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# Walkability assessment: a comparative study between two neighborhoods in João Pessoa - PB

**Aryelle Nayra Azevedo Silva**
M.Sc, UFPB, Brazil.
aryelleazevedo@gmail.com

**Luiz Bueno da Silva**
Ph.D, UFPB, Brazil.
bueno@ct.ufpb.br

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**ABSTRACT**
The urban design can influence human behavior. This influence can be manifested through walkability, an attribute of the urban environment capable of encouraging active transport and physical activity, and which has been presented as an intelligent alternative to make cities more sustainable and healthier. In view of this, this study has the general objective of evaluating the walkability of João Pessoa - PB from a sample formed by two neighborhoods of the city, Miramar and São José, which have different morphological characteristics. Urban sections in the neighborhoods were selected using the Proportional Stratified Sampling (PSS) method. The evaluation was then carried out in the study areas, using the walkability index iCam 2.0, a tool developed by the Institute for Transport and Development Policies (ITDP Brazil). The results reveal that walkability is insufficient in several sections of both neighborhoods, but the results of the São José neighborhood show worse conditions of mobility, pedestrian infrastructure, safety, and attractiveness, suggesting a socioeconomic segregation in relation to urban planning. The results of this research can contribute to the construction of the literature concerning on the subject and to the understanding of aspects of urban design that favor walkability in Brazilian cities.

**KEYWORDS:** Urban Planning. Active Transportation. Pedestrian Infrastructure.

## 1 INTRODUCTION

The built environment integrates all the physical characteristics and elements of man-made spaces where people live, work and play (FRANK; ENGELKE, 2005). Its particularities can either promote or inhibit walking. More walkable neighborhoods have been associated with increased physical activity, and as a result, better health conditions among their residents (BILLINGS et al., 2016; DE COURRÈGES et al., 2021; DOMÈNECH-ABELLA et al., 2020; HOWELL et al., 2019; MÉLINE et al., 2017; ZAPATA-DIOMEDI et al., 2019).

On the other hand, the accelerated process of urbanization, with cities designed for cars and precarious pedestrian infrastructure, negatively influences the way people move, generating a strong dependence on cars. Congestion, high noise levels, air pollution, longer daily trips, deficient or non-existent cycling infrastructure, in addition to the poor quality of pedestrian spaces, are some of the adversities observed daily in public spaces dominated by cars. (NIEUWENHUIJSEN, 2018), something recurrent in many Brazilian cities.

Seeking to mitigate the negative effects caused by rampant urbanization, researchers have sought environmental solutions that result in beneficial results for the population's health. Changing certain environmental characteristics to which many people are exposed may be more cost-effective than individual preventive interventions. Allocating resources aimed at environmental prevention appears to be an efficient strategy to deal with the growing burden of chronic diseases and their costs, because even if the effect of a changed environment is small individually, the cumulative effect on the population can be significant (CHOKSHI; FARLEY, 2012). Given this scenario, research on walkability, and active transport in general, has been gaining notoriety.

Walkability is defined as a measure that helps assess how favorable the urban environment is for residents to access different parts of the city on foot (WANG; YANG, 2019). This assessment is not just about the physical space of the sidewalk, but about the entire pedestrian experience in urban space. Speck (2017), author of the General Theory of Walkability, explains that to be adequate, walking needs to be beneficial, safe, comfortable and interesting, and this goes beyond having wide, paved sidewalks.

Walkability is a multidisciplinary concept (TALEN; KOSCHINSKY, 2013) that covers both

physical aspects and subjective issues, such as the quality of sidewalks and the feeling of public safety, respectively. Therefore, urban spaces considered walkable need to be designed from the perspective of pedestrians and not automobiles, prioritizing the human scale (BARROS et al., 2013) and offering amenities to walkers, so that they can carry out various day-to-day activities through active transport.

With the aim of measuring and evaluating walkability, indices composed of variables that are related to this urban attribute were developed. One of the first indices was proposed by Cervero and Kockelman (1997), which sought to evaluate walkability based on three variables: density, diversity and urban design, which became known as the "3Ds". This proposal was well accepted and used for a long time, but due to the numerous factors that influence the walk, the methodology proved to be limited. Later, Cervero and Ewing (2001, 2010) saw the need to add two more variables to the index: destination accessibility and distance to public transport.

Since then, many indices have been developed by different researchers and tested in different contexts. As an example, Frank's index (2010), which in addition to residential density, mixed land use (diversity) and street connectivity (property of urban design), also evaluates the retail area ratio; and WalkScore, a validated index widely applied in the literature, but which only considers distance to amenities in its assessments, where a higher WalkScore in dicates greater proximity to basic services (MÉLINE et al., 2017). Due to the multidisciplinary characteristic of walkability, studies in this area usually reflect the priorities of its researchers and the specific context of the study area. Some variables in the urban environment that are decisive in encouraging or inhibiting walking in one location may not have an influence on other areas (SHASHANK; SCHUURMAN, 2019), for this reason, there is a demand for updated studies that consider urban, social and cultural aspects of each location analyzed.

