domestic product (GDP), unemployment rate, consolidated debt, nominal monthly household income, Gini index, and trade balance.

2.2.1- Gross Domestic Product: GDP

It corresponds to the most used indicator in the world economy to measure the wealth of geographic regions around the world (country, states, mesoregions, or municipalities). GDP measures the value in monetary units of all goods and services produced from market prices, in other words, it can be defined as an aggregate indicator measured from the measurement of production in an economy where it has a monetary counterpart (Jacquinet, 2019).

GDP refers to the aggregate value of all final goods and services produced within the economic territory, regardless of the nationality of the owners of the units producing these goods and services, and from these values' other indicators such as the HDI and GDP can be determined per capita, which also has an important contribution to the economic debate and, consequently, to the debate on development (Sandroni, 2019) . Caiden and Caravantes (1988) point out that:

> Development was seen as a set of interdependent processes and, through it, traditional society would be transformed into modern society [...] development was above all economic development [...] expressed in monetary terms. (CAIDEN and CARAVANTES, 1988, p.22).

The "monetary terms" highlighted by the author of the excerpt above, can be called GDP in modern times, however, it is necessary to highlight that for the state, only growth in GDP will not necessarily imply an increase in the development of the region. There are two main forms of measuring GDP, they are from the perspective of production and from the perspective of income. all the people who intervene in the productive process of the economy in which they are measuring (Jacquinet, 2019).

2.2.2 - Unemployment Rate

According to the IBGE, unemployment corresponds to the number of people of legal work age who are out of work, but available to find a job. Within the economical literature, it can be perceived a constant and deep debate about the unemployment rate and its relation to development, since a worker with a stable job and with constant remuneration is more conducive to consumption and obtaining investment, causing the wheel of the economy to move again, consequently providing new jobs and to a new generation of wealth.

2.2.3 - Net Consolidated Debt

The National Treasury of Brazil (2021) defines net consolidated debt as:

> The total amount, calculated without duplication, of the financial obligations of the entity of the Federation, assumed under laws, contracts, agreements, or treaties and the performance of credit operations, for amortization into a period exceeding twelve months. Credit operations with a term of fewer than twelve months whose revenues have been included in the budget are also included in the consolidated public debt. (TREASURY - NATIONAL TREASURY SECRETARIAT, 2021)

In simple words, it can be said that the debt is the difference between what is collected and what is spent by the public power, at any of the three levels. The disorderly growth of state

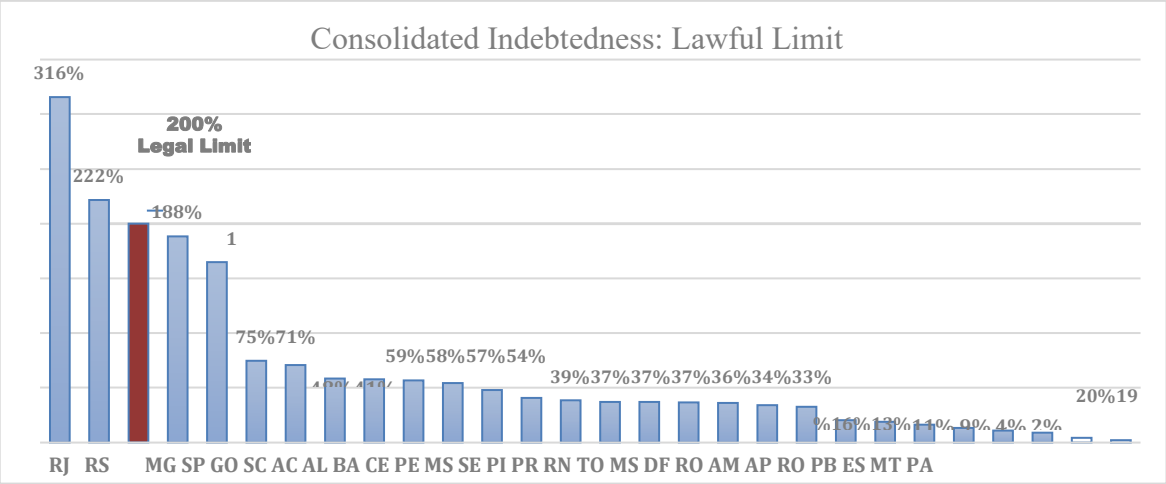
expenditures implies direct consequences on public finances, which can cause disorder and imbalance in their budgets (Miranda, 2018).

At a national level, public debt assumes a central role in economic debates, mainly due to its size and limit, but the debt of Brazilian states is an issue that does not assume the same centrality in the debate, even though it is an issue that must be taken into account in the design of long-term planning in national states.

The fiscal framework of all states in Brazil currently has a worrying character, according to a report by FIRJAN – Federation of Industries of the State of Rio de Janeiro, in 2017, in addition to the financial risk, the imbalance of accounts can cause social and political-institutional risk, since the states already claim that their debt exceeds the limit imposed by the Discal Responsibility Law- LRF approved in 2016, a limit that requires that the state debt only reaches to the level of 200% of the value of its net current revenue. This lack of control makes it worrying when within this monetary value are included issues such as the payment of civil servants, transfer maintenance of services such as health and safety, pension expenses, and the ability to direct investment in development programs.

