QUALITY OF LIFE IN RIO DE JANEIRO:
A MULTICRITERIA ANALYSIS BASED ON MASLOW'S HIERARCHY OF NEEDS

Bruno Baptista Blanco[1*] and Igor Leão dos Santos[2]

ABSTRACT. This research evaluates the quality of life of the ninety-two cities in the state of Rio de Janeiro using a non-compensatory composite aggregator index. It was a multimethodological research, which combines a qualitative conceptual map with a quantitative multicriteria model to assess variables of difficult definition. The criteria are based on Maslow's concepts, which also define the weights between them, bringing more coherence to the index. We conclude that our measurement model with non-compensatory rationality offers an alternative for calculating the quality of life. The cities of Niteroi, Rio de Janeiro and Volta Redonda scored best in our proposed index. Silva Jardim, Sumidouro and São Francisco de Itabapoana scored worst. Niteroi scored best in Physiological and Esteem needs. Nova Friburgo scored best in Safety needs. Mesquita scored best in Love and belonging needs. A sensitivity analysis shows that our method's structure makes results distortion difficult.

Keywords: quality of life, multicriteria decision aid, Promethee, Maslow's pyramid, human development index.

1 INTRODUCTION

Quality of life is a term that has been intensely discussed in the scientific community in the most different areas, such as sociology, education, economics, medicine, among others. Such interdisciplinarity means that there are several ways to define its meaning (Farquhar, 1995).

There is also a particular debate about the evaluation or measurement of quality of life, whether at the individual or collective level. In this sense, to measure the basic human development of

*Corresponding author

[1]Federal University of Rio de Janeiro (UFRJ), Production Engineering Department, Avenida Aluízio da Silva Gomes, 50, Granja dos Cavaleiros, 27930-560, Macaé, RJ, Brazil / Nacional Institute of Traumatology and Orthopaedics (INTO), Teaching and Research Division, Avenida Brasil, 500, São Cristóvão, 20940-070, Rio de Janeiro, RJ, Brazil – E-mail: bbblanco@into.saude.gov.br – https://orcid.org/0000-0001-7012-9721

[2]Centro Federal de Educação Tecnológica Celso Suckow da Fonseca (CEFET/RJ), Programa de Pós-graduação em Engenharia de Produção e Sistemas (PPPRO), Avenida Maracanã, 229, Maracanã, Rio de Janeiro, RJ, Brazil – E-mail: igor.santos@cefet-rj.br – https://orcid.org/0000-0002-9473-3728

countries, the Human Development Index (HDI) is an index published annually by the United Nations Development Program (UNDP). This is still an important instrument used as a basis for public policies and for relevant decisions about human development and social well-being. However, the HDI has suffered many criticisms, including the compensatory effect between the dimensions, the incorrect way of measuring the income dimension, the inappropriate use of some indicators, the redundancy of others and the lack of data (Pereira & Mota, 2014).

Although the HDI is a more complete index than the GDP, in a complex and comprehensive context, it is pertinent to use methodologies that allow a multidimensional look at the problem. According to Greco et al. (2019) there are already about 100 different indices used as a measure of human development. There has been an exponential growth of these measures in the last 20 years and an increase in popularity by researchers and public policymakers.

In this context, according to Lins et al. (2021), despite the use of mathematical models contributing to decision-making in complex situations, any decision-making process involves qualitative and even informal criteria, making it difficult to structure, formalize and model the problem.

This article presents a discussion about this scenario of complexity and conflicting perspectives when measuring quality of life, a multidimensional concept. And in view of this, it proposes a multimethodological research, which is based on a qualitative problem structuring technique combined with a quantitative decision support model. Fundamentally, the study is based, for methodological procedures, on the work of Franco & Montibeller (2011), Lins et al. (2021) and de Almeida et al. (2015), and to propose the quantitative model, in studies on quality of life and human development by Allardt (1993), Sen (1999) and Maslow (1943). Thus, this article proposes an assessment of the quality of life in cities belonging to the State of Rio de Janeiro based on an aggregator composite index calculated on a non-compensatory basis.

In the second part of the article, a discussion was held about the complexity and usefulness of assessing quality of life using mathematical models, in addition to presenting some criticisms of the HDI and analyzing other studies that proposed different ways of assessing quality of life. In chapter 3, a literature review on multicriteria decision support methods will be presented. In chapter 4, we discuss the characterization of the methodology used in this research and the methodological procedures followed, in addition to presenting the construction of the mathematical model. In chapter 5, we have the presentation of the results applied to Rio de Janeiro in Brazil and some discussions about these results found. In the last chapter, we present the conclusions of the study.

2   QUALITY OF LIFE ASSESSMENT

For Stewart (2018), mathematics is historically divided into two categories: pure and applied. Pure mathematics is a logical game that is not aware of reality, whereas applied mathematics is practical and solves problems in the so-called real world. However, for the author, there is no clear definition between these two categories, that is, mathematics is not divided into two disconnected areas. Rather, ideas flow from theory to practical applications and back again, enriching both.

However, within the spectrum of applied mathematics, mathematical models of the real system are formulated, where the resulting mathematical questions are analyzed to obtain a view of the natural or human world.

But, within this context, the author points out that the mathematical model is not reality, that is, a model will never have complete accuracy (Stewart, 2018). About this, Einstein (1921) apud Stewart (2018) has a well-known phrase: "as far as the laws of mathematics refer to reality, they are not certain; insofar as they are certain, they do not refer to reality". That is, the map is not the territory, but we create maps that represent and have a similar structure to the territory, which explains its usefulness according to Korzybski (1933) apud Stewart (2018).

That said, we will start a discussion about the definition of quality of life and attempts to measure it. Mariano & Rebelatto (2014) present in their research the relationship between quality of life and economic growth, stating that its main role is to help promote human development and, at the same time, generate quality of life. However, this relationship between economic growth and quality of life is neither automatic nor obvious.

Mariano & Rebelatto (2014) conducted a study on the efficiency of nation-states in producing a quality of life based on their wealth. The authors still associate the quality of life with the term happiness. However, they point out that happiness is a broader and more subjective concept. Thus, they assume that wealth is a means, then, to achieve quality of life and, subsequently, happiness. Happiness is dependent on a good quality of life, and this is on the wealth produced by a country, building an efficient relationship between wealth and quality of life, and between quality of life and happiness.

Diener (2000) considers happiness as a "subjective well-being" and divides it into four dimensions: satisfaction with life as a whole, satisfaction with specific domains of life, positive affect levels, and levels of negative affect. Happiness can be understood as something deeper associated with the full satisfaction of human beings with life.

For Allardt (1993), quality of life is the result of complex interactions between subjective and objective factors. Allardt's approach was introduced in the quality of life survey in the Scandinavian Welfare Survey and belongs to the so-called Scandinavian quality of life approach. Allardt (1993) invented his famous "have, love and be" to give a complete description of the human condition, being defined as the ability to (i) have material conditions to exist and develop; (ii) love, which is the ability to relate to other people and build an identity; (iii) be, which is the ability to integrate into society and live in harmony with nature.

This definition can be related to the concept of human development proposed by Maslow (1943). Abraham Maslow's Theory of Human Motivation presents the human being as a type of psychological organism struggling to satisfy its needs in search of full growth and development. This theory suggests that human beings are motivated by a hierarchy of needs ranging from basic to psychological and self-fulfillment (Morgan, 2006).

For Maslow (1943), "man is an animal eternally dissatisfied" and "human needs are organized in hierarchies of dominance", that is, "the emergence of a need generally rests on the previous need for another need". Maslow (1943) developed a relevant theory for human motivation, in which the author suggests that it functions as a kind of framework for future research on the subject. When developing his theory, the author presents a hierarchical classification of human needs, starting with physiological, safety, social, esteem, and, finally, self-actualization needs. These needs can be represented through a pyramid that became widely known as Maslow's Pyramid.

It is possible to relate this search for human development proposed by Maslow (1943) with the search for quality of life in a society, which can be defined by a fair distribution of capacities (Mariano & Rebelatto, 2014), i.e., upon reaching a certain level of quality of life, a city, for example, creates possibilities for its citizens to meet their human needs, from the most basic to those of self-fulfillment. For Allardt (1993), human needs are material and non-material, and both types have to be considered in systems of indicators designed to measure the actual level of well-being in a society.

Knowing these complex interactions between objective and subjective factors and that it is a broad concept, assessing the quality of life is like defining a representative map of a territory that is difficult to understand. Despite the complexity and assumption that an indicator or mathematical model does not represent reality in its systemic nature, the usefulness of models is known to obtain a clearer view of this reality.

Along with this, there is a growing concern related to the distribution of resources for social programs, as well as with the identification of population centers that suffer more significant deprivation. To improve the scenario, it becomes even more necessary to develop assertive public policies. This way, the ability to analyze socioeconomic information at different spatial levels should be increased. In this aspect, the indicators responsible for quantifying certain data help the decision-making process, as they simplify and quantify the information, in addition to mirroring the form and direction of the collective.

