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BASIC SANITATION IN THE MUNICIPALITY OF CACOAL (RO) MULTI-ANNUAL PLAN, AN EVALUATION USING CLUSTER ANALYSIS

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Abstract

Due to the important role civil society plays in public management, the Multi-Annual Plan (MAP) is a management tool, indicated in the Federal Constitution, to plan and structure public actions. Considering that, this study aimed to identify the greatest demands of the 2018-2021 Multi-Annual Plan in the municipality of Cacoal, state of Rondônia, Brazil so that it could distinguish the regional similarities among the demands. The information was taken from the city hall website and tabulated in the Microsoft Excel program. To identify the similarity between the regions analyzed, data were organized according to the hierarchical clustering method using Statistica software. Initially, the elements were distributed according to their own pattern and, gradually, all the groupings created were intertwined in a single group, containing all the data. The results show that the major demands of the municipality are, in priority order, 1 – infrastructure improvements, 2 – creation of spaces for education, 3 – expansion of basic sanitation.

Keywords: urban planning, similarity-based hierarchical clustering analysis, water resource management.

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Introduction

The human right to water supply warrants everyone to sufficient, affordable and safe access to water. Regarding the human right to sanitary sewage, it entitles affordable services made possible in a dignified, safe, hygienic and culturally accepted manner, (Albuquerque 2014). In Brazil, the economic planning denotes an important tool of public policy to the development of health, education, basic sanitation and social well-being.

Aiming to implement its constitutional obligations, the planning must follow the current legislation and engage the population in the decision-making process. The normative instruments of management are initiated by articles 182 and 183 of the Federal Constitution (FC) of 1988, whose main goal is to ordain the full development of the social functions of the city and ensure the well-being of its inhabitants (Brasil, 1988).

The City Statute, created in 2001 by the Federal Law No. 10,257 that regulates Articles 182 and 183 of the Federal Constitution, establishes important guidelines on urban policy that are still disregarded 19 years after its creation (Brasil, 2001).

In addition to the City Statute, the Law of Public Consortia and Joint Management, Law 11,107 of 2005 (Brasil, 2005), and Decree 6,017 of 2007 (Brasil, 2007) that regulates it, the Law of National Directives for Basic Sanitation, Law 11,445 of 2007) (Brasil, 2007a), and the National Policy on Solid Waste, PNRS – Law 12,305 of 2010 are tools that aim to change the current basic sanitation framework (Brasil, 2010).

Despite the expansion of investments, small municipalities and the North region still have a difficult access to resources (Borja, 2014). Thus, due to the important role civil society plays in public management, the 2018-2021 MAP, proposed by the municipality of Cacoal (RO), sought social engagement not only as a directive for the implementation of public policies, but also for its elaboration and planning. The participation of population and regional entities was achieved by public hearings and online voting, with proposals for the 2018-2021 MAP formulation. The MAP collective creative process, conceived by organized debate, qualifies and strengthens the planning (Ribeiro, 2013).

This study shows the priorities listed by 2018-2021 MAP, focusing mainly on the basic sanitation of the municipality of Cacoal (RO), and it discusses essential issues to regional development and how these actions reflect on collective health. The premise of basic sanitation is to improve the population's water quality and adequate hygiene conditions, in view of reducing the incidence of diseases, especially the ones disseminated by the water supply system. As an example, prior research restates the relationship between ineffective sanitation and cases of diarrhea in Brazil (Guimarães et al, 2013; Teixeira and Guilhermino, 2006; Rasella, 2013; Bellido *et al.*, 2010). In the

North, there were 358.09 cases of waterborne diseases per 100,000 inhabitants, two times higher than the national average of 175.55 (Paiva and Souza, 2018)

The proposal presented contributes to the discussion of civil society participation in the construction and operation of actions regarding regional planning and development. Most importantly, it may allow a clear vision on how, in the municipality studied, the population participating in this important arena of debate considers the actions of basic sanitation to the detriment of other themes.

Methods

Study Area

The area chosen for the study is the municipality of Cacoal, located in the southern part of the state of Rondônia, about 480 km distant from the capital, Porto Velho. To the south, Cacoal borders the municipalities of Rolim de Moura and Pimenta Bueno; to the east, Espigão D'Oeste; to the north, the state of Mato Grosso and, to the west, Ministro Andreazza, Presidente Médici and Castanheiras (IBGE, 2018).