Considering the dimensions and plurality of regions in Brazil, studies on walkability are limited, and there is still a lot of knowledge to be built on the topic, both in Brazil and in other developing countries (HUMBERTO et al., 2019). Furthermore, the fact that the responsibility for the construction and maintenance of the sidewalk is delegated to the owners of the lots, means that the pedestrian infrastructure is not considered in road planning, and added to the precariousness of municipal inspection, results in poor quality sidewalks in Brazilian cities (VASCONCELLOS, 2017), revealing how the topic of walkability is not yet being used in everyday life by the country's urban managers.

After decades of shaping public spaces according to the teachings of modernist urban planning, prioritizing the use of motor vehicles and moving people away from urban centers through suburban neighborhoods and gated communities, solving urban mobility problems is today one of the biggest challenges faced by those responsible for managing and planning cities. Thus, this research seeks to contribute to the construction of knowledge about the walkability conditions of Brazilian cities, through a study that aims to evaluate the walkability of areas in the city of João Pessoa – PB, from a sample formed by two neighborhoods with different morphological characteristics, as it is believed that by ensuring adequate walkability many of the other urban adversities end up being resolved at the same time (SPECK, 2017).

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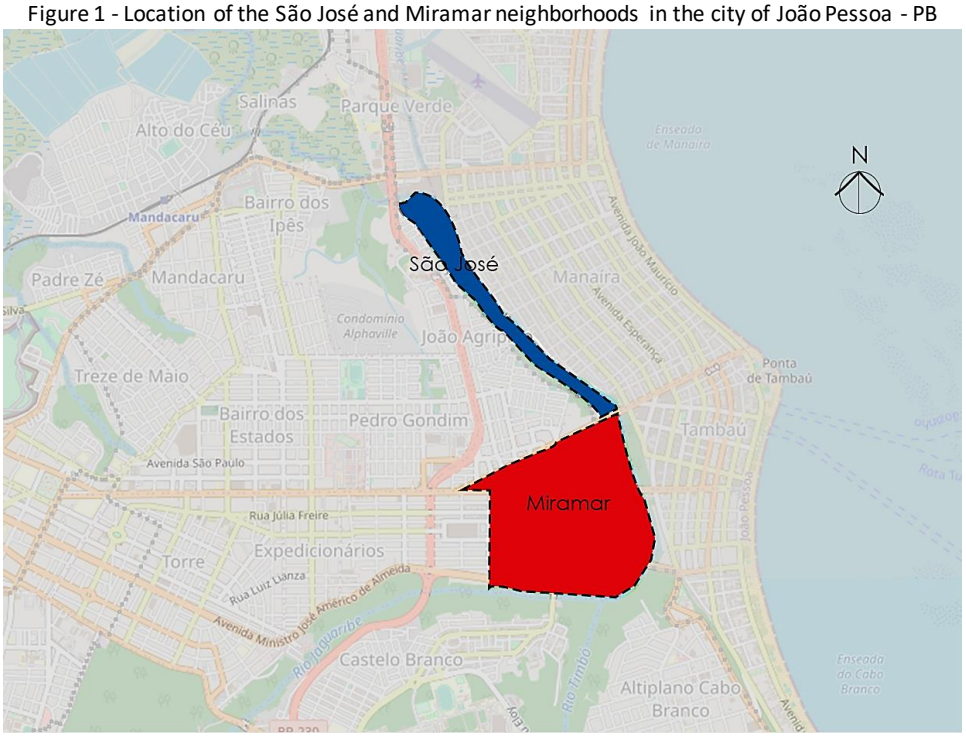
## 2 METHODS

The methodological strategy adopted was the case study, because according to Yin (2015), this is an appropriate approach to analyze in detail contemporary phenomena inserted in some real context, in which the researcher has little or no control.

### 2.1 Study area

This article was developed in the city of João Pessoa, capital of the State of Paraíba. The city is limited to the North by the city of Cabedelo, to the South by the city of Conde, to the West by the cities of Bayeux and Santa Rita and to the East by the Atlantic Ocean. The Brazilian Institute of Geography and Statistics (IBGE) estimates that the population of João Pessoa reached 825,796 inhabitants in 2021. Among the 65 neighborhoods into which the city is divided, Miramar and São José were selected for the development of this research. Figure 1 shows the location of the neighborhoods that are part of the study area on the map of the city of João Pessoa.

Figure 1 - Location of the São José and Miramar neighborhoods in the city of João Pessoa - PB




Font: Adapted from Open Street Maps by the authors (2021)

The São José neighborhood is in the east of the municipality, on the banks of the Jaguaribe River. According to data from João Pessoa City Hall, São José covers a total area of approximately 0.40 km2, divided into 21 blocks. The neighborhood is located close to upscale areas of the city of João Pessoa, neighboring the city's largest shopping center and the Manaíra and Tambaú neighborhoods. The formation of the community dates to the 1970s, at the time known as the Beira-Rio favela, driven by its location close to upper-middle class neighborhoods,

which offered employment opportunities for less qualified labor, such as bricklayers, watchmen and domestic services (SUASSUNA LIMA; HUGO, 2013).

