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MARÍA ALEJANDRA SOTO-GUAYARA, JORGE MARIO GALINDO-GARCÍA , MARÍA JULIANA ROJAS-SALGADO , JUAN GUILLERMO ZULUAGA-VILLERMO
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ANALYSIS OF PEDESTRIAN MOBILITY IN THE COMMERCIAL AREA OF IBAGUÉ, COLOMBIA [1]

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MARÍA ALEJANDRA SOTO-GUAYARA [2]
JORGE MARIO GALINDO-GARCÍA [3]
MARÍA JULIANA ROJAS-SALGADO [4]
JUAN GUILLERMO ZULUAGA-VILLERMO [5]

1 Article developed based on the results of the thesis work for the degree of Civil Engineers by MariaAlejandra Soto Guayara and Jorge Mario Galindo Garcia, supervised by Maria Juliana Rojas Salgado and Juan Zuluaga-Villermo.

2 Estudiante programa profesional. Ingeniería Civil
Universidad de Ibagué, Ibagué, Colombia
https://orcid.org/0009-0006-7355-5148
2520201036@estudiantesunibague.edu.co

3 Estudiante programa profesional. Ingeniería Civil
Universidad de Ibagué, Ibagué, Colombia
https://orcid.org/0009-0007-6298-0664
2520201082@estudiantesunibague.edu.co

4 Ingeniera Industrial
Docente, Departamento de Logística y Ciencias de datos
Universidad de Ibagué, Ibagué, Colombia
https://orcid.org/0000-0002-8834-243X
maria.rojas@unibague.edu.co

5 Magíster en ingeniería
Estudiante de doctorado en Sistemas de Transporte. Instituto Superior Técnico
Universidade de Lisboa, Lisboa, Portugal
https://orcid.org/0000-0002-2236-6279
Juan.villermo@tecnico.ulisboa.pt

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La caminabilidad describe la facilidad y comodidad con la que las personas pueden desplazarse a pie en un entorno urbano de manera ágil y fluida. Para analizar este aspecto, se utiliza el índice de caminabilidad, un indicador que relaciona el espacio público con la infraestructura y las condiciones que la ciudad ofrece para que los peatones puedan desplazarse de un lugar a otro de manera segura, cómoda y eficiente. Planificar ciudades caminables ofrece beneficios en salud, bienestar, eficiencia e inclusión para sus habitantes. Este trabajo construye un índice de caminabilidad en la Carrera Tercera entre calles 10 y 19 en Ibagué, Colombia. Se utilizó una metodología de 4 fases: contextualización de la zona, recolección y categorización de datos, construcción del indicador y aplicación del índice. Se obtuvo un puntaje de 3.27 en una escala de 1 a 5. Aunque la infraestructura tuvo puntajes altos, las variables socioambientales impactaron el resultado final, subrayando la necesidad de crear espacios que fomenten la interacción social y la convivencia comunitaria.

Palabras clave: caminabilidad, infraestructura, índice, espacio público.

Walkability refers to the ease and comfort with which people can move around on foot quickly and fluidly in an urban environment. To analyze this aspect, the walkability index is used, an indicator that relates public space to the infrastructure and conditions that the city offers for pedestrians to move from one place to another in a safe, comfortable, and efficient manner. Planning walkable cities provides benefits for their inhabitants, including improved health, well-being, efficiency, and inclusion. This work constructs a walkability index for Carrera Tercera between Calles 10 and 19 in Ibagué, Colombia. A four-phase methodology was used: contextualization of the area, data collection and categorization, construction of the indicator, and application of the index. A score of 3.27 was obtained on a scale of 1 to 5. Although the infrastructure received high scores, the socio-environmental variables influenced the final result, underscoring the need to create spaces that promote social interaction and community living.

Keywords: walkability, infrastructure, index, public space.

I. INTRODUCTION

Walkability indices objectively evaluate the characteristics that influence the pedestrian experience and generate a numerical score. These results identify components of the environment that have shortcomings and allow monitoring improvement projects or prioritizing interventions during the infrastructure's useful life. Historically, walkability was quantified only as the extent to which a physical environment allows walking, based on geometric characteristics of design or condition and the quality of the surfaces. However, it is currently known that infrastructure should not be measured in isolation, as it might not adequately reflect walkability (Stockton et al., 2016). Paulo dos Anjos Souza Barbosa et al. (2019) confirm that factors such as population density and land use are key for walking, both for pedestrians and people with reduced mobility. In addition, the interaction between land use, transport systems, and urban design affects pedestrian behavior and generates significant environmental consequences (Larranaga et al., 2019).

The objective of this work is to develop a specific walkability index for the study area, combining qualitative and quantitative variables, to identify areas with a high potential for improvement. This research was carried out in the city of Ibagué, in central-western Colombia, specifically in the historic center, along Carrera Tercera between 10th and 19th streets (Figure 1).

II. THEORETICAL FRAMEWORK

The literature suggests that more walkable environments are associated with increased physical activity, lower obesity rates, and better cardiovascular health. Ewing and Handy (2009) mention that important factors for walkability include considering the population density of the area, the mix of land uses, the connection of the streets, safety (both personal and road), and the quality of the pedestrian environment. Additionally, Sallis and Glanz (2006) in their research showed that the design of the built environment can influence and change people's behavior, in terms of health and physical activity.

In recent decades, there has been a growing interest in investigating the relationship between urban space and movement, divided into two main lines: one on the spatial behavior of people and their interaction with the environment, and the other on the application of this knowledge in infrastructure planning, natural area management and non-motorized mobility (Orellana et al., 2017). In cities not designed for walking, pedestrians face dangers such as unsafe roads, pollution, and stress, which affect physical and mental health. According to the Institute for Transportation & Development Policy [ITDP], the most vulnerable sectors of the population tend to walk due to a lack of alternatives, while walkable cities, with dense and mixed-use neighborhoods, allow saving on transportation and reducing stress (ITDP, 2020).