In 2021, the fiscal conditions of the states were worsened due to the health crisis that attacked the whole world at the beginning of the previous year, in 2020 two states presented a tax situation above the legal limit allowed by the LRF, were Rio de Janeiro and the Rio Grande do Sul. Another 2 appear with their accounts within the allowed limit, but with situations that can be aggravated, they are Minas Gerais and São Paulo. The following Figure 2 is based on the data provided by the National Treasury Secretariat – STN.

Figure 2: Indebtedness ranking of Brazilian states in 2020



Source: Author

Starting from a macro view, one of the primary conditions for achieving development in the states is necessary to achieve financial health, and this growth would be reflected in the country. If we highlight the 9 states in the northeast, all of them manage to remain within the legal limits of public debt (Rigolon, 1999).

2.2.4 - Nominal Monthly Household Income per Capita

The nominal monthly household income per capita is published by the IBGE and is calculated from information collected from the Continuous National Household Sample Survey – Continuous PNAD. Its value is obtained from the sum of income from work and other sources received by each resident of the residence in the month referring to the survey (IBGE, 2021). This indicator offers the view of the size of the income disparity and social consequences of Brazilian states, the difference between the highest value in 2020, which was the state of Distrito Federal, and the lowest value, which was the state of Maranhão, is R$ 1,799. It is noteworthy that in the immediate Brazilian regions a big difference can be seen depending on the state, in the northeast, the difference between the states with the highest and lowest value in 2020 was R$401 in the states of Rio Grande do Norte and Maranhão respectively, the values from all states can be seen in Table 1 below.

Table 1: Value of the nominal monthly household income per capita in Brazilian states in 2020

State	Income	State	Income	State	Income
MS	R$ 1.488,00	DF	R$ 2.475,00	RN	R$ 1.077,00
MT	R$ 1.401,00	SP	R$ 1.814,00	CE	R$ 1.028,00
RO	R$ 1.169,00	RS	R$ 1.759,00	SE	R$ 1.028,00
TO	R$ 1.060,00	RJ	R$ 1.723,00	BH	R$ 965,00
RR	R$ 983,00	SC	R$ 1.632,00	PE	R$ 897,00
AC	R$ 917,00	PR	R$ 1.508,00	PB	R$ 892,00
AM	R$ 893,00	ES	R$ 1.347,00	PI	R$ 859,00
PA	R$ 883,00	MG	R$ 1.314,00	AL	R$ 796,00
AM	R$ 852,00	GO	R$ 1.258,00	MA	R$ 676,00

Source: Author (IBGE, 2020)

It is also worth mentioning that this index reflects the purchasing power of people in each place in Brazil, with consumption being one of the main drivers of growth and consequently, of the country's development. These values gain importance in the present study. As a consequence of its economic formation, Brazil has a high value in the GDP composition of activities directly related to family consumption, in 2010 the Economic Commission for Latin America and the Caribbean (CEPAL,2010) study sought to reflect on ways of recovering GDP After the 2009 crisis, he stated that about 60% of GDP was dependent on family consumption and the same was the target of the main countercyclical efforts to face that crisis.

In the book Valsa Brasileira (2018), Laura Carvalho highlights that family income was one of the fundamental pillars of what she called the economic miracle, which corresponds to the period of growth of the national economy between 2003 and 2011. For Carvalho with the

programs of social inclusion and income distribution that came into force in the period, the income in particular of families with lower incomes increased the share of consumption of basic survival inputs, such as food, which was reflected in upper classes that directed their income to greater consumption of low-complexity services. This dynamic gave rise to a series of low-efficiency services that stimulated an economy mainly reverted to this population that was rising in their social class, which Carvalho highlights:

> If we compare the increase in wages in the low-productivity sectors (mostly services) with those in the high-productivity sectors (mostly manufacturing) the former rose much more over those years [...] was the demand for less qualified workers, the more these workers gained bargaining power in the labor market" (CARVALHO, 2018)

As highlighted by Carvalho (2018), due to the dynamics adopted by the public policies taken by the rulers of the time, the income level increased, but it was sustained by low-skilled work demand and services that presented low complexity, conditions that were not sustained over time throughout the years and which impacted the values of family income in the succeeding years. These factors imply reflecting that family income is an important device that provides and stimulates development, but it must be supported and provided with firm and lasting foundations so that long-term results are reverted and not just contained in small intervals.

2.2.5- GINI Index

The Gini index corresponds to another way of measuring the social levels at which an interpretation is obtained regarding the quality of life in which the population finds itself. The Gini index represents, in statistical measures, the value of inequality expressed by a degree of income concentration varying in each region, the basis of the calculation of the Gini index corresponding to the economic concept of the Lorenz curve, being the curve in how the cumulative proportion of income varies as the function of the cumulative proportion of the population (Nishi, 2010).

The main advantages of this index are that it presents a measure of inequality between different areas, whether rural or urban, allowing for a comparison of inequality between economies over time (IPECE, 2017). Therefore, it is natural to perceive that in most developed countries that have a lower value of the Gini index, the higher their levels of development, because for this index, the closer to 0 the index is, the lower the inequality will also be. environment.