As a result of the disorderly occupation, on the banks of the Jaguaribe River and next to a cliff, the residents of São José suffer from precarious infrastructure. The neighborhood is in an area at risk for flooding, which is recurrent during periods of intense rain in the city. Furthermore, residents deal daily with a series of urban problems, such as river pollution and socio-spatial exclusion. (SUASSUNA LIMA; HUGO, 2013).

The Miramar neighborhood is also located in the east of the city. According to data from the City Hall, Miramar covers a total area of 1.33 $km^2$, which is divided into 90 blocks. Miramar is considered a privileged area of the city, since the neighborhood is located close to the seafront and its higher topography than the neighboring neighborhood, Tambaú, allows taller buildings to have views of the sea. Furthermore, the neighborhood is crossed by the city's main avenue, which connects the center to the beach, Avenida Epitácio Pessoa, and is bordered by two other important avenues: Avenida Senador Ruy Carneiro and Avenida Ministro José Américo de Almeida.

In addition to socioeconomic aspects, Miramar and São José also differ from each other from a morphological point of view. Miramar is a consolidated and central space in the urban fabric, where its formation was important in guiding the expansion of the capital of Paraíba from the 1950s onwards (TABOSA, et al. 2018). São José, on the other hand, is the result of a precarious and illegal settlement, in an environmentally fragile area (SUASSUNA LIMA; HUGO, 2013). According to the latest Social Topography of the city of João Pessoa, published in 2009, São José was the territory with the highest concentration of low-income people, while Miramar is characterized as an area of medium-high income.

**2.2 Selection of urban areas**

To select the urban areas within the chosen neighborhoods, the Proportional Stratified Sampling (AEP) method was used, carried out by dividing a sample into smaller groups of known strata (COCHRAN, 2007; SHARMA, 2017). The neighborhoods were stratified into Avenues, Streets, Blocks and Squares, thus forming four strata that are very similar in terms of their characteristics, where a sample of a fixed minimum size was taken from each stratum as representative of the respective populations. Therefore, a sample fraction of 10% was set for each of the four selected strata. Figure 2 shows the delimitation of the study areas of the neighborhoods after the cut made using the AEP method and the roads inserted in these cuts.

In the urban area selected in the Miramar neighborhood, there are relevant roads for the city, such as Rua Tito Silva and Av. Pres. Epitácio Pessoa, where it is possible to see a diverse use of land, with the presence of gas stations, pharmacies, stores and gyms. The area also includes Praça das Muriçocas, Praça Rotary Club, the Eco Business Center building and the building where the Miramar Baptist Church operates, important points of reference for the neighborhood. In some other roads in the area, typical residential use is observed. The urban area of the São José neighborhood comprises a section of the neighborhood's main road, Rua Edmundo Filho, the only one where public transport runs and which has diverse uses, including

commercial points, churches and mechanic workshops. The other roads within the São José neighborhood are typically used for residential purposes.

Figure 2 - Sections evaluated in the Miramar and São José neighborhoods


Font: The Authors (2021)

### 2.3 Walkability index

The selected study areas were evaluated using the Walkability Index 2.0 (iCam 2.0), developed by the Institute of Transport and Development Policies (ITDP, 2018) in partnership with the City of Rio de Janeiro - RJ. iCam 2.0 was built to enable accurate diagnosis of the main variables that affect walkability in Brazilian cities, and for this reason, it presents itself as a viable tool for analysis in the study areas of this research.

The index analyzes 6 categories (sidewalk, mobility, attraction, public safety, road safety and environment) subdivided into 15 indicators (sidewalk width, paving, block size, walking distance to transport, physically permeable facades, visually active facades, mixed uses, day and night public use, street typology, crossings, lighting, day and night pedestrian flow, shade and shelter, noise pollution and garbage collection and cleaning). The index is evaluated on a scale ranging from 0 (insufficient) to 3 (excellent). Each indicator has a pre-established score based on parameters determined by the authors (ITDP, 2018). The noise pollution indicator was removed from the index due to the need for specific equipment to obtain the data. The daytime and nighttime pedestrian flow indicator was also subtracted from the index, as the flow was reduced, due to the social distancing generated by the Covid-19 pandemic during the time of data collection.

To apply iCam 2.0, the urban area is subdivided into “sidewalk segments”, which refers to the part of the street located between adjacent intersections, where only one side of the block is analyzed at a time. The segment's final score is calculated considering the proportion that each segment represents in the total length of the sections evaluated in that spatial section. (ITDP, 2018).

During data collection, a 5-meter Starrett manual tape measure and a Samsung A71 smartphone were used, which helped in the analysis of some elements of the sections, such as the width of the sidewalks, and in photographic records. The information was collected section

by section, walking in the selected urban areas and experiencing the experience of pedestrians who walk every day through the analyzed segments. Data from the mobility category were collected remotely using Google Maps, where it was possible to measure the length of segments and the distance to public transport in a more practical way.

