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Safe walking: Analysis of sidewalk segments in Belém – Pará

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***Abstract*—** *Introduction: The study analyzes "safe and secure" walking in urban spaces. Problem: To what extent do street lighting and pedestrian flow contribute to improving public safety in the urban environment? General Objective: To analyze the contribution of public lighting and pedestrian flow to improving public safety in the urban environment. Materials and Methods: Applied, descriptive and multidisciplinary study, with a quali-quantitative approach. Data Collection: Bibliographic and field research. Spatial and temporal delimitation: four sidewalk segments in Belém, Pará, August 2021. Variables: lighting and daytime and nighttime pedestrian flow, referring to the Public Safety category, analyzed according to the Institute for Transportation and Development Policies (IPTD) and theoretical referential. Results: Three of the four segments present reasonable walking conditions; they have sufficient width despite the obstacles. Concerning lighting, no points are facing the sidewalk. As for the number of pedestrians, only one segment was insufficient, the others were good. Conclusion: Pedestrians need sidewalks with adequate infrastructure, lighting, and easy access to other locations. These are conditions that ensure the maintenance of health and well-being in addition to improving public safety.*

I. INTRODUCTION

The act of walking has been part of human life since the beginning of its presence on Earth, whether it is to search for food, hunt animals, look for new areas to live in, or practice physical activities in the open air. The conception of walking has not changed; what has changed are the conditions of how to exercise it, especially in urban areas, whose uncontrolled growth, coupled with a lack of planning, has relegated to a secondary plan the life of man as a pedestrian, making it difficult for him to walk short distances, despite the relevant data presented by the National Agency of Public Transport (ANTP) that in "cities with more than 60. 000 inhabitants, 36% of trips are made on foot to their destinations, while 27% are made in individual motorized transport and 29%, in collective public transport"(ITDP Brazil, 2019, p.9).

Thus, from the pedestrian perspective, aiming at their safety, one realizes the importance of seeking alternatives that ensure the improvement and conservation of sidewalks through "investments in urban infrastructure aimed at improving the conditions of walkability in Brazilian cities" (ITDP Brasil, 2019, p.9).

The analysis of walkability presupposes the need for the urban space to be configured appropriately for

pedestrians, enabling them to interact with the various means of transportation and places in the city.

> Walkability comprises aspects such as the conditions and dimensions of sidewalks and intersections, the attractiveness and density of the neighborhood, the perception of public safety, road safety conditions, and any other characteristics of the urban environment that influence the motivation for people to walk more frequently and use urban space (ITDP Brazil, 2019, p. 10).

The tool for measuring the index of walkability (iCam) was presented in 2016 by the Institute for Transport and Development Policy (ITDP), consisting of 15 indicators distributed into six categories (Environment, Attractiveness, Sidewalk, Mobility, Public Safety, and Road Safety), being that "each one of them incorporates a dimension of the walking experience (...) and are used as central reference parameters for the evaluation, defining the distribution of the score" (ITDP Brazil, 2019, p. 13).

In this study, the Public Safety category was chosen, considering its breadth about the interaction between man and the public space, notably the street and open spaces, such as squares and parks. There is a need to seek a redesign of the urban space that, at least, tries to minimize the deep socio-spatial and environmental inequalities that exist in Brazil.

Despite the efforts of both the government and society to improve the rates, the field of public security continues to be one of the most difficult to achieve in terms of reducing the number of cases of crime, considering the multidimensionality of the theme, which involves very diverse aspects - social, economic, environmental and political. The studies on public security in Brazil and the world go through many biases that make decision-making difficult. However, the urgency of the theme is growing and requires that other perspectives, such as urban design, for example, be used to contribute to its better understanding.

Jacobs' (2011, p.29, 36) study highlights the importance of streets and sidewalks for cities to be dynamic, considering them as "the principal public places (...) if the city streets are free from violence and fear, the city is therefore reasonably free from violence and fear." She goes on to say that public order depends much more on "the intricate, almost unconscious network of spontaneous controls and behavioral patterns present among and enforced by the people themselves" than on police intervention. For the author, a safe street needs public and private spaces to be truly separated, with "eyes to the street" and having people "transiting uninterruptedly."

