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Use of geospatial analysis in Parintins/AM (Brazil) in the evaluation of the National Urban Development Policy (PNDU)

Uso de análises geoespacial em Parintins/AM (Brasil) na avaliação da Política Nacional de Desenvolvimento Urbano (PNDU)

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Abstract

This manuscript focuses on understanding the urban development driven by the folkloric Festival of Boi Bumbá, held annually in the island city of Parintins in the Brazilian state of Amazonas. As an island, the city experiences an atypical situation, uncommon among many other cities in the country. The general objective of this article is to evaluate the urban development of the city of Parintins through variables assigned by the National Plan for Urban Development (PNDU) of 2021, from the perspective of the urban population. The results show that the population residing in the peripheral areas of the city is in general excluded from and does not benefit from the annual festival. The authors suggest the application of the following public policies in the city of Parintins: projects to increase accessibility, improvement of the quality of public spaces such as parks, squares and gardens, improvement of the state of conservation of the roads and buildings, mainly of historical-cultural value and improvements in the quality and diversification of the hotel and restaurant chains present in the city.

Keywords: Cultural manifestations; Geospatial Technologies; UNDP; Urban public policy.

Resumo

Este manuscrito tem como foco compreender o desenvolvimento urbano impulsionado pela Festa folclórica do Boi Bumbá, realizada anualmente na cidade de Parintins, no estado brasileiro do Amazonas. Como ilha, a cidade vive uma situação atípica, incomum entre muitas outras cidades do país. O objetivo geral deste artigo é avaliar o desenvolvimento urbano da cidade de Parintins por meio de variáveis atribuídas pelo Plano Nacional de Desenvolvimento Urbano (PNDU) de 2021, sob a ótica da população urbana. Os resultados mostram que a população residente nas áreas periféricas da cidade é, em geral, excluída e não se beneficia do festival anual. Os autores sugerem a aplicação das seguintes políticas públicas na cidade de Parintins: projetos de ampliação da acessibilidade, melhoria da qualidade dos espaços públicos como parques, praças e jardins, melhoria do estado de conservação das vias e edificações, principalmente na valorização histórico-cultural e melhorias na qualidade e diversificação das redes hoteleiras e gastronômicas presentes na cidade.

Palavras-chave: *Manifestações culturais; Tecnologias geoespaciais; PNDU; Política pública urbana.*

Introduction

Worldwide, there is a need to build strategies that guarantee that urban development progresses and proceeds in a sustainable way (Abulatif, Silva & Colusso, 2021). This is best accomplished through the creation and implementation of public policies that regulate and govern urban projects, enabling possible improvements in the population's quality of life (Abulatif, Silva & Colusso, 2021; Kantamaturapoj et al., 2022; Mazutis & Sweet, 2022). Urban development, in terms of sustainability (environmental, economic and social), can be considered adequate when there is a high capacity for public and private investments as a way of strengthening and boosting the economy (Wen, Qiang & Liu, 2022). Cabrera-Moya (2021) and Souza (2022) define urban development as the process of thinking about design in cities in a dignified way, in order to meet the population's needs with adequate access to urban infrastructure and services.

Maricato (2003) points out that Brazilian urban development has become dispersed in recent decades, in the sense of acting on only two axes: urbanizing and legalizing the urban environment (an informal environment) in order to improve the quality of life of its inhabitants; and considering the capacity of new housing. Some Brazilian cities have begun to actively court urban development aimed at tourism and leisure in an effort to strengthen the local economy (Farias, 2005).

The urban environment becomes the site of intense transformation when considering the diversity of activities, work and leisure, that are able to express the cultural manifestations known and appreciated in Brazil (Farias, 2005; Souza, 2022). Cultural festivals in Parintins are spatial phenomena that generally take place in rural areas, modeled on the city as a revealing environment in the constant process of urban development (Lefebvre, 1991; Martines et al., 2020). The focus of this article is centered on the urban development of the city of Parintins, Amazonas (Brazil); correlating its historical, cultural and economic factors with the Festival of Boi Bumbá, which is rich in the use of symbolic cultural figures characterized by the Garantido and Caprichoso oxen. The authors also consider the current perspective of the local population's opinion, based on variables established in Brazil's National Urban Development Policy (PNDU), which was first implemented in 2021.

The effectiveness of analyses using PNDU (2021) variables to assess the urban development of Brazilian cities has not yet been attested. This justifies and emphasizes the importance of the critical study presented here, as a form of application and measurement of the urban development policy itself. This analysis is not only based on PNDU variables, but also on typical characteristics of a riverside city in the Amazonian region. Cities such as Parintins exhibit regional, economic, political and cultural specificities unique to their location. Parintins is the seat of a micro-region known as the Middle Amazon. It is worth noting that the culture of Boi Bumbá has become a popular manifestation in other Brazilian regions, although it has acquired different names during the urban development process. In this sense, it is valid to reflect on the cultural exceptionalities of the city of Parintins, while examining the historical factors of the Boi Bumbá festival in relation to urban development, the economy, politics and culture. This combination has led to the growth of Parintins to become the second largest municipality in terms of population in the state of Amazonas.

Studies focused on urban development make it possible to understand new trends and indicators responsible for changes in the zoning plan and/or urban design of an area, which may change the structure of mobility in a locality (Bernardes et al., 2021). Any such changes which take place within Brazil are governed by the City Statute of Legislation nº. 10.257 (July 10, 2001), which establishes

norms aimed at the social interest and collective use of the urban environment in relation to social and environmental importance (Brasil, 2001).

It is worth remembering that the PNDU (2021) is an urban management document built to support Brazilian municipalities in the implementation of urban development agendas focused on local sustainability. This needs to be adapted to the specific needs of each city on a global scale, and it is important to contextualize the UNDP to the fulfillment of the goals of the 2030 Agenda, to contemplate the scope of international initiatives aimed at sustainability. For example, Parintins' location within the Amazon region, along the river, means that motorized vehicles are of very limited use. Transport in Parintins takes place mostly by bicycle and motorcycle. Consequently, evaluation, revision and elaboration of public instruments and policies that result in improvements in its built environment must take this into account. Public actions should fall in line with the common agreement of society, independent of different social and urban profiles. Public policies that have shown great success in a city of comparable size to Parintins, but one in which motorized vehicles were the primary mode of transport, would experience great difficulty in this region due to this significant difference.

The objective of this article is to evaluate the urban development of Parintins through the variables of the PNDU (2021) (history, sidewalks, squares, paving, micro drainage, bus stops, solid waste collection, active mobility, quality of buildings, and transitions between public and private spaces) from the point of view of the urban population.