2.2.6 – Trade Balance

Brazil has a history of being an exporting country, one of the main slices of the public budget of many states. The balance of trade represents the balance of payments on its statistical-accounting record that corresponds to all economic transactions carried out between residents of a country with residents of other countries, so it can be said that it aggregates all transactions of goods, services, physical and financial capital between the country and the rest of the world (Vansconcellos, 2013).

When there is a value of exports greater than that of imports, it is understood that the country has to surplus in the trade balance. For many states in Brazil, their trade balance surplus represents to direct increase in their ability to invest both directly and indirectly, as these

resources are necessary for the region's budget. It should be noted that the values of the trade balance vary depending on the exchange values, being an intense and deep debate in the economy that the exchange rate corresponds to the one that best provides economic development since a devalued exchange benefits the export of commodities. and products with low added value, however, it prevents the export of manufactured products that do not have competitive strength at a global level, since the national industry in its vast majority does not have high technological complexity, which prevents the market dispute at a global level.

2.3– Multi-Criteria Model

Most of the time, the problem does not consider not only one criterion but several criteria with relevant differences to be able to choose the alternative that presents the best performance. For problems, it is necessary to search for evaluation methods for a set of parameters, which is how multicriteria models appear. The multi-criteria decision methods can be adopted to assess whether one is more viable than the other, for that it is necessary to observe their advantages and disadvantages and then confront them until it becomes clear which is the most viable alternative, being similarly put the pros and cons of each alternative on a scale and observe which side the scale weighs the most (Almeida, 2013).

Multicriteria methods emerged as decision support methods that are seen as mathematical tools, effective for solving problems in which there are conflicting criteria, having advantages in their use at the point where very few cases present options simultaneously optimal at all points, making which facilitates the choice of the best possible option (Brans, 2005). Among the various existing multi-criteria analysis methods, the one chosen to be used in this study was the overclassification method.

2.3.1 Overrating Method

The method performs, through pairwise comparisons, to the relationship between the alternatives, seeking to analyze the characteristics of each. It should be noted that in this method, evaluations of a non-compensatory nature can occur, highlighting (Almeida, 2015):

> “In these methods, the inter-criteria evaluation can be represented by the weights of the criteria, which assume the notion of degree of importance. Since there is no transformation from intra-criteria assessment scales to global assessment scales, in which each alternative receives a global score, in the overclassification methods there is no problem with using this notion for the weights as with the aggregation methods by a single criterion of synthesis" (ALMEIDA, 2015)

The families most used to perform this method are ELECTRE and PROMETHEE, in the present study the method used will be PROMETHEE.

2.3.1.1- PROMETHEE Method

PROMETHEE – Preference Ranking Method for Enrichment Evaluation, was developed by Brans (1982) who sought to explore the relationship of over ranking of values to assist in decision making, and can be used in different areas. PROMETHEE implementations have a series of variations and following the literature we can highlight below (Almeida, 2005; Behzadian, 2010; Brans, 1994):

1- PROMETHEE I: It seeks to establish an initial and partial order (which may be incomplete) among the alternatives, indicating the problem of choices and being built from 2 existing indicators.
2- PROMETHEE II: It seeks to establish complete order among the alternatives, indicated for the ordering problem and generate a comparison score, which results in a more comfortable interpretation of the data.
3- PROMETHEE III and IV: Both methods were designed to work with decision problems of greater complexity and with stochastic character.
4- PROMETHEE V: Uses the analysis of alternatives carried out by PROMETHEE II to introduce restrictions found in the problem, seeks to incorporate the concept of integer optimization.
5- PROMETHEE VI: It fits for decisions in which the decision-making agent is not able to choose the weights for the criteria, being the method capable of establishing a complete or partial pre-order used for the choice and order problem.

The models with the applications in the literature, and consequent greater usability are PROMETHEE I and II, with the second being the introducer of the aggregation form with a portion of distortion within the overclassification method, which leads to loss of information regarding the I, on the other hand, the author argues that there is a possibility that there is a relationship of indifference at the end of the analysis of PROMETHEE I while in II this possibility is almost zero, for these reasons the method that best fits the present study is PROMETHEE II, being the same one used (Almeida ,2013).

2.3.1.1.1 - Application of the Promethee II

The PROMETHEE multi-criteria decision method seeks to propose an evaluation of the exposed alternatives through the defined number of criteria (Vincke, 1992), the base problem of the multi-criteria decision is defined by applying the equation (Brans, 1986):

$$\text{Max } \{ f1 (a),....., fk (a)/ a \text{ Ɛ } a \} \quad \text{(Eq. 1.1)}$$

Where the values assumed in to and F are represented in Equation (1.2) below:

$$A = \{a1 , a2 , a3 ,. \quad , an\} \text{ alternative group and}$$
$$F= \{ f j (.), j = 1,2,...., k\} \text{ criteria group} \quad \text{(Eq. 1.2)}$$

The search for the relationship that will be attributed to the relationship of maximizing or minimizing the criteria normally presents several objections within the matrix that represents the criteria from the perspective of the evaluation of the alternatives, Equation 1.3. The optimal

solution is hardly found, as it usually does not exist taking into account all the criteria, but it helps the decision-maker in his decision-making.