In other words, public safety must be understood by the person as the feeling that they are safe; it is abstract, therefore. However, this abstraction is translated concretely through an environment that allows people to come and go safely.

In this sense, the iCam (ITDP Brazil, 2019) attributes to the Public Safety category two indicators, street lighting, and daytime and nighttime pedestrian flow, highlighting, however, that due to the multifaceted character, other elements are essential, such as sidewalk conditions, attractiveness, and mobility potential, for example.

After contextualization, we formulate the central question of this study: To what extent do street lighting and pedestrian flow contribute to the relationship between walkability and the feeling of public safety in the urban environment?

We aim to analyze the contribution of public lighting and pedestrian flow in the relationship between walkability and the feeling of public safety in the urban environment.

The motivation and justification for this study lie in need to broaden the discussion about the importance of guaranteeing people, especially those who walk, cities whose pillars are vitality and sustainability.

II. SIDEWALKS AND WALKABILITY

The complexity that permeates the analysis of walkability leads to the consideration of the influences that the urban environment exerts on the pedestrian, favoring or not, walking. In this sense, it is not enough to have a narrow view of a specific sidewalk segment but a holistic understanding of how and why the pedestrian uses it.

> Urban planning neglects the “human dimension (…) a common characteristic of practically all cities is that people who use public urban space, on a large scale, have been increasingly mistreated”. These are limited public spaces, with “obstacles, excessive noise, pollution, accident risk, and degrading conditions” that “are part of the daily lives of urban residents” (GEHL & SVARRE, 2017, p. 13).

Walking on safe sidewalks goes beyond the issue of safety for the pedestrian, it should demonstrate the liveliness of healthy urban spaces, contribute to the improvement of public health by reducing sedentary

lifestyles, and also allow the full insertion of the concept of sustainability.

Gehl & Svarre (2017, p. 15) corroborate Jacobs (2011) by stating that

> A walkable city, by definition, has a cohesive structure, offering short pedestrian distances, space, and a variation of urban functions. In this way, the street becomes more observable and there is a greater incentive to follow what is happening around houses and buildings. These elements intensify activity as well as provide a greater sense of security.

Sadik-Khan & Solomonow (2017, p.21) point out that understanding people's use of sidewalks "would be an essential starting point for reactivating streets and cities in the way people themselves seek to define them. Sidewalks are not simply concrete strips at street level above the street along which pedestrians walk." They are highlighted as "a valuable space," whether in residential, commercial, or a "maze of narrow alleys."

In a study conducted by Dias (2019), Belém ranked last among the 27 Brazilian capitals, including the Federal District, regarding the conditions of its sidewalks. Thirteen items were evaluated, among which, "regularity and inclination of the floor, width, barriers and obstacles, conditions of accessibility ramps, pedestrian crosswalks, pedestrian traffic lights, maps and orientation signs, arborization and landscaping, urban furniture, air pollution, urban noise, and safety." The municipality's situation reflects the neglect of the pedestrian and the care and presentation of the space.

By enabling people to walk and, therefore, to have a greater presence in the streets, "the potential for a safe city is reinforced." However, it is noticeable that in most cities around the world, the difficulties for the implementation of road systems that prioritize the pedestrian are perceptible, although positive examples have been increasing, such as Copenhagen, Melbourne, and Venice, the latter, designed for pedestrians since its foundation (GEHL, 2013, p.6).

III. MATERIALS AND METHODS

The present study is applied, descriptive and multidisciplinary, with a quali-quantitative approach. Regarding data collection procedures, it was used bibliographic and field research (Sá, 2013).

The spatial and temporal delimitation is Belém, capital of Pará. Data collection was carried out during October 2021, in four segments of sidewalks delimited by the polygon formed by Travessa 14 de Março, Avenida Gentil Bittencourt, Avenida Alcindo Cacela, and Avenida Conselheiro Furtado, involving two neighborhoods, Nazaré and Cremação (Figure 1).

Fig.1: Spatial delimitation of the study
Source: elaborated by the authors, based on https://mapas.guiamais.com.br/belem-pa/.

The choice for the segments presented was due to the possibilities that the pedestrian has, when walking through these locations, to be able to reach touristic points of the city, such as the Emilio Goeldi Museum of Para and the Basilica Santuário de Nazaré, as well as the proximity of various commercial establishments, in addition to points of public transport.