Data collection sheets were used, in which all information relating to each indicator was entered in the field. Subsequently, the data was transferred to Microsoft Excel software spreadsheets to calculate the final score according to the index, based on the pre-established score for each parameter determined by the authors of iCam 2.0.

For each category, results maps were constructed, so that the information presented visually facilitated the reader's understanding of the situation in each segment analyzed. These maps were produced in Adobe Photoshop 2021 software based on the base map of the city that is available on the official website of João Pessoa City Hall.

## 3 RESULTS

After applying iCam 2.0 in the study areas, better walkability was identified in the Miramar neighborhood, which was classified as sufficient for achieving a score of 1.49; The São José neighborhood obtained a score of 0.84, considered insufficient. The maps with the results of each section analyzed in the neighborhoods can be seen in Figure 3. Table 1 shows the summary of the results obtained in the study areas for the six categories that make up the iCam, where the scores ranged from insufficient to good.

Figure 3 - Walkability result in the Miramar and São José neighborhoods according to iCam 2.0


Font: The Autors (2021)

Table 1 - Summary of walkability results assessed using iCam 2.0

| Categories | Miramar | São José |
|---|---|---|
| Sidewalk | 1,88 | 0,16 |
| Mobility | 2,65 | 1,78 |
| Road Safety | 0,75 | 0,62 |
| Public security | 0,90 | 0,82 |
| Attraction | 1,03 | 0,56 |
| Environment | 1,71 | 1,12 |
| **iCam 2.0** | **1,49** | **0,84** |

Font: The Autors (2021)

### 3.1 Sidewalk category

The score given to the Sidewalk category is the result of the arithmetic average between the scores of the two indicators that make it up: paving and width. In the evaluated area of the Miramar neighborhood, the sidewalk obtained a score of 1.88, considered sufficient, where the paving indicator reached a score of 1.65 and the width indicator 2.10. On the other hand, the São José neighborhood presented a score close to zero and classified as insufficient. In this neighborhood, both indicators presented low scores: width (0.00) and paving (0.32).

Of the 42 sections analyzed in Miramar, 69.0% obtained a good score (2) and 26.2% a sufficient score (1). The extreme scores, 0 and 3, were observed in only one section each, corresponding to 4.8% of the segments. In the São José neighborhood, 100% of the sections evaluated received an insufficient score. From Figures 4a and 4b it is possible to identify the sections with the worst and best walkability conditions and thus concentrate efforts on improving the segments that obtained the lowest scores, thus guaranteeing the comfort and safety of pedestrians.

The results from the São José neighborhood draw attention to the precariousness of the area's pedestrian infrastructure, which in some segments, such as sections 4 and 5 shown in Figure 5a, is non-existent. In sections 2, 6 and 10, located on Rua Edmundo Filho, one of the main roads in the neighborhood, the sidewalks are insufficiently wide to accommodate the flow of local pedestrians. The little space allocated to walkers is commonly occupied by vehicles of different sizes or by “puxadinhos” from local traders. Furthermore, the high number of differences in level to access the garages in the segments makes walking even more difficult. Given all the problems mentioned, walking along the side of the streets of the São José neighborhood has become a frequent habit for its residents, as captured in Figure 5b.

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Figure 4 - Sidewalk category results


(a) Miramar (b) São José

Font: the Autors (2021)

The sidewalks in the Miramar neighborhood presented better conditions, both in terms of dimensions and in terms of conservation, than the sidewalks in São José. Only section 33 was scored as insufficient. Although the segment was entirely paved, there are many gaps in the area built to facilitate car access to residential garages, which make walking uncomfortable and dangerous for those with reduced mobility. Another problem identified in section 33 was the width of the sidewalks. Despite being a section with low pedestrian flow, in places where there are trees, the already narrow sidewalk is still occupied by tree trunks, making it difficult for people to pass through the area, as seen in Figure 6b.

Figure 5 - Sections located in the São José neighborhood

(a) Section 4 and 5 (b) Section 2

Font: The Autors (2021)

The presence of trees is a positive point in the segments, as they provide shelter and comfort on hot days, however they need to be planted appropriately so as not to create an obstacle for pedestrians. Section 13, located on Avenida Epitácio Pessoa, one of the main roads in the city of João Pessoa, presents precarious paving conditions due to the invasion of tree roots

into the local pavement, as can be seen in Figure 6a. This problem is commonly observed in several sections along the avenue, the advanced age of the trees combined with the lack of maintenance in some sections contributes to the deterioration of the sidewalk surface .

The construction and maintenance of sidewalks is the responsibility of the lot owners, and this directly contributes to the lack of standardization on city sidewalks. The lack of intervention and supervision by public authorities, in turn, contributes to sidewalks being built with inadequate coverings and dimensions. There is a need for improvements to the pe destrian infrastructure in both neighborhoods analyzed, especially to meet the needs of pedestrians safely and comfortably with low mobility, such as children, the elderly and wheelchair users.