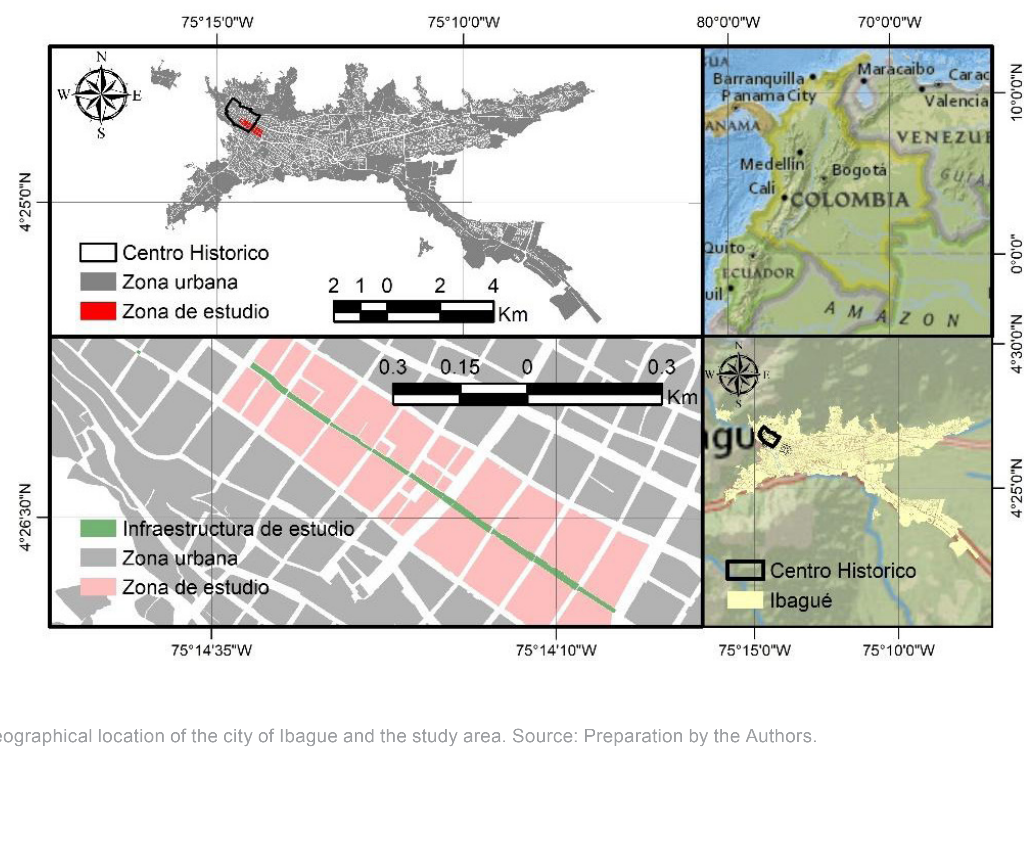

Figure 1. Geographical location of the city of Ibague and the study area. Source: Preparation by the Authors.

Authors	Place	Categories
Gutiérrez-López et al. (2019).	Bogota, Colombia	Environmental quality, density, proximity, comfort, and entropy
Castro (2021).	Bogota, Colombia	Infrastructure, road safety, citizen safety, access to the destination, and comfort
Wibowo et al. (2015).	Bandung, Indonesia	Safety, security, comfort, attractiveness, and support policies
Pulla & Hermida (2021).	Cuenca, Ecuador	Mixticity of uses, environmental comfort, safety, and road infrastructure
Ewing & Handy (2009).	USA	Population density, mix of land uses, street connectivity, safety, and quality of pedestrian environment
Sallis & Glanz (2006).	USA	Environmental design, public health

Table 1. International and domestic benchmarks in the choice of variables for walkability measurements. Source: Preparation by the Authors.

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Walking is an essential component to fostering healthier, more ecologically and socially active communities, and in many cases, it is the only way many people can access their daily activities. However, the decline of pedestrian access in most cities over the last century has created significant challenges for urban design, especially in terms of safety, accessibility, and social inclusion (Moura et al., 2017).

Quality of life covers multiple dimensions, from the physical and mental health of citizens to access to basic services, safety, and employment and recreation opportunities. Although it is not always easy to measure, it is an indicator that reflects diverse factors that directly affect urban well-being. In this sense, the case of Pontevedra, a city located in the northwest of Spain, specifically in the autonomous community of Galicia, is an example, since the improvement of the quality of life was achieved through the creation of safer public spaces, better pedestrian mobility, and the reduction of pollution, which has made the city more livable and attractive for its inhabitants (Pazos-Otón et al., 2024).

It is the responsibility of society and the authorities to guarantee an accessible environment for all citizens on equal terms (Hernández Galán, 2011). Planning for sustainable mobility is a key goal for governments. Improving the conditions for pedestrians and cyclists facilitates movement, reduces pollution and congestion, and offers social benefits (Guzman et al., 2020). Cities where walking is a predominant means of transport benefit both privileged and marginalized groups. In the United States, people with the lowest incomes allocate almost a third of their income to transportation. In Nairobi, Kenya, more than half of low-income residents walk to work because public transport is not economically accessible. However, this high level of walking is not due to an urban design for pedestrians, but to the lack of alternatives (ITDP, 2020).

Therefore, pedestrian infrastructure must prioritize accessibility for all users, especially the most disadvantaged. In addition, the public space must be designed not only to offer adequate conditions for pedestrians, but also to promote social integration, the inclusion of marginalized groups, and improve mental and emotional well-being during commuting. This vision implies adopting an urban design with a focus on the human dimension, which considers factors such as accessibility, scale, safety, furniture, and vegetation (Cevallos & Parrado, 2018).

Urban mobility is a key component of well-being, and its analysis allows evaluating the applicability of different measurement approaches and methodologies (Oviedo & Guzman, 2020). In this context, the development of a walkability index offers a solution to overcome these limitations, providing a standardized and objective measure of the quality of the pedestrian environment. This index can combine multiple criteria and factors to offer a more complete assessment and be used by urban planners to identify areas in need of improvement and measure the impact of interventions on walkability (Giles-Corti et al., 2016).