$$\begin{array}{ccccccc} F_1 & F_2 & \ldots & F_j & \ldots & F_k \\ (a1) & (a1) & .. & (a1) & .. & (a1) \\ F_1 & F_2 & \ldots & F_j & \ldots & F_k \\ (a2) & (a2) & .. & (a2) & .. & (a2) \\ : & : & & : & & : \\ : & : & & : & & : \\ F_1(a & F_1(a & & F_j(a & & F_k(a \\ j) & j) & & j) & & j) \\ : & : & & : & & : \\ F_1(a & F_2(a & \ldots & F_j(a & \ldots & F_k(a \\ n) & n) & .. & n) & .. & n) \end{array}$$

(Eq 1.3)

The information generated by matrix 2.3 is used together with additional information for the formulation of the decision maker's preference. The concept of preference function should be incorporated into the discussion to provide a theoretical framework in the explanation of the method.

The preference function has the role of orienting and adorning the alternatives, providing aid of the multicriteria model in the comparison between pairs of alternatives. Brans (1986) highlighted 6 main types of preference functions, along with their criteria, which are exposed below (Tables 4 and 5). These preference functions are developed from the comparisons generated in the method of overclassification of one alternative over another, the greater the degree of overclassification of an alternative over the other, the better it is concerning the other. The degree of overclassification is obtained from Equation 1.4:

$$\pi(a,b) = \sum^{n}_{i=} p_i * F_i(a,b) \qquad (1.4)$$

Where:
- π (a,b): Degree of overrating from to over b;
- p i: Criteria weight i;
- F i (a,b): Difference function that is related to the decision maker's interpretation of the difference between the criteria.

The decision-maker must enter information about the evaluation criteria, such as weights and preference functions, and it is possible that, in decision situations, thresholds of preference and/or indifference about the performance of alternatives are inserted, and the representation of the criteria becomes associated with the type of function to represent the preferences of the decision-maker (Clemente, 2015).

The phase of the overrating flow represents the exploration of the overrating relationship to support decision-making. In this phase, 3 indicators are mainly used, they are inflow, outflow, and mixed flow (Brans, 1982).

- Outflow - $\emptyset^{+}(a)$: Refers to the degree of preference intensity among specific alternatives compared to other alternatives in the set in which it belongs. Therefore, this flow measures the forces of overclassification of the alternative, on its set.

- Input flow - $\emptyset^{-}(a)$: Refers to the intensity degree of preference of the set of alternatives over a specific alternative that integrates this set. Therefore, this flow places the forces of overclassification of the set on a specific alternative.

- Net flow: Corresponds to the difference between the outflow and the inflow of the alternative.

$$\emptyset : \emptyset^{+}(a) - \emptyset^{-}(a)$$

The net flow has a variation from -1 to 1, where the closer the value approaches -1, the worse the alternative, and the closer the value approaches 1 the better. In this way, PROMETHEE II provides a comparison between net flow values.

3. Methodology

The present study seeks, through multi-criteria analysis, to evaluate the contribution of each factor to contribute to the debate about the regional development of the Brazilian northeast. Celso in his classic 1961 book "Development and underdevelopment", highlighted:

> The development process takes place either through new combinations of existing factors at the level of known techniques or through the introduction of technological innovation. In a theoretical simplification, it is possible to admit as fully developed at a given moment, in those regions in which there is no unemployment of factors, it is only possible to increase productivity (real production per capita) by introducing new techniques. (FURTADO, 1961).

Therefore, it is necessary to reflect on new techniques and paths that each location must take, not consisting of a recipe ready to be followed to achieve success, development appears as an unknown to be solved and followed from each intrinsic characteristic. of each region, and in this wake the present study wants to contribute by adding analyzes not yet well explored in the economic literature.

3.1- Set of Criteria

To choose the criteria used in the formulation of the model, a series of works and academic productions were consulted that could give support regarding the direct connection of the indicators with the focus of the exploration of the study, it is worth noting that in multi-criteria analysis it is difficult to achieve find an alternative where all the parameters analyzed to achieve a good performance, so it was necessary to choose the indexes so that they did not provide information that would not add to the debate proposed by the study.

The theoretical framework of the relationship between the index and the development theme is shown in the table below:

Table 2: Theoretical basis for choosing indicators

Index	Reference
GDP	- Caetano, F. A. O; Araujo, A. J; - Khan, A. S (1997). - JACQUINET, Marc. (2019).
Unemployment rate	- Oliveira, G.B (2002). - Baltar, P (2015). -BNDES. Banco nacional do desenvolvimento (2018).
Consolidated debt	- De Mello, G.R; Slomski, V. (2009) - Ferreira, C.J; Junior, A. E. R. S; Sekunda. A; (2020)
Nominal monthly household income per capita	- De Carvalho, S.S; Dos Santos, C.H; De Almeida, V, A; Joel, Y.K.Z; Paiva, K.C; Caldas. L.F; (2016). -De Oliveira, F.P.M; De Sousa, R.P.M(2020).
Gini Index	- Dedecca, S.C; (2012) - Mendonça, R; De Barros, R.P (1997).
Trade Balance	- Bastos, F.S ; Irffi, Guilherme; Castelar, I; (2017) -Cavalcanti, M.A.F.H; Frischtak, C.R (2001).