Methodology

The city of Parintins is located in the interior of the Brazilian state of Amazonas (Figure 1). According to official data from the Brazilian Institute of Geography and Statistics (IBGE, 2022), Parintins has a territorial area of 5,951,200 km² and a total estimated population of 115,465 inhabitants in 2021. The urban development of the city is driven by the generation of jobs serving the area's primary economic activity, tourism (Souza, 2022). For Souza (2022), the formation of the Festival of Boi Bumbá in the Amazon region considerably influenced the population density of Parintins and boosted the appreciation of urban land (Souza, 2022), especially in the city center. According to the IBGE (2021), local residents with the highest income (R$2,590 to R$3,237 per month) occupy the central area, where the Parintins Cultural Center (Bumbódromo) is located. This space hosts the aforementioned festival (Figure 1).
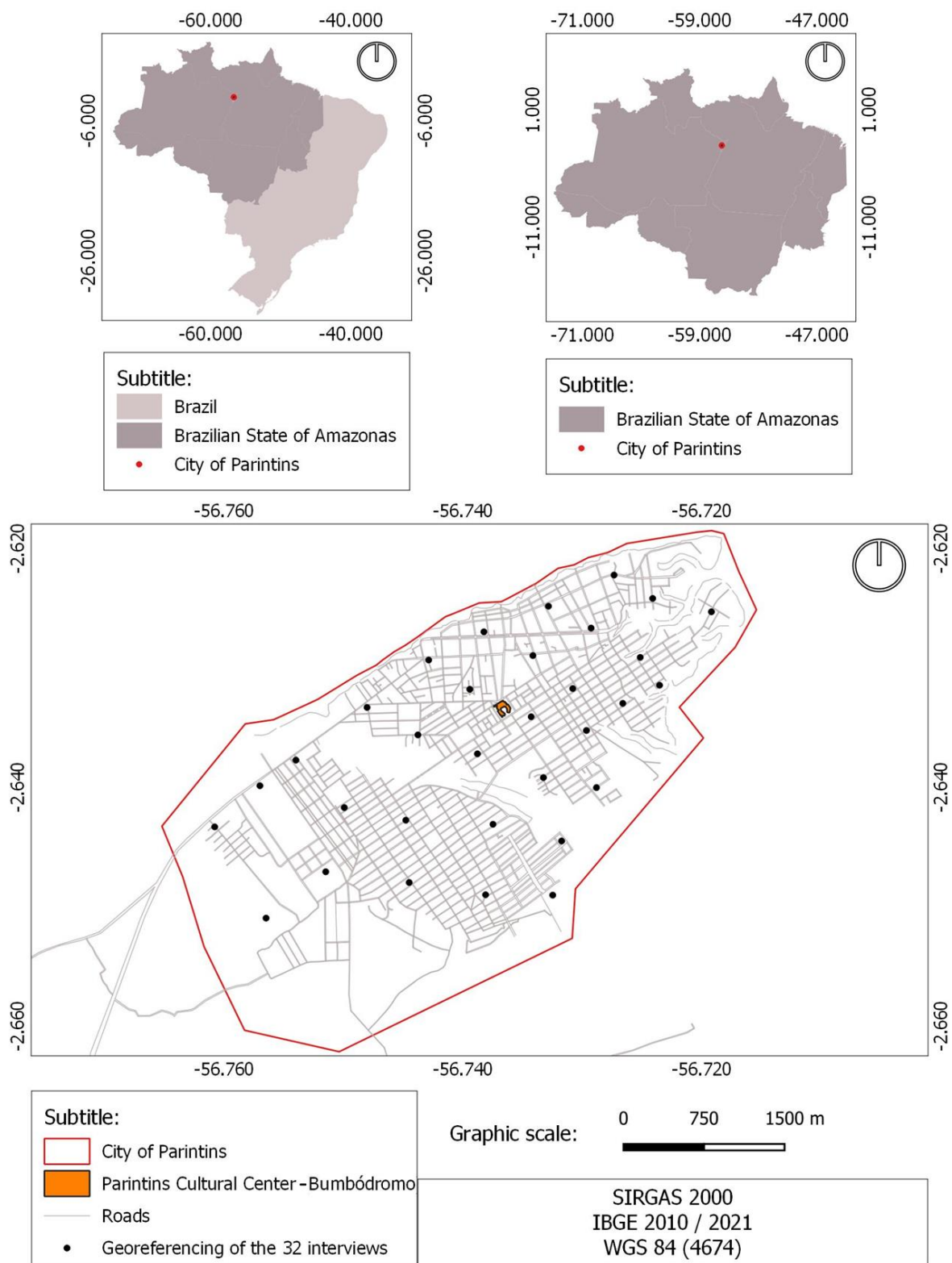
Figure 1 – Location of the 32 points sampled in the City of Parintins (Brazilian State of Amazonas - Brazil). Source: Adapted from the IBGE database (2010, 2021).

In this study, multiple methods of geospatial and statistical analyses were used in which the researcher assumes the role of spectator, with non-participant observation for better interpretation of the results (Bardin, 2016). In addition to the use of a specialized bibliography on the topic and object of study, Bardin's (2016) recommendations on the subdivision of the study into three methodological steps were followed. They are:

a) PNDU evaluation indices and the affectiveness of cultural festivities: Documental research is first carried out. Data is gathered regarding field activities in the urban area of Parintins from the perspective of the urban population. In order to accomplish this, a questionnaire was developed, applied in the form of an opinion survey to residents of the city of Parintins, in which survey respondents were asked to rate the variables established in the PNDU (2021). The variables available for rating in the questionnaire were as follows: state of conservation of the sidewalks (Q1); universal accessibility (Q2); quality of public spaces (parks, squares and gardens) (Q3); state of conservation of paved roads (Q4); quality of urban micro drainage (Q5); quality of micro mobility (Q6); quality of micro mobility during the Boi Bumbá festival (Q7); garbage collection system in the city (Q8); garbage collection system during the Boi Bumbá festival (Q9); quality of macro mobility (Q10); quality of walking (Q11); state of conservation of buildings in general in the city (Q12); oldest buildings in the city that receive preservation incentives (Q13); public facilities (schools, health units, etc.) that serve the population (Q14); the proximity of the respondent's residence to the Parintins Cultural Center (Bumbódromo) (Q15); quality of local hotel and restaurant chains (Q16); and the degree of affection of the respondent toward the Boi-Bumbá festival (Q17). It is worth mentioning that the population's degree of affection towards the Festival of Boi-Bumbá became the centralizing variable of this study, as it is better correlated statistically with the other variables. Bearing in mind that the choice of defining these variables took into account the guidelines of the PNDU document (2021), which determines the items to be evaluated in Brazilian cities, with the current understanding of urban development.

The term affectivity is consistent with a more subjective reading of the urban experience in relation to socio-spatial dynamics. Through affectivity, it becomes possible to understand how the population, perceives the city as a whole and its dynamics of functionality in a systematic way (Mares, 2019; Kong et al., 2022). Thus, the city can be measured through affectivity, characterized in the emotions and feelings perceived by the user (interviewees) (Kong et al., 2022) which, in this case, is the urban population of Parintins. In this context, the profile of the interviewees consisted mainly of those who live in the urban area of Parintins, who according to the PNDU (2021) are able to better assess urban development as they know and experience this reality in addition to having easy access to services, infrastructure and other facilities provided by the government. Sampling was performed randomly, following the standards of the Irregular Triangulation Network (TIN), with spacing of points between 300 and 500 meters, as determined by Goellner et al. (2021), Maroni et al. (2021) and Souza (2022) Sampling was conducted at random. A total of 32 opinion interviews were conducted at random in residences. The questionnaire confidence level was 90%, generating a sample error margin of 12.41% (Prunzel *et al.*, 2016). It is important to note that the profile of the interviewees was not considered in the 32 questionnaires collected, as it is not recommended in the PNDU document (2021). Additionally, the sampling was characterized as an opinion survey, where personal questions regarding income, gender and education of the interviewees should be avoided (Souza, 2022).

a) Questionnaire responses were subjected to the Geographical Weighted Regression (GWR) method, which consists of one of the techniques of analysis by spatial regression being assigned in analysis geographically over the territory. This explicitly includes space in the regression equation, thus generating a certain set of data (Yuan et al., 2020; Nazarpour et al., 2022; Saputra & Radam, 2022). The results were tabulated and statistical evaluation of GWR was performed to answer the following question: how do different urban components affect the quality of the Festival of Boi Bumbá at the Parintins Cultural Center in the Bumbódromo? To assess the respondents' response level, the Likert scale (from 1-5) was used, in which, 1 (considered a great loss in functionality or performance impacting the event) and 5 (related to satisfactory service of functionalities during the event) (Maroni et al., 2021).

b) Cartographic design based on the opinion of the interviewees: the geospatial representation of the interviewees' opinions was based on the 32 points distributed by the TIN (Figure 1), with the cartographic database (IBGE, 2022) serving as a reference. The composition of the TIN network is presented in a Digital Terrain Model (DTM) with three vertices (x, y, z) (Maroni et al., 2021), made up of 32 collection points represented in geographic coordinates. The TIN, when distributed over the urban area of Parintins, made it possible to understand the variations of certain results, presented on maps with color variations (Souto & Cohen, 2021). The variation from stronger (red) to weaker (blue) colors is of fundamental importance in the representation of urban objects (Souto & Cohen, 2021), expressed by the opinions attributed by the interviewees (Figure 1).