The municipality of Cacoal has a land area of 3,792,948 km² and a population of 78,574 people, according to the last IBGE census (2010) (IBGE, 2010). Its population density is 20.72 people/km². The municipality urban area corresponded to 16.7 km².

For the 2018-2021 MAP formulation, the neighborhoods in the municipality were clustered within nineteen regionals, according to Cacoal City Hall criterion. Each regional represented a specific set of neighborhoods, so that the demands of the population could be computed faster and more efficiently.

Data Collection

Demand data were obtained by Cacoal City Hall website in request of 2018-2021 Cacoal MPA, in which public hearings and online voting were held to gather the most relevant interests of each regional. However, for this study, only public hearing data were used, as not every regional participated in the website online voting and it could interfere in the analysis results.

Then demand information was tabulated in the 2010 Microsoft Excel, following the priority order of the three most relevant priorities per region. To standardize the variables of similarity, the demands were listed from 1 to 3 and then divided by 19, number of regionals in the municipality. Thus, 0.0526 was obtained for priority three (or third-level priority action between the three listed), 0.107 for priority two (or second-level priority action between the three listed) and 0.157 for priority one (or first-level priority action between the three listed). These values were

converted into graphics with small, medium and large bar, to show the three priority categories in each regional within the urban areas 1 to 15 in Figure 1. In rural areas, 16 to 19, the information was given in Chart 1, as it was not possible to work with a scale that comprehended all the regionals in Figure 1 (shown in the Results section).

Data were organized according to the hierarchical clustering method, in which the elements are initially distributed according to their own pattern and, gradually, all the groupings created were intertwined in a single group that contained all the data.

In the beginning, groupings are small and have a high degree of similarity. Nonetheless, by the end of the process, few groupings are obtained, each of which may contain many elements and little similarity among them. To use the method, a similarity matrix is created by measuring the distance between the groupings, and the lowest value must be found, showing the most similar values (Vale, 2006). Given this context, dendograms appear as graphical representations in the shape of a “tree,” illustrating the order in which the data were clustered.

The method of simple connection, in which the distance between two groupings is calculated though the distance among their most similar patterns, was chosen to calculate the distance between the demands of the population. This method shows good results for Euclidean distance, as well as for others (Viana, 2004)

Ward’s method, in which the generated partitions aim to reduce the losses produced by each grouping, was used for the similarities between the demands made by Regional. The method created by Ward in 1963 is also known as the “Minimum Variance,” in which groupings are obtained by maximizing homogeneity within-group (Mingoti, 2005). Thus, Ward’s method attempts to minimize the sum of squares within-group, considering, for its initial formation, the variables that provide the smallest sum of squared deviations (Tomaz and Matos, 2017).

Finally, analysis graphs were generated by Statistica software, version 10.

Results

Priorities listed in the Municipality of Cacoal (RO)

Figure 1 shows the twenty-six demands for the municipality of Cacoal. These priorities were listed by regionals and converted into “categories.” According to empirical findings, the most significant results among the urban area demands were: Paving, Day Care and Sewage Network, as they are the largest patterns graphically represented, often found among regionals. Nevertheless, these variables present great dissimilarity among other groupings – calculated by distance, as they comprise smaller and less similar groupings.