Source: The Author

Therefore, it is essential to evaluate each alternative proposed from the parameters exposed to measure its performance, and it is possible to indicate which of the alternatives is more suitable. Each index surveyed has a parameter or an intention that serves as guidance in the decision-making support process.

Table 3: Relationship between indexes and model intent

Index	Intent
GDP	Maximize
Unemployment Rate	Minimize
Consolidated Debt	Minimize
Nominal monthly household income per capita	Maximize
Gini Index	Minimize
Trade balance	Maximize

Source: The Author

4. Data and Analysis of Results

This section aims to show the results of the configuration exposed in the development of the work, considering that the proposed discussion is based on the aforementioned authors in the rationale and the specific concepts detailed in the study.

4.1- Data Description

For the construction of the model, index data were collected from official bodies and documents from specialized studies in the area. To better use the interpretation of the data after building the model and generating the results, the handling of the data behaved as follows:

Table 4: Legend of data use in the development of the multicriteria model.

Index	Model Application
GDP	The average percentage of GDP divided by the population mean
Unemployment Rate	Average percentage of unemployed people
Consolidated Debt	Average percentage compared to consolidated net revenue
Nominal monthly household income per capita	The average value in the period studied
Gini Index	The average value in the period studied
Trade balance	The average value in the period studied was divided by the national average

Source: The Author

Data were collected in annual sequences from 2010 to 2020, it is worth noting the lack of information in some years of some indices, From this data series, the VISUAL PROMETHEE software was used to be able to elaborate the analysis visualizations and the plots of the graphs to develop the interpretations that will be presented in the section below on the exposed problem.

4.2- Analysis of the Promethee Method

The extraction of results for interpretation and analysis of the proposed model was supported by plotting graphs, which provide a particular view of the behavior of each criterion as well as the behavior of each parameter and its overclassification from the universe and data limits that were added to the model, it is worth noting that each criterion was added to the value of weight 1 for the execution of the model and after that, the sensitivity analysis was performed with the variation of this value.

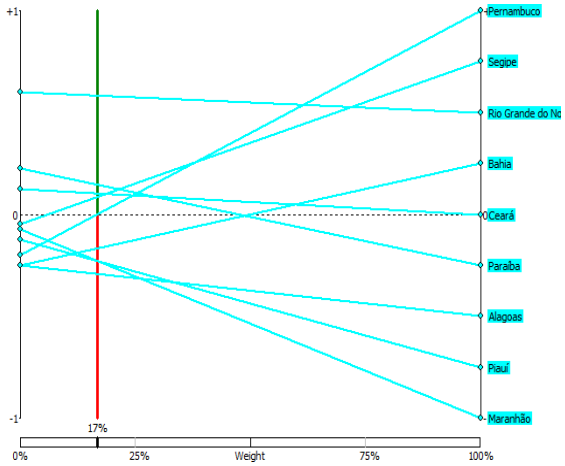
4.2.1 Analysis of the Criteria

At this stage, an analysis will be carried out on each criterion that was raised throughout the study. The software used provides the values displaying the values of the mean, standard deviation, maximum value, and minimum value of each criterion used, these values were added in the interpretation of the model, realizing that the percentage of stabilization among all the criteria that was used for the analyzes was worth 17%. Below are the graphs to show an overview of how the parameters behaved from the values used.

4. 2.1.1 - GDP

The GDP used as a function of the population amount shows that some states whose GDP has a higher value than others, were below the position of another that HAS a lower value of GDP, but the division between the population behaves more efficiently. It is worth mentioning that GDP consists of all the wealth produced in the state, and when it is divided according to population, it ends up becoming an indicator of wealth varying by population quantity, but it is important to note that this is not the most efficient indicator of income division, Because this wealth is often not evenly distributed, so we can conclude that the state of Pernambuco does not necessarily have a greater distribution of wealth among its population, this conclusion is only possible with monitoring and analysis of other indicators.

Figure 3: Ranking through GDP



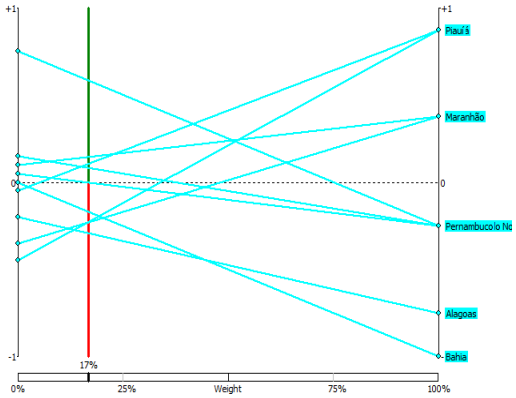
Source: The Author

Max Value	R$16,99
Min Value	R$ 10,58
Std Dev	2,1
Average	R$ 13,82

4.2.1.2- Unemployment Rate

The unemployment rate behaved homogeneously between where Piauí and Ceará appear with the best results, followed by Maranhão and Paraíba, right after Pernambuco, Rio Grande do Norte, and Sergipe, and with the worst performances the states of Alagoas and Bahia. This ranking is important because it provides the possibility to analyze which states are achieving a more efficient population employability policy. have a different remuneration and job stability profile in each location, but it is unquestionable the important of considering the employability levels of each state as they provide a vision in several dimensions both from the perspective of a possible greater or lesser power of buy by the population, as well as from the perspective of a more or less heated economy and stimulated absorption of more people in jobs.

