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The use of Multicriteria Decision-Making Methods for the implementation of equipment to protect women victims of violence: a case study in the Amazon

O uso de métodos multicritérios de tomada de decisão para a implementação de equipamentos para proteger as mulheres vítimas de violência: um estudo de caso na Amazônia

El uso de métodos de decisión multicriterio para la implantación de equipos de protección de las mujeres víctimas de la violencia: un estudio de caso en la Amazonia

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Saulo William da Silva Costa
ORCID: https://orcid.org/0000-0002-6073-8432
Universidade Federal do Pará, Brazil
E-mail: saulo.costa@ifpa.edu.br
Fernando Augusto Ribeiro Costa
ORCID: https://orcid.org/0000-0002-0226-7505
Universidade Federal do Pará, Brazil
E-mail: fernando.costa@naea.ufpa.br
Marcos César da Rocha Seruffo
ORCID: https://orcid.org/0000-0002-8106-0560
Universidade Federal do Pará, Brazil
E-mail: marcos.seruffo@gmail.com

Abstract
The use of multi-criteria decision-making methods aims to optimize decision-making process from sets of criteria and characteristics that are sometimes disregarded in other ways of selecting priorities for the decision task. Accordingly, decisions that require technical criteria for the implementation of public services can benefit from the use of, for example, the Analytic Hierarchy Process (AHP). The purpose of this paper is to demonstrate how and based on what objective and subjective criteria the AHP can be used to decide where to implement the Casa da Mulher Brasileira, one of the main facilities to assist women victims of violence, in the Metropolitan Region of Belém, capital of Pará, Amazon. Using as criteria Cases of Violence, Female Population in each of the five municipalities and Accessibility to them, it was verified that the capital, Belém do Pará, is the most appropriate municipality to receive the public facility within the region considered.
Keywords: AHP; Violence against women; Casa da Mulher Brasileira.

Resumo
O uso de métodos de decisão multicritérios visa otimizar tomadas de decisão a partir de conjuntos de critérios e características que às vezes são desconsiderados em outras maneiras de selecionar prioridades para tal tarefa. Assim, decisões que requerem critérios técnicos para a implementação de serviços públicos podem se beneficiar do uso, por exemplo, do Analytic Hierarchy Process (AHP). O objetivo deste trabalho é demonstrar como e com base em que critérios objetivos e subjetivos o AHP pode ser usado para decidir onde implementar a Casa da Mulher Brasileira, um dos principais equipamentos de assistência às mulheres vítimas de violência, na Região Metropolitana de Belém, capital do Pará, Amazônia. Usando como critérios Casos de Violência, População Feminina em cada um dos cinco municípios e Acessibilidade a eles, verificou-se que a capital, Belém, é o município mais apropriado para receber a instalação pública dentro da região considerada.
Palavras-chave: AHP; Violência contra a mulher; Casa da Mulher Brasileira.

Resumen
El uso de los métodos de decisión multicriterio pretende optimizar la toma de decisiones a partir de conjuntos de criterios y características que a veces no se tienen en cuenta en otras formas de selección de prioridades para dicha tarea. Así, las decisiones que requieren criterios técnicos para la implantación de servicios públicos pueden beneficiarse del uso, por ejemplo, del Analytic Hierarchy Process (AHP). El objetivo de este trabajo es demostrar cómo y en base a qué criterios objetivos y subjetivos se puede utilizar el AHP para decidir dónde implantar la Casa da Mulher Brasileira, uno de los principales equipamientos de asistencia a mujeres víctimas de la violencia, en la Región Metropolitana de Belém, capital de Pará, Amazonas. Utilizando como criterios los Casos de Violencia, la Población Femenina en cada uno de

los cinco municipios y la Accesibilidad a los mismos, se verificó que la capital, Belém, es el municipio más apropiado para recibir la instalación pública dentro de la región considerada.
Palabras clave: AHP; Violencia contra las mujeres; Casa da Mulher Brasileira.

1. Introduction

The formulation of public policies, in general, but particularly in Brazil, has served multiple interests with varied nuances. In this sense, understanding, first of all, what a public policy is and what it is intended for is an important step towards understanding the need for balanced and rationally directed decision-making, even in the political sphere, in order to meet truly public demands (inputs).