Figure 6 - Sections located in the Miramar neighborhood


(a) Section 13 (b) Section 33

Font: The Autors (2021)

### 3.2 Mobility category

Among the six categories evaluated by iCam 2.0, this was the one that obtained the highest score in both neighborhoods. Mobility was considered good in the Miramar neighborhood, where a score of 2.65 was achieved based on the arithmetic average of the indicators “block size” (2.34) and “walking distance to transport” (2.97); In the São José neighborhood, mobility was assessed as sufficient (1.78), where the indicators reached scores of 1.56 and 2.00, respectively.

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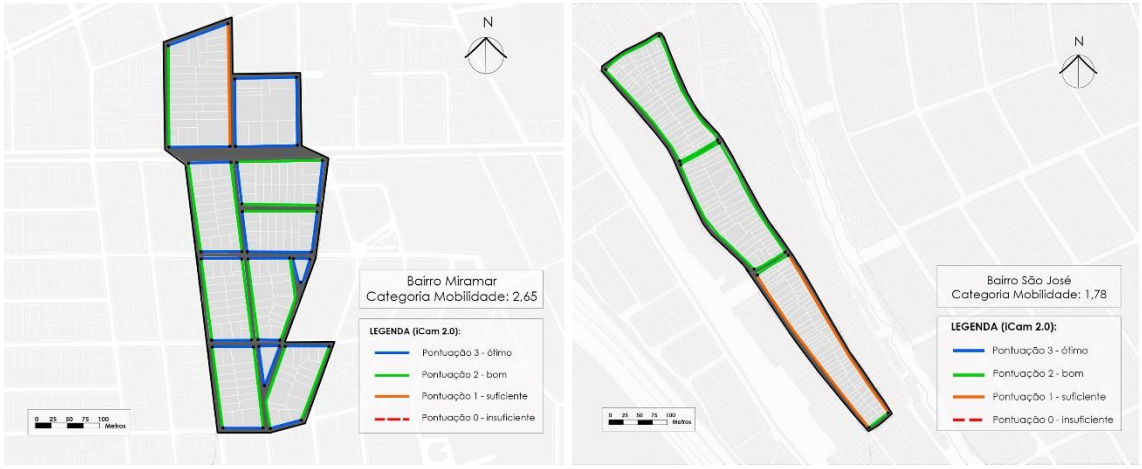
In Miramar, no section had insufficient mobility. Of the 42 excerpts evaluated, the majority (64.3%) achieved an excellent score (3), 33.3% a good score (2) and 2.4%, which corresponds to just one segment, obtained a sufficient score ( 1). The São José neighborhood did not present extreme scores for this category, 83.3% of the sections were classified as good and 16.7% achieved a sufficient score. The results for each neighborhood are mapped in Figures 7a and 7b.

Figure 7 - Mobility category results




(a) Miramar (b) São José

Font: The Autors (2021)

Short segments were found in both neighborhoods (most less than 150 meters long) that promote better connectivity between streets, enabling pedestrians to reach a greater number of destinations within a walkable distance. However, due to the fact that the emergence of the São José neighborhood occurred in a disorderly manner and through the occupation of vulnerable areas, its urban design does not follow any standard. Within the analyzed area there are blocks with sides measuring 217 meters on one side and 28 meters on the other. Sections longer than 190 meters are classified as insufficient in the “block size” indicator and the presence of two sections with these characteristics (sections 10 and 11) made it impossible to obtain a better grade in the São José Mobility category.

During the data collection it was observed that the distribution of bus stops is not uniform. In the São José neighborhood, public transport only runs along Rua Edmundo Filho, and in Miramar, bus stops are concentrated on the neighborhood's main roads, such as Rua Tito Silva and Av. Pres. Epitácio Pessoa. Residents of points further away from the main roads need to travel a considerable distance to the nearest bus stop, creating a limiting factor for neighborhood mobility.

### 3.3 Category road safety

Road Safety reached a score of 0.75 in the Miramar neighborhood and 0.62 in São José, therefore being classified as insufficient in both neighborhoods. In both neighborhoods, the “street typology” indicator achieved a sufficient score, reaching a score of 1.43 in Miramar and 1.23 in São José. The “crossings” indicator obtained insufficient scores, 0.06 in Miramar and 0.00

in São José, which harmed the grade for this category.

Figures 8a and 8b illustrate the Road Safety situation for each section assessed by iCam 2.0 in the two neighborhoods in question. Of the 42 segments evaluated in Miramar, 40.5% obtained a sufficient score, while the remaining 59.5% obtained scores below 1 and were classified as insufficient. In São José, 50% of the passages achieved a sufficient score and 50% an insufficient score.

Figure 8 - Road safety category results


(a) Miramar (b) São José

Font: The Autors (2021)

The typology of streets is a factor that strongly influences the walkability of a location. Roads with speeds above 50km/h are more susceptible to accidents and for this reason the World Health Organization recommends that this be the speed limit in urban areas (WHO, 2017). In the two neighborhoods evaluated, no streets or avenues have a speed limit above 50 km/h or are roads with segregated sidewalks, which considerably reduces the score in the "street typology" indicator. However, the maximum score of 3, considered an optimal typology, is reserved only for pedestrian-only roads (sidewalks), which was not the case in any section of the evaluated areas and therefore the indicator did not achieve higher scores in the neighborhoods.