In this sense, many studies have been developed with proposals for indexes to evaluate and rank countries and cities according to economic, political, social, and environmental measures. Greco et al. (2019) speak of more than 400 official indices, 100 of which are used to measure human development, showing exponential growth in the last 20 years and demonstrating the current popularity of these measures by researchers and public policymakers.

Historically, the first indicator disseminated worldwide was GDP to measure economic growth. For Schumpeter & Backhaus (2003), however, economic growth and economic development are distinct terms of meaning. Economic development is presented as a broader concept associated with innovations in products and means of production, in addition to social and political transformations. For Aristotle (2000), the primary function of wealth is to serve as an instrument to achieve a universal good that is happiness, i.e., placing wealth as something to reach the "purpose of political life". Therefore, a measure of economic growth becomes insufficient for understanding more complex dimensions of human development.

Thus, social indicators were inaugurated, bringing a broader view to the issue of human development. Thus, the Human Development Index (HDI) appears as an attempt to quantify the quality of life through the synthesis of indicators of life expectancy, literacy rate, years of schooling, and GDP per capita.

Three dimensions are considered in the HDI. The first of these is longevity, usually associated with adequate access to good nutrition and health care throughout life, which allows people to develop their skills and talents over a more extended period of time. Another dimension is education, measured by two indicators related to the population's level of knowledge and literacy. There is also an economic dimension, indicated as an instrument to achieve other human development purposes (Pereira & Mota, 2014).

However, the HDI has been the subject of analysis in different studies and has received much criticism from the literature, such as the use of low-quality data, inadequate indicators, problems in the calculation used, and measurements considered incorrect in the economic dimension. There is a discussion about the relevance and ability to measure quality of life using these indicators and the dimensions proposed by the HDI. Furthermore, the data may present biases, different ways of measuring the indicators for each country, in addition to missing data (Pereira & Mota, 2014).

Another criticism found in the literature refers to the calculation of the index. Using equal weights for dimensions is arbitrary and may be inappropriate. Still on the calculation, the index does not consider differences within each country and adopts a compensatory model, that is, a good performance in one dimension compensates for an inferior performance in another (Pereira & Mota, 2014). Therefore, some authors have developed alternative proposals to assess human development in countries. The study by Greco et al. (2019) conducts a broad literature review on the methodological framework used to construct these indices, presenting the advantages and disadvantages of various methodologies used.

Within this perspective, Somarriba Arechavala & Zarzosa Espina (2018) developed a model based on the DP2 distance measurement technique to evaluate the quality of life in the 28 countries of the European Union. The developed model aimed to assess whether there are differences in the levels of quality of life between men and women and to study which factors prove to be more decisive considering spatial and gender aspects. The results warn about these gender differences and point out where social policies can be aimed at improving the lives of citizens.

Based on the assumption of an efficient relationship between economic growth and human development, Mariano & Rebelatto (2014) used an approach based on Data Envelopment Analysis (DEA) to calculate an indicator of a country's performance in converting wealth into quality of life. The authors used 10 criteria and analyzed the results from 101 countries. 23 of these countries were considered socially efficient, and the authors highlighted some characteristics among them, such as: countries with high social standards driven by high per capita income; countries with low wealth contribution; and countries that formed the Soviet Republic or socialist countries of the past.

do Carvalhal Monteiro et al. (2018) used a clustering algorithm to develop another proposal to measure quality of life, but considered the dimensions and criteria used in the Better Life Index (BLI), the OECD indicator. In this research, the authors propose a methodology different from the composite indices, customarily used to rank countries, but rather an alternative for grouping these countries. This grouping is based on each dimension of the BLI. According to the authors, the cluster profiles obtained for each dimension allowed essential insights that could not be made with the analysis through a single composite index.

Pereira & Mota (2014) used an ELECTRE TRI-C multicriteria method to suggest a different composite indices methodology. The method was applied in the city of Recife in Brazil with the same criteria as the HDI, but with different weights for each criterion and with a non-compensatory calculation proposal, to classify the regions of Recife in quality of life levels. For the authors, this proposal proved to be more satisfactory for dealing with nuances of the city and attenuated some distortions generated by the Municipal Human Development Index (MHDI) methodology.

The MHDI was developed to adapt the HDI to the reality of municipalities in Brazil by the United Nations Development Program (UNDP) in Brazil, the Brazilian Institute for Applied Economic Research (IPEA), and the João Pinheiro Foundation. The same HDI dimensions are considered for the MHDI, which are longevity, education and income, however, adapting the global methodology to the Brazilian context and the availability of indicators (Silva et al., 2021).

The calculation of the MHDI takes into account four variables: life expectancy at birth (longevity); education of the adult population and school flow of the young population (education); per capita income (income). At the end, a geometric mean is calculated, with the same weight for all dimensions. The final results vary from 0 to 1, where above 0.7 is considered a high MHDI for a municipality (Silva et al., 2021). As well as for the spatial level of countries, a Human Development Index for municipalities contributes to decision-making in local public policies. It can be used as a tool to build cities with better living conditions for their citizens (Pereira & Mota, 2014).

Another index at the local level, whose objective is more focused on defining lines of public investments, is the Municipal Quality Index (IQM), developed by the Rio de Janeiro Data and Information Center Foundation (CIDE). This index was developed by CIDE with the following objectives: to measure the ability of municipalities to attract investments; identify municipalities with the best conditions for new ventures; identify weak points to be corrected; and classify municipalities according to the index. The IQM, therefore, considers seven indicators: centrality and locational advantage, workforce qualification, wealth and consumer potential, business facilitation, infrastructure for large-scale ventures, dynamism, and citizenship (CIDE, 2001).

The emphasis of this work is on identifying dynamic municipalities and the most central ones in assessing the influence of networks, in determining the indicative elements of the existence or absence of favorable conditions for economic development, such as workforce qualification,

household head income, and the scale of retail trade, which will compose the attributes of each indicator (CIDE, 2001).

The procedures adopted for the development of this index, such as the selection of indicators, as well as the assumptions considered for the evaluation of the results obtained, are based on studies of industrial and spatial economics, mainly those focused on understanding and analyzing the urban regions that make up the reality of the state of Rio de Janeiro, in addition to the significant concentration observed in the Rio de Janeiro Metropolitan Area (CIDE, 2001).

At the local level, the quality of life index should be more precise or disaggregated into more indicators and attributes. This way, it can better contribute to guiding public policies to improve the quality of life.

3 MULTICRITERIA DECISION AID (MCDA)

We are often faced with complex problems and they usually involve multiple criteria. Within this context, multicriteria decision aid (MCDA) was developed to support the decision maker in his personal and unique decision process, that is, MCDA methods provide techniques to find a solution by placing the decision maker at the center of the decision process. These methods do not offer automatable, one-size-fits-all solutions but rather incorporate subjective information provided by the decision-maker. It is, therefore, a discipline that encompasses mathematics, administration, information technology, psychology, social sciences and economics (Ishizaka & Nemery, 2013).

In this context, according to de Almeida et al. (2015), many problems analyzed within the structure of an organization are multicriteria, especially at the highest and strategic levels of the organizational structure. For the author, when a problem is analyzed as a single objective, generally the other objectives are considered as restrictions. Thus, the multicriteria decision problem is characterized by presenting two or more objectives that cannot be combined, being expressed mathematically as:

$$\max\{f_1(a),...,f_k(a)|a \in K\} \tag{1}$$

where K is a finite number of actions and f_i, with i = (1, ..., k), the criteria to be maximized or minimized, each criterion being an application of K in R. Around 1970, the first MCDA methods appeared to help in resolving conflicting problems, in addition to enabling the decision elements and possible consequences of actions to become more transparent for decision-makers Ishizaka & Nemery (2013).

There is a growing interest in applying MCDA methods in different situations. Some examples in the literature are: Hierarchical Analysis (AHP), Elimination Et Choix Traduisant la Realite (ELECTRE), Preference Ranking Organization Method for Enrichment of Evaluations (PROMETHEE), Decision Making Trial and Evaluation Laboratory (DEMATEL), Technique for Order Preferences by Similarity to Ideal Solutions (TOPSIS) and others.

Thus, Roy (1981) apud Ishizaka & Nemery (2013) presents four types of decisions that we normally encounter in problems with multiple criteria. First is the choice problem, when the objective is to select the best option or reduce the group of so-called "good" options. Second is the classification problem, when the objective is to classify the options into ordered groups or categories. It is intended to regroup options with similar behaviors or characteristics for descriptive, organizational, or predictive reasons. Third is the ranking problem, when options are ordered from best to worst through scores or pairwise comparison. Fourth is the description problem: the objective is to describe options and their consequences. It is usually done as a first step to understanding the characteristics of the decision problem.