Das Graças Rua (1997) has well defined the difference between public policies and political decisions. While political decisions (politics) are under the variations of alternatives and at the flavor of the choices and preferences of agents involved in the issue to be decided, public policies function as outputs of political action, constituting a set of decisions and actions related to the determinant allocation of values. In this sense, a political decision is on the threshold of a public policy, but does not constitute one.

In this way, the problems arising from the socio-spatial environment can always wait for a solution or even be objects of solution by the public power; the non-solutions end up also being a solution and the problems increase (Das Graças Rua, 1997). Besides the interests that are not always republican behind political decisions, vis a vis the paradigms of public policy formulation, one must also consider the innumerable confrontations of corporate interests in the effective implementation of public policies, which almost always hinders or makes it difficult to find more adequate answers to urgent problems or for which one should take into account a loss of popularity or its increase (Reis, 1995).

Among the most recurrent and urgent problems in Brazilian reality today is the specter of violence against women. In a recent paper, Costa et al. (2021) demonstrate the emergency that this issue represents while showing official data that considers the Amazon, and particularly Pará, as places where such violence has intensified in recent years, requiring the agents involved in the issue, public or not, to formulate policies aimed at efficiently assisting victims of all forms of violence against women. One of the governmental decisions within the National Women's Care Policy is the construction or implementation of the equipment today called Casa da Mulher Brasileira (CMB) (Ayres, 2017; Brasil, 2021; Marques, 2017; Martins & Araújo, 2019; Peraro, 2021).

Launched in 2013 as part of the "Women: Living without Violence" program, the Casa da Mulher Brasileira (CMB) project provided for the construction of 27 units of a facility designed to concentrate "the main specialized and multidisciplinary services of the network of assistance to women in situations of violence, according to the typologies and guidelines established by the National Secretariat of Policies for Women of the Ministry of Women, Family and Human Rights" (Brasil, 2021, p. 3) (Marques, 2017; Peraro, 2021; Martins & De Araújo, 2019).

The CMB, once installed, would act in partnership with the other bodies of attention to women victims of violence giving them access to numerous services ranging from the first care to even the most delicate procedures, namely, those linked to lawsuits and other measures against the aggressor.

However, Martins & De Araújo (2019) point out severe bottlenecks to the implementation of this equipment showing that between the launch, in 2013, and 2018 only 6 of the 27 were inaugurated. One of the difficulties pointed out by the authors concerns legal issues, since even though the CMB is implemented in partnership between the Union and the states and municipalities, there is no legal regulation on the responsibilities of each of these entities.

In a very accurate analysis regarding the process of installing the CMB and the rates of violence against women in Brazil, Martins & De Araújo (2019) reveal how decisions made only from political and economic axes generate a staggering

mismatch between places that need the equipment and places with more occurrences.

Following these considerations, it is important to highlight that: i) the formulation of public policies must aim at meeting social demands and cannot be at the mercy of mere political decisions in which diverse interests and agents compete; and ii) as a highly urgent demand, violence against women needs to be taken objectively and actions aimed at solving it must be based on equally objective criteria.

It is in this sense that we now present this article whose objective is to demonstrate the possibility of using a multicriteria method for decision making to help public authorities regarding the most appropriate location for the implementation of the Casa da Mulher Brasileira, reducing the interference of agents and interests that are deviated from the social objective and thus safeguard the effective protection of women victims of violence. The case study takes place in the Metropolitan Region of Belém do Pará (RMB), which is made up of five municipalities: Belém, the state capital, Ananindeua, Marituba, Benevides and Santa Bárbara.

Thus, the multicriteria decision-making method chosen to support this process was the Analytic Hierarchy Process (AHP), since this process accepts both quantitative and qualitative variables, allowing evaluations to be made based on the knowledge and subjective impressions that the decision maker has about the issue at hand; this way, both knowledge and subjective impressions are transformed into a set of scores that will serve as a basis for the classification of alternatives; finally, by resorting to some software that performs the calculations of the multicriteria analysis based on the data entered, the decision maker can perform his work (Moraes & Santaliestra, 2019).