The low scores obtained in the "crossings" indicator were the determining factor for the Road Safety category to be classified as insufficient. Few crossings, only in the Miramar neighborhood, referring to segments 6, 9 and 14, met the minimum prerequisites to be considered sufficient, presenting minimally acceptable conditions for the safe crossing of pedestrians. No crossings with directional tactile flooring were found in any section. Pedestrian crossings and ramps with an appropriate slope for wheelchairs, or crossings at sidewalk level, were identified in a few segments.

A neighborhood with poor Road Safety negatively affects the pedestrian experience. Walkers who feel unsafe walking on fast-moving roads and/or where there is no way to cross from one segment to another in a protected and comfortable way, will avoid traveling on foot whenever there is another option that does not put their life and well-being at risk.

### 3.4 Public safety category

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The neighborhoods' scores were close, and both were classified as insufficient in this regard: Miramar scored 0.90 and São José scored 0.82. The map in Figure 9a reveals that of the 42 stretches evaluated in Miramar, 71.4% of these were classified as sufficient, 21.4% were considered insufficient and only 7.2% obtained an excellent score. The situation in the São José neighborhood is shown in Figure 9b, where 75% of the segments obtained a sufficie nt score and the remaining 25% received an insufficient score.

Figure 9 - Public safety category results

(a) Miramar (b) São José

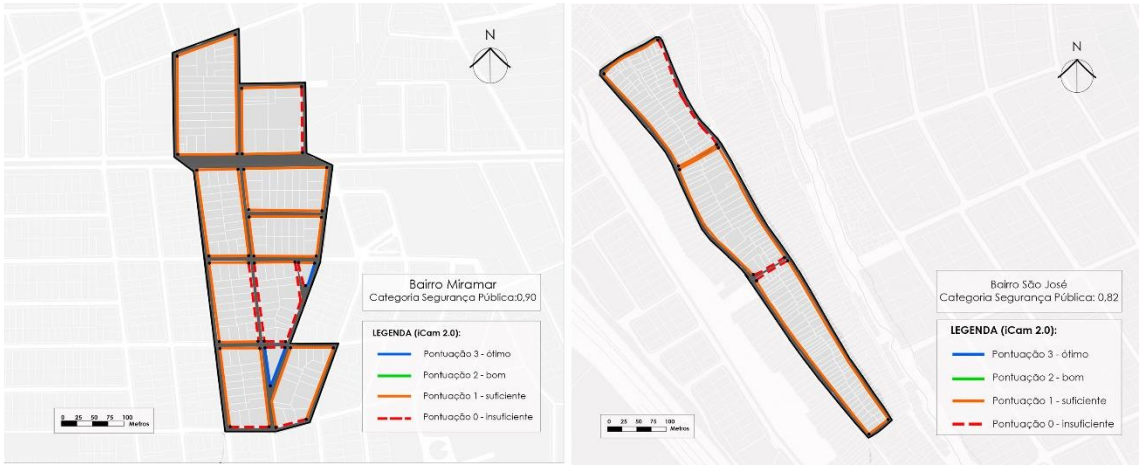
Font: The Autors (2021)

It is important to highlight that in segments of typically residential use, such as section 35 in Miramar and section 3 in São José, where there are no other sources of lighting, such as light from night-time shops, it is essential that public lighting is adequate and sufficient so that pedestrians feel safe walking at night, highlighting the need for interventions in stretches with these characteristics.

Although only one indicator was considered when evaluating Public Security, other criteria included in iCam 2.0 also reflect the feeling of security, such as the permeability of facades and visually active facades, which play the role of “eyes of the city”, term created by Jacobs (2009), where the openings present in the facades make the buildings have a view of the sidewalks, so that these “eyes” act as street watchers.

### 3.5 Attraction category

In Miramar, the Attraction achieved a score of 1.03, being classified as sufficient; The São José neighborhood obtained just 0.56 and had Attraction categorized as insufficient. In the Miramar neighborhood, three of the four indicators obtained sufficient scores: physically permeable facades (1.18), visually active facades (1.14) and mixed uses (1.15). The indicator that




evaluates “day and night public use” was classified as insufficient as it scored only 0.63. In São José, only the “physically permeable facades” indicator obtained a sufficient score and higher than the score for the same parameter in the Miramar neighborhood: 1.30. The other indicators