Two variables were analyzed: lighting and daytime and nighttime pedestrian flow, according to what was suggested by ITDP Brazil (2019) for the Public Safety category.

The information on lighting and daytime and nighttime pedestrian flow was surveyed and processed as follows:
(a) Lighting: considering the impossibility of illuminance measurement, the criteria suggested by ITDP Brasil (2019, p.45) were adopted for an alternative survey:
Lighting points are facing the street (vehicle circulation lanes) - Score +20;
There are lighting points dedicated to pedestrians, exclusively illuminating the sidewalk - Score +40;
There are lighting points at the ends of the segment, illuminating the crossing (score +20 if only one end) - score +40
There are lighting obstructions caused by trees or broken lamps - Score -10.
After the survey, the "yes" or "no" answers were crossed with their respective weights to arrive at the sum, highlighting that the ideal score would be +100, "for the segment to meet all the quality criteria of the public lighting infrastructure" (ITDP BRASIL, 2019, p.45).
(b) Daytime and nighttime pedestrian flow: pedestrian counts were conducted on two working days, at each of the locations, for 15 minutes, within the intervals between 7 a.m. and 7:15 a.m.; between 1 p.m. and 1:15 p.m.; between 6 p.m. and 6:15 p.m. (ITDP BRASIL, 2019, p. 46).

After collection, it was summed, then divided by the number of counts (three). The average pedestrian flow/minute was obtained by dividing the result by 15, making it possible to reach the score of the analyzed place, according to criteria suggested by ITDP Brasil (2019, p. 46):

If ≥ 10 pedestrians/minute or ≤ 30 pedestrians/minute - Score 3 - great;

If ≥ 5 pedestrians/minute - Score 2 - good;

If ≥ 2 pedestrians/minute - Score 1 - sufficient;

If < 2 pedestrians/minute or > 30 pedestrians/minute - Score 0 - insufficient.

Although the focus was on the variables lighting and daytime and nighttime pedestrian flow, the study also included observing the infrastructure conditions of the analyzed sidewalk segments, considering the multifaceted nature of the Public Safety category.

The analysis of the information took into consideration the theoretical reference and its crossing with the results and observations of the variables.

IV. RESULTS AND DISCUSSION

For the analysis of the segments, the following direction was adopted: Travessa 14 de Março, Avenues Gentil Bittencourt, Alcindo Cacela, and Conselheiro Furtado.

(a) Field observation

Regarding the floor, although all sidewalks are paved and wide, except for the segment of Travessa 14 de Março, on the right side (Figure 2), we noticed the existence of numerous obstacles, such as holes accentuated unevenness, mainly due to residential garages. However, given the width of the other segments, people with reduced mobility can pass through these spaces using wheelchairs or other accessories.

Fig.2: Right sidewalk of Travessa 14 de Março
Source: authors, 2021.

As for afforestation, on Travessa 14 de Março, it is practically non-existent, with some shrubs located on the central sidewalk, called "footbridge" by the residents because it is the cover of a canal, does not support larger trees capable of providing shade. In the other segments, one can observe trees predominantly of the mango tree type, planted along the sidewalks, highlighting the left sidewalk of Avenida Gentil Bittencourt, which has an adequate amount of trees to provide shade. Another point to be highlighted is the left sidewalk of Avenida Alcindo Cacela, a commercial segment (gas station, gym, church, department store with supermarket and dental care store) that does not have any vegetal species planted on the sidewalk. The climatic characteristics of the region stand out, with high temperatures throughout the year, as well as an increased incidence of rainfall.

As previously mentioned, the choice for these segments was mainly due to the access possibilities to several points in the city. Thus, the pedestrian who lives in the neighborhoods of Nazaré and Cremação can walk to places like stores and supermarkets, churches, schools, leisure areas, medical offices, beauty centers, beauty salons, and squares. These segments allow these accesses, besides having public transportation points, except in the segment of Travessa 14 de Março. It can be verified that at the confluence of Alcindo Cacela and Conselheiro Furtado Avenues, there is a more effective presence of public security agents through the more frequent passage of Military Police cars.