The paper is organized as follows: Section 2 presents the Analytic Hierarchy Process (AHP) as a methodology used in this study; Section 3 demonstrates the results achieved and the discussion about them; and Section 4 brings the Final Considerations.

2. Methodology: Multicriteria Method Analytic Hierarchy Process (AHP)

Appeared in the late 1960s, this method was developed by mathematician Thomas Saaty as a result of the difficulty of communication among members of the American government; thus, the Analytic Hierarchy Process (AHP) aims to model unstructured problems of people's daily lives, since sometimes one has no notion of the details inherent to the decision about a given situation (Briozo & Musetti, 2015; Moraes & Santaliestra, 2019).

In direct words, the AHP consists of decomposing and synthesizing the relationships among the criteria until a prioritization of their indicators is reached, approaching a best single performance measurement answer (Saaty, 1991). Saaty (1994) points out that the benefit of the method is that since the values of the judgments of pairwise comparisons are based on experience, intuition, and also physical data, AHP can deal with both qualitative and quantitative aspects of a decision-making problem (Wind & Saaty, 1980). Grandzol (2005), however, states that one of the limitations of the method is its inappropriate application, that is, in unfavorable environments where the application is perceived as oversimplification or as a waste of time.

Specifically concerning the use of AHP in the decision-making process concerning the implementation of public equipment, Briozo e Musetti (2015) state that this method enables the resolution of problems with conflicting criteria, and one of the advantages of its use is the fact that it allows the participation of several people, as occurs in public management, a circumstance in which numerous agents are also involved and a mosaic of criteria, alternatives and consequences is presented.

Considering, for all of the above, the need to adapt the implementation of the CMB as reasonably as possible to the realities where they are needed, we propose the use of AHP to help make this decision. Although the use of methods like this does not replace consultations and analysis by organized civil society, it is undeniable that their use can guide political decisions regarding public policy on assistance to women victims of violence.

Randhawa e West (1995) state that in order to use AHP for the purposes of equipment facilities, four steps must be

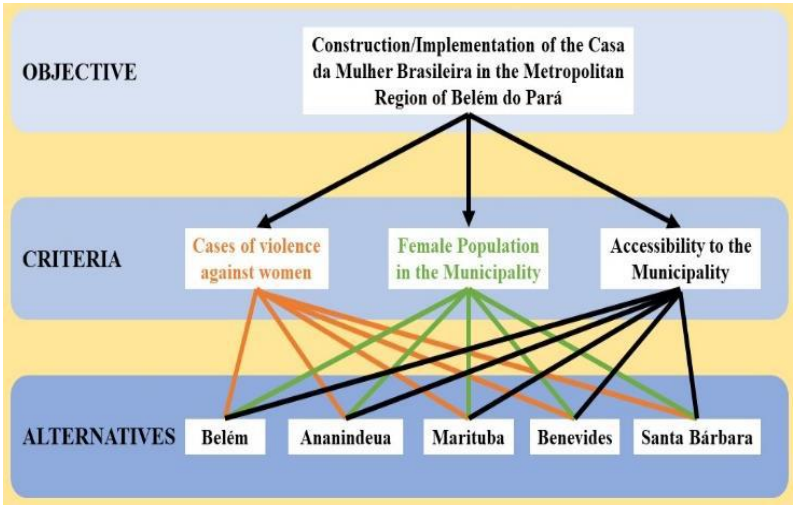
observed, namely: i) identify a set of criteria to evaluate candidate sites; ii) develop weights for the criteria that reflect the relative importance of each in the decision environment; iii) evaluate each site with respect to each criterion; and iv) aggregate the weights of each criterion into an overall ranking. Alosta et al. (2021) and Suman et al. (2021) point to the use of AHP combined with other methods.

In this paper, a case study is made in order to demonstrate the use of the AHP alone to support the aforementioned decision making. In this way, the problem in question can be put like this: in order to advance in the public policy of confrontation to the cases of violence against women in the Metropolitan Region of Belém, the federal government should implant there the equipment called Casa da Mulher Brasileira, being this the objective.