Figure 4: Ranking from the perspective of the unemployment rate



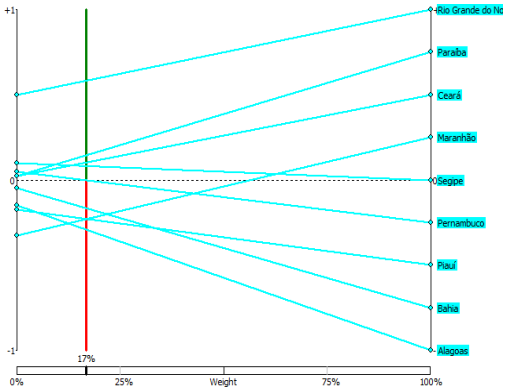
Source: The Author

Max Value	15%
Min Value	10%
Std Dev	2%
Average	12%

4.2.1.3- Net Consolidated Debt

Although all states had, over the period studied, the consolidated debt limit within the limits required by law, some states such as Alagoas present a result that starts to be worrying to their "fiscal health", while other states such as the Rio Grande do Norte, Paraíba, and Ceará present a better performance in this criterion. It is important to monitor and evaluate the debts of the states, because unlike the country and its economic bodies such as the national treasury and the central bank, which manage to regulate and issue the amount of money present in the economy, thus increasing its investment capacity. depending on the moment and the economic policy strategy, in the national states, economic bodies need to manage money in the best way, as an imbalance will imply a lack of investment in essential areas or the non-payment of civil service salaries.

Figure 5: Ranking from the point of view of net Consolidated debt



Source: The Author

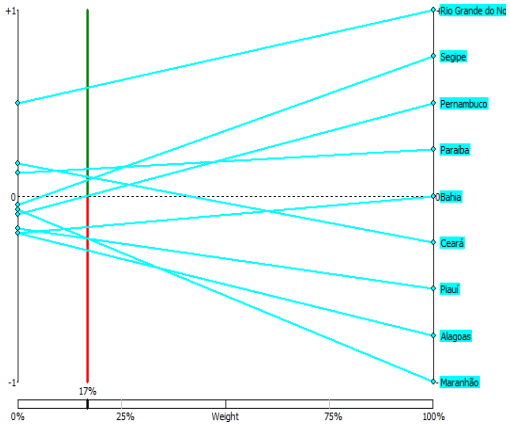
Max Value	119%

Min Value	23%
Std Dev	26%
Average	51%

4.2.1.4 Nominal Monthly Household Income Per Capita

One of the criteria that presented the highest standard deviation and the greatest difference between the Maximum Value and Minimum Value within the research, thus indicating the size of the disparity in terms of income and consequently of purchasing power in the region. It is worth noting that states that are popularly known as having the highest concentration of wealth, such as Ceará, Bahia, and the state of Pernambuco itself (which in the index that relates GDP as a criterion achieved the best performance) did not present the best performance positions concerning their peers, which indicates that despite the high level of wealth produced by these states, this amount is not shared equally.

Figure 6: Ranking from the perspective of Nominal Monthly Household Income Per Capita



Source: The Author

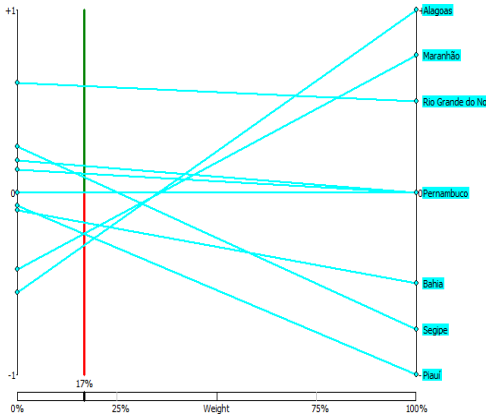
MaxValuee	R$ 1038,14
Min Value	R$ 579,29
Std Dev	R$ 121,21
Average	R$ 810

4.2.1.5 GINI Index

The result of the Gini index presented a very similar scenario between the states of the region, which can mean a certain homogeneity between the social levels of the states, we can base this statement to start from a low value in the standard deviation of the samples. Because this study used PROMETHEE II and in the elaboration of the model the criteria were not compensatory, it is natural that even with indices that were previously analyzed and showed a high concentration of income in certain states, they present a good performance here about the Gini indicator. However, it should be noted that the Gini index performs the internal comparison to the method application environment, thus showing the difference in the quality of life between

the richest and poorest people in the environment or region, not analyzing the level or quantity of wealth that these people possess.