Following collection of the results in points, a density map (heat map) was generated for each of the questions in the questionnaire, through the generation of a point shapefile using QGIS software version 3.10.4's Quick map service tool. To elaborate the radius assigned to the heat map projection, the distance matrix of the points was constructed using the Shapefile Distance Matrix tool, based on the distance radii from a central point (Rizzatti et al., 2020). Next, the data from the distance matrix was used to determine the value of the radius (R) in the heat maps. The R was determined by subtracting and adding the mean of the distance $\bar{X}$ of each of the points with the mean of the standard deviation ($\bar{X}\sigma$) (Equation 1), in order to approximate the appropriate value of distance in relation to the sampled points (Rizzatti et al., 2020).

$R = \bar{X} - \bar{X}\sigma$ (Equation 1)

$\bar{X}$ Mean of average distance.
$\bar{X}\sigma$ Mean standard deviation.

The density map in the QGIS software environment was obtained using the heat map tool. The radius used was 500 meters in the Kernel band, with a spatial resolution of 30x30 meters. The point shapefile was used to generate all heat maps. According to Rizzatti et al. (2020), Dal Moro et al. (2021), Maroni et al. (2021), Li, Zhang and Zhang (2022) the elaboration of heat maps makes it possible to estimate the point intensity by the stronger (red) and weaker (blue) color scale to represent a certain density per region, represented using the Likert scale .c) Analysis of clusters attributed to the opinions

of respondents: the generation of clusters was based on K-means clusters, which consist of sets of construction data that are gathered and organized in a single database (Maroni et al., 2021). The database is analyzed to identify the number and features of elements that contributed to the urban development of Parintins, with the number of repeated data entries and the integrity of the data sets. Data cleansing was necessary to create a complete dataset, which is used as input for clustering algorithms (Dal Moro et al., 2021; Maroni et al., 2021). Missing data removal procedures were performed, resulting in a decrease in the number of data entries and analysis of variance (ANOVA) in JASP software version 0.14.1.0. (Wang, Zhang & Zheng, 2019). This procedure made it possible to identify problems capable of enhancing possible suggestions for future public policies, programs and/or urban projects for Parintins.

Results and discussion

PNDU evaluation indices and the affection felt toward Boi Bumbá cultural festivities

The results of this study demonstrate the opinions of the population residing in the center of Parintins, where it was possible to perceive the functionality of the urban space of the city, based on the variables addressed by the PNDU (Q1; Q2; Q3; Q4; Q5; Q6; Q7; Q8; Q9; Q10; Q11; Q12; Q13; Q14; Q15; Q16; Q17). Recall that the analyzed urban components have the greatest effect on Q17, which deals with the degree of affection toward the Parintins Cultural Center (Bumbódromo), where the Festival of Boi Bumbá takes place.

Table 1 represents the adjustment of the statistical model to the results obtained from the survey instrument applied to the population. The R^2 value was 0.929 and the adjusted R^2 was 0.854, considering that values above 0.7 demonstrate the quality of the statistical adjustment of the model, allowing for greater attributed reliability to these results (Dal Moro et al., 2021; Maroni et al., 2021). According to Bardin (2016), the level of reliability of the main variable is of fundamental importance. In this case, the respondents' affection for the Festival of Boi Bumbá and the surrounding urban elements add up to 85.4% of reliability.

The Analysis of Variance (ANOVA) by means of comparison shows a cause-and-effect relationship (Table 1). The alternative hypothesis (H1) was accepted, as the degree of affection for the festival (Q17), as influenced by the different urban variables shown. The linear regression statistic of GWR provided a P-Value of 6.925 e-6, a value below 0.05, demonstrating that there is a significant effect between the analyzed variable (Q17) and the others.

Table 1 – ANOVA of the evaluation of the relationship between urban elements and the Festival of Boi-Bumbá

Model	Type	Sum of Squares	Medium Square	F	p
H_1	Regression	82.699	5.168	12.366	6.925e^{-6}
-	Residual	6.269	0.417	-	-
-	Total	88.968	-	-	-

Source: Data from interviews modeled by the authors (2022), submitted in the linear regression model of Wang, Zhang & Zheng (2019).

The analysis of these results considered the reliability interval of the linear regression calculation between the dependent variable (Q17) and the other questions that were considered

independent variables. This formula generated the "p" value for each of the independent variables considering the 95% confidence interval (Table 2) (Prunzel et al., 2016). The variable Q17 was most influenced by the following variables: Q2 with a p-value of 0.001 and Q16 with a p-value of 0.081. The variables with the least influence on Q17 were: Q8, Q9 and Q11. It is understood that the population does not relate the type of garbage collection with the festival activities that take place in the city, most likely because they do not usually notice their urban impacts. Another factor is not relating the festival to urban mobility, since the festival activities are centralized in the city's center, which essentially involves walking short distances for the analyzed population. According to Merli et al. (2015) and Xue et al. (2022) the degree of location of the individual interviewed can directly influence the probability of sample results. Xue et al. (2022) emphasizes that the distance between the center of a city and the periphery regions can influence a sample in a significant way. Therefore, when evaluating a location in relation to the mobility of the interviewees, it is possible to have negative impacts on the sample as they do not present a statistical pattern (Xue et al., 2022). This study emphasizes the importance of not integrating the Boi-Bumbá Festival in the city of Parintins with urban mobility, as the location of pedestrian paths can influence the sample in a negative way (Merli et al., 2015; Strömblad et al., 2022; Xue et al., 2022).

Table 2 – Independent variables to verify how the degree of affectivity of the Boi-Bumbá Festival (Q17) is influenced by the different urban elements in the city of Parintins/AM

Variables	P-value	Sample Error (5%)	Confidence Interval (95%)
Q1	0.439	-0.829	0.379
Q2	0.001	-2.087	-0.627
Q3	0.354	-0.255	0.670
Q4	0.231	-0.667	0.174
Q5	0.747	-1.091	0.800
Q6	0.314	-1.514	0.521
Q7	0.702	-0.477	0.329
Q8	0.914	-1.319	1.463
Q9	0.806	-0.578	0.457
Q10	0.194	-0.529	2.395
Q11	0.953	-0.409	0.387
Q12	0.185	-0.173	0.820
Q13	0.240	-0.357	1.317
Q14	0.180	-0.162	0.788
Q15	0.481	-0.649	0.321
Q16	0.081	-0.855	0.056

Source: Data from interviews modeled by the authors (2022), submitted in the linear regression model of Wang, Zhang & Zheng (2019).