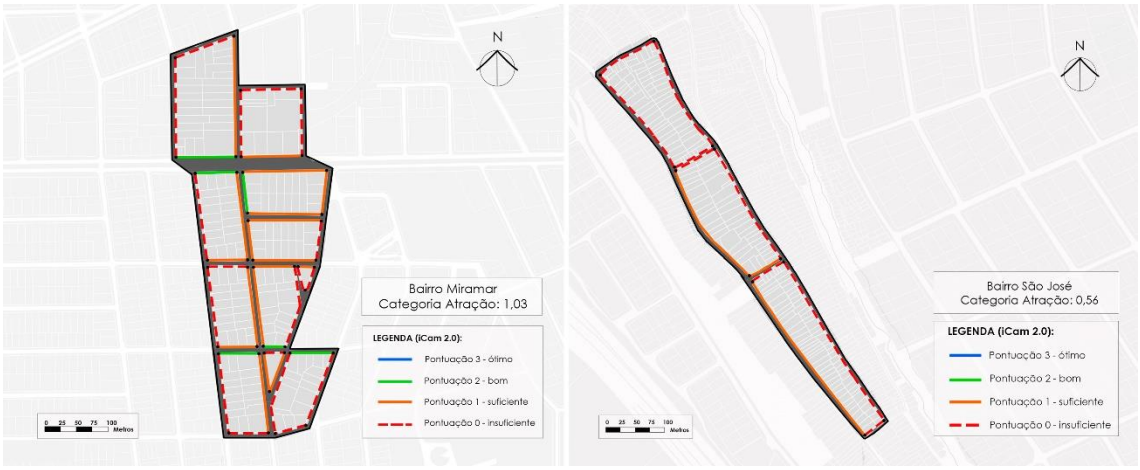
received insufficient scores in the neighborhood: visually active facades (0.17), day and night public use (0.07) and mixed uses (0.71).

Observing the final score for the attraction category, in the São José neighborhood, many sections (75%) were identified as insufficient and the remaining 25% as sufficient, as shown in Figure 10b. Figure 10a shows the results in the Miramar neighborhood, where 42.9% of the analyzed segments were classified as insufficient, 42.9% as sufficient and 14.2% obtained a good score.

In Miramar, the sections with the best scores are located on streets and avenues with the greatest number of commercial points, such as Rua Tito Silva and Avenidas Presidente Epitácio Pessoa and José Liberato. In these locations, more diverse land use, with the presence of commercial locations that have more permeable and more active facades, make the stretches more attractive to pedestrians. On the other hand, the segments located on streets with predominantly residential land use, such as Rua Otávio Novais and Avenida Carlos Barros, for example, have block faces with high walls, making it impossible to create a visual connection between the interior and exterior of buildings, which contributes so much to the pedestrian's sense of safety.

Only three sections (6, 8 and 10) obtained a sufficient score in the São José neighborhood, two located on Rua Edmundo Filho, the main street in the neighborhood, and on Rua Prof. José Carlos de Almeida. These stretches stand out from the others because they have a good number of commercial points, such as grocery stores and bakeries, which have physically permeable facades, and due to the diverse use of land, such as section 10, which has residences and a Catholic church with day and night use. For the rest of the neighborhood, the situation is typically residential, with facades that make visual contact between those outside and inside the residences and lots that are not accessible to the public impossible.

Figure 10 - Attraction category results




(a) Miramar (b) São José

Font: The Autors (2021)

The “day and night public use” indicator reached the lowest scores in both neighborhoods, reflecting spaces with low circulation of people at certain times of the day. For stretches that obtained low scores in the “Public Security” category, such as segments 35 in Miramar and 3 in São José, insufficient scores also in this indicator reflect an area vulnerable to crimes in general. The feeling of insecurity generated due to the low circulation of people and

poor lighting means that people avoid walking along these stretches whenever there is another route available or another transportation option.

### 3.6 Environment category

The Miramar neighborhood obtained an insufficient score in the shade and shelter indicator (0.54) and a good score in the garbage collection and cleaning indicator (2.88), reaching an average of 1.71 for the category and being classified as sufficient. The São José neighborhood also had this category evaluated as sufficient (1.12), the result of the average between the scores for the shade and shelter indicator (0.00) and garbage collection and cleaning (2.24).

Figure 11a reflects the situation of each segment analyzed in Miramar. 59.5% of the

Figure 11 - Environment category results


42 sections evaluated in the neighborhood received a sufficient score for the category in question, 33.3% obtained a good score and 4.8% achieved an excellent score. Only section 5 was classified as insufficient, representing 2.4% of the sections analyzed in the area. In the São José neighborhood, 58.3% were categorized as sufficient, and the remaining 41.7% were insufficient, as can be seen in Figure 11b.

(a) Miramar (b) São José

Font: The Autors (2021)

The garbage collection and cleaning indicator obtained good scores in most sections of both neighborhoods. In Miramar, only two sections (7 and 9) obtained a sufficient score (1), due to the presence of irreversible assets (debris in the section, antlers or tires) in certain points of the segments, for all the other 40 sections analyzed in the neighborhood, garbage collection and cleaning conditions were evaluated as excellent. Despite having obtained a good score for the indicator, when compared to Miramar, São José presented unhealthy conditions in more sections: in sections 4, 5, 6, 7 and 12 there was the presence of irreversible goods, and in sections 4, 5 and 12, there was visibly more than one piece of debris every meter.

