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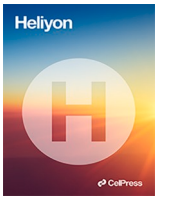

Walk and connect. Measurement of inclusion criteria for people with functional diversity. Ibague, Colombia

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ABSTRACT

The absence of comprehensive and structured planning strategies for pedestrians, especially for those with functional diversity, promotes the need to address tools that allow broadening the spectrum of their assessment and prioritizing the inclusive development of cities. Therefore, this document describes the application of the Transit Oriented Development Standard guide in an area with mixed uses in Ibague city, as an evaluation tool in the analysis of the principles of walking and connecting. For its general understanding, the terms of Transit Oriented Development, walkability and functional diversity are analyzed. Evidence is presented on the need to project balanced intermodal systems that demonstrate the importance of universal accessibility in urban mobility.

1. Introduction

The gradual increase of people who present difficulties in their mobility, leads to the need to focus research on their interaction with the conditioning factors of the environment in which they live [1,2]. Consequently, it seeks to deepen access to the opportunities and resources offered by the city, through the integrated urban environment designed to connect people, activities, pedestrian paths, public spaces and services [1].

Thinking about accessible spaces favors people with functional diversity and provides benefits to a broader range of citizens, which contributes to generating solid guidelines to improve the construction of fair cities [2]. People with reduced mobility face obstacles and realities on a daily basis that stigmatize and discriminate against their access to spaces that involve the use and enjoyment for everybody.

For this reason, it is necessary to involve the concept of inclusive development, adopted in the fundamental principles of urban mobility [3], which generates various questions such as why urban infrastructure is designed to socially segregate and isolate people with physical and communicative disabilities? How to demonstrate the need for inclusive spaces in the urban environment? What should be done to make visible the absence of effective and pertinent measures that promote respect for the rights and dignity of differently abled people? What can be the effective strategies to minimize the discrimination of the structuring systems of the city? These concerns raise awareness about a problem generated by a model of urban growth with conditioning patterns of globalization.

There are methods and tools with different approaches, they allow to explore accessibility indices through the collection of data for the construction of a solid base of information. The methodologies vary from one country to another and affect the results, but lead to

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specific solutions that can be extrapolated, according to each case analysis. However, the importance of considering the use of instruments with a broad comprehensive measurement spectrum is anticipated. In this sense, the application of international frameworks and resources is considered of great importance. Therefore, the Transit Oriented Development TOD standard guidance becomes an important application tool to recognize the spatial inequities of urban development and its impact on people, activities, and opportunities. It identifies the need to prioritize and promote inclusive and equitable forms of urbanization to actively protect and integrate the most vulnerable population groups.

Its application includes measurement and assessment criteria with indicators for the selected characteristics, which require clarity in the implementation objectives. They are practical, since they are applied through direct observation and their verification is independent, objective and relatively simple, which allows understanding the characteristics of the existing land use and identifying challenges and opportunities. It involves eight urban indicators that include walking, cycling, connecting, transporting, mixing, densifying, compacting and changing [4].

However, for the purposes of promoting access for all, highlight spatial inequalities and concentrating the research on the population with functional diversity as the group of interest, two fundamental principles for people are adopted from this frame of reference: walking and connecting. Through these two principles it is possible to identify the scarcity of studies on accessibility at the local level and, consequently, the lack of incorporation of these criteria in urban analysis and the implementation of universal accessibility measures, which generates a high range of exclusion. In this sense, this study contributes to fill the lack of data and generate a basis for the implementation of international strategies in the local environment.

The objective of this study is to present evidence on the need to project balanced intermodal systems that allow "strengthening the social fabric, improving quality of life and reducing dependence on individual motorized transport" [5]. Likewise, it aims to improve participation and inclusion at all levels and sectors through the incorporation of elements, endowments, or services necessary for the proper functioning of the city.

2. Theoretical background

2.1. Transit Oriented Development

The origins of the TOD concept date back to the mid-19th century with the implementation of streetcar-oriented development patterns in European and North American cities [6]. Similarly, it shares criteria with the concept of urban planning presented in the Garden City or “development-oriented transit” in the 20th century [7]. However, modern TOD studies started with the idea of New Urbanism in the 1980s in the US [8]. Some sources indicate that it emerged in the 1990s [5] and that it was recognized in urban academia until 1993 [8]. Specifically, the formal introduction of TOD is credited to Peter Calthorpe, Cervero, and other Transit scholars in the 1990s [6].