From this, it was possible to construct an equation to verify the influence of urban elements on the local population's affinity for the Festival of Boi Bumbá for the city of Parintins (IEUA) (Equation 1). According to Goellner et al. (2021), Maroni et al. (2021) and Souza (2022) the Irregular Triangulation Network allows an understanding of the extent of the results of the sampled population, through

geospatial analysis. This enables an understanding of the results of the interviewees' opinions, which can be extrapolated by the geographic scope of the city, thus considering an estimate from the entire population. Equation 2 consists of the sum of indicators and independent variables multiplied by the P-value, contained in the linear regression statistics of each of the independent variables. This made it possible to quantitatively measure the relationship that each urban element presents with a degree of affection toward the Festival in the 32 points studied. The mathematical modeling to evaluate the influence of urban elements on the affection for the Festival of Boi Bumbá for the city of Parintins presents the result of linear regression shown in Equation 2.

$$P17 = \sum_{I=16}^{k=32} \quad (\sum VARIABLES * P - value) \text{ (Equation 2)}$$

SVI= (Q1=77*0,439) + (Q2 = 40*0,001) + (Q3 = 81*0,354) + (Q4 = 107*0,231) + (Q5 = 117*0,747) + (Q6 = 76*0,314) + (Q7= 71*0,702) + (Q8 = 111*0,914) + (Q9= 111*0,806) + (Q10 = 139*0,194) + (Q11 = 78*0,953) + (Q12 = 101*0,185) + (Q13 = 37 * 0,240) + (Q14= 121*0,180) + (Q15= 61*0,481) + (Q16= 70*0,081) = SVI= 625,545

Q17 = "Degree of affection for the Festival of Boi-Bumbá."
k = number of observations.
I = number of independent variables.
SVI= sum of independent variables.
P-Value = P value of significance of the linear regression analysis.

Equation 3 made it possible to quantitatively measure the data collected from the evaluation of the effect that different urban elements generate on the degree of affection for the Festival of Boi Bumbá in Parintin. For that, the Sum of Independent Variables (SVI) was verified and the maximum performance level of each urban element (NDM-EU) was calculated in order to estimate the potential performance level (NDP) from then on.

$$NDP = \frac{SVI}{NDM-EU} * 100 \text{ (Equation 3)}$$

SVI = sum of independent variables.
NDM-EU= level of maximum performance of the urban elements.
NDP = level of potential performance.
NDP = (625.545/1092.75)*100
NDP= 57.245%

The application of Equation 3 resulted in an NDP of 57.245%. In this case, the degree of affection for the festival was influenced by urban elements in general by 57.245%. This demonstrates that there is a great possibility of increasing urban improvements, aimed at the degree of affection towards the Festival of Boi Bumbá. This rating of needed improvements in the urban environment, pointed out by the population, highlights potential support for future public policies that will contribute to the population's quality of life.

Cartographic analysis designed in the opinion of respondents

The cartographic representation presents a spatial view of the opinion of respondents in certain regions through the use of representative heat maps (Maroni et al., 2021). Figure 2 examines the interpolation of the variable Q1, and its high variability; demonstrating how much the city of Parintins differs in sidewalk quality. This issue certainly needs more attention from the public authorities. The interviewees attributed low evaluations regarding Q2 in general, pointing to the need for investments in urban accessibility standards. Q3 refers to the quality of public spaces (parks, squares and gardens), and there is a high (favorable) evaluation for the central area, where the Parintins Cultural Center (Bombódromo) is located, towards the waterfront (Figure 2). For variable Q4, the best results were attained in the vicinity of the urban center. The results from Parintins corroborates with Villaça (2012) discussion that is possible to notice changes in buildings and income between center and periphery.
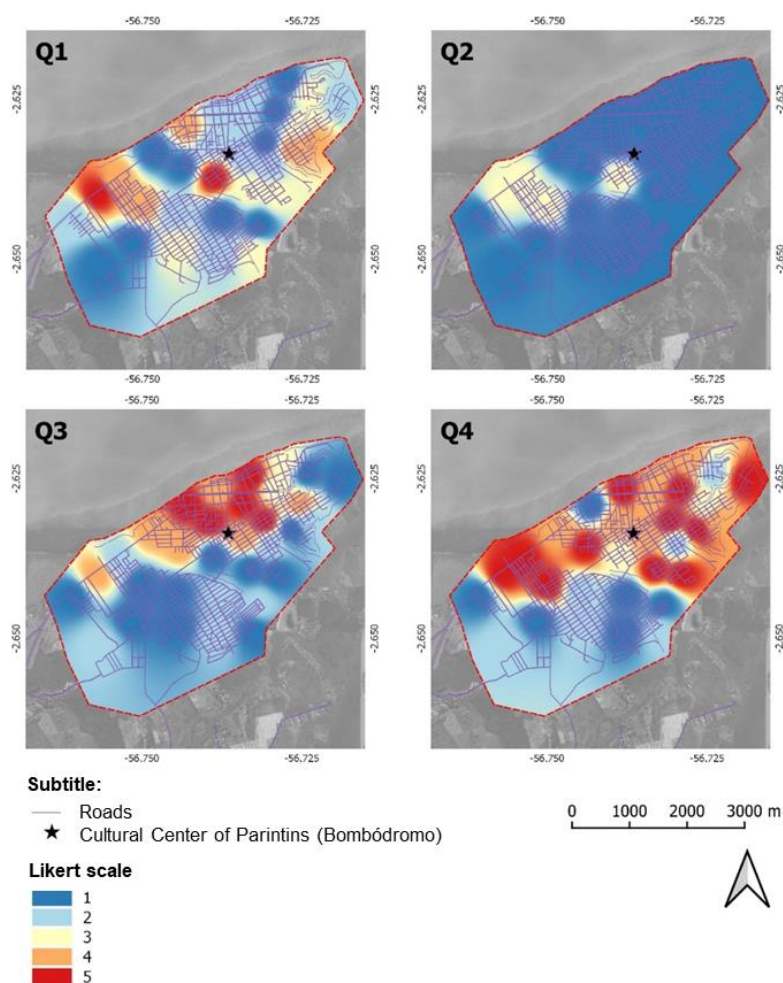

Figure 2 – State of conservation of sidewalks (Q1); universal accessibility (Q2); quality of public spaces (parks, squares and gardens) (Q3); state of conservation of paved surfaces (Q4).

Figure 3 examines Q5, which consists of the downtown and waterfront region, presenting high evaluations of the quality of urban micro drainage. Micro drainage in the area occurs in peripheral regions due to the ease of flow of surface water to the nearby Amazon River. Q6 was rated rather poorly