Despite the importance of walkability, measuring this concept remains a challenge for urban planners and researchers. There are different tools and methods, each with strengths and weaknesses. Some focus on the subjective perception of walkability (Wibowo et al., 2015; Gutiérrez-López et al., 2019; Pulla & Hermida, 2021), while others use geospatial data to evaluate the pedestrian environment (Castro, 2021; Ewing & Handy, 2009; Sallis & Glanz, 2006). Each method has limitations, such as the subjectivity of the evaluators or the lack of standardization.

In recent years, the pedestrian mode of transport has gained significant relevance in the planning and growth of cities around the world, so several investigations have been carried out that generate a theoretical basis to understand and research this

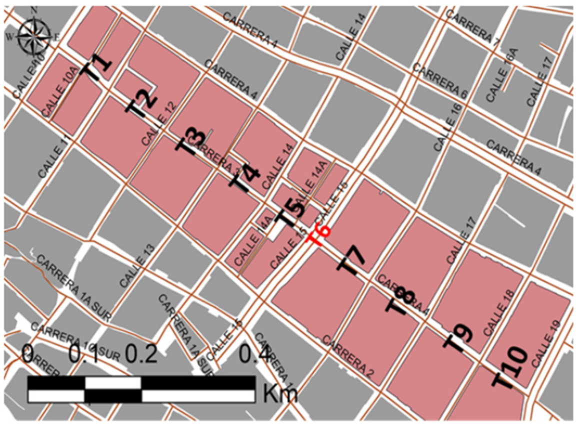

Figure 2. Sections of the study area. Source: Preparation by the Authors.

topic (Pulla & Hermida, 2021). However, studies estimating walkability have not yet been carried out in the city of Ibagué. This is the basis for building a walkability index for the study area. The categories used by the reference articles of the research were considered for this (Table 1).

III. CASE STUDY

Historically, Ibagué has expanded from its original core to the west, east, and southeast, developing a monocentric model where the provision of trade and services is mainly concentrated in the center, which generates center-periphery mobility patterns (National Council of Economic and Social Policy [CONPES], 2020). Carrera Tercera, located in the city's central core, has been a key intersection since the city's early days. This corridor is home to shops, urban facilities, public spaces, government offices, and cultural centers (Francel, 2015), attracting journeys as it concentrates most of the city's economic and social activity. One of its most relevant transformations was its pedestrianization, from 10th to 15th Street (Sections T1 to T5) in 2003, becoming the city's only pedestrian section.

The study focuses on Carrera Tercera (Figure 2) between 10th and 19th Streets (Sections T7 to T10), Ibagué's main pedestrian section. This section has undergone a significant urban transformation since its partial pedestrianization in 2003. This road concentrates a high density of commercial, cultural, and governmental activities, which represent typical patterns of pedestrian mobility in historical centers of intermediate Latin American cities. The selection of the case study seeks to highlight an everyday urban context in the region, where

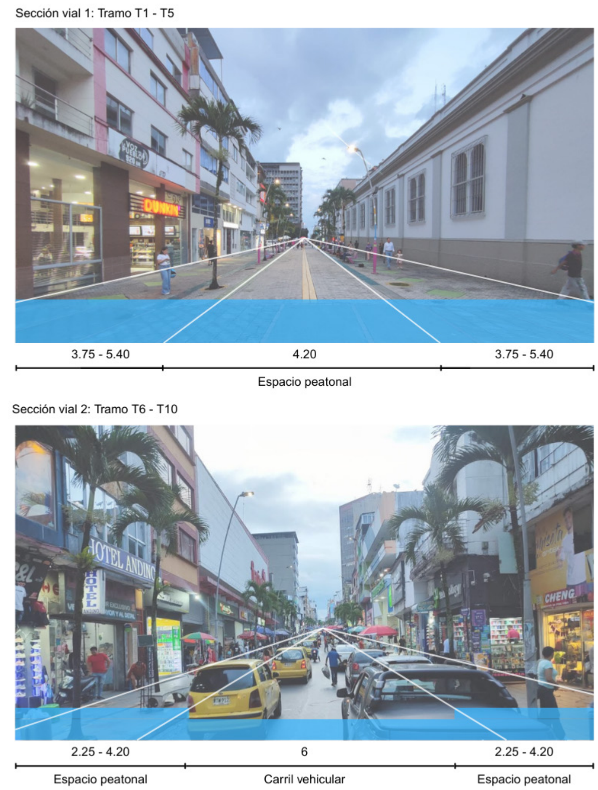

Figure 3. Comparison between the exclusive pedestrian section and the shared section in Ibague's Carrera Tercera. Source: Preparation by the Authors.

the processes of revitalization of public space face similar challenges in terms of accessibility, informality, and shared use of urban space.

This study seeks to provide a basis for decisions in public policy and urban planning for this pedestrian area, considering that the section from 15th to 19th Streets is not yet pedestrianized. The municipal administration, through the Strategic Public Transport System [SETP, in Spanish], seeks to transform the center with the "Camina La Tercera (Walk La Tercera)" pedestrianization project, which promotes active and sustainable mobility. By improving walkability, it is hoped to encourage physical activity, reduce congestion, and create a more pleasant urban environment, improving the quality of life for residents (Enfoque Teve, 2023).

Two characteristic road sections were identified within the study area (Figure 3). The first (sections T1 to T5) is a road for exclusive pedestrian use, with a central space of 4.20 meters for pedestrian circulation, flanked by lateral sidewalks with varying widths between 3.75 and 5.40 meters, which configures a total cross-section of between 11.7 and 15 meters. The second section (T6 to T10) is a shared road that combines a 6-meter vehicle lane with pedestrian strips on both sides, whose widths range between 2.25 and 4.20 meters. This mixed configuration, with an estimated total width of 10.5 and 14.4 meters, reflects a coexistence between vehicle and pedestrian traffic, conditioned by the space available and the commercial pressure in the area. According to the recommendations of the Institute for Transportation and Development Policy (ITDP, 2020), the minimum accessible width for a sidewalk should be 1.80 meters, enough to allow the simultaneous passing of two wheelchairs. This reference was taken as a parameter to assess the sufficiency of pedestrian infrastructure in each section.