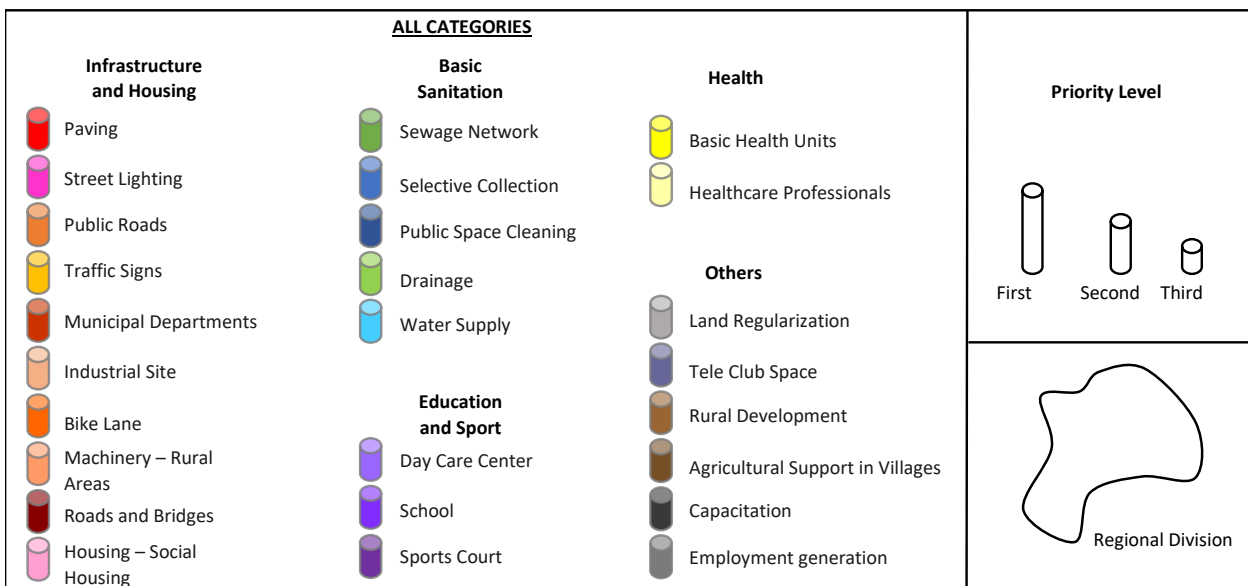
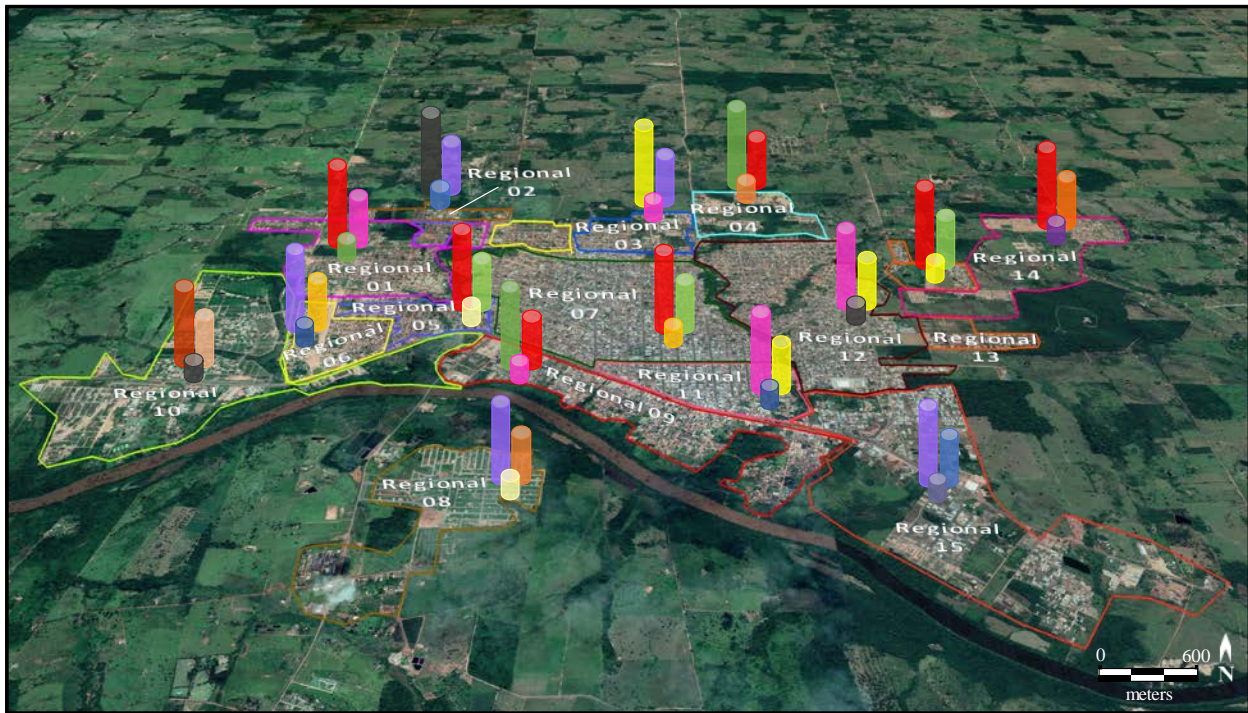


Figure 1. Priority actions listed for the urban area of the municipality of Cacoal (RO), in 2018-2021 Multi-Annual Plan.