in the center and edge and better rated to the south of the city, Thus, it is noteworthy that in the southern region of the city of Parintins the roads and sidewalks are in a better shape overall as they were recently constructed, while other, older stretches are in need of maintenance. Q7 highlights a very big change in the experience of the city during the festival, as the waterfront increases in rating compared to the rest of the city. Q8 is rated most favorably both in the center and on the edge. This was expected, as shown in the literature, which emphasizes that the central areas of the city with population interaction are the areas that receive the most focus regarding urban mobility and selective garbage collection by the government (Jacobi, 2003). However, the peripheral areas of cities grow more than the central nuclei as urbanization proceeds. This results in problems during the urban development process of Brazilian cities, with a greater spread of poverty (Maricato, 2000).
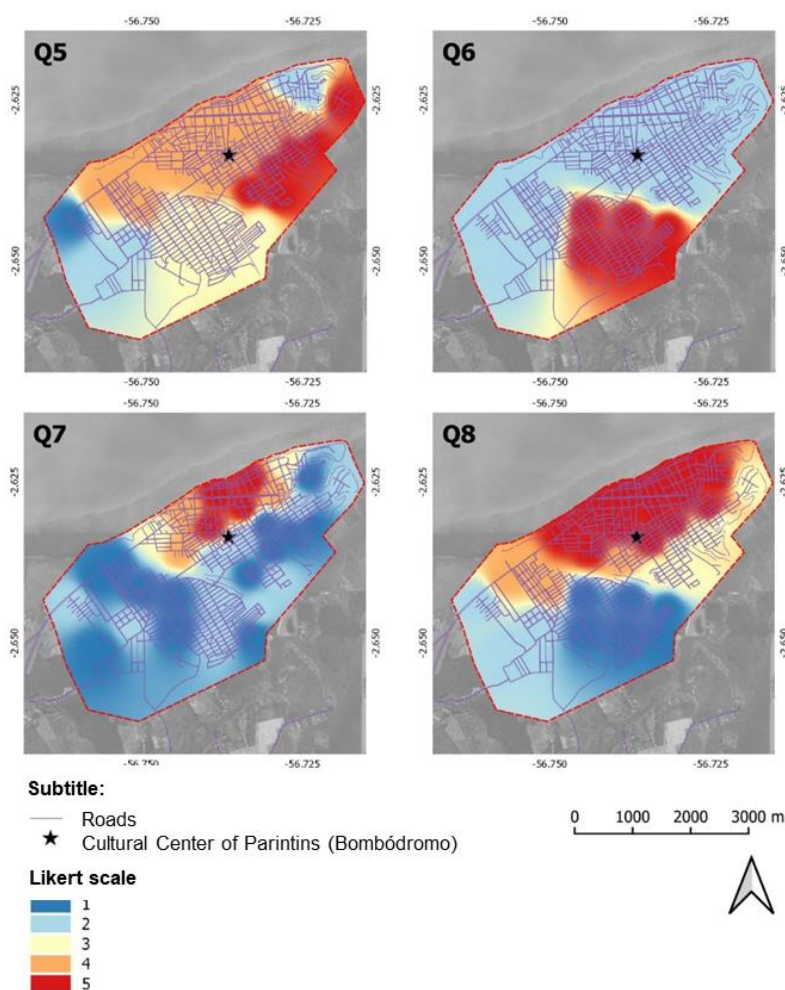

Figure 3 – The quality of urban micro drainage (Q5); quality of micro mobility (Q6); quality of micro mobility during the festival (Q7); effectiveness of garbage collection system in the city (Q8).

Figure 4 focuses on Q9, with a result very similar to Q8, demonstrating that opinions regarding this item are weakly influenced by the festival. Regarding the variable Q10, the evaluations were quite favorable by the population, especially in the central city and on the edge. When the focus is on the quality of pedestrian displacement attributed to variable Q11, the central city and the edge were poorly

evaluated. This may indicate that the government needs to develop a public policy, perhaps a municipal urban mobility plan. Gaglione, Gargiulo & Zucaro (2022) highlight the need to take care of public sidewalks, with a strategy to provide the population with adequate spaces for pedestrian activity.

In this study, an important issue to be considered in the urban development of Parintins is tourism in relation to the perception of the urban landscape. When stimulating the opinion of the residents' perception about the state of conservation of historic buildings in the city (Q12) (Figure 4), it was observed that the best results are related to the waterfront region and the central city square, where the settlement initiated historically. The peripheral region of Parintins contain extremely precarious wooden houses, which, in a tropical climate are very short lived. Therefore, the importance of preserving old buildings is low in the city's periphery. Consequently, the population of the peripheral region does not perceive the importance of preserving old buildings as it is not a perceived reality in the neighborhood. Neckel et al. (2020) emphasize that historic buildings contribute to a city's identity, collectively representing many cultural issues of the resident population throughout the urban development process.

According to Serrao (2019), and Wu et al. (2022), the concept of historical heritage consists of a set of goods which include economic, historical, aesthetic, artistic and tourist values; thus generating social and cultural benefits for the city. In this context, when analyzing the results of the collection points in the city of Parintins, as recommended by the PNDU (2021) and corresponding with the perception of the interviewees in relation to the historical heritage; it is clear that Municipal Law Nº 375/2006 of the city of Parintins, Article 10, Item IV, guarantees the strengthening of urban identity with the promotion of the preservation of cultural heritage (Parintins City Hall, 2006). However, Serrao (2019) in a previous study carried out in the city of Parintins, emphasizes the need for constant preservation of historical heritage, not only for tourists, but also for the population as a whole within the confines of the city limits. Therefore, the weak compliance with public policies in the preservation of historic heritage is noted in the perception of the interviewees. This is a topic that the authors recommend be considered by future participatory planning events that generally involve the population of the city of Parintins.
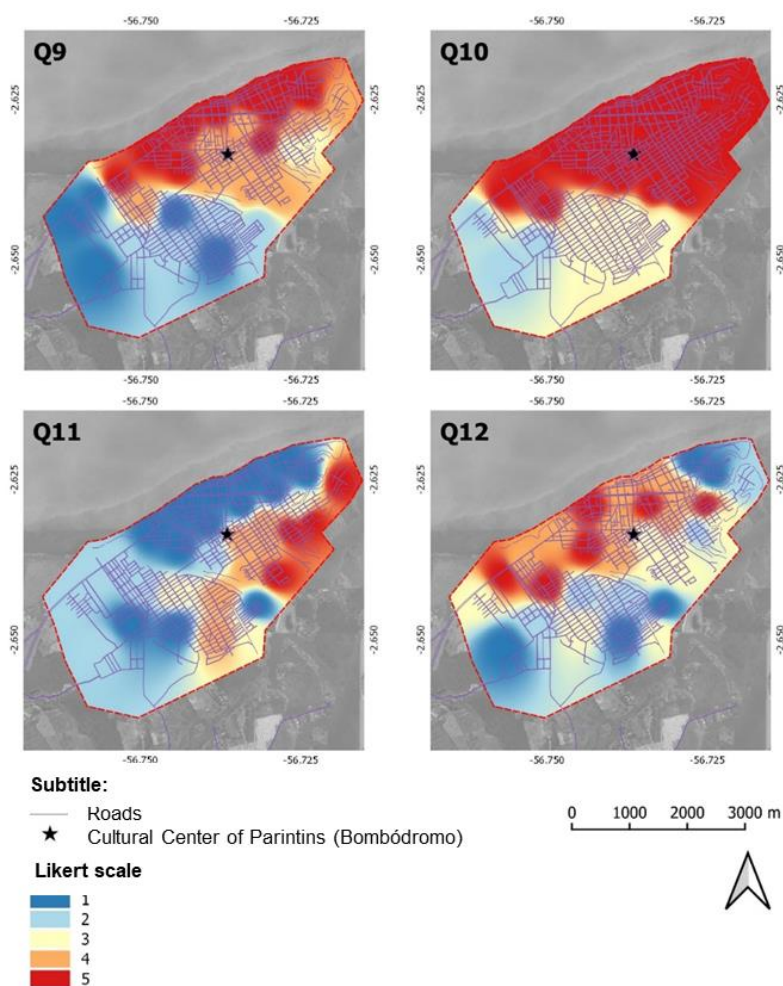
Figure 4 – Effectiveness of garbage collection system during the Festival (Q9); quality of macro mobility (Q10); quality of pedestrian movement (Q11); state of conservation of buildings in general in the city (Q12).