This urban design philosophy evolved TOD. Architect and urban planner Peter Calthorpe introduced this concept for the first time in his book *The Next American Metropolis*, in which he states that “city planning must be focused on pedestrians and public transport, which does not mean eliminating the use of the car. but to balance it” [4]. Subsequently, many definitions, guides and manuals emerged based on the Calthorpe synthesis, that is, on the ecological, aesthetic, pedestrian, regional, equitable and anti-spread planning principles [7].

Currently “numerous cities in many countries are planning future TODs to focus on mixed-use urban development” [9]. According to Erik Vergel, at the Latin American level, cities such as Guayaquil, Quito, Guatemala, Sao Paulo, Bogotá and Goiânia have incorporated sustainable and inclusive development in urban projects [10]. Its definition as an "urban design tool" [4], "urban and territorial optimization model within the framework of the planning of transport systems" [11] and "planning policy to design and develop walkable, dense and diverse neighborhoods" [12], promotes the adoption of a set of territorial strategies based on the articulation of diverse urban components that seek a model of sustainable cities around the structuring axis of mobility.

This new vision of the city allows planning to focus on pedestrians and traffic in a balanced way, so that the pedestrian is the main actor [13]. That is, it pays special attention to pedestrian-oriented Transit infrastructure, “defined by the 10-min or quarter-mile walk, with small lots, low-rise buildings, and pedestrian paths” [7]. Additionally, the argument of mixed land uses around public transport involves residential, commercial, administrative areas, open areas and public spaces, which allows us to imagine a walkable environment with places designed for the interaction of people with the rest of the environment of the city and prioritizes non-motorized transport [14]. This is the main argument to address its methodology in this research.

On the other hand, the application of the principles and objectives for Transport-Oriented Development established in the international arena, presents a flexible model of application in any city, "taking into account the conditions of its urban area" [11]. In addition, its interest in involving "inclusive objectives in planning and design policies to actively protect and integrate excluded people and groups" [3], strengthens the argument of being considered a resource evaluation tool. In this sense, as stated by the Institute of Transport and Development Policies - ITDP, it becomes a tool for the creation of policies based on three fundamental pillars, evaluation, recognition and development [4].

2.2. Walkability and connectivity

Within the framework of the TOD concept, one of the goals is the successful transition from a car-centric city to one with public transport and high walkability [15]. From this perspective, "walking becomes its premise and improvement policies are focused on this strategy" [16]. This purpose allows us to understand that walking, in addition to being simple, natural, healthy, economical and

inclusive, "can potentially be the most enjoyable, safe and productive way to move" [3]. However, "many times it is mistreated in the planning and research process" [17], since the physical conditions for walking, traffic and associated pedestrian behavior have been ignored because during many decades, cities have been planned for cars and not for pedestrians [18], that is, both the focus on universal accessibility to the goods and services that together constitute the built environment, and microscale design factors that enable the exercise of the right to enjoy the city as a common good [19]. Therefore, it is relevant to consider sidewalks as fundamental components of the Transit network [20], which "must provide safe, attractive, healthy and inclusive conditions" [21].

Consequently, "focusing on the physical and functional environment, land use, density and other related factors" [21], as characteristics of the physical or social environment, tending to aggravate the challenges that walking represents, is a hit of significant consideration on the part of TOD. These efforts, with special criteria of the effective pedestrian environment, favor the only activity universally available to all: walking [22]. They contribute to the appreciation and promotion of an active lifestyle for all pedestrians, including people with functional diversity, because "their abilities do not allow them to overcome the obstacles they encounter along the way, go up or down steps or dodge barriers" [3].

On the other hand, most people who can or want to walk in ordinary everyday situations do so for about 400–500 m (1300 to 1600 feet). For children, the elderly, and the disabled, the acceptable walking distance is often considerably less [23]. Consequently, people who present some type of limitation and greater risks associated with transit or displacement on public roads deserve special attention, regardless of the number or quantity. It is a matter of fairness and justice, especially when it comes to fragile, unprotected and vulnerable users.

From this perspective, "walkability is the potential of the built environment to encourage people to walk" [24] and "one of the factors that contributes to a better fit between individual function and the built environment" [25], taking into account the marked differences in user behavior, derived from the capacities of the different groups of citizens and their walkable space. These situations demonstrate the need for a "new city approach with inclusive, fair and sustainable development" [26].

Connectivity is a term closely associated with the ideas of union, linkage, interrelation, or connection. However, its conceptual utility in spatial terms involves the development of mobility relationships, meaning the ability to link or connect to the road structure based on street patterns and locational logic, where people are the primary component of configuration. For this reason, urban structure planning should be focused on meeting the needs of users in terms of effort, time, and cost, while also taking into account vulnerable population groups, such as individuals with functional diversity [27,28].