IV. METHODOLOGY

The research was based on the articles: ***Índice de caminabilidad para la ciudad de Bogotá*** (Gutiérrez-López et al., 2019), ***Metodología para la estimación del índice de caminabilidad a nivel ciudad y su aplicación al caso de estudio de Bogotá*** (Castro, 2021), Walkability Measures for City Area in Indonesia (Case Study of Bandung) (Wibowo et al., 2015) and ***Índice de Caminabilidad en el eje tranviario dentro del Centro Histórico de Cuenca*** (Pulla & Hermida, 2021). This bibliography was considered valuable as a precedent of indexes created in similar contexts to that of Ibagué, with the Cuenca index in Ecuador, standing out for its similarity in inhabitants and its focus on the walkability of the historic center. Based on this, four stages were considered.

Stage 1: Exploratory analysis of the environment and relevant actors

Stage 1 of the methodology focused on the exploratory analysis of the environment and the key social actors for the study. This phase was fundamental to understanding the context of the research and establishing a solid foundation. Information gathering techniques were used to become familiar with the area. This included a documentary and historical review of Carrera Tercera in academic, government, and press sources, as well as direct observation. The criteria for data collection were defined based on this and the literature review.

Stage 2: Data collection and cleansing

The data collection was carried out on Saturday, June 5th, Monday, June 7th, and Wednesday, June 9th, 2022, from 4 to 6 pm. Two typical days (Monday and Wednesday) and an atypical one (Saturday) were chosen to ensure the results are representative according to the sector's commercial dynamics. During the day, passers-by were interviewed using convenience sampling to identify key aspects of the pedestrian experience. Direct measurement, urban furniture inventory, and photographic registration were also carried out. This phase included the data cleansing and categorization, describing the most relevant qualitative and quantitative aspects of the walkability in the area.

The categories found were also hierarchized, assigning a value of their importance when calculating the walkability index. This made it possible to establish a more accurate and appropriate assessment of the area's situation regarding walkability.

Stage 3: Construction of the walkability indicator

Based on the literature review and the categories identified in stage 2, an indicator was constructed to calculate the area's walkability index. These categories were weighted to generate an average that adequately reflected the characteristics of the area. The indicator's construction required a careful analysis of the collected data, considering the perception of the people who live or pass through the area, providing a more complete and accurate view of the situation.

Stage 4: Implementation of the indicator for the study area

The last stage of the research focused on the application of the indicator built for the study area. Once the formula for calculating the walkability index was developed and applied to the data collected in stage 2, the indicator for the study area was calculated. Subsequently, relevant observations were made regarding the results obtained. It was important to analyze the results in detail and compare them with the data obtained in the previous phases. In addition, the areas with higher or lower walkability quality were identified, which allowed evaluating and diagnosing the area satisfactorily.

It is important to emphasize that the application of the indicator for the study area was a continuous process and required periodic measurements and evaluations to monitor the progress and effectiveness of the measures taken.
The researchers provided all the tools and resources used, and also applied the methodological process used. All the measurement tools used to carry out the research are attached in the appendices**.**

V. RESULTS

An exploratory analysis of the environment was conducted, and key actors were identified: passers-by, merchants, and government authorities. According to the National Census of Projection and Housing 2023 of the DANE [National Administrative Department of Statistics], Ibagué has 541,101 inhabitants (DANE, 2023). On this basis, a sample of 385 people was selected with a confidence level of 95% and a margin of error of 5%. Through semi-structured interviews, the essential characteristics for a satisfactory pedestrian experience and aspects to improve were investigated.

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To classify the responses, categories used in previous research were taken as references (Table 1), where the categories of safety, road infrastructure, and comfort-environment were defined. In addition, a new category was added, sidewalk obstruction, identified as a frequent problem in the area. On the other hand, the mix of uses, proximity, and density categories were discarded due to their low relevance in this context.

The interview responses were organized into four categories (Figure 4). Some categories were more recurrent, so weights were assigned according to the frequency of responses and the actors' perception of what was relevant for a satisfactory pedestrian experience.

Walkability will be evaluated in the 10 sections mentioned, excluding section 6, using four of the categories identified in

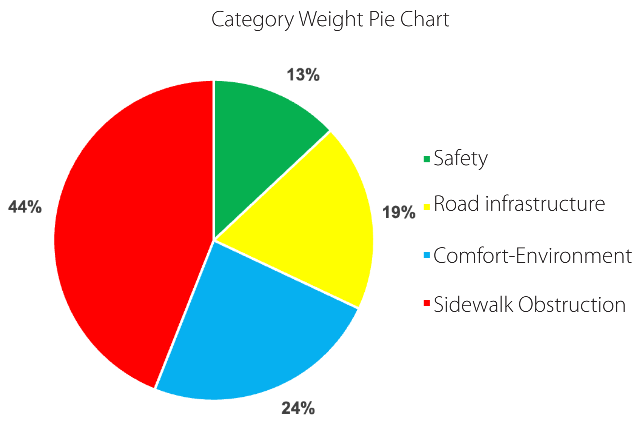

Figure 4. Corresponding weights for each of the walkability index categories. Source: Preparation by the Authors.