Q13 involves the oldest buildings in the city that receive preservation incentives. This variable received practically unanimous low ratings, indicating that the municipality lacks urban legislation to safeguard the built heritage (Figure 5). In relation to public facilities that serve the population (Q14), the center and the waterfront have high ratings from the interviewees. Regarding the question of living near the Bumbódromo (Q15), the respondents did not consider this item to be very significant. Perhaps the government should rehabilitate this facility in order to make it more usable by the community throughout the entirety of the year.

For a city to be successful in tourism, the quality of the hotel and restaurant network (Q16) is of utmost importance. Regarding Parintins, the survey respondents highlighted the need to invest in the infrastructure of restaurants and in the hotel sector.
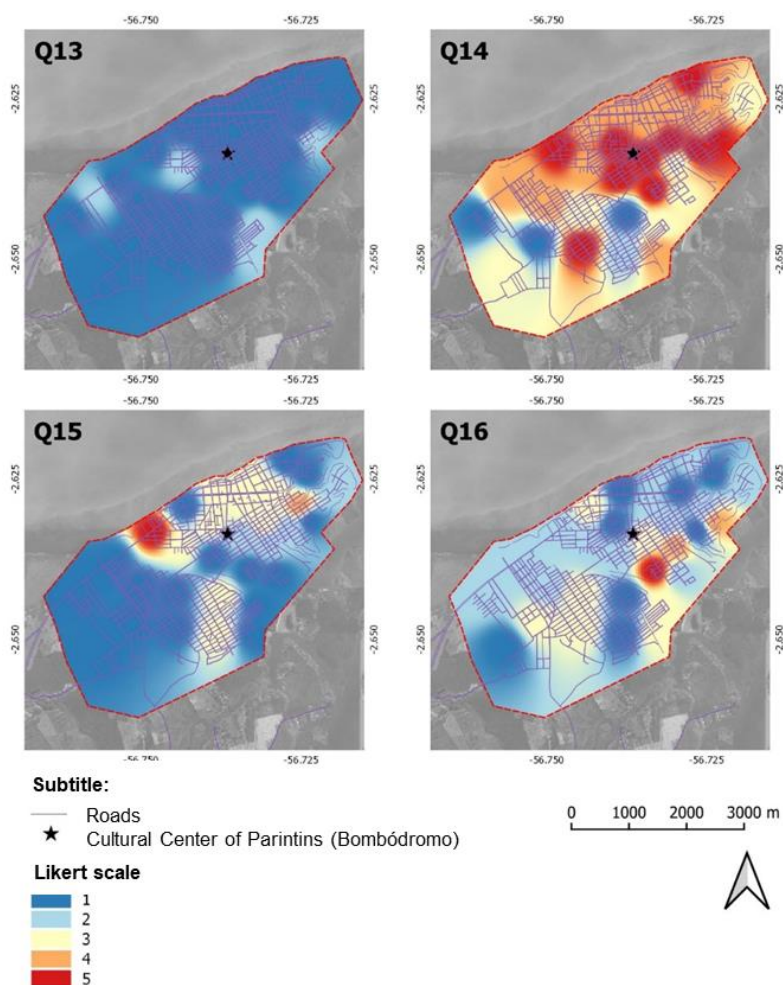
Figure 5 – The oldest buildings in the city receive preservation incentives (Q13); public facilities serving the population (Q14); do you live near the Parintins Cultural Center (Bumbódromo) (Q15); the quality of hotel and restaurant chains in the city (Q16).

Figure 6 examines the degree of affection toward the Festival of Boi Bumbá (Q17). Ratings were highest in areas close to the shore and downtown, and lower in outlying areas. These results may be related to the way the festival is managed in Parintins. It is believed that the festival is excluding the population residing in the most peripheral areas of Parintins, evolving into a more elite event in the face of increasing prices for tickets and concessions over time. In this sense, there is a demonstrated need to rethink actions and practices of inclusion in order to serve the neediest portion of the population when it comes to their participation in this festival.
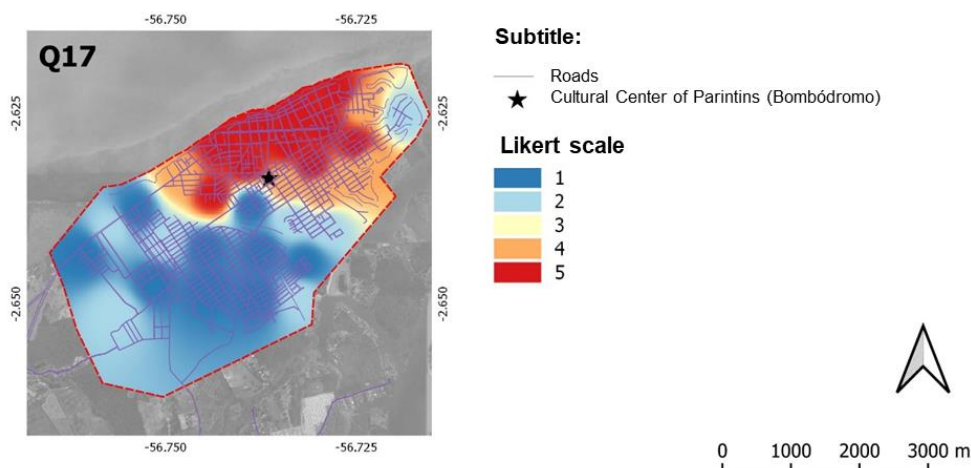
Figure 6 - The degree of affection toward the Festival of Boi-Bumbá (Q17).

Figure 7 displays the totality of the linear regression results of the spatial modeling carried out in Parintins, in relation to the verification of how the urban elements have a greater effect on the degree of public affection displayed toward the Festival of Boi Bumbá. The authors observed this effect to be greatest in the center of the city, followed by the area directly adjacent to the center and, in weakest on the city's periphery. This can be explained as the center has more overall services than the other locations. The Parintins Cultural Center was constructed in the city center, and more activities related to the Festival take place in this location. However, the majority of the population, which resides on the outskirts of the city of Parintins are not integrated in and have limited access to these activities.
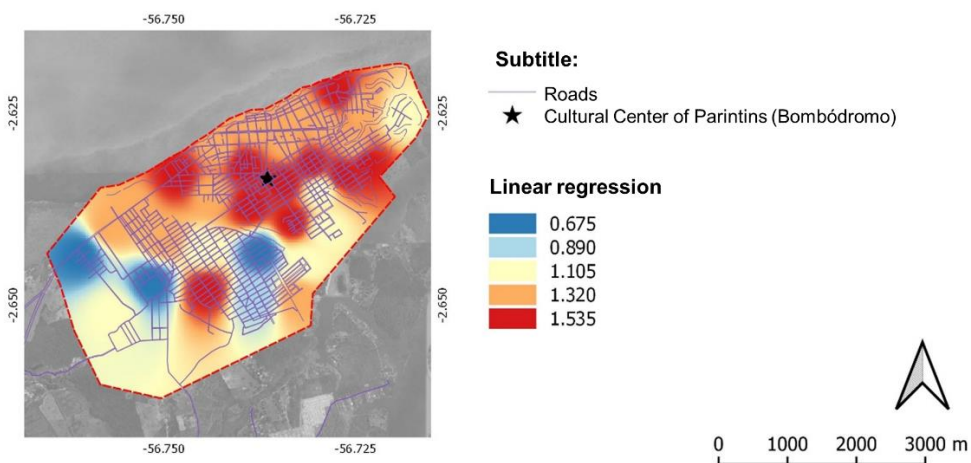

Figure 7 - Linear regression based on the totality of respondents' opinions on the degree of urban affection in Parintins.