With MCDA methods, it is possible to combine different and conflicting objectives through a subjective evaluation, usually represented by eliciting preferences from a manager or other representative of the organization, this subjectivity being inherent to the problem (de Almeida et al., 2015). Thus, de Almeida et al. (2015) presents two ways of classifying MDCA methods. The first, more commonly found in the literature, classifies methods into three categories: (i) Single criterion synthesis methods, (ii) Outranking methods, and (iii) Interactive methods.

The first group is so called because they aggregate the criteria into a single summary criterion. For this group, methods based on the deterministic additive model and the Multiattribute Utility Theory (MAUT), derived from Keeney and Raiffa's Utility Theory (1976) stand out. In the second group, the ELECTRE family of methods and the PROMETHEE family of methods stand out. For the third group, multiobjective linear programming methods stand out, which mostly use interactive methods (de Almeida et al., 2015).

Still, according to de Almeida et al. (2015), the methods can be classified as compensatory or non-compensatory. This is a relevant characteristic of the aggregation model related to the possibility or not of compensation between the criteria. In compensatory models, there is the idea of compensating for a lower performance of an alternative in a given criterion by means of a better performance in another criterion. Therefore, de Almeida et al. (2015) adds that, in compensatory methods, the evaluation of an alternative considers the trade-offs between the criteria, while in non-compensatory methods, there are no trade-offs between the criteria.

The decision maker must consider this fundamental issue when choosing the most appropriate method for his problem (de Almeida et al., 2015). This analysis is part of defining and structuring a problem with multiple criteria. However, according to Franco & Montibeller (2011), very little attention is given in the literature to the process of structuring this type of problem, considered by the authors as a complex and crucial task to generate significant effects in the analyzed organization.

4   METHODS

This research is about a multimethodology applied to a complex societal problem. According to Mingers & Brocklesby (1997), multimethodology is the combination of methodologies or parts of methodologies, usually based on different paradigms. This combination is necessary to deal

with different natures of the problem, using both quantitative and qualitative models. While some methodologies focus on specific parts of the problem, multimethodology considers its focus on a real and complex problem. This is the case of public policy decisions in sectors such as education, health, environment and security (Mingers & Brocklesby, 1997; Lins et al., 2021).

This research is also applied to a complex societal problem. According to DeTombe (2002), these problems involve many people and actors, with different goals, emotions, and perspectives on the situation. For the treatment process of complex societal problems, a broad, integral, and long-term approach is required, involving uncertain knowledge or lack of knowledge. For DeTombe (2002), an integral approach means carrying out interventions in all aspects of the problem in a systemic way, as well as proposing implementations that cover the problem as a whole.

DeTombe (2002) adds that greed, corruption, ignorance, war, huge private profit, inadequacy, and indifference often cause the problems. There is also a tendency to privatize the benefits of the problems and to socialize the costs. For the author, these problems are not treated properly, or worse, they are treated dangerously, without due attention being given to the exploration and structuring of the problematic situation. However, due to the impact that complex societal problems have on society and the costs involved, they should be treated in a more structured, transparent, and democratic way.

Regarding this, for Franco & Montibeller (2011), the use of qualitative model decision structures are appropriate for situations in which problems are ill-structured or confusing. For the authors, the definition of the problem is not clear and presented as an initial data, but continuously negotiated between the members of the organization before and during an intervention.

Different managers and members of an organization assume unique perspectives on a particular situation, and this happens due to the unique mental structure that each one develops through experiences and systems of beliefs and values. Thus, each stakeholder will be able to represent the problem in a different and particular way, from their perspective. A challenge for the analyst conducting the intervention is to model these different perceptions and seek a broad understanding of the problem situation. For this, some tools serve as support such as cognitive mapping, dialog mapping, strategic choice approach, and group model building. Many of these tools were developed to collect multiple aspects of a problem, whether objective or subjective (Franco & Montibeller, 2011).

The multimethodology proposed in this article combines two methods. The first consists of a concept map to elicit and organize information in the literature about quality of life, its conceptual aspects and correlation with measurable criteria. This method also contributed to elucidate aspects with greater measurement difficulties, the possibility of redundancies, situations of ambiguity or paradoxes, in addition to allowing visualization of the unfeasible of measuring certain factors due to lack of adequate data. That is, the use of concept maps allowed a broader and more structured view of the problem.

For Franco & Montibeller (2011), it is necessary to recognize that some organizational or societal problems involve negotiations between multiple worldviews, and the use of concept maps and

other tools can help in this process of discussion about different perspectives of the problem. For Novak & Cañas (2006), concept maps are based on an explicit cognitive psychology of learning and constructivist epistemology. It is a very powerful and concise knowledge representation tool, demonstrating clarity and precision in the cognitive structure it wants to represent.

The second method proposes a quantitative assessment of the quality of life in the municipalities of Rio de Janeiro, Brazil. Thus, an interface is proposed with the qualitative aspects raised from the complex societal problem through a mathematical method, even assuming, as previously stated, the incompleteness of this model in representing the analyzed systemic reality.

The problem is inserted in the context of public policies, involving the interest of multiple actors and a great impact on society. Thus, it is expected, with a systemic and integral approach, to build an indicator to evaluate and compare human development in cities and serve as support for decisions and actions aimed at improving the conditions and capacities of the population.

Therefore, this work presents itself as a ranking problem, where the intention is to establish an order among the municipalities of Rio de Janeiro according to criteria chosen to evaluate the quality of life, combined in an aggregator composite index. It is also a multicriteria decision model that allows the construction of a synthetic indicator used to rank cities. Multicriteria support for decision-making helps solve complex problems and supports the entire decision-making process so that the elements of the decision and the consequences of potential actions are clear.

Both methods are integrated from the methodological procedures proposed in de Almeida et al. (2015), which presents twelve steps for building a multicriteria decision model. The first phase includes five preliminary steps, including the structuring of basic elements for formulating the problem. In the second phase, the factors that have the most influence on the choice of decision method are structured. At the end of this phase, not only is the method chosen, but the model is built. In the third phase, the final steps for solving the problem and implementing the solution are developed (de Almeida et al., 2015). Discussions on the construction of the multicriteria model are then presented in the next section of this article, containing more details on the steps of the methodological procedure seen in Figure 1.

4.1 Model building

The methodology for building the model proposed in this study is based on the procedure suggested by de Almeida et al. (2015), consisting of twelve steps.

The first step was characterizing the decision makers and other actors. How it is a public policy evaluation problem, the decision makers could be those most interested in the metrics developed for the quality of life: the civil society. However, as a way of allowing democratic debate, but still viable in the decision-making process, society must be represented by people or entities chosen as representatives for this specific context.

In this case, the public manager, as a decision maker, could use the model to analyze the quality of life in cities in a multidimensional way, and propose actions to offer better conditions so that
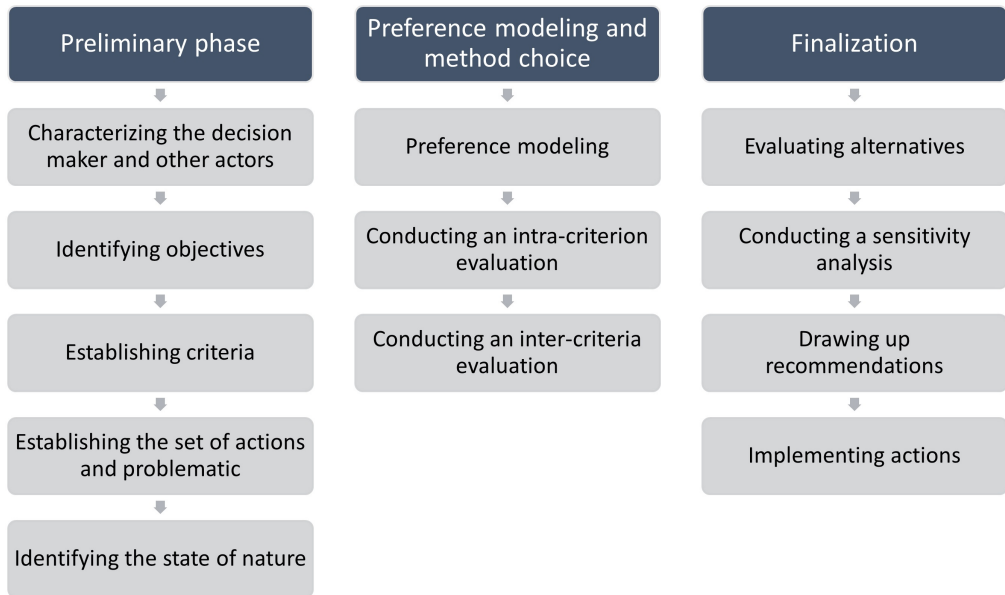
Preliminary phase	Preference modeling and method choice	Finalization
Characterizing the decision maker and other actors	Preference modeling	Evaluating alternatives
Identifying objectives	Conducting an intra-criterion evaluation	Conducting a sensitivity analysis
Establishing criteria	Conducting an inter-criteria evaluation	Drawing up recommendations
Establishing the set of actions and problematic		Implementing actions
Identifying the state of nature		

Figure 1 – Phases of the research methodology.