Category	Components	Qualification criteria
Safety	Lighting pedestrian spaces Pedestrian volume Openings to the sidewalk Perception of safety Speed signposts Presence of speed reducers Vehicle invasion on the sidewalk Conflicts between motorized and pedestrian means Safety when passing intersections Presence of a traffic light Presence of a zebra crossing Presence of a single platform Vehicle doors opening to the sidewalk	1. It is perceived to be dangerous. Pedestrians are susceptible to crime, traffic accidents, etc. 5. It feels safe. The street is well used, there is good lighting, and reduced vehicle speed.
Infrastructure	Presence of sidewalk Continuity of sidewalk Sidewalk width Condition of the sidewalk Non-slip sidewalk Slope of the section Presence of tactile paving Presence of a ramp Quality and condition of the ramps	1. There are risks and difficulties to walk on the sidewalk, or otherwise, there is no sidewalk available. 5. A walking surface without cracks or one that provides functional and well-maintained infrastructure for people with reduced mobility.
Comfort-Environment	State of trash cans [check] State of benches State of bicycle racks Lighting Condition of the surrounding buildings Presence of graffiti Cleanliness Green areas Covered sidewalk area for the weather	1. Absence of urban furniture or in a decadent state. A smelly and dirty environment that significantly reduces comfort. 5. The path is clean. It has urban furniture and green areas.
Obstruction of the sidewalk	Mobile obstacles Fixed obstacles Presence of informal vendors on the sidewalk	1. Street furniture, signs, vehicles, and informal vendors constantly block pedestrian traffic. 5. Pedestrian traffic is uninterrupted by permanent or moving obstacles.

Table 2. Rating components of each category. Source: Preparation by the Authors.

the surveys (Figure 4). The first, safety, will analyze personal and road safety. The second, infrastructure, will examine sidewalks and streets in terms of paving, accessibility, and signage. The third, comfort-environment, will evaluate aspects such as noise, shade, vegetation, and cleanliness. The last one, obstruction of the sidewalk, will identify elements that hinder pedestrian traffic, such as vehicles, urban furniture, and informal commerce (Table 2).

Section 6, on being an intersection with traffic signals, requires a particular analysis because it does not conform to the criteria of the other sections. This will include the safety perceived by pedestrians regarding crossing times, sidewalks, zebra crossings, and compliance with rules by drivers. Intersections, critical points of road safety, are especially relevant, since according to the National Road Safety Observatory (ONSV, 2024), pedestrians come second in road users with the most fatalities in Ibagué.

Each of the sections is scored individually in the four categories. The scores of the 10 sections were then averaged for each category. Finally, the weighted average of the results of each category was calculated, considering the previously determined weights. The mathematical model below, Equation 1, was based on the one applied from the article Walkability Measures for City Area in Indonesia (Case Study of Bandung) written by Wibowo et al. (2015).

$$\textit{Walkability Index} = \frac{\sum_{i=1}^{n} n\, w_j P_j}{\sum_{i=1}^{n} n\, w_j} \quad \text{Equation (1)}$$

Where:
n: Number of sections.
w_j: Weight applied to category j.
P_j: Section score for category j.

Tramo	Calificación
T1	3.75
T2	3.58
T3	3.08
T4	3
T5	2.83
T6	-
T7	3.36
T8	2.64
T9	2.5
T10	2.64
Promedio	3.04

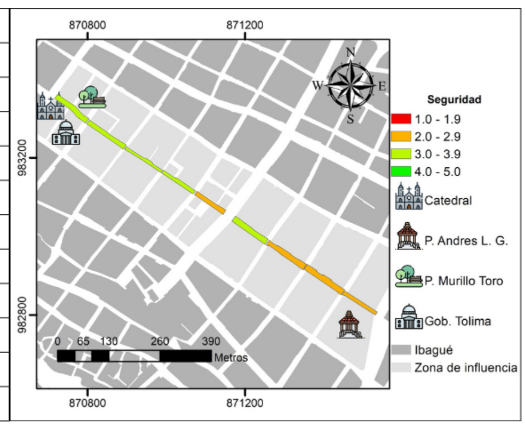

Figure 5. Safety score. Source: Preparation by the Authors.

Tramo	Calificación
T1	3.67
T2	3.67
T3	3.67
T4	3.67
T5	3
T6	-
T7	3
T8	3
T9	3
T10	2.33
Promedio	3.22

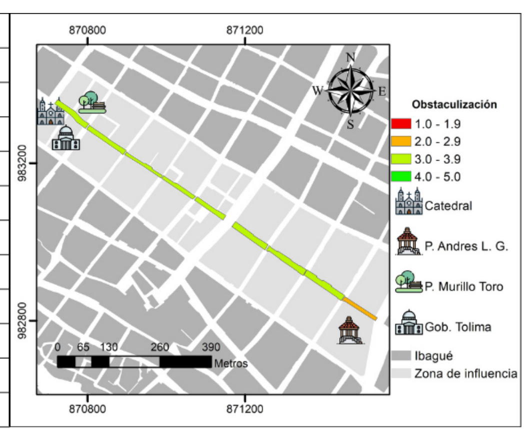

Figure 6. Sidewalk obstruction score. Source: Preparation by the Authors.

Tramo	Calificación
T1	2.78
T2	2.67
T3	2.56
T4	2.33
T5	2.11
T6	-
T7	2.67
T8	2.86
T9	3.22
T10	2.11
Promedio	2.59

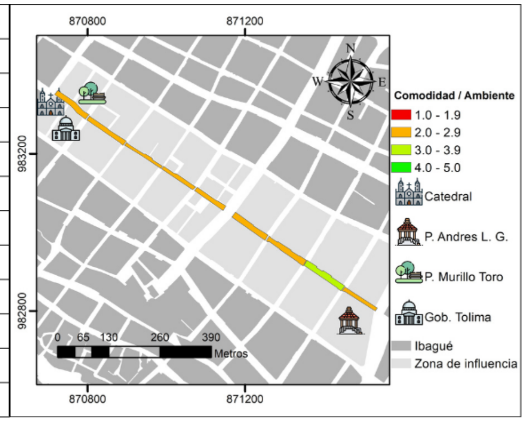

Figure 7. Comfort/environment score. Source: Preparation by the Authors.