After the three major demands for the urban area of the municipality, we observed that the capacitation and creation of Basic Health Units are prioritized, followed by the expansion of drainage systems. Other elements have great similarity among them, which suggests these variables are not priorities claimed by the population. However, they are relevant enough to be among the 26 listed categories.

Chart 1 shows the priorities listed by the population in relation to Regional 16, 17, 18 and 19. These regionals were not shown with the central urban area of the municipality, in Figure 1, due to their distant geographic position, which hampered the use of an adequate scale.

Chart 1. Priority actions listed for the rural area of the municipality of Cacoal (RO), in 2018-2021 Multi-Annual Plan

Regionals	Priority Level		
	First	Second	Third
Regional 16	Paving	School	Basic Health Units
Regional 17	Land Regularization	Water Network	Generation of employment
Regional 18	Capacitation	Machinery – Rural Areas	Rural Development
Regional 19	Roads and Bridges	Housing – Social Housing	Agricultural Support in Villages

The results are informed through the Chart: infrastructure, basic sanitation and health actions are demanded. As they are also rural regions, the demand for construction of roads and bridges (in the infrastructure area) is emphasized; furthermore, Regional 19, composed of the municipality's indigenous land, demands rural development and agricultural support.

Regional similarity and demand for public services

Figure 2 shows the similarity between the demands of each Regional.

Regarding the similarity between the nineteen regionals, two large groupings are observed where remaining hierarchies are clustered. For this, an imaginary line, 0.6 parallel to the horizontal distance, is drawn. This line intersects the lines of the largest grouping generated, which covers all the data.

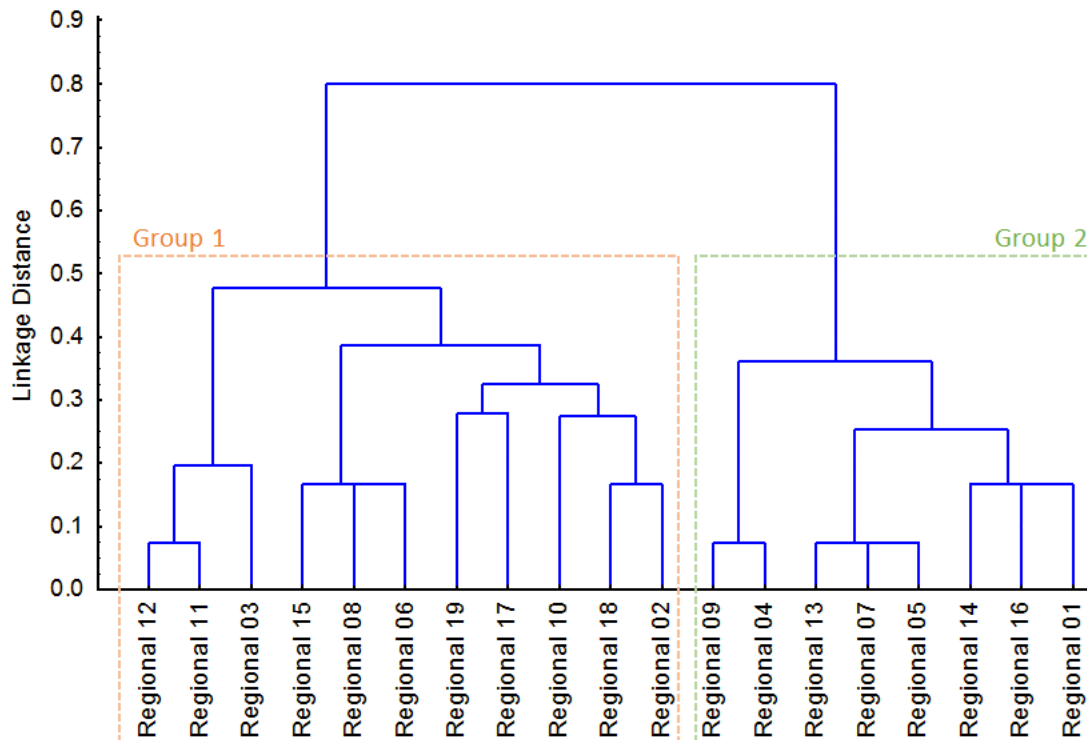


Figure 2. Cluster of the Regionals studied.