Cluster analysis attributed to respondents' opinions

The K-means analysis presents the fit scores for this statistical model, where K = 4 clusters for a data set that totaled 32 points in the city of Parintins. The observed R^2 value was 0.690, demonstrating

that the model presents a good answer to the research question. The Akaike Information Criterion (AIC) and the Bayesian Information Criterion (BIC) also measure the goodness of fit of a model, but in addition, they penalize the number of free parameters of the model, and the models that have lower information criteria are perceived as models that generalize better (Wang, Zhang & Zheng, 2019). The silhouette index for k=4 clusters was 0.39, demonstrating a low tendency to cluster, according to the established variables.

Table 3 represents the different sizes of the clusters, with the variability within each cluster in terms of the sum of squares, the proportion of explained heterogeneity within the cluster and the silhouette index. Cluster 4 is the largest with 13 sectors and is also the most heterogeneous, as the proportion of explained heterogeneity within the cluster is 0.370. Cluster 3 is the cluster that has the lowest silhouette value, and therefore exhibits greater variability of observations within the cluster (Table 3).

Table 3 – Cluster information in relation to respondents' opinions

Cluster Information				
Cluster	1	2	3	4
Sample Size	4	7	8	13
Proportion explained within the cluster heterogeneity	0.024	0.238	0.366	0.370
Within the sum of squares	1.411	13.732	21.138	21.348
Silhouette score	0.772	0.403	0.135	0.421

Source: Respondent location data, modeled by the authors (2022), submitted in the linear regression model of Wang, Zhang & Zheng (2019).

Table 4 shows which variables contributed the most to the grouping. Although not strictly part of the k-means clustering technique, it is a useful step when the variables have a high significance related to the analyzed items. Cluster 1 was more influenced by universal accessibility (Q2). Cluster 2 was influenced by the quality of macro mobility (Q10) and public facilities (schools, health facilities, etc.). Cluster 3 was more influenced by the quality of the hotel and restaurant chain (Q16) and, finally, cluster 4 was more influenced by the degree of affection towards the Festival of Boi Bumbá (Q17).

Table 4 – Cluster information in relation to respondents' opinion responses

Cluster Averages						
Clusters	Q2	Q16	Q14	Q12	Q10	Q17
Cluster 1	2.604	-0.187	0.387	0.997	0.598	-0.903
Cluster 2	-0.372	-0.187	-1.470	-1.070	-1.617	-1.114
Cluster 3	-0.372	1.064	0.283	-0.208	0.142	-0.239
Cluster 4	-0.372	-0.496	0.498	0.398	0.598	1.025

Source: Data from interviews modeled by the authors (2022), submitted in the linear regression model of Wang, Zhang & Zheng (2019).

The attributes that imply the relationship between the urban elements and the degree of affection towards the Festival can be evaluated by the density graphs of the variables evaluated in this study, originating from the urban development of Parintins. Recalling that the smoothed Gaussian kernel density of the canopy height distributions (> 0m) consist of the stratified random sampling base of each cluster (Maroni et al., 2021). Each cluster has a specific color, and the legend describes in more

detail the cluster color assignments (Maroni et al., 2021). For each graph it is possible to visualize the densities of the clusters in each variable, as well as any overlaps that occur. As a result, the apexes of each of the variables of each cluster are reflected.

In Figure 8, the following density graphs can be seen: (A) the variable Q2 for clusters 3 and 4 show a density peak and are concentrated between levels 0 and -0.5. Cluster 1 is very heterogeneous, with levels ranging from 0 to 3. This means that, even though the majority of respondents evaluated Parintins' accessibility as favorable, some parts of the city are still not covered efficiently, usually the peripheral regions. Thus, the authors suggest the creation of an accessibility plan to guide projects.

In Figure 8(B), the variable Q10 has a density peak for clusters 1, 3 and 4 and is concentrated between levels 0 and 1. This variable was well evaluated by respondents in practically all sectors. In Figure 8(C), the variable Q12 shows a density peak in cluster 3 and is concentrated between levels -0.5 and 0, showing that in these sectors there is a greater concern with the state of conservation of buildings, since cluster 1 shows a density peak. This homogeneity may mean that in these sectors there is a higher level of installed urban infrastructure, which justifies the better evaluations and the homogeneity attributed by the interviewees. This occurs in Figure 8(D) for the variable of public facilities (schools, health centers, etc.) that serve the population (Q14). In Figure 8(E), the variable of quality of the hotel and restaurant chain (Q16) demonstrated non-elevated values, which demonstrates a certain concern held by the population regarding Q14 and Q16.

Figure 8(F) highlights variable Q17, where two peaks were recorded at opposite levels. Cluster 2 presented a density peak between -1.5 and -1 and cluster 4 presented a density peak between levels 1 and 1.5. This demonstrates how the degree of affection toward the Festival of Boi Bumbá is diverse within the city of Parintins. In the sectors that make up cluster 4, the degree of affection toward the Festival is higher, and in the sectors that make up cluster 2 the degree of affection was lower. Furthermore, the homogeneity that is represented by the occurrence of the peaks demonstrates how cohesive these observations are.
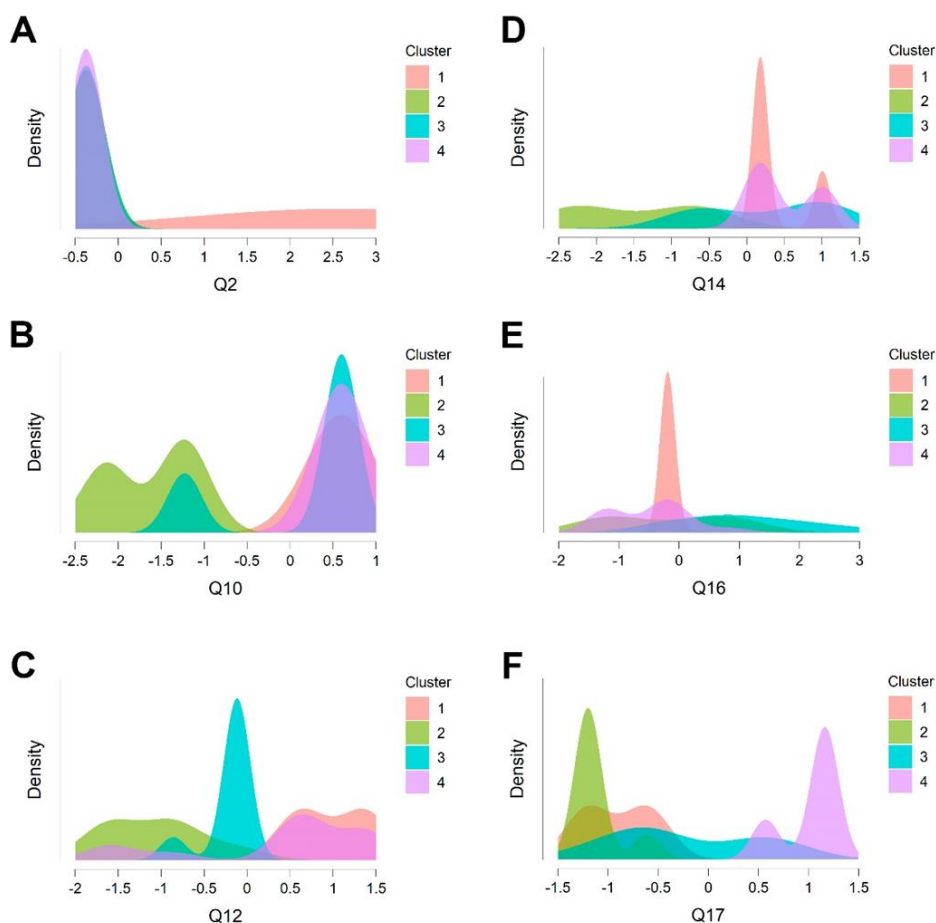
Figure 8 – Scatter plots, referring to universal accessibility (Q2); quality of macro mobility (Q10); state of conservation of buildings in general in the city (Q12); public facilities (schools, health centers, etc.) that serve the population (Q14); the quality of hotel and restaurant chains in the area (Q16); and the degree of affection toward the Festival of Boi Bumbá (Q17).