Tramo	Calificación
T1	4.5
T2	4.13
T3	4
T4	4
T5	3.88
T6	-
T7	4.79
T8	4.71
T9	4.79
T10	4.88
Promedio	4.41

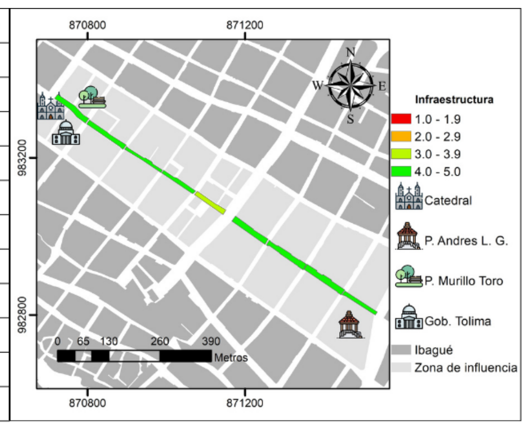

Figure 8. Infrastructure score. Source: Preparation by the Authors.

Tramo	Calificación
T1	3.62
T2	3.50
T3	3.39
T4	3.32
T5	2.93
T6	-
T7	3.31
T8	3.25
T9	3.33
T10	2.80
Promedio	3.27

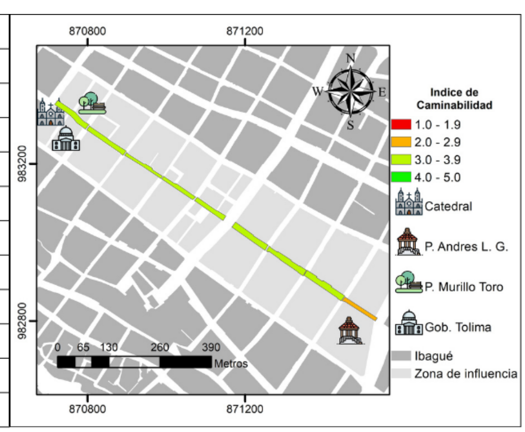

Figure 9. Overall score of the walkability index. Source: Preparation by the Authors.

The score of each category considers the criteria in the appendices, estimated through interviews with relevant actors. Criteria from the reference articles considered relevant to the case study were also taken into account. Sections 7, 8, 9, and 10 are not yet pedestrianized; however, the local administration expressed the intention to do so.

The results of each section in each of the categories (Figures 5, 6, 7, and 8) and the general walkability index (Figure 9) are shown below.

VI. DISCUSSION

The general walkability index had a score of 3.27, which indicates that the streets evaluated have a moderate/regular quality on a scale of 1 to 5, suggesting that although the current space meets acceptable physical conditions for pedestrians, there are aspects that could be improved to offer a more positive experience for pedestrians.

As previously mentioned, infrastructure stands out as the factor with the best score in all sections (4.41). Historically, physical attributes were quantified as the sole factor in determining the walkability indicator. However, the current consensus considers that measuring the attributes of the physical environment in isolation may be insufficient, since it reflects the different urban dynamics that affect walkability (Stockton et al., 2016).

It can be seen that the comfort/environment and the safety categories have the worst results, 2.59 and 3.04, respectively. It is coherent that people negatively perceive these aspects, since the two are closely related. When a pedestrian environment lacks elements that ensure comfort, such as wide sidewalks, suitable lighting, and noise control, this not only affects the overall pedestrian experience but also decreases the feeling of safety. An uncomfortable and poorly maintained environment can generate a greater perception of risk, which makes people feel more vulnerable to possible dangers.

Birche's study (2021), carried out in the city of La Plata, Argentina, offers a relevant perspective on the valuation of pedestrian space from a landscape and functional perspective. Her approach combines the diagnosis of the design, state, and accessibility of pedestrian road space with a critical reading of the urban car-centered model. The importance of considering variables such as the verified walkable width, vegetation, the quality of urban furniture, and the presence of obstacles is highlighted. Incorporating these criteria into the analysis of walkability in Ibagué allows enriching the study with an integrated vision that goes beyond the merely functional and reinforces the idea of the street as a public space for meeting, enjoyment, and urban landscape.

Pedestrians require a comprehensive comfort and safety experience that encompasses all their senses: from the ease of movement to the visual, sound, and thermal quality of the environment (Salem et al., 2022). The way elements are arranged in the urban landscape has a significant impact on how people perceive their surroundings and, therefore, on their general well-being. Comfort is closely linked to the perception of safety. A clean and well-maintained pedestrian environment, with obstacle-free sidewalks, not only facilitates pedestrian traffic but also reinforces the feeling of safety and accessibility (Arellana et al., 2019).

According to Irafany et al. (2020), continuity and mobility are key factors affecting urban walkability. This is reflected in the results, where the category of sidewalk obstruction scored 3 out of 5, indicating a significant presence of obstacles. The invasion of streets by informal vendors reduces the available space and creates barriers that hinder safe transit, especially for older or disabled people. In addition, uneven surfaces and the accumulation of trash worsen the pedestrian experience. The occupation fragments the pedestrian flow, forcing detours to the street, which increases risks and hinders efficient movement.

These findings support the findings of Arellana et al. (2019) and Stockton et al. (2016), who point out that the state of urban furniture, cleanliness, and continuity of pedestrian space directly influences perceptions of safety and comfort.

It is important to analyze the results of each category (infrastructure, comfort, environment, safety, and obstacles) individually, since, according to the methodology, some are more relevant for citizens. This will allow identifying the strengths of the study area and specific improvements in each section. The overall index of 3.27 can serve as a basis for diagnosing streets and provide key information for designing interventions that improve pedestrian mobility. From this point, specific actions can be developed to raise the quality of the streets and promote a better pedestrian experience.

VII. CONCLUSIONS

Carrera Tercera between 10th and 19th streets is the most important pedestrian corridor in the city of Ibague. It also provides a good atmosphere for pedestrians, according to the score of 3.27 obtained in the walkability index. It can be seen that the evaluated sections mostly obtained very good scores (between 4 and 5) in the infrastructure category, but the idea

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REVISTA URBANO Nº 51 / MAYO 2024 - OCTUBRE 2025
PÁG. 74 - 85
ISSN 0717 - 3997 / 0718 - 3607

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PÁG. 74 - 85
ISSN 0717 - 3997 / 0718 - 3607

of Stockton et al. (2016) is reiterated, that walkability not only depends on the built space, but is influenced by many more variables. One of the most notable characteristics of the study area is its commercial nature, which encourages the invasion of pedestrian space by informal vendors and other actors (street artists, workers, among others). This invasion of the sidewalk is the main reason why walkability is punished in the area. The presence of informal vendors and street artists not only obstructs the sidewalk (Figure 6), but also brings with it more effects to walkability, such as: solid waste pollution, noise pollution, insecurity, invasion of urban furniture, among other factors that adversely impact the scores of other categories such as safety and comfort-environment.