Adapted from de Almeida et al. (2015).

the population can meet their needs. It is noteworthy that the model is still easily replicable for other sets of cities, or even for administrative units within a single city. The decision maker could also define different criteria for each type of need, according to his own preference structure.

The information provided by the model contributes to the debate on the subject and favors the integration of other actors in the search for better living conditions for the population of cities. There are, therefore, specialists and academics who could contribute and participate in the decision-making process, in addition to monitoring agencies and agents from the productive sectors.

The second step was identifying the objectives. The general objective is to evaluate and compare the quality of life in the municipalities of the State of Rio de Janeiro, through criteria that can bring a broad and multidimensional look. The research starts from the assumption that the measurement of quality of life is a complex and ill-structured problem and also intended to seek a new conceptual model that would support the decision to classify the criteria and hierarchy for measuring this quality of life.

In order to better structure the problem, a concept map was developed, based on the literature, correlating concepts about quality of life and defining specific objectives according to Maslow's Theory. Figure 2 shows the concept map developed by qualitatively analyzing the problem and correlating the fundamental concepts of Maslow's Pyramid (1943) with the quality of life model proposed by Allardt (1993). The objectives were extracted from this concept map and were defined as: (i) Assess the ability of the cities to meet physiological needs; (ii) Assess the ability of

the cities to meet safety needs; (iii) Assess the ability of the cities to meet love and belonging needs; (iv) Assess the ability of the cities to meet esteem needs; and (v) Assess quality of life in the cities.
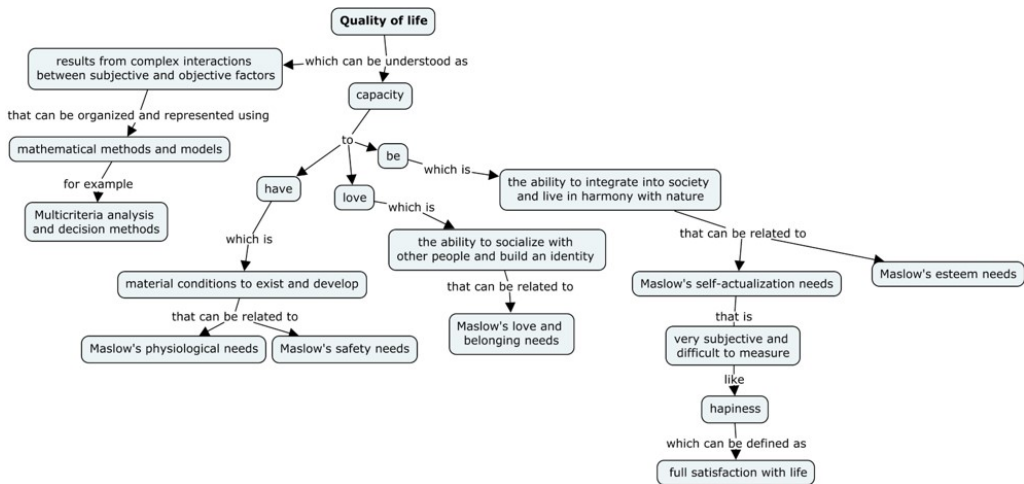

Figure 2 – Concept map – quality of life and the relationship with
Maslow's Theory of Human Motivation (1943).

For the step 3, we must establish criteria. There are several social, health, safety and environmental indicators that could be selected to assess the quality of life in a city. The absence of other indicators or data recognized as relevant, but which could not be incorporated into the model, can also be noticed. There is also the difficulty in defining the number of criteria, which may or may not be classified by themes, for example.

The methodology for choosing the criteria was based on the concept map developed, understanding that a city with a high level of quality of life has a fair and adequate distribution of capacities and relating such capacities to the human needs proposed in Maslow's Theory (1943) . That is, by providing quality of life to its inhabitants, this city allows them to satisfactorily meet their physiological, safety, social, esteem and, subsequently, self-realization needs, providing human development.

Self-actualization needs were not contemplated with evaluation criteria because no indicators considered adequate to be incorporated into the model and capable of measuring this more complex aspect of human need were found. In addition, a greater proximity between the concept of happiness and the needs for self-actualization proposed by Maslow (1943) was identified, which is not the purpose of this study. Figure 3 presents the criteria chosen and classified according to Maslow's Pyramid, that is, associated with each objective.

The choice of criteria followed some objectives: (a) define a very close number of indicators for each group of needs; (b) choose few criteria and, therefore, the most representative possible for
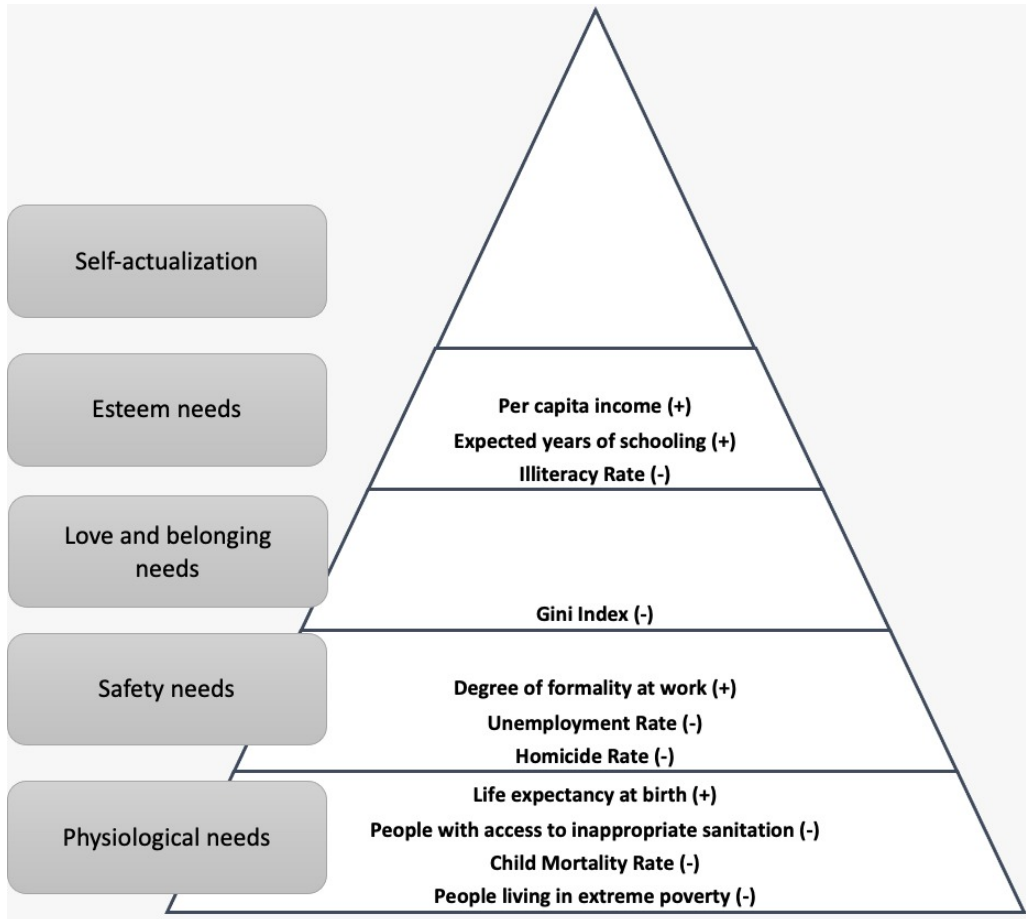
Figure 3 – Criteria chosen and classified according to Maslow's Pyramid

each group of needs; (c) seek a balance between more basic needs and other needs, so that a city with low access to basic needs is not contemplated with a high quality of life index.

Regarding the choice of criteria to represent physiological needs, we have: (a) Life expectancy at birth; (b) Percentage of people without access to appropriate sanitation; (c) Child Mortality Rate; (d) Percentage of people living in extreme poverty.

According to Maslow (1943), the concept of homeostasis is central to the definition of these needs. Homeostasis refers to the body's automatic efforts to maintain a balance. Hunger, for example, is one of the body's reactions when faced with bodily needs, in this sense, people in extreme poverty would find it very difficult to meet certain physiological needs, which justifies the choice of criterion (d).

Other physiological needs are better met with access to adequate basic sanitation. This (b) and the other criteria (a), (c) are mainly related to access to good health conditions for a popula-

tion, reflecting on longevity. This access also reflects on the body balance of these individuals throughout life (concept of homeostasis mentioned by Maslow (1943)).

The criteria chosen for the security needs group were: (e) Degree of formality at work; (f) Unemployment rate; (g) Homicide rate. Criteria (e) and (f) refer to stability at work and, consequently, financial stability. For Maslow (1943), this need for security is perceived in the preference of human beings for routine and predictability. In the search for security, routine, and predictability, it is assumed that unemployment and informality are unfavorable conditions for this.