Figure 7: Ranking from the perspective of the Gini Index



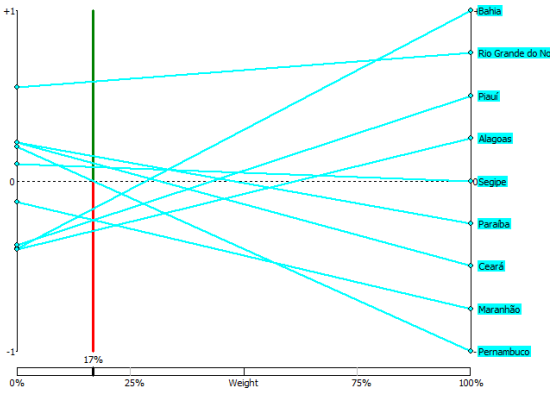
Source: The Author

Max Value	0,55
Min Value	0,45
Std Dev	0,03
Average	0,51

4.2.1.6- Trade Balance

The result from the trade balance data behaved in a way that clearly shows the disparity with which each state deals with the relationship between exports and imports. States such as Bahia and Rio Grande do Norte present a trade balance related to their population amount, behaving in a surplus way, while Pernambuco presents extreme deficit results.

Figure 8: Ranking from the point of view of the trade balance



Source: The Author

Max Value	US$ 46,63
Min Value	US$ -471,62
Std Dev	US$ 149,48
Average	US$ -96,95

4.2.2 - Preference Flow Analysis

Preference flow values on each parameter used in the model, positive, negative, and net outranking results were extracted (see Table 5 and Figure 9).

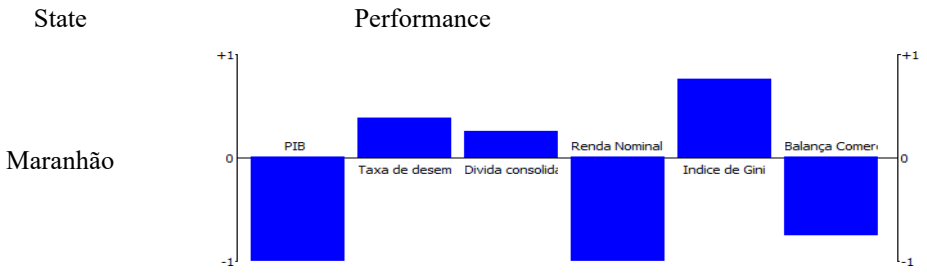
Table 5: Outranking Results

State	ø+	ø−	Ø	Order
Maranhão	0,375	0,604	-0,229	7º
Piauí	0,375	0,604	-0,229	7º
Ceará	0,520	0,416	0,104	3º
Rio Grande do Norte	0,770	0,187	0,583	1º
Paraíba	0,541	0,395	0,145	2º
Pernambuco	0,458	0,458	0,000	5º
Alagoas	0,354	0,645	-0,291	8º
Sergipe	0,520	0,437	0,083	4º
Bahia	0,416	0,583	-0,166	6º

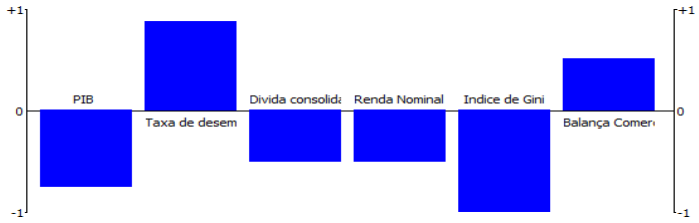
Source: The Author

The states that had the best performance were Rio Grande do Norte, Paraíba, and Ceará in that order, and the states Alagoas, Maranhão, and Piauí had the most negative performance results. It should be noted that each region has particularities that are reflected positively or negatively in the extraction of results, the performance of each state is represented below:

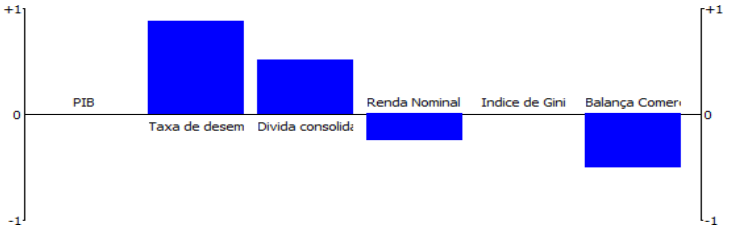
Figure 9: Performance of each state by criteria.