On the other hand, it was observed that the score of each stage decreases as one moves along Carrera Tercera, from Section 1 to Section 10. Section 1, with the best rating of 3.62, stands out for its privileged location near parks, green areas, government buildings, and historical places of the city, which contribute to its optimal comfort, clean environment, and well-maintained infrastructure, as well as a reduced presence of informal vendors. In contrast, Sections 5 and 10 get the lowest scores, of 2.93 and 2.80, respectively. Section 5 poses a challenge for pedestrians, as it marks the end of the pedestrian section and is located near a busy vehicle crossing. Section 10 (between 18th and 19th Streets) is located in a tolerance zone in Ibagué, and both sections face similar problems, such as steep slopes, infrastructure deterioration, high concentration of informal vendors, and poor solid waste management.

The study of pedestrian zones using the walkability index allows detecting areas with limited pedestrian space, which is key to achieving greater equity in access to pedestrian infrastructure. This approach balances the use of urban space by identifying where investment is required in sidewalks, pedestrian streets, and other elements that promote walkability. In addition, this analysis offers decision makers valuable information to improve pedestrian cohesion in historic centers, favoring an inclusive and accessible environment for all (Navarro-Franco & Foronda-Robles, 2024).

One of the main strengths of this study is its comprehensive methodological approach, which combines data from the built environment with citizen perceptions collected through fieldwork. This methodology not only allows a more complete understanding of the urban phenomenon, but also offers a replicable tool to diagnose the quality of pedestrian space in other Latin American cities, especially those with partially pedestrianized historical centers or with pedestrianization projects and informal commercial dynamics that strain the public space. Intermediate cities with monocentric structures, peripheral expansion patterns, and similar social pressures can benefit significantly by adapting this index to their contexts.

Finally, although this study focused on a specific area of Ibague, its findings can be extrapolated to other Latin American urban contexts with monocentric structures, partially pedestrianized historical centers, and problems associated with informal trade. The methodology used allows replicability and adaptation in intermediate cities with similar conditions, which contribute to the development of diagnostics and public policies that favor inclusive and sustainable urban mobility. In addition, it makes aspects usually relegated to infrastructure plans visible, such as the perception of safety, multisensory comfort, and obstacles on the sidewalk, which are key to achieving more walkable and fairer cities.

VIII. CONTRIBUTION OF AUTHORS CRediT:

Conceptualization, M.S. J.G. M.R. J.G.; Data Curation, M.S. J.G.; Formal Analysis, M.S. J.G. M.R. J.G.; Acquisition of financing N/A.; Research, M.S. J.G.; Methodology, M.S. J.G. M.R. J.G.; Project Management, M.S. J.G.; Resources, X.X.; Software, X.X.; Supervision, M.S. J.G. M.R.; Validation, M.S. J.G. M.R. J.G.; Visualization, M.S. J.G. M.R. J.G.; Writing - original draft, M.S. J.G.; Writing - proofreading and editing, M.S. J.G. M.R. J.G.

IX. BIBLIOGRAPHIC REFERENCES

Arellana, J., Saltarín, M., Larranaga, A.M., Alvarez, V., & Henao, C.A. (2019). Urban walkability considering pedestrians' perceptions of the built environment: a 10-year review and a case study in a medium-sized city in Latin America. *Transport Reviews, 40*(2), 183–203. https://doi.org/10.1080/01441647.2019.1703842

Birche, M. (2021). Diagnóstico de diseño y uso del espacio vial peatonal: aportes desde el paisaje para la ciudad de La Plata, Argentina. *Urbano, 24*(44), 58–69. https://doi.org/10.22320/07183607.2021.24.44.05

Castro, W. (2021). *Metodología para la estimación del índice de caminabilidad a nivel ciudad y su aplicación al caso de estudio de Bogotá* [Tesis de Maestría, Universidad de los Andes]. Repositorio Institucional Séneca - Universidad de los Andres, Colombia. https://hdl.handle.net/1992/53799

Cevallos, A., & Parrado, C. (2018). Cartografía del deseo: Diseño, caminabilidad y peatones en la ciudad de Quito. *QUID 16. Revista del Área de Estudios Urbanos,* (10), 210-229. https://publicaciones.sociales.uba.ar/index.php/quid16/article/view/2811/pdf_29

Consejo Nacional de Política Económica y Social [CONPES]. (2020). *Nº4017. Declaración de importancia estratégica del proyecto sistema estratégico de transporte público (SETP) de Ibagué.* https://colaboracion.dnp.gov.co/CDT/Conpes/Econ%C3%B3micos/4017.pdf?Mobile=1

DANE. (22 de marzo de 2023). *PROYECCIONES DE POBLACIÓN*. https://www.dane.gov.co/index.php/estadisticas-por-tema/demografia-y-poblacion/proyecciones-de-poblacion

Enfoque Teve. (11 de marzo de 2023). *Paso vehicular de la 3a será cerrado por dos días. El cierre corresponderá a un plan piloto para el proyecto 'Camina la Tercera'* *desde la calle 15 hasta la 17. La peatonalización de la vía será el próximo 17 y 18 de marzo. El cierre corresponderá a un plan piloto para el proyecto 'Camina la Tercera' desde la calle 15 hasta la 17. La peatonalización de la vía será el próximo 17 y 18 de marzo.* https://enfoqueteve.com/paso-vehicular-de-la-3a-sera-cerrado-por-dos-dias/

Ewing, R., & Handy, S. (2009). Measuring the Unmeasurable: Urban Design Qualities Related to Walkability. *Journal of Urban Design, 14*(1), 65–84. https://doi.org/10.1080/13574800802451155