Group 1

In Group 1, the first grouping is formed primarily by Regions 12 and 11, the most similar of the cluster, with an approximate distance of 0.09. It means that both regionals listed Street Lighting and Basic Health Units as first and second-level priorities, respectively. In addition, they are neighboring regions, showing a lack of public actions for that specific area of the city. Next, there is Regional 3, whose Euclidean distance was 0.2, more similar to regionals 12 and 11. The first demand of this regional is related to the Basic Health Unit. Regionals 15, 8 and 6, in turn, showed great similarity among themselves. Their distance was 0.18, and their first demand is for day care centers.

Regionals 6 and 15 are also similar, as they both lack urban cleaning services. The distance of regionals 19 and 17 was about 0.29, followed by regionals 18 and 2, whose distance was about 0.18. Finally, Regional 10 showed about 0.29 similarity when compared to regions 18 and 2, generally related to capacitation, improvement of municipal departments, as well as actions related to rural development and supply of water, concluding the elements of the first group.

Group 2

In Group 2, the most similar Regionals were 9 and 4, and their distance was approximately 0.09. This association is related to the needs of implementation of Sanitary Sewage Networks, followed by a paving request. After the first grouping, the distance of the regionals 13, 7 and 5 was 0.09, the same as before. They prioritize the same demands: paving at first-level and Sanitary Sewage in second-level. Finally, the distance of regionals 14, 16 and 1 was approximately 0.18, establishing their similarity. Such association is presented mainly by the demand for paving.

Group 1 and Group 2: comparison

Ward's method results showed that the elements of the Group 2, formed by regionals 9, 4, 13, 7, 5, 14, 16 and 1, are more similar among themselves when compared to the elements of the Group 1, in which the greater similarity was presented by the grouping of regionals 12 and 11. Therefore, regionals of the second cluster have similar, if not the same, demands for the municipality, thus showing that these areas, although geographically distant from each other, share the same problems in infrastructure, health, sanitation and alike.

This analysis is also valid for regionals of Group 1. However, the similarity between them is smaller when compared to regionals of Group 2, – except the regionals 12 and 11 – suggesting they have similar demands, and perhaps the same problems aforementioned. Empirical findings indicate these regionals are not in such a vulnerable situation as regionals present in Group 2.

The Basic Sanitation strand among social demands

Regarding categories framed in Basic Sanitation – water network, drainage, public space cleaning, selective collection and sewage network – a histogram of multiple variables was generated, as shown in Figure 3.

The higher levels illustrated are inversely proportional to the demand for sanitation, since their class values vary from -0.02 to 0.00. This level suggests that most of the analyzed variables are not priorities of the regionals, fact discussed in Figure 1, which shows that Paving, Day Care and Sewage Network are the most demanded measures by the population. However, classes between 0.04 and 0.06 demand for Sewage Network and selective collection actions, in which the occurrence frequency was approximately 1.

Within the same class, the demand for Public Space Cleaning frequency was 2. Between classes 0.10 to 0.12 the demand for Selective Collection and Water Network frequency was 1, followed by 2.5 for Drainage. Finally, in class 0.14 there is only demand for Sewage Network, whose frequency was 2.