Figure 9 demonstrates the location of clusters in the city of Parintins. It is observed that cluster 4 is composed of sectors located on the edge and in the center of the city. This justifies the results observed by the different analyses. Clusters 1 and 2 are composed of sectors located on the outskirts of Parintins. Thus, it is emphasized that the Festival is not fully accepted by the population residing in the periphery. In this context, it was identified that a large part of the riverside population of Parintins is not fully integrated into the Festival, and further studies are needed to identify the reasons for this social distancing from the most significant cultural event in the city.
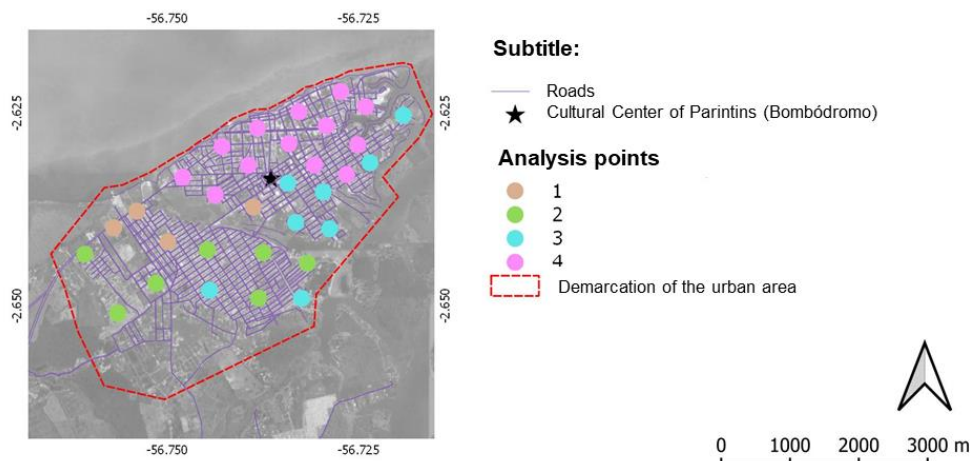
Figure 9 – Scatter plots, referring to universal accessibility (Q2); quality of macro mobility (Q10); state of conservation of buildings in general in the city (Q12); public facilities (schools, health centers, etc.) that serve the population (Q14); the quality of hotel and restaurant chains in the area (Q16); and the degree of affection toward the Festival of Boi Bumbá (Q17).

Regarding the variables stipulated by the PNDU of 2021 and considered in this study that were identified in the opinion survey, the following results stand out: 1) historical: a strong relationship of a large part of the population with the cultural issues of the city during the urban development process, which is necessary to create policies of urban inclusion so that the riverside population can participate in the cultural festivities held in Parintins. 2) sidewalks for transitions between public and private spaces: these pedestrian transport spaces are not maintained in Parintins and many are in states of disrepair. There is a greater neglect in the peripheral region, indicating the absence of incentives (services provided in exchange for taxes) for the population, especially low-income people. The authors strongly suggest more specific studies of walkability in the area, which would identify the points in need of attention. 3) squares: adequate infrastructure existed in the square, which served as a heavily utilized meeting and circulation point, especially related to the church's religious activities. 4) paving: a significant variation in the quality and functionality of paved surfaces through the city was identified. The highest quality road infrastructure is located in the central area of the city. Remembering that Parintins is a city that moves entirely through the use of bicycles and motorcycles as it is an island that does not allow road entry for motorized cars. Thus, greater maintenance of paved surfaces is necessary as there are peripheral paved sections in various states of advanced disrepair. 5) micro-drainage: areas of consistent flooding were recorded. This is common in riverside cities and settlements.

The construction of adequate networks of drainage or the creation of dikes capable of solving this problem is sorely needed in Parintins. 6) bus stops and solid waste collection: it is clear that the system of garbage collection utilized during the festival (Q9) does not service the entire city of Parintins. Efficiency is concentrated in the central area of the city. As one moves away from the center, garbage is collected more haphazardly and less frequently. This failure is out of compliance with both the Master Plan made available by the Municipality of Parintins (2006) and by the City Statute (BRASIL, 2001) which makes public authorities responsible for selective garbage collection. 7) active mobility: Regarding the quality of macro mobility (Q10) and pedestrian displacement (Q11), greater

efficiency of these services exists in the city center. As one moves toward the city's periphery, the efficiency decreases. This is similar to what happens in the majority of Brazilian cities. The authors suggest the creation and implementation of economic subsidies focusing on urban projects capable of improving the quality of the built environment on the city's periphery. 8) quality of buildings: we can see a better state of conservation of buildings (Q12) in the central area of the city as compared to other city sectors. Therefore, the study authors suggest the creation and implementation of public policies focusing on the conservation of historic buildings throughout the city as a whole.

Conclusions

When evaluating the city of Parintins regarding the variables established in the PNDU (2021) (historical preservation, existence and use of sidewalks, existence of squares, quality of paved surfaces, micro drainage, availability of bus stops, quality and frequency of solid waste collection, active mobility, quality of buildings, transitions between public and private spaces), from the point of view of the urban population; the responses gathered showed a proportional decrease in the degree of affection towards the Festival of Boi Bumbá moving from the city's center toward the peripheral areas. This demonstrates, among other aspects, the absence of actions and activities to include the population residing outside the urban border. In this sense, it can be said that activities of the Festival of Boi Bumbá do not have a high degree of significance for a certain portion of the urban population of the city of Parintins. This population faces problems of scarcity and/or the complete absence of urban infrastructure and basic services, reflecting a lesser degree of trust and interest in public power. This is particularly acute in the case of riverside regions, which house the largest portion of the population in a state of expressive social vulnerability.

The need to create and implement public policies for the conservation of historic buildings in general in the city (Q12) was expressed in the opinion responses gathered from the questionnaires. The authors thereby suggest the creation of projects that will contribute to the maintenance and preservation of and/or safeguard the historical heritage of Parintins, as well as the development of heritage education policies for the population. Perhaps the latter could incorporate and/or focus on the Boi Bumbá Festival festivities held in the city annually. Such actions contribute to the preservation of historical-cultural assets, their landscape, their recognition as holding value and worth for preservation, their appreciation and their perpetuation. Such activities also contribute to the consolidation of identity and the preservation of memory in a city.

The subject is changing very abruptly, especially when it comes to population characteristics, opinions, etc. The authors hereby recommend that future studies capable of more closely examining the limitations assumed in this study, related to the presentation of the characteristics of the socioeconomic profile of the people who answered the questionnaires (gender, age, etc.) be carried out in order to understand whether the opinions of the interviewees vary according to the characteristics of the population in the same locality. The authors also suggest the following: an analysis of impacts on urban development in Parintins in the post COVID-19 pandemic world, identification of the representative peripheral occupations by residents of the city and the reasoning behind why the population residing on the city's periphery does not have a high degree of affection in relation to the Festival of Boi Bumbá.

Data availability statement

The dataset that supports the results of this paper is available at SciELO Data and can be accessed via https://doi.org/10.48331/scielodata.0EOYLD

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