According to Maslow (1943), the smoothly functioning 'good society' makes its members feel safe enough from wild animals, extreme temperatures, criminals, assaults, and murders, tyranny, etc. This corroborates the choice of criterion (g), which is defined as a representative indicator for the security dimension.

The criterion chosen for the social needs group was the (h) Gini Index. This criterion is an index that varies from 0 to 1 and corresponds to the degree of inequality of a population, with 0 representing a situation of equality. The Gini Index then measures the degree of income concentration in a locality, pointing out income differences between the poorest and richest.

For Maslow (1943), the frustration of these needs is the most commonly found in cases of various psychopathologies. We, therefore, need affective relationships with people in general or even to feel that we belong to a specific group. In this research, an assumed assumption for building good affective relationships within a society is the search for equality, which justifies the choice of criterion (h).

This assumption can be ratified by the theory of class struggle enunciated by Marx and Engels in several of their works (Losurdo, 2016)). For Marx and Engels (2016) apud Losurdo (2016)), the history of all society until our days has moved in class antagonisms, i.e., all society, throughout its development, is crossed by different class struggles, among them the struggles between bourgeoisie and proletariat, whites and blacks, men and women (Losurdo, 2016).

Finally, the indicators that represent esteem needs are: (k) Per capita income; (l) Expected years of schooling; (m) Illiteracy Rate. (Maslow, 1943) classifies these esteem needs into two subgroups. In the first are the need for adequacy, confidence in relation to the world, independence, freedom. In the second we have the need for reputation or prestige, for recognition, attention, importance, or appreciation. Maslow (1943) further adds that, when these needs are satisfied, they lead to a feeling of self-confidence, of being useful and necessary to the world.

Thus, the indicators chosen to represent this group of needs are related to two dimensions: income and education. Sen (1999)) in his book presents demonstrations that development can be seen as a process of expanding the freedoms. For Sen (1999), growth individual incomes can obviously be very important as a means of expanding the freedoms, but freedoms also depend on other determinants, such as social and economic arrangements (eg education and health services) and civil rights (eg freedom to participate in public discussions and inquiries).

In this way, income is a factor that impacts people's capacity, as already discussed in this text. As assumed by Mariano & Rebelatto (2014), all human development depends, to a greater or lesser extent, on economic performance. However, Aristotle (2000) recognizes, as well as Sen (1999), that wealth is a means and not the end of political life, for him, it is evident that wealth is not the good we seek, as it is merely useful in profit from something else.

This relationship between income and a person's degree of ability is even more evident in the capitalist system we live in, where the lack of money deprives us of various freedoms and can impact on the non-satisfaction of various needs, from basic to self-fulfillment. In this sense, the choice of criterion (k) as part of the group of esteem needs becomes relatively arbitrary, since, despite recognizing it as relevant in the search process for quality of life, it intends to attenuate its impact on the overall result of a city, assuming this indicator as a means and not as an output.

About education, Sen (1999) comments that it is relevant for the quality of life in two senses: as an important element of human capital, input for economic growth, and, on the other hand, it also increases, by itself, the capacity of people. Through the author's literature, it is possible to identify relationships between education and the increased ability to satisfy certain esteem needs, such as independence, freedom, recognition, and self-esteem, which justifies the choice of criteria (l) and (m).

Within Maslow's Pyramid (1943), there is still a need for self-actualization at the top of this search for human development. For Maslow (1943), even if all these needs are satisfied, we can still (if not always) expect that a new discontent or restlessness will soon develop, unless the individual is doing what he wants. "He's ready to do it".

Apparently, the definition of what a person is prepared to do is complex and difficult to define. Maslow (1943), then, complements that people who have these needs met can be considered people "basically satisfied" and it is at this stage that maximum and vigorous creativity can be expected. Therefore, it is possible to make a parallel between self-realization and the concept of happiness (already discussed in this article), understood as something deeper than the quality of life and associated with the full satisfaction of the human being with life (Mariano & Rebelatto, 2014). Thus, this research does not intend to include indicators for self-actualization needs within the quality of life measurement model, considering such needs not as part of quality of life, but as a result of it.

In step 4, it was establishing the space for actions and issues. This first version for the space of actions presents some data collected based on the choice of criteria that were grouped according to the types of needs defined by Maslow (1943). The Theory of Human Motivation proposed by Maslow is suggested here as a proposal to serve as a theoretical basis for choosing, classifying and defining the importance of criteria. Table 1 presents the chosen criteria, their measurement units, and their classification according to the needs of Maslow's Pyramid.

The data used were taken, mainly from the Demographic Census, carried out by IBGE, from the Department of Informatics of the SUS (DATASUS) and from the Atlas of Human Development in Brazil, developed by the Institute of Applied Economic Research (Ipea) in partnership

with João Pinheiro Foundation (JPF) and UNDP. In addition, one more indicator was added as an integral part of the model, but not available in the Demographic Census, the homicide rate, available through the Ipea website. Indicators referring to the year 2010, last census, were considered. It should be noted that it was necessary to standardize the database, since this article has a comparative focus.

Table 1 – Criteria classified by type of need defined by Maslow (1943).

N.	Criterion	Measurement unit	Classification	Objective	Source
A	People living in extreme poverty	Percentage	Physiological needs	Minimize	Atlas of Human Development in Brazil
B	Child Mortality Rate	Number of deaths under one year of age per 1000 births	Physiological needs	Minimize	Atlas of Human Development in Brazil
C	people without access to appropriate sanitation	Percentage	Physiological needs	Minimize	Atlas of Human Development in Brazil
D	Life expectancy at birth	Number of years	Physiological needs	Maximize	Atlas of Human Development in Brazil
E	Unemployment Rate	Percentage	Safety needs	Minimize	Atlas of Human Development in Brazil
F	Degree of formality at work	Percentage	Safety needs	Maximize	Atlas of Human Development in Brazil
G	Homicide Rate	Number of deaths per 100,000 inhabitants	Safety needs	Minimize	Institute of Applied Economic Research (Ipea)
H	Gini Index	Coefficient that measures inequality in a population	Love and belonging needs	Minimize	Atlas of Human Development in Brazil
I	Illiteracy Rate	Percentage	Esteem needs	Minimize	Atlas of Human Development in Brazil
J	Expected years of schooling	Number of years	Esteem needs	Maximize	Atlas of Human Development in Brazil
K	Per capita income	Currency units	Esteem needs	Maximize	Atlas of Human Development in Brazil

For step 5, de Almeida et al. (2015) comments about the relevance of identifying uncontrolled factors. However, due to the simplification of the elaborated model, non-controlled factors that had a relevant impact on the results were not identified and considered.

In step 6, it was time to establish the model preferences. According to Maslow (1943), it is necessary to consider this relationship of preponderance between needs, however, it is not necessary

for a more basic need to be completely met for another to emerge. Thus, the author offers an example to clarify this relationship: "For example, if overbearing need A is only 10 percent satisfied, then need B may not be visible at all. However, when this need A becomes 25 percent satisfied, need B may appear at 5 percent; when need A becomes 75 percent satisfied, need B may arise at 30 percent, and so on" (Maslow, 1943, p. 11).

Maslow's statement demonstrates the relevance and difficulty of establishing the order of preference among the criteria, demonstrating the preponderance or hierarchy among human needs. There is also a compensatory rationality between the criteria within the same group of needs and a non-compensatory rationality between the categories of needs established in the Pyramid. That is, a better performance in the child mortality rate criterion has a compensatory rationale with the life expectancy at birth criterion, for example, since both are part of the physiological needs group, however, they do not present a compensatory rationale for a representative criterion of any other group of human need.

Thus, the additive aggregation model is used for each need category that will serve as input for the non-compensatory model. The latter will serve to propose an ordering between the cities and a global value for each one of them.

So, in the step 7 we have the perform intra-criteria evaluation. This was based on the linear function. Thus, the normalization procedure used was:

$$v'_j(a_i) = \frac{v_j(a_i) - \min\{v_j(a_i)\}}{\max\{v_j(a_i)\} - \min\{v_j(a_i)\}} \tag{2}$$

Both the choice of criteria and the intra-criteria relationship were not based on the preference structure of a specific decision maker, being only a suggestion. That is, there was no elicitation process for the weights, which were established as equal for all criteria after normalization.

After that, in step 8, an inter-criteria evaluation was now performed. After the normalization procedure and after finding the global values for each type of human need, the method used to comparatively evaluate the (alternative) cities was a non-compensatory method: PROMETHEE ROC. The order of weights followed the hierarchy of Maslow's Pyramid, in which the most basic needs must be met as a priority. Therefore, these needs received greater weight in the order of preference, which was determined as: physiological needs, safety needs, social needs and, lastly, esteem needs. Table 2 presents the result of the ROC weights based on the definition of priority. The formula for calculating the weights is given below, where n is the number of criteria and j is the position of the criteria in the ranking. ROC uses the vertices of a simplex to define the centroid weight for each criterion (de Almeida et al., 2015).

$$w_i(ROC) = \frac{1}{n} \sum_{j=1}^{n} \left(\frac{1}{j}\right) \tag{3}$$

PROMETHEE was chosen because it is considered a non-compensatory method, balancing the alternatives. For ranking problems, some multicriteria decision methods are more appropriate.