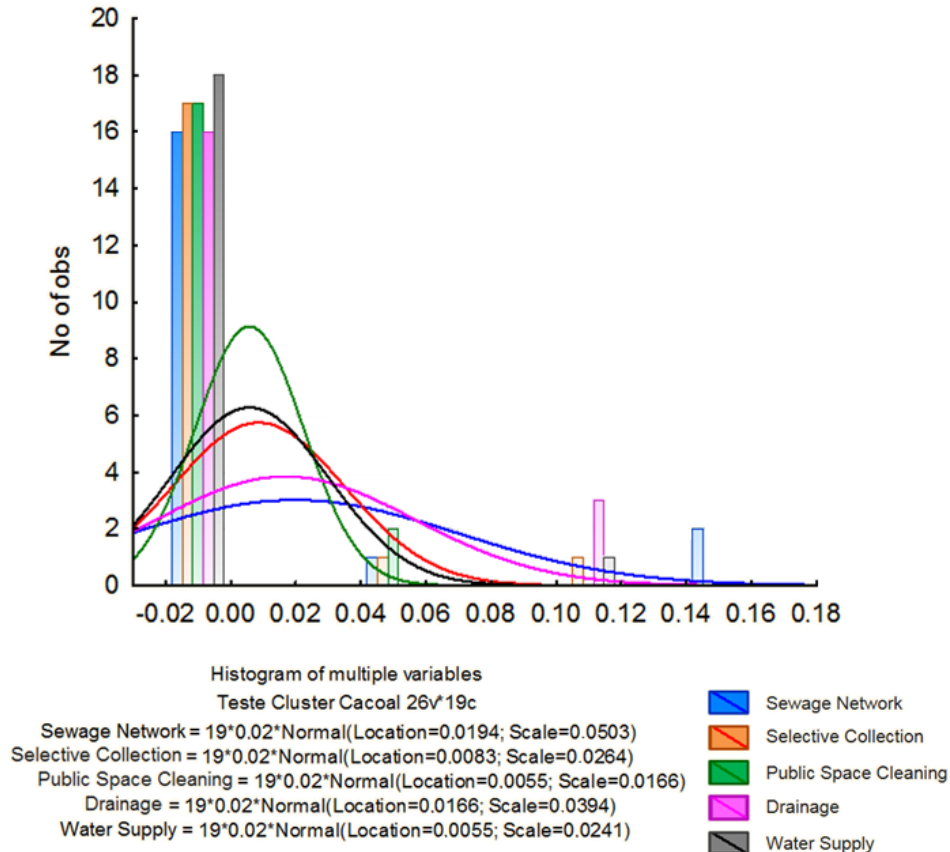


Figure 3. Histogram of Basic Sanitation variables listed in the demands of the 2018-2021 MPA of the municipality of Cacaoal (RO).

Consequently, the most demanded sanitation actions are those regarding Sewage and Drainage Network; sewage because it appears in two distinct classes, although on different frequencies – defining which region prioritizes the action the most – and drainage network because it is the highest positive frequency of the analysis, even though present in a single class. This fact is emphasized by the trend lines representing the behavior of the set variables whenever different from one another – which suddenly decrease from the highest negative value to the lowest positive. Trend lines for Sewage Network and Drainage are more uniform, extending cohesively until suppressed by the class axis.

Figure 4 shows the similarity among regionals whose demands are Basic Sanitation practices.