Considering the need to elaborate criteria to subsidize the decision for the implantation of the CMB in the metropolitan region of Belém and, at the same time, the lack of clarity of the official parameters for this, as well as the body of literature already cited here, we propose the establishment of three general criteria that are based both on the data provided by the local public power and on the daily experience of a resident of this region of the State of Pará. Thus, three criteria are considered for judging the alternatives: cases of violence (relative to the year 2020), female population, and accessibility.

As it is about the implementation of public equipment in the Metropolitan Region of Belém, there are five possible alternatives: Belém, Ananindeua, Marituba, Benevides and Santa Bárbara do Pará. Figure 1 shows the hierarchy of alternatives for the proposed problem.

Figure 1 – Hierarchy of Alternatives.



Source: Authors.

As stated earlier, AHP is a method that aids multicriteria decision-making that is quite popular and has been used more than any other method of equal purpose (Badi et al., 2021). With AHP, comparison between potential pairs can be made to weight each factor and give a relationship of consistency, breaking down a complex problem into hierarchy or levels. The AHP allows a tree structure in order to simplify complex problems into subproblems, these somewhat less sophisticated and whose examination is facilitated.

The AHP is a multicriteria decision-making tool that uses feedback from a well-designed questionnaire; through it, the relative weights of factors are evaluated based on pairwise comparisons in order to establish priorities and thus reach the best decision (Alosta et al., 2021). The AHP Matrix is built using the comparisons and the priorities are calculated using the formula shown in equation 1.

$$AW = \lambda_{max} w \qquad \text{(equation 1)}$$

where A is the comparison matrix, λ_{max} is the principal eigenvalue, and W is the priority vector. The AHP model provides feedback to the decision maker on the consistency of the judgments entered by measuring the consistency ratio (CR) using the formulas shown in equations 2 and 3.

$$CR = \frac{CI}{RI} \quad \text{(equation 2)}$$

$$CI = \frac{\lambda_{max} - n}{n-1} \quad \text{(equation 3)}$$

where CI is the consistency index, n is the dimension of the comparison matrix, λmax is the principal eigenvalue, and RI is the ratio index. The values of the Random Consistency Index (RI) *versus* the dimension of the matrix (n) is in Suman et al. (2021). The matrix is considered consistent when RI<0.1 while the matrix is considered inconsistent when RI>0.1 (Alosta et al., 2021). In this sense, first, the values are established for each pair to be compared in the initial matrix considering which are equally important (1), moderately more important (3), more important (5), much more important (7) or extremely more important (9).

After performing the steps of transforming fractions into decimals and the appropriate normalization of the matrix (n=3), the priority vectors found are: 0.696 (Cases of Violence), 0.232 (Female Population) and 0.072 (Accessibility). Next, the vectors are used as weights for each of the criteria established in the decision process. After multiplying these weights by each of the values assigned in the judgment matrix, Table 1 is obtained.

Table 1 – Sum of Criteria Weights.

Deploy CMB	Cases of Violence	Female Population	Accessibility	**Sum of the Weights**
Cases of Violence	0.696	1.160	0.504	**2.360**
Female Population	0.139	0.232	0.360	**0.731**
Accessibility	0.100	0.046	0.072	**0.218**

Sum of the Weights		Priority	**Result**
2.360	÷	0.696	**3.391**
0.731		0.232	**3.151**
0.218		0.072	**3.028**
		TOTAL	**9.570**
		÷3	**3.190 (λ_{max})**

Source: Authors (2022).

Applying equation 3, the result is 0.095; applying, from this, equation 2, it is obtained that the consistency ratio is of the order of 0.164; thus, the judgment is consistent. Once these operations have been performed with respect to each of the criteria, we will now calculate the priorities of each alternative based on these same criteria; this is Section 3 in which we present the results of the study.

3. Results and Discussion

3.1 First criterion: Cases of Violence against women in each municipality

The Secretariat of Public Security and Social Defense of Pará publishes, through its website, data relative to the occurrence of violent acts per year, city, and types of crimes/occurrences[1]. Considering the present case study, that is, the implementation of the CMB in the Metropolitan Region of Belém, this work will take into account feminicide and rape cases

[1] Available at <http://sistemas.segup.pa.gov.br/transparencia/estatisticas-2020/>.

together in order to have a clearer idea about the numbers of this reality in each municipality of the RMB so that the judgment can be established in a way that is closer to reality. The year considered is 2020. Thus, Belém registered 495 cases; Ananindeua, 179; Marituba, 53; Benevides, 49; and Santa Bárbara, 12 (PARÁ, 2020)[2]. The values assigned in the pairwise comparison generated a matrix where n=5.