Table 2 – ROC Weights.

Needs	ROC weights
Physiological needs	0,5208
Safety needs	0,2708
Love and belonging needs	0,1458
Esteem needs	0,0625

PROMETHEE is an outranking method for a finite set of alternatives that are prioritized and selected according to some criteria that may conflict. It is also a rather simple ranking method in design and application compared to other methods for multiple criteria analysis (Brans et al., 1986).

For Brans et al. (1986), the main characteristics of PROMETHEE are simplicity, clarity and stability. To use the method, only a few parameters have to be fixed, and they all have economic significance. Regarding stability, Brans et al. (1986) comment that every outranking method involves the determination of some parameters that the decision maker cannot accurately specify. Therefore, stability, or the low influence that these parameters have on rankings, seems to be a necessary condition for a good method.

That is, when small deviations in the parameters are introduced, there is not a great influence on the results generated through the PROMETHEE method, however, large deviations end up generating implications in the classifications, which allows the method to take into account the particularities of each problem (Brans et al., 1986).

Thus, Visual PROMETHEE was used in this research, the only software supported by the authors of the methodology Jean-Pierre Brans and Prof. Bertrand Marshal. The quality and consistency of the user interface, in addition to ease of use, stand out as positive points. Regarding the preference function, the usual criterion was chosen to represent the preference of the decision maker for each of the chosen indicators. More details about the method are presented in Brans & Vincke (1985) and Brans et al. (1986).

5 RESULTS

Step 9 was the assessment of alternatives itself. In this section the results of this assessment are presented. The PROMETHEE ROC method served to rank the cities according to a quality of life indicator based on global values found for each category of need defined by Maslow. Figure 4 shows a map of the State of Rio de Janeiro, where each point represents a city. Bigger and bluer circles present better quality of life results, while smaller and redder circles have worse quality of life results.
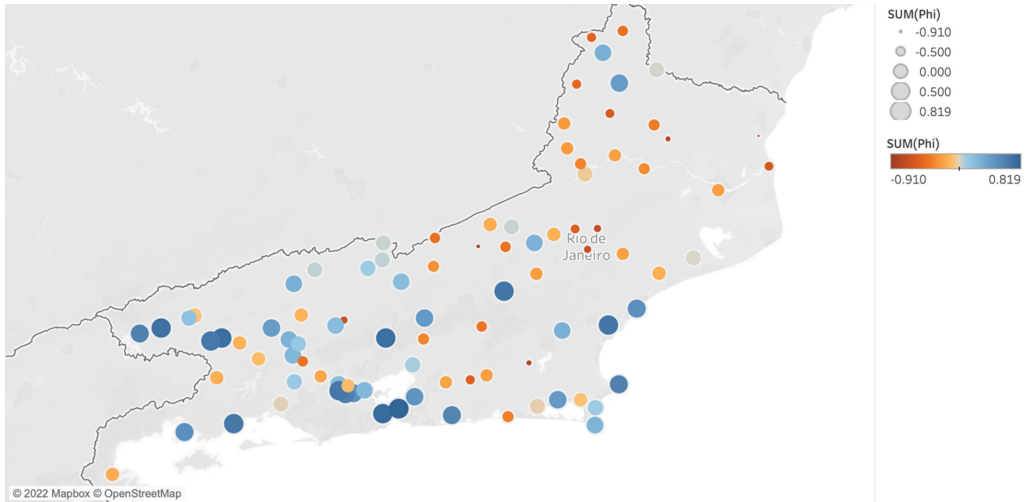
Figure 4 – Result of the PROMETHEE (Phi) method by city, used as an index to assess the quality of life.

Figures 5 and 6 present the results of the 10 cities with the best and worst performances, respectively. The result of the PROMETHEE ROC method, The Phi value, and which was used to rank the cities is obtained through the sum of Phi+ and Phi-, that's why it's represented on the figures as SUM(Phi). More details about the calculations can be seen in Brans & Vincke (1985) and Brans et al. (1986). In Figures 7 and 8, it is possible to see the results of the intra-criterion evaluation of the same cities presented in Figures 5 and 6. This result is prior to the application of PROMETHEE ROC, demonstrating the performances of each city for each type of need. It is, therefore, a result of step 7 of this work. It is noteworthy that the choice was restricted to only twenty cities in Figures 5, 6, 7 and 8 due to the size of the image needed to represent the ninety-two cities in the state.
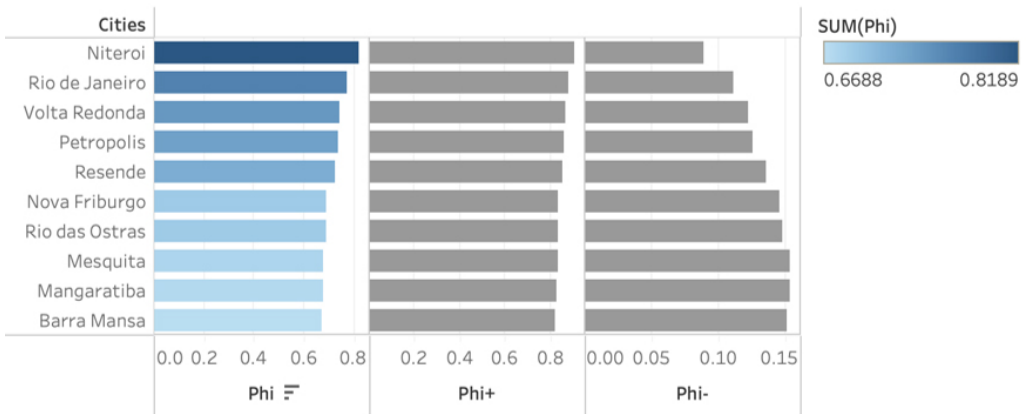
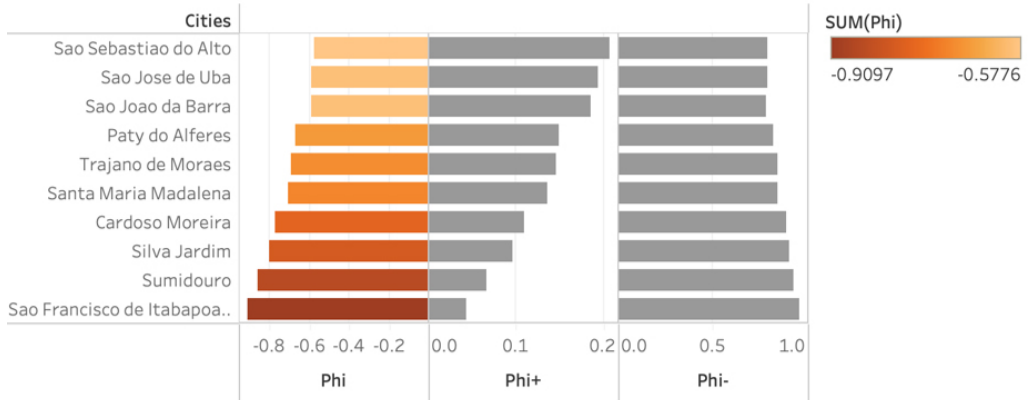**Figure 5 –** Ranking of the 10 best placed cities according to quality of life.

Figure 6 – Ranking of the 10 worst ranked cities according to quality of life.
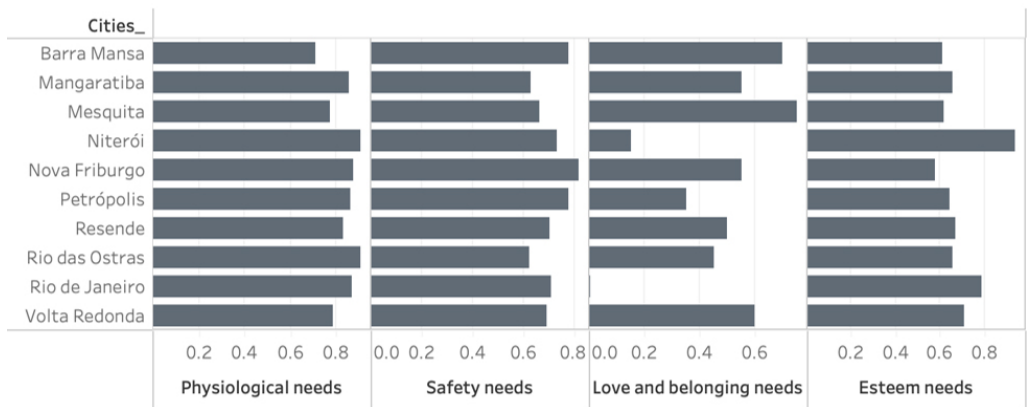