On the other hand, the shade and shelter indicator prevented better results for this category. All sections of the São José neighborhood received a score of 0, justified by the small number of shelter elements, such as marquees, along the evaluated segments. The lack of

protection when walking in São José begins with the insufficient dimensions of the sidewalks (non-existent in some sections), which makes it difficult to plant trees in the neighborhood's pedestrian infrastructure. In Miramar, some stretches in better conditions were identified, such as segments 8 and 9 located on Avenida Presidente Epitácio Pessoa, classified as excellent for this indicator, however, well-shaded stretches are not a feature present throughout the neighborhood, where most segments scored insufficiently. In section 33, shown in Figure 6b, the presence of trees, although welcome, occupies pedestrian space and makes movement on the sidewalks impossible.

The existence of shade and shelter is a determining factor that can both inhibit and encourage walking in a place like João Pessoa. The city has a hot and humid climate, with high temperatures for much of the year, where at certain times of the day, walking on sidewalks without shade is an unbearable task.

## 4 CONCLUSION

In this work, an assessment of walkability was carried out in a sample from the city of João Pessoa - PB, formed by two neighborhoods (Miramar and São José) with different morphological characteristics, using the iCam 2.0 walkability index. The results of applying iCam revealed that walkability is insufficient in several sections of both neighborhoods. The problems extend beyond the physical aspects of the sidewalks: the lack of safety, attractiveness, shading and efficient public transport is also part of the current picture of the areas analyzed. The findings are of great importance in building knowledge about walkability in Brazilian cities, as some of the flaws found are characteristics of the country's social and urban reality.

The prioritization of motorized vehicles, especially cars, negatively affected several aspects assessed by the walkability index. Many uneven sidewalks were identified to facilitate vehicle access to garages, which hinders pedestrian movement. It was also common to find parking lots located in the front setbacks of commercial facades, which provides a convenience for the driver, by allowing him to park as close as possible to his destination, but they end up blocking the pedestrian's view and making it impossible to have a visual connection between the internal and external environment of the buildings. This dynamic is something that recurs in a culture that favors the automobile and makes its use more comfortable in relation to active means of transport. Furthermore, the infrastructure dedicated to cars occupies a large part of public space that could be used for other purposes, such as green space, space for leisure and social interaction, or space for walking; contributing to a lifestyle that increases cardiovascular morbidity and premature cardiovascular mortality (NIEUWENHUIJSEN, 2018).

Although the Miramar and São José neighborhoods present morphological divergences, for the assessment of road safety, the neighborhoods presented similar results, both insufficient. Traffic accidents represent a serious problem with walkability. In 2018, 16% of all fatal victims involved in traffic accidents in Brazil were pedestrians (BASTOS; CALDEIRA; BRANCO, 2020), representing a significant number of deaths in a country with continental dimensions like Brazil. This data reinforces the need for improvements to offer safe environments for walking.

Thermal discomfort, caused by the lack of shading in most of the segments analyzed,

is also something that discourages the choice for active modes. In cities with a hot climate, such as João Pessoa, the presence of vegetation plays a fundamental role in pedestrian well-being and should therefore be considered as a variable that influences walkability. Planting trees along sidewalks is a viable strategy to overcome the effect of high temperatures, in addition to making walking more comfortable, improving air quality and contributing to urban beautification. However, few studies consider shading in their analyzes (KIM; PARK; LEE, 2014; LIAO et al., 2022; TALAVERA-GARCIA; SORIA-LARA, 2015; YIN, 2013) and the most widespread indices in the literature (FRANK et al., 2010; WALKSCORE, 2010) do not include this variable when evaluating walkability.

The construction of high walls on the facades of residential buildings was also a very common problem in the study area. The adoption of walls is often justified by the search for privacy and security, however, they end up making it impossible for the "eyes of the streets" to emerge, as cited by Jacobs (2009) as something fundamental for urban attraction and vitality. Consequently, streets become more unsafe, reducing pedestrian flow.

The fact that the construction and maintenance of sidewalks are the responsibility of the lot owners, who are generally unaware of the benefits that a walkable street provides, helps prevent improvement interventions from taking place in the current scenario. In addition to sidewalks with insufficient widths, during data collection, several sections with uneven floors, unevenness and lack of accessibility were also found. Therefore, it is essential that the construction and maintenance of sidewalks are part of Brazilian road planning, which remains focused on automobiles and contributes to the precariousness of walkability in the country. (VASCONCELLOS, 2017).

Even though the two neighborhoods analyzed have several imperfections, the results for the São José neighborhood indicate socioeconomic segregation in relation to urban planning. For many residents of the neighborhood, walking is not a choice, and a city shaped to meet the demands of cars disregards those who cannot afford to own a private vehicle. Narrow roads and no space for building cycle paths discourage cycling. Added to these problems are the lack of shading, public and road safety, attractiveness and efficient public transport. Given the strong scenario of inequality in Brazil, ranging from the regional to the intra-urban scale, comparative studies, mainly in different areas of the same city, are valuable for highlighting and quantifying inequalities related to walkability, and provide support for reversing problems in the urban structure (BONATTO; ALVES, 2022).

Promoting improvements in variables in the urban environment, to which countless people are exposed, can be more efficient and economical than specific actions. Therefore, understanding the aspects of urban design that favor walkability can help public managers and urban planners direct efforts and investments to promote better walking conditions for pedestrians, and consequently, provide benefits to the health of the population.

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