After performing the steps of transforming fractions into decimals and the appropriate normalization of the matrix (n=5), the priority vectors found are: 0.496 (Belém), 0.268 (Ananindeua), 0.116 (Marituba), 0.091 (Benevides) e 0.029 (Santa Bárbara). Next, the vectors are used as weights for each of the criteria established in the decision process. After multiplying these weights by each of the values assigned in the judgment matrix, Table 2 is obtained.

Table 2 – Sum of Weights of the Violent Cases criteria for each alternative.

Violent Cases	Belém	Ananindeua	Marituba	Benevides	Santa Bárbara	**Sum of the Weights**
Belém	0.496	0.804	0.580	0.637	0.261	**2.778**
Ananindeua	0.165	0.268	0.348	0.455	0.261	**1.497**
Marituba	0.099	0.089	0.116	0.091	0.203	**0.598**
Benevides	0.071	0.054	0.116	0.091	0.145	**0.477**
Santa Bárbara	0.055	0.030	0.017	0.018	0.029	**0.149**

Sum of the Weights		Priority	**Result**
2.778	÷	0.496	**5.601**
1.497		0.268	**5.586**
0.598		0.116	**5.155**
0.477		0.091	**5.242**
0.149		0.029	**5.138**
		TOTAL	**26.722**
		÷5	**5.344 (λ_{max})**

Source: Authors (2022).

Applying equation 3, the result is 0.086; applying, from this, equation 2, we obtain that the consistency ratio is of the order of 0.077; thus, the matrix is consistent.

3.2 Second criterion: Female population of each municipality

Regarding the second evaluation criterion, the municipality of Belém has a yearbook with the estimated female population in 2020[3], while the other municipalities do not have this data, using as parameter the 2010 Census conducted by the Brazilian Institute of Geography and Statistics (IBGE, in Portuguese). In this sense, Belém has a population of 798,456 women; Ananindeua, 245,345; Marituba, 54,362; Benevides, 25,836; and Santa Bárbara, 8,386.

After performing the steps of transforming fractions into decimals and the due normalization of the matrix (n=5), the priority vectors found are: 0.473 (Belém), 0.308 (Ananindeua), 0.116 (Marituba), 0.074 (Benevides) e 0.029 (Santa Bárbara). Next, the vectors are used as weights for each of the criteria established in the decision process. After multiplying these weights by each of the values assigned in the judgment matrix, Table 3 is obtained.

[2] Available at <http://sistemas.segup.pa.gov.br/transparencia/estatisticas-2020/>.
[3] Disponível em <https://anuario.belem.pa.gov.br/wp-content/uploads/2020/12/Tabela-8-Demografia.pdf>

Table 3 – Sum of Weights of the Female Population criterion for each alternative

Female Population	Belém	Ananindeua	Marituba	Benevides	Santa Bárbara	**Sum of the Weights**
Belém	0.473	0.924	0.580	0.518	0.261	**2.756**
Ananindeua	0.158	0.308	0.348	0.370	0.261	**1.445**
Marituba	0.095	0.103	0.116	0.074	0.203	**0.591**
Benevides	0.068	0.062	0.116	0.074	0.145	**0.465**
Santa Bárbara	0.053	0.034	0.017	0.015	0.029	**0.148**

⇩

Sum of the Weights		Priority	**Result**
2.756		0.473	**5.827**
1.445	÷	0.308	**4.692**
0.591		0.116	**5.095**
0.465		0.074	**6.284**
0.148		0.029	**5.103**
		TOTAL	**27.001**
		÷5	**5.400** (λ_{max})

Source: Authors (2022).

Applying equation 3, the result is 0.100; applying, from this, equation 2, we obtain that the consistency ratio is of the order of 0.089; thus, the matrix is consistent.