Figure 7 – Result of the intra-criterion evaluation for each group of needs defined by Maslow (1943) –
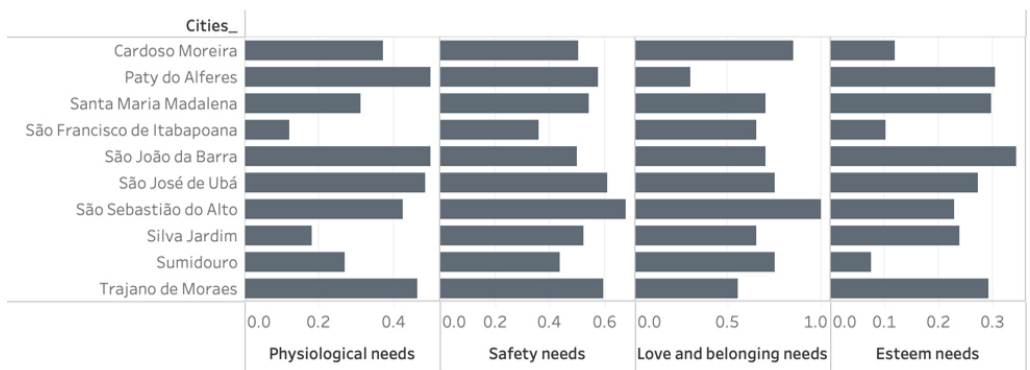10 best placed cities in the ranking.

Figure 8 – Result of the intra-criterion evaluation for each group of needs defined by Maslow (1943) –
10 worst placed cities in the ranking.

A sensitivity analysis was still conducted in step 10. Based on the ROC procedure, for the elicitation of the weights, only the order of importance between the criteria was necessary as information. As already mentioned, this order followed the hierarchy established in Maslow's Theory, giving greater weight to basic needs (physiological and safety) when compared to social and esteem needs. In Figure 7 and 8, one can see how different cities had very different results for each type of need. It is also worth mentioning the low performance of the best ranked cities for the criteria of social needs, such as Rio de Janeiro and Niterói. Table 2 presents the ROC weights for the types of needs.

Changes in weights or in the order of preference of the decision maker would impact the performance of some cities and some positions in the ranking. In Figure 9, it is possible to analyze the difference between the first scenario, already shown, and new scenarios, alternating the order of preference between Maslow's group of needs. The greatest impact is perceived when the group of social needs is placed as a priority over the other criteria. In Figure 10, it is possible to visualize the sensitivity analysis with equal weights for all criteria and if the order between Maslow's groups of needs were inverted, creating the image of an inverted pyramid in the previously defined priorities.
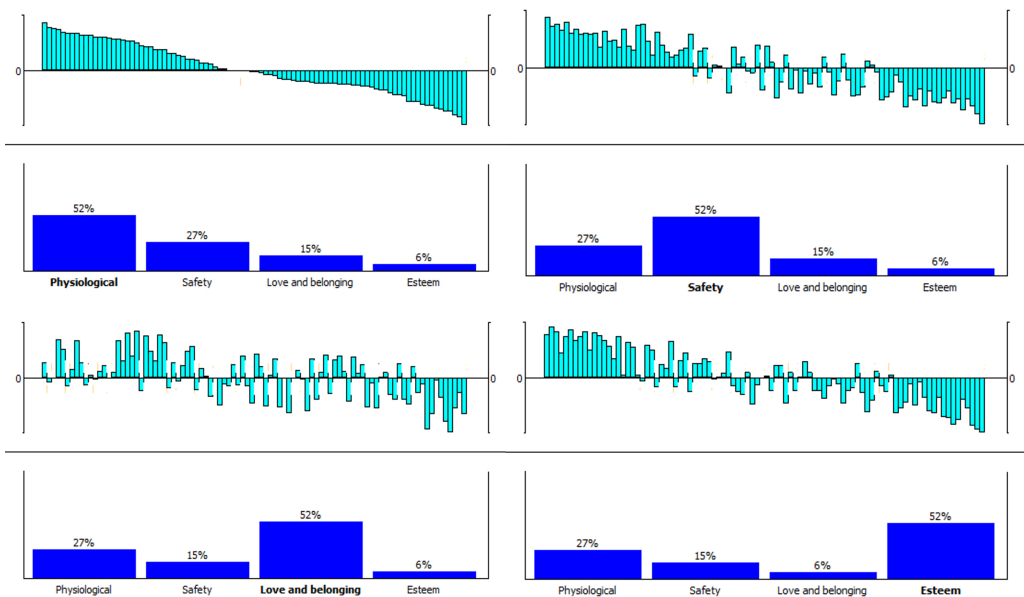

Figure 9 – Sensitivity analysis from the alteration in the priority order of the groups of criteria.

In the step 11, it was time to analyze results and draw up recommendations. The analyses demonstrate that the model can serve to assist decision-making in actions of public managers on the quality of life of the population. The proposed model works as a multidimensional alternative to other proposals such as the HDI, which has been criticized in the literature (Pereira & Mota, 2014).
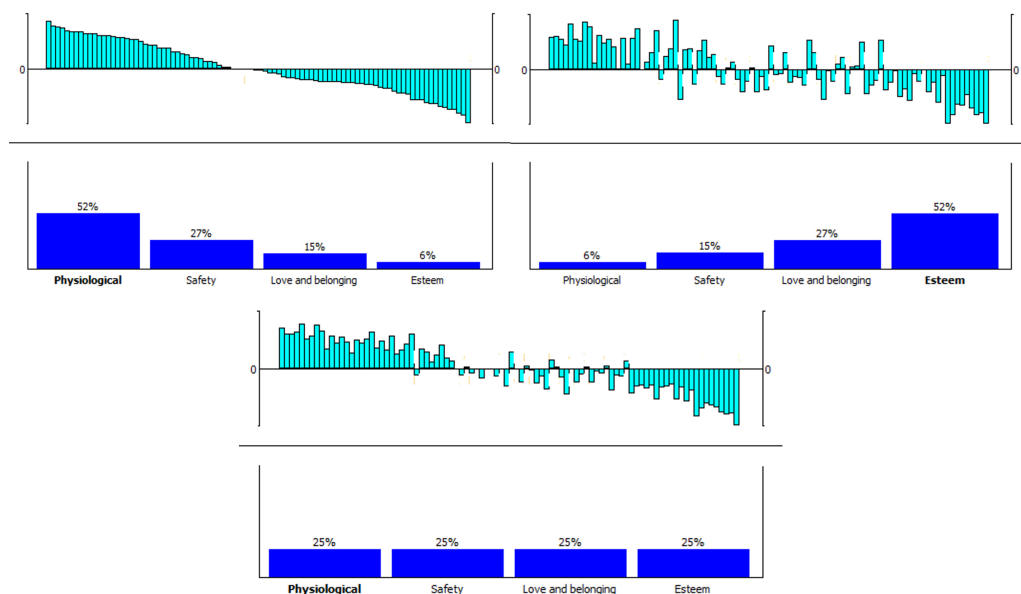
Figure 10 – Sensitivity analysis from the change in the weights chosen for the groups of criteria.

In addition, the outranking method allowed a ranking of cities through the choice of some criteria, demonstrating simplicity during use and analysis of results. The model also reduces the compensatory effects between the criteria and can be easily replicated for other universes or sets of cities. It is worth mentioning that it is a method that creates a ranking by comparing the alternatives in pairs, that is, the result of the performance of each city depends on this chosen universe of alternatives (cities).

The application proposed in this case served to demonstrate the consistency of the model, but there is the possibility of making changes according to the structure of preferences of the decision maker, choosing new criteria, for example.

Step 12 talks about implementing the decision. About this, it is important to highlight the difficulty of quantifying the quality of life. Although the choice of indicators was theoretically based, there are several aspects that could impact this variable, many of them quite subjective. The multidimensional characteristic makes it impossible to obtain a set of indicators capable of considering all human needs (Mariano & Rebelatto, 2014).

This, therefore, was never the objective of this research, which intends to broaden the debate on the subject through another look, allowing the incorporation of improvements in implementing public policies. It is also worth mentioning the complexity of implementing such policies to meet different human needs hierarchically related. That is, the policymakers must develop multiple and integrated policies to consider both citizens in situations of extreme poverty and those in search of esteem and self-actualization.

Thus, the model intends to promote an environment of debate and collaboration between the actors involved and facilitate the decision-making process in search of public policies that generate quality of life for the population in cities. The decision maker, for example, can make changes to the model to understand more specific dimensions and details that he is interested in during his decision process, such as giving greater weight to the criteria of a type of human need.

6   CONCLUSION

The methodology of this research was fundamentally based on the conceptual models of Allardt (1993), Sen (1999) and Maslow (1943), understanding that a city with a high level of quality of life has a fair and adequate distribution of capacities and relating such capabilities with human needs proposed in Maslow's Theory of Human Motivation. That is, by providing quality of life to its inhabitants, this city allows them to satisfactorily meet their physiological, safety, social, esteem and, subsequently, self-actualization needs, providing human development.