Francel, A. (2015). La calle del Comercio de Ibagué (Colombia), 1893-1950. Un estudio sobre sus transformaciones arquitectónicas y conceptuales derivadas del modelo industrial en el tránsito de la Colonia a la República y las primeras manifestaciones del Art Déco. *Dearq*, *1*(17), 56-73. https://doi.org/10.18389/dearq17.2015.04

Giles-Corti, B., Vernez-Moudon, A., Reis, R., Turrell, G., Dannenberg, A.L., Badland, H., Foster, S., Lowe, M., Sallis, J. F., Stevenson, M., & Owen, N. (2016). City planning and population health: a global challenge. *The Lancet*, *388*(10062), 2912-2924. https://doi.org/10.1016/S0140-6736(16)30066-6

Gutiérrez-López, J. A., Caballero-Pérez, Y. B., & Escamilla-Triana, R. A. (2019). Índice de caminabilidad para la ciudad de Bogotá. *Revista de Arquitectura (Bogotá),* 21(1). https://doi.org/10.14718/revarq.2019.21.1.1884

Guzman, L. A., Peña, J., & Carrasco, J. A. (2020). Assessing the role of the built environment and sociodemographic characteristics on walking travel distances in Bogotá. *Journal of Transport Geography*, *88*, 102844. https://doi.org/10.1016/j.jtrangeo.2020.102844

Hernández Galán, J. (2011). *Accesibilidad universal y diseño para todos. Arquitectura y urbanismo.* https://biblioteca.fundaciononce.es/publicaciones/colecciones-propias/coleccion-accesibilidad/accesibilidad-universal-y-diseno-para Institute for Transportation & Development Policy [ITDP]. (2020). *Why Walkability*. https://pedestriansfirst.itdp.org/about

Irafany, S., Wunas, S., Trisutomo, S., Akil, A., Arifin, M., & Rasyid, A. (2020). Walkability Index Based on Pedestrian Needs in the Losari Beach area of Makassar City. *Indian Journal of Forensic Medicine & Toxicology*, *14*(4), 7936-7947. https://doi.org/10.37506/ijfmt.v14i4.12899

Larranaga, A. M., Arellana, J., Rizzi, L. I., Strambi, O., & Betella Cybis, H. B. (2019). Using best–worst scaling to identify barriers to walkability: a study of Porto Alegre, Brazil. *Transportation*, *46*, 2347–2379. https://doi.org/10.1007/s11116-018-9944-x

Moura, F., Cambra, P., & Gonçalves, A. B. (2017). Measuring walkability for distinct pedestrian groups with a participatory assessment method: A case study in Lisbon. *Landscape and Urban Planning, 157*, 282-296. https://doi.org/10.1016/j.landurbplan.2016.07.002

Navarro-Franco, I., & Foronda-Robles, C. (2024). Medición de las confluencias espaciales en el centro histórico de Sevilla: peatonalización, comercio y turismo. *Ciudad Y Territorio Estudios Territoriales, 56*(219), 71–88. https://doi.org/10.37230/CyTET.2024.219.4

Observatorio Nacional de Seguridad Vial [ONSV]. (2024). *Boletín Estadistico Colombia: Fallecidos y Lesionados por Siniestros Viales*. https://ansv.gov.co/sites/default/files/2024-01/Boletin_Nacional_Septiembre_2023.pdf

Orellana, D., Hermida, C., & Osorio, P. (2017). Comprendiendo los patrones de movilidad de ciclistas y peatones. Una síntesis de literatura. *Revista Transporte y Territorio*, (16), 167-183. http://revistascientificas.filo.uba.ar/index.php/rtt/article/view/3608

Oviedo, D., & Guzman, L. A. (2020). Revisiting Accessibility in a Context of Sustainable Transport: Capabilities and Inequalities in Bogotá. *Sustainability*, *12*(11), 4464. https://doi.org/10.3390/su12114464

Paulo dos Anjos Souza Barbosa, J., Henrique Guerra, P., de Oliveira Santos, C., de Oliveira Barbosa Nunes, A. P., Turrell, G., & Antonio Florindo, A. (2019). Walkability, Overweight, and Obesity in Adults: A Systematic Review of Observational Studies. *International Journal of Environmental Research and Public Health*, *16*(17), 3135. https://doi.org/10.3390/ijerph16173135

Pazos-Otón, M., Fari, S., & Avellaneda, P. (2024). La transformación de las políticas de movilidad en Pontevedra: una ciudad para caminar. *Ciudad Y Territorio Estudios Territoriales*, *56*(220). https://doi.org/10.37230/CyTET.2024.220.18

Pulla, J. S., & Hermida, C. M. (2021). *Índice de Caminabilidad en el eje tranviario dentro del Centro Histórico de Cuenca* [Tesis de pregrado, Universidad del Azuay]. Repositorio Institucional - Universidad del Azuay, Cuenca, Ecuador. http://dspace.uazuay.edu.ec/handle/datos/11083

Salem, D., Khalifa, S. I., & Tarek, S. (2022). Using landscape qualities to enhance walkability in two types of Egyptian urban communities. *Civil Engineering Architecture*, *10*(5), 1798-1813. https://doi.org/10.13189/cea.2022.100508

Sallis, J. F., & Glanz, K. (2006). The Role of Built Environments in Physical Activity, Eating, and Obesity in Childhood. *The Future of Children*, *16*(1), 89-108. https://dx.doi.org/10.1353/foc.2006.0009

Stockton, J. C., Duke-Williams, O., Stamatakis, E., Mindell, J. S., Brunner, E. J., & Shelton, N. J. (2016). Development of a novel walkability index for London, United Kingdom: cross-sectional application to the Whitehall II Study. *BMC Public Health*, 16, 416. https://doi.org/10.1186/s12889-016-3012-2

Wibowo, S. S., Tanan, N. & Tinumbia, N. (2015). Walkability Measures for City Area in Indonesia (Case Study of Bandung). *Journal of the Eastern Asia Society for Transportation Studies*, *11*, 1507-1521. https://doi.org/10.11175/easts.11.1507

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