3.3 Third criterion: Accessibility to each Municipality

The lack of reliable statistical data on mobility, transportation, and accessibility in the Metropolitan Region of Belém makes the evaluation of the Accessibility criterion a little more demanding; however, the judgment values were the result of daily experience in this region, as well as of the consideration of the geographical position of one municipality in relation to another.

After performing the steps of transforming fractions into decimals and the due normalization of the matrix (n=5), the priority vectors found are: 0.128 (Belém), 0.139 (Ananindeua), 0.362 (Marituba), 0.297 (Benevides) e 0.074 (Santa Bárbara. Next, the vectors are used as weights for each of the criteria established in the decision process. After multiplying these weights by each of the values assigned in the judgment matrix, Table 4 is obtained.

Table 4 – Sum of Weights of the Accessibility criteria for each alternative.

Accessibility	Belém	Ananindeua	Marituba	Benevides	Santa Bárbara	**Sum of the Weights**
Belém	0.128	0.417	0.072	0.099	0.074	**0.790**
Ananindeua	0.043	0.139	0.121	0.099	0.370	**0.772**
Marituba	0.640	0.417	0.362	0.297	0.370	**2.086**
Benevides	0.384	0.417	0.362	0.291	0.222	**1.682**
Santa Bárbara	0.128	0.028	0.072	0.099	0.074	**0.401**

Sum of the Weights		Priority	**Result**
0.790		0.128	**6.172**
0.772	÷	0.139	**5.554**
2.086		0.362	**5.762**
1.682		0.297	**5.663**
0.401		0.074	**5.419**
		TOTAL	**28.570**
		÷5	**5.714** (λ_{max})

Source: Authors (2022).

Applying equation 3, the result is 0.179; applying, from this, equation 2, the result is that the consistency ratio is of the order of 0.160; thus, the matrix is consistent.

Once these priority vectors are rescued, each cell is multiplied by its respective weight for each criterion, obtained during the first judging stage. Thus, these weights are: 0.696 (Cases of Violence), 0.232 (Female Population) e 0.072 (Accessibility).

One can immediately observe the preponderance of the criterion "Cases of Violence" in the evaluation set about which city of the RMB to choose to implement the Casa da Mulher Brasileira; at the same time, one can identify that the criterion "Accessibility" has a relatively low relevance for this decision making.

Table 5 – Priority in the alternatives/criteria relationship.

	Cases of Violence	Female Population	Accessibility	**PRIORITY**
Belém	0.346	0.110	0.009	**0.465**
Ananindeua	0.187	0.071	0.010	**0.268**
Marituba	0.081	0.027	0.026	**0.134**
Benevides	0.063	0.017	0.021	**0.101**
Santa Bárbara	0.020	0.007	0.005	**0.032**

ALTERNATIVE	**FINAL PRIORITY**
Belém	**0.465** (1st)
Ananindeua	**0.268** (2nd)
Marituba	**0.134** (3rd)
Benevides	**0.101** (4th)
Santa Bárbara	**0.032** (5th)

Source: Authors (2022).

Performing the multiplication previously highlighted, Table 5 also presents the priority extracted from the relation between alternatives and criteria.

4. Final Considerations

In the governmental sphere, as stated above, the decision-making process regarding social demands involves much more than a simple will, intention, or desire of the competent authority to execute or not execute. It is a task heavily intersected by countless interests, sometimes beneficial to the collectivity, sometimes benefiting specific groups.

Thus, using the AHP to help in the decision-making process, especially in the case of public equipment installation, can be a satisfactory alternative to avoid leaving the task of deciding solely to the prerogative of the decision maker. At the same time, this case study demonstrated the efficiency in the use of public resources when their final destination is to attend such urgent causes in society, which is the protection of women victims of violence.

Finally, we verify that the implementation of the AHP for the purpose of this study defines in a clearer and less impersonal way the criteria that will be considered regarding the implementation of public services and construction of equipment, thus optimizing the results expected from the government.

As future projects, we hope to add other Multicriteria Decision Making methods in order to give more reliability to this proposal, while at the same time we intend to develop an application in which not only these, but other data related to any decision-making processes can be at the disposal of public planners.

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