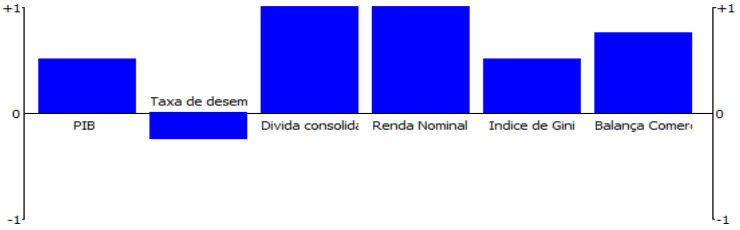
Piauí



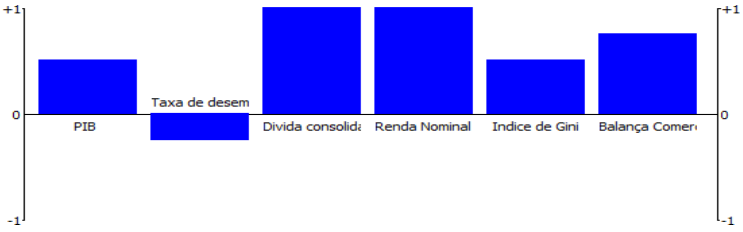
Ceará



Rio Grande do Norte

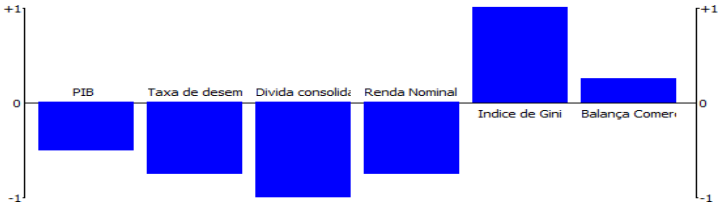


Paraíba

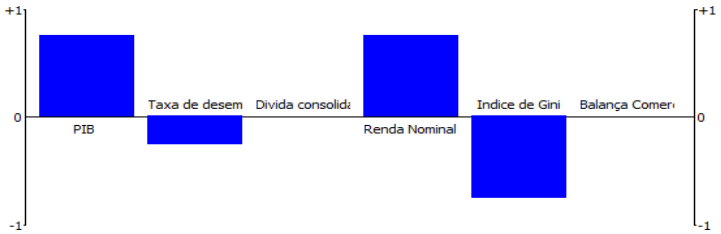


Pernambuco

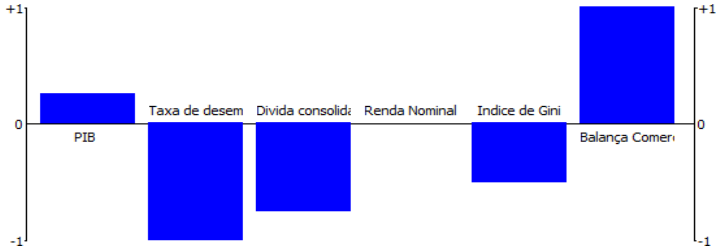
Alagoas



Sergipe



Bahia



Source: The Author

4.3- Sensitivity Analysis

Sensitivity analysis was performed from the variation of weights and analysis was performed on the changes that were generated on the initial analysis. Two simulations were performed, the first adding 5% more in each criterion and the second subtracting 5% in each criterion. The results are shown in Tables 6 and 7 below.

Table 6: Result of over ranking adding 5% to the weight of the criteria

State	ø +	ø−	ø	Order +5%	Order
Maranhão	0,389	0,588	-0,198	6	7º
Piauí	0,352	0,625	-0,272	8	7º
Ceará	0,536	0,397	0,139	3	3º
Rio Grande do Norte	0,764	0,191	0,573	1	1º
Paraíba	0,551	0,382	0,169	2	2º
Pernambuco	0,485	0,426	0,058	5	5º
Alagoas	0,338	0,661	-0,323	9	8º
Sergipe	0,552	0,433	0,088	4	4º
Bahia	0,382	0,617	-0,235	7	6º

Source: The Author

Table 7: Result of over ranking by subtracting 5% from the weight of the criteria

State	ø+	ø−	ø	Order -5%	Order
Maranhão	0,375	0,604	-0,229	7	7º
Piauí	0,375	0,604	-0,229	7	7º
Ceará	0,520	0,416	0,104	3	3º
Rio Grande do Norte	0,770	0,187	0,583	1	1º
Paraíba	0,541	0,395	0,145	2	2º

Pernambuco	0,458	0,458	0,00	5	5º
Alagoas	0,354	0,645	-0,291	8	8º
Sergipe	0,520	0,437	0,083	4	4º
Bahia	0,416	0,583	-0,166	6	6º

Source: The Author

It can be observed that in the evaluation with the weights added 5% the only change concerning the ascending order of classification of the parameters occurred in the states of Maranhão and Piauí, where they were previously tied, after the addition, Maranhão occupied 6th and Piauí to 7th. In the evaluation decreasing by 5%, no type of modification was noticed to the original order of the parameters.

5. Final Considerations

The present study aimed to evaluate factors that impact the development of the states of the northeast region of Brazil from the adoption of economic criteria that reflect the development process, the criteria chosen in question were: GDP, Unemployment rate, Consolidated Net Debt, Consolidated Nominal Monthly Income, Gini Index and Trade Balance. The criteria were evaluated using the multi-criteria decision model PROMETHEE II – Preference Ranking Organization Method for Enrichment of Evaluations, which provided the construction of a composite indicator based on the data collected in the period defined for the execution of the study.

The analysis of the results provided shows a technical view of the situation of each state from various perspectives, thus being able to provide an instrument to help the evaluations of public managers in the elaboration and implementation of their policies. It is relevant to highlight that it is necessary to have a long-term view of management and for those planning actions must be taken in the present, respecting the divergences between thoughts and political aspects but with pragmatism and a clear vision that the management of the public machine must be done to benefit solely and a population and not possible unilateral desires.

Given the above results, the use of the multicriteria methodology can be applied in the public sector, but for better performance, an improvement of the studies with this characteristic is necessary since the present was prepared in a short period, together with a historical series that could have been greater and with a greater set of criteria, thus enabling greater precision in the elaboration of the model and consequently improving its results.

Finally, the main scientific contribution that was sought in this study was a theoretical essay involving economic criteria in a region that historically suffers from several difficulties in its development process, but with an improvement of its public management, it can raise its indicators and achieve the goals and desires that every society desires.

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