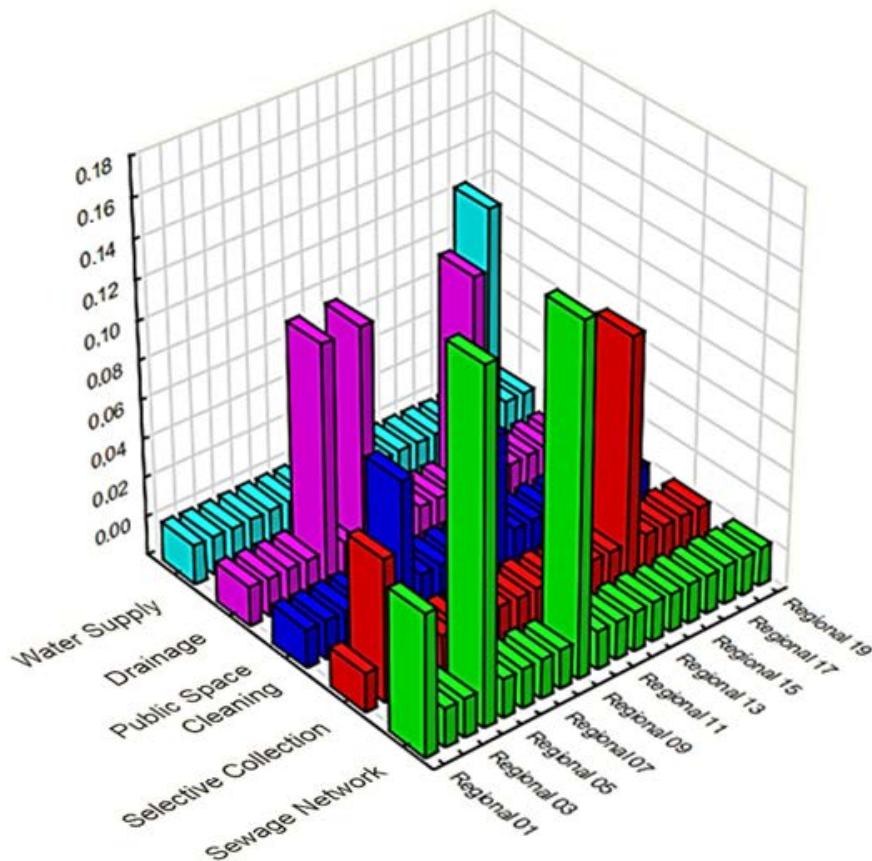


Figure 4. Relationship between the demand for Basic Sanitation practices, by Regional.

Assuming the distances presented on the y axis as the parameter, 0.00 is the minimum demand value and 0.18 the maximum. Therefore, it is evident the higher patterns represent the level of interest in a given sanitation action per analyzed area, justifying the similarity between the regionals.

Regionals 3 and 9 showed 0.12 similarity in the demand of Sewage Network, followed by regional 1, with 0.04 similarity. Regarding the claim for Selective Collection in the municipality, regional 3 presented a similarity of 0.04 when compared to regional 15, in which the demand value was 0.10. In the regionals 5 and 11, in turn, the similarity level was 0.06 regarding the claim for cleaning public space. Regionals 5, 7 and 13 presented the same level of similarity regarding expansion of drainage systems, and the euclidean distance was 0.08. Finally, only regional 17 showed a significant value of 0.12 regarding the demand for Water Network.

Results illustrated in Figure 4 show that the demand for Basic Sanitation, per regional, reinforces what had been previously discussed in Figure 3: that the major demands for sanitation in the municipality are the Sewage and Drainage Systems, followed by Waste Collection, Urban Cleaning Services and, finally, Water Network. However, the graph specifically detects which regions resemble by reporting major sanitation problems, and concisely demonstrates the similarity among them.

Therefore, the results show that the population of the municipality studied needs, in priority order of demand: 1 – infrastructure improvements, 2 – creation of spaces for education, 3 – expansion of basic sanitation. It also indicates what are the major problems shared among study areas, as demands depend on the lack of listed services.

Discussion

The Multi-Annual Plan should establish the intersection among objectives of the State, forming a long-term planning, medium-term government policies and performing the expenditures foreseen by the budget (Paulo, 2010). Considering that, an MPA is elaborated in two stages: 1 – identification of demands, problems and potentialities; 2 – identification of the root causes of problems (Pinheiro, 2012). The relationship between urban development and the public power is meaningful, and their thematic coexistence is different or redundant within the same spaces

In the urban area of the municipality of Cacoal (RO), demands were observed in different sectors, especially Infrastructure and Housing, Health, Basic Sanitation and Education and Sports, open to community participation. In a similar study, founds that for Curitiba (PR) 2018-2021 MPA public hearing “meeting,” the resulting priorities were: “Safety,” “Health,” “Education” and “Sports and Leisure.”

In another work, was made a document analysis on the Multi-Annual Plan demands, the Budget Directives, and the Santana do Livramento (RS) Annual Budget Law (Ferreira, 2010). The study found that such demands are not being met, which causes part of the population to distrust and doubt the effectiveness of the project, given the low investment of the municipality. Thus, in order to have a participatory democracy, there must be a wider societal participation on deciding the distribution of budgetary resources, an improved access to public resources, and an increasing Participatory Budgeting capacity to decide and establish rules.