It is a method that creates a ranking by comparing the alternatives in pairs, i.e., the result of each city's performance depends on the universe of alternatives (cities) chosen. In addition, the ranking was obtained from an aggregating composite index, which has been gaining popularity among public policymakers due to the simplicity of adopting a single measure of quality of life. However, this type of methodological structure has been increasingly criticized when the procedure followed is not clear and reasonably justified, generating considerable space for manipulation of the result and distortions.

To deal with this, this work sought to assess the quality of life from concept maps to broaden the understanding of its dimensions and sought to integrate the qualitative result of the map with a quantitative model. The choice of each criterion is then justified based on the concepts of Maslow (1943), which also served to define the weights of the criteria, bringing more coherence in the construction of the index. We can say that MCDA serves as an alternative within a complex context such as the evaluation of difficult-to-define multidimensional variables. In this sense, the use of the PROMETHEE method also made it possible to structure a measurement model with non-compensatory rationality, offering an alternative to the HDI.

As a result of the method application, the cities of Niteroi, Rio de Janeiro and Volta Redonda scored best in our proposed index. Silva Jardim, Sumidouro and Sao Francisco de Itabapoana scored worst. Niteroi scored best in Physiological and Esteem needs. Nova Friburgo scored best in Safety needs. Mesquita scored best in Love and belonging needs.

One of the advantages of the proposed method is the possibility of analyzing the performance of cities in each group of needs in Maslow's Pyramid. The method has a clear framework where the variables are grouped according to the categories of human needs and each group is evaluated using a non-compensatory mathematical relationship. Therefore, the structure of our method makes it difficult to distort the results.

References

ALLARDT E. 1993. Having, Loving, Being: An Alternative to the Swedish Model of Welfare Research. In: NUSSBAUM M & SEN A (Eds.), *The Quality of Life*. pp. 88–94. Oxford University Press. Available at: https://academic.oup.com/book/9949/chapter/157298031.

ARISTOTLE. 2000. *Aristotle: Nicomachean Ethics*. 1 ed. Cambridge University Press. Available at: https://www.cambridge.org/core/product/identifier/9780511802058/type/book. edited and translated by Roger Crisp, St Anne's College, Oxford.

BRANS J, VINCKE P & MARESCHAL B. 1986. How to select and how to rank projects: The Promethee method. *European Journal of Operational Research*, **24**(2): 228–238. Available at: https://linkinghub.elsevier.com/retrieve/pii/0377221786900445.

BRANS JP & VINCKE P. 1985. A Preference Ranking Organisation Method: (The PROMETHEE Method for Multiple Criteria Decision-Making). *Management Science*, **31**(6): 647–656. Available at: http://pubsonline.informs.org/doi/10.1287/mnsc.31.6.647.

CIDE. 2001. *IQM - carências: índice de qualidade dos municípios*. CIDE: Centro de Informações e Dados de Rio de Janeiro. 67 pp.. Available at: https://minerva.ufrj.br/F/?func=direct&doc_number=000622336&local_base=UFR01.

DE ALMEIDA AT, CAVALCANTE CAV, ALENCAR MH, FERREIRA RJP, DE ALMEIDA-FILHO AT & GARCEZ TV. 2015. Multiobjective and Multicriteria Decision Processes and Methods. In: *Multicriteria and Multiobjective Models for Risk, Reliability and Maintenance Decision Analysis*, vol. 231. pp. 23–87. Cham: Springer International Publishing. Available at: http://link.springer.com/10.1007/978-3-319-17969-8_2. series Title: International Series in Operations Research & Management Science.

DETOMBE DJ. 2002. Complex Societal Problems in Operational Research. *European Journal of Operational Research*, **140**(2): 232–240. Available at: https://linkinghub.elsevier.com/retrieve/pii/S0377221702000668.

DIENER E. 2000. Subjective well-being: The science of happiness and a proposal for a national index. *American Psychologist*, **55**(1): 34–43. Available at: http://doi.apa.org/getdoi.cfm?doi=10.1037/0003-066X.55.1.34.

DO CARVALHAL MONTEIRO RL, PEREIRA V & COSTA HG. 2018. Analysis of the Better Life Index Trough a Cluster Algorithm. *Social Indicators Research*, **142**(2): 477–506. Available at: http://link.springer.com/10.1007/s11205-018-1902-7.

FARQUHAR M. 1995. Definitions of quality of life: a taxonomy. *Journal of Advanced Nursing*, **22**(3): 502–508. Available at: http://doi.wiley.com/10.1046/j.1365-2648.1995.22030502.x.

FRANCO LA & MONTIBELLER G. 2011. Problem Structuring for Multicriteria Decision Analysis Interventions. In: *Wiley Encyclopedia of Operations Research and Management Science*. p. eorms0683. Hoboken, NJ, USA: John Wiley & Sons, Inc.. Available at: https://onlinelibrary.wiley.com/doi/10.1002/9780470400531.eorms0683.

GRECO S, ISHIZAKA A, TASIOU M & TORRISI G. 2019. On the Methodological Framework of Composite Indices: A Review of the Issues of Weighting, Aggregation, and Robustness. *Social Indicators Research*, **141**(1): 61–94. Available at: http://link.springer.com/10.1007/s11205-017-1832-9.

ISHIZAKA A & NEMERY P. 2013. *Multi-Criteria Decision Analysis: Methods and Software*. 1 ed. Wiley. Available at: https://onlinelibrary.wiley.com/doi/book/10.1002/9781118644898.

LINS ME, PAMPLONA L, LINS AE & LYRA K. 2021. Metacognitive attitude for decision making at a university hospital. *International Transactions in Operational Research*, **30**(3): 1366–1386. Available at: https://onlinelibrary.wiley.com/doi/10.1111/itor.12975.

LOSURDO D. 2016. *Class struggle: a political and philosophical history*. Marx, Engels, and Marxisms. New York, NY: Palgrave Macmillan. oCLC: ocn946967931.

MARIANO EB & REBELATTO DADN. 2014. Transformation of wealth produced into quality of life: analysis of the social efficiency of nation-states with the DEA's triple index approach. *Journal of the Operational Research Society*, **65**(11): 1664–1681. Available at: https://www.tandfonline.com/doi/full/10.1057/jors.2013.132.

MASLOW AH. 1943. A theory of human motivation. *Psychological Review*, **50**(4): 370–396. Available at: http://doi.apa.org/getdoi.cfm?doi=10.1037/h0054346.

MINGERS J & BROCKLESBY J. 1997. Multimethodology: Towards a framework for mixing methodologies. *Omega*, **25**(5): 489–509. Available at: https://linkinghub.elsevier.com/retrieve/pii/S0305048397000182.

MORGAN G. 2006. *Images of organization*. Updated ed ed. Thousand Oaks: Sage Publications.

NOVAK JD & CAÑAS AJ. 2006. The Origins of the Concept Mapping Tool and the Continuing Evolution of the Tool. *Information Visualization*, **5**(3): 175–184. Available at: http://journals.sagepub.com/doi/10.1057/palgrave.ivs.9500126.

PEREIRA DVᴇS & MOTA CMᴅM. 2014. Human Development Index Based on ELECTRE TRI-C Multicriteria Method: An Application in the City of Recife. *Social Indicators Research*, **125**(1): 19–45. Available at: http://link.springer.com/10.1007/s11205-014-0836-y.

SCHUMPETER J & BACKHAUS U. 2003. The Theory of Economic Development. In: BACK-HAUS J (Ed.), *Joseph Alois Schumpeter*, vol. 1. pp. 61–116. Boston: Kluwer Academic Publishers. Available at: http://link.springer.com/10.1007/0-306-48082-4_3. series Title: The European Heritage in Economics and the Social Sciences.

SEN A. 1999. *Development as Freedom*. New York: Alfred Knopf. Available at: http://www.amazon.com/Development-as-Freedom-Amartya-Sen/dp/0385720270/ref=sr_1_1?s=books\&ie=UTF8\&qid=1310743622\&sr=1-1.

SILVA ALM, BARROS MFd & SANTOS L. 2021. Development of a Sustainability Index at the Local Level: methodological proposal and its application in the case study of Rio de Janeiro, Brazil. *Production*, **31**: e20210034. Available at: http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0103-65132021000100701&tlng=en.

SOMARRIBA ARECHAVALA N & ZARZOSA ESPINA P. 2018. Quality of Life in the European Union: An Econometric Analysis from a Gender Perspective. *Social Indicators Research*, **142**(1): 179–200. Available at: http://link.springer.com/10.1007/s11205-018-1913-4.

STEWART I. 2018. Mathematics, Maps, and Models. In: WUPPULURI S & DORIA FA (Eds.), *The Map and the Territory*. pp. 345–356. Cham: Springer International Publishing. Available at: http://link.springer.com/10.1007/978-3-319-72478-2_18. series Title: The Frontiers Collection.

How to cite