There are boulevards and villas, such as those of Jardim Independência and Conjunto Santa Maria de Belém and the Vilas Alegre, Natal and Pará (Gentil Bittencourt and Conselheiro Furtado Avenues), constituting important access channels connecting the segments under analysis to other high flow routes, such as Magalhães Barata and Mundurucus Avenues.

In the observed segments, except for Avenida Alcindo Cacela, predominantly commercial, the others have "eyes to the street," corroborating Jacobs (2011), with facades mainly constituted by open railings and therefore are an extra attraction for pedestrians to walk with a sense of security. Because they are located in central neighborhoods of the urban area, with a considerable concentration of middle- and high-income residents, residences built-in masonry have some attractiveness for pedestrians, even serving for early morning walks.

(b) Illumination

Although the segments analyzed have public lighting, all the points are facing the street; none is dedicated to pedestrians lighting the sidewalk.

It was verified that, except for the segment of Travessa 14 de Março, which had a post with a burned-out light bulb, throughout the observation period, totaling 50 points, the other segments reached 60 points, which was below the ideal of 100 points.

Regarding the segment of Travessa 14 de Março, it is important to highlight the occurrence of robberies in the vicinity of the area without lighting, corroborating with ITDP Brazil (2019, p. 44) when showing that

> A well-lit sidewalk creates conditions for nighttime use of public spaces and favors the perception of safety by pedestrians. Moreover, it is a key element in promoting public safety: the occurrence of crimes can decrease by up to 20% with investments in lighting, compared to the 5% reduction coming from a camera surveillance system.

It is noteworthy that most homes have patios with lighting during much of the nighttime period, contributing significantly to pedestrian safety when walking.

(c) Pedestrian flow

The results found corroborate Jacobs (2011) and Gehl (2013), noting considerable "coming and going" throughout the day, mainly because these segments serve as important circulation channels, connecting various parts of the city in different neighborhoods.

In the pedestrian/minute count, the data found were: Travessa 14 de Março, 5.6 pedestrians/minute; Avenida Gentil Bittencourt, 5.1; Avenida Alcindo Cacela, 31.4 and at Avenida Conselheiro Furtado there were 17.9 pedestrians/minute. These numbers, according to the criteria suggested by ITDP Brasil (2019, p.46), are considered "good", except for Avenida Cacela, which proved to be "insufficient", a result that can derive from the fact that this segment concentrates numerous commercial activities, highlighting that people can reach it through other segments not analyzed in this study. About the data from Avenida Cacela, one can see how much this calculation tool corroborates reality, considering the number of robbery occurrences in this location and its surroundings, justifying the constant passage of the Military Police vehicle.

The results are in line with the study by ITDP Brazil (2019, p.46) when affirming the need for sidewalks to allow people to move around, to keep the street "alive", giving them a sense of security, "the presence of pedestrians at different times of the day and night works as a natural surveillance element and tends to attract other pedestrians, contributing to a virtuous circle of street use." However, he points out that "excessive crowding of pedestrians at specific times and places may cause discomfort or risks related to public safety", i.e., balance in the number of people walking is essential to maintain a healthy relationship between pedestrians and the street, to enable them to walk safely.

V. CONCLUSION

By investigating the relationship between walkability in the urban environment and public safety, through the contribution of street lighting and pedestrian flow, it can be concluded that (a) despite the physical obstacles and the public lighting not facing the sidewalk, the analyzed sidewalk segments, present reasonable walkability condition, given their widths are sufficient for the pedestrian to walk, except in the right sidewalk of Travessa 14 de Março; (b) regarding the pedestrian flow, the results were considered good, except in the segment of Avenida Alcindo Cacela, which does not invalidate the character of reasonability for the pedestrian to make use of the sidewalk. Thus, the question formulated in this study was answered, meeting the intended goal.

Finally, it is essential to emphasize that studies such as this one emphasize the importance of understanding the role that sidewalks represent for the urban environment, mainly due to the possibility of citizens becoming assiduous pedestrians, taking trips in which they have a sense of safety, an essential condition for the maintenance of this activity. Mobility, facilitated by the conditions of sidewalk infrastructure, is positive not only for the vitality of streets and reduction of polluting conditions of vehicles, for example, but mainly for the maintenance of people's health and well-being.

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