Although environmental sanitation conditions have improved over the years, in Brazil they are still insufficient. In the Northern region, just over half of the population (57.1%) is covered by the service, below the reality of other regions. Although North is located between two large hydrographic basins,

the population has little access to drinking water, reality experienced in several Amazonian states: Amazonas, Acre, Amapá, Pará, Roraima, Rondônia and Tocantins (Bordalo, 2017).

In Amapá, whose capital is Macapá, has one of the lowest basic sanitation rates in Brazil, with 36.92% water treatment facilities, significantly lower than the national average. The lack of sanitation in Macapá causes serious problems to its population and their rights, especially to the most vulnerable classes.

Sanitation investments and Health Conditions improvements, reduce social inequalities within most fragile communities (Moura *et al.*, 2010). The synthesis of the results from other studies is described in Chart 2.

Therefore, ensuring public health stimulates the creation of policies that embrace and solve environmental, economic and social issues. Thus, understanding the characteristics of municipalities and regions is important for planning and decision making.

Chart 2. Comparison between results of studies in the literature.

Author/Year	Summary of Results
Paulo (2010)	The MPA was created to be a strategic planning and management tool, however the structure and methodologies adopted over the years have kept it away from this purpose.
Moura <i>et al.</i> (2010)	In recent years, hospitalization for gastroenteritis is more evident in regions with precarious socioeconomic conditions, especially regions where sanitation services are ineffective.
Ferreira (2010)	Potential for urban development, as well as creating more democratic planning. In contrast, there is the conflict between public authorities and the scarcity of agreements or consortia, and budgetary resources.
Rosa <i>et al.</i> (2017)	With the lack of fulfillment of demands, it was found that for there to be participatory democracy, in addition to increasing popular participation in decision-making, there must be an increase in access to public resources of the Participatory Budget.
Oliveira e Moraes (2017)	In terms of management, planning, development, critical analysis and control, they happened in an insufficient way, causing the lack of water supply in the city of Macapá, northern region of Brazil. Thus, there must be planning with a focus on sustainable water management, so that sanitation services reach the sustainability goals established.
Bordalo (2017)	The water crisis in the Brazilian Amazon is not related to low water availability, but is the result of poor management of water resources available in the region, as well as low technological and financial investment, both public and private.
Pinheiro (2018)	Although there are strategies for the development of the state based on theories, it is noted that most of them are planned without a thorough study of the real demands of the population, implying that the economic programming and the allocation of budgetary resources are built according to the wishes of the rulers.
Oliveira <i>et al.</i> (2018)	The documentary study showed that the 2006-2009 MPAs had little interaction with citizens, as well as the years 2010-2013. The survey found that over the years, the 2014-2017 and 2018-2021 MPAs have been more socially closer to the management system, although the number of participations has decreased.

Source: The authors

Conclusion

The cluster analysis enabled the consistent presentation of the major demands resulting from the 2018-2021 MPA, in the municipality of Cacoal. It sought to emphasize the import role civil society plays in public management decisions, in which social engagement not only acted as a directive for the implementation of public policies, but also for its elaboration and planning.

The data show that the major demands of the municipality are, in priority order: 1 – infrastructure improvements, this means that the population of the municipality wants infrastructure improvements in most of the regions, mainly in relation to Paving and Street Lighting; 2 – creation of spaces for education, the data also show a recurring desire of the population of Cacoal (RO) to expand spaces for basic education with Day Care Center; 3 – expansion of basic sanitation, it is possible to highlight that Sewage Network or Drainage are also requested by the population, according to a survey carried out in this study.

Still in relation to basic sanitation, Sewage Network was considered at first-level priority in regionals 4 and 9. In turn, Drainage was considered at second-level priority in regionals 5, 7 and 13. Selective Collection and Public Space Cleaning they were also listed as second-level priority or third-level priority in regionals 2, 6, 11 and 15. Finally, a Water Wupply was placed as a second-level priority in regional 17, which is located in the rural area. This shows that more than half of the Cacoal's regions consider it necessary to increase financial resources in basic sanitation.

Furthermore, this study can serve as a basis for further studies, which it might show whether the demands were met, and whether the civilians are in better conditions regarding the services offered by the public authorities.

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