2.3. Disability vs functional diversity

The general picture reveals a gradual increase in the various approaches to the magnitude of disability. It is estimated that 15 % of the world's population, that is, approximately 1000 million people have some type of intellectual, physical or sensory deficiency. Likewise, demographic aging has led to a higher prevalence of disability in activities of daily living (ADL) [29]. These indicators argue the need to deepen access to the opportunities and resources offered by the city in the integrated urban environment.

The preamble to the United Nations Convention on the Rights of Persons with Disabilities (CRPD) stresses that it "results from the interaction between persons with disabilities and attitudinal and environmental barriers that prevent their full participation and effective in society on equal terms with others" [30]. This concept presents the immediate environment as a factor with a significant impact on the degree of disability. In addition, it shows its importance in minimizing the negative aspects derived from a health condition to guarantee social participation and inclusion. From this perspective, its sociocultural constructed meaning can be understood to modify the stereotype of disability in the sense that "there are no disabled, but disabled societies and cities" [31].

The term disability "as a socially legitimate meaning comes from the health sciences" [32]. However, in the social sphere it has generated various discussions due to its association with discriminatory, limiting and sometimes derogatory ideas and concepts. Theorists affirm that this problem lies in the erroneous interpretation derived from the imposition of the term normality, according to which this would be an insufficiency exclusively of the disabled person.

For this reason, it is stated that "disability is not an objective characteristic applicable to the person, but an interpretive construction inscribed in a culture" [33]. In this sense, mentioning equal opportunities for all people is considered "because of their equality of humanity and not because of the equality of their abilities" [34], taking into account that people with disability category may have different competencies to address the environment.

This analytical consideration leads to involving the social model of functional diversity based on the principles of "independent living, non-discrimination, universal accessibility, normalization of the environment and civil dialogue, among others" [35]. In other words, it is considered as a transversal category from the individual body dimension to the cultural dimension of the social group [34] because it makes it possible to make visible the particular characteristics involved in carrying out their own operations, without adopting attitudes of denial or discrimination and much less result in a loss of well-being or quality of life.

In a planning and practical dimension, vulnerable users include wheelchairs, users with walking sticks, frames and other mobility aids. In general, during the last decades, cities have failed in planning sidewalks for these vulnerable users [36]. A balance of these inclusion processes in studies from diverse fields of knowledge, encompassing both the conceptual difference between disability and functional diversity, as well as the types of users that must be acknowledged in a universal accessibility context, is approached from the perspective of contributing data and reflections to the ongoing configuration of the concept "within the discipline of Social Work, from both epistemological and professional lines of intervention" [37] that includes the urban planning.

It's important to highlight that the term functional diversity always requires context, as within urban studies, it could be confused with the characteristics of flora and fauna or mixed land uses. However, in this case, the rights-based approach is embraced, associating functional diversity with human dignity, while disability aligns with the paradigm of exclusion, of the other [35].

Consequently, adopting the term functional diversity is a great success to refer to "people who function in an unusual way, instead of the meaning according to which they lack capabilities" [32]. Therefore, its use in the common lexicon is not simply a matter of communication or semantics, it is the positive recognition of the negative concept of disability and "should be part of the set of operations through which well-being and quality are evaluated. of life" [34].

3. Materials and methods

3.1. Study area

Ibagué is an intermediate city, the capital of the Tolima Department, located in the center of Colombia, with an approximate population of 500,000 inhabitants [38]. The urban criteria used to evaluate the walking and connecting conditions in Bogotá could potentially be replicated in other departmental capitals of the country like Ibagué. Thus, it serves as a platform for connecting and contextualizing urban thought from the metropolis to smaller cities. As a departmental capital, it offers services at both the local and regional levels, organized into zones that stem from the functionalist orientation of the early to mid-20th century [39].

In Ibagué, a total of 10,751 people with reduced mobility are identified, accounting for 2.02 % of the total population, however, there are no segregated data available for neighborhoods or smaller administrative zones (Municipal Government of Ibague, 2020, p.117)

The Fifth Avenue (*Carrera 5*) is the structural axis of the city, as it was the road that connected Ibagué with Honda during colonial and republican times, the main inland port on the Magdalena River [40]. Nowadays, it presents a fragmented area, 'physically segregated, socially unjust, economically wasteful, culturally miserable, and politically ungovernable' [41]. The decline in public space areas, both in quantity and quality, highlights the consequences of implementing a Fordist urban ideology, in which the human dimension is minimized, since "currently, the road space is still almost exclusively dedicated to cars and proves challenging for other forms of mobility to integrate into the system" [18].

For its application in Ibague city, we selected an area on the 5th Avenue between 60th and 71st streets. This area is characterized by the mix of uses, covered by various hospitals and the constant circulation of the population of interest in this study, therefore, represent great relevance in the focus of this research [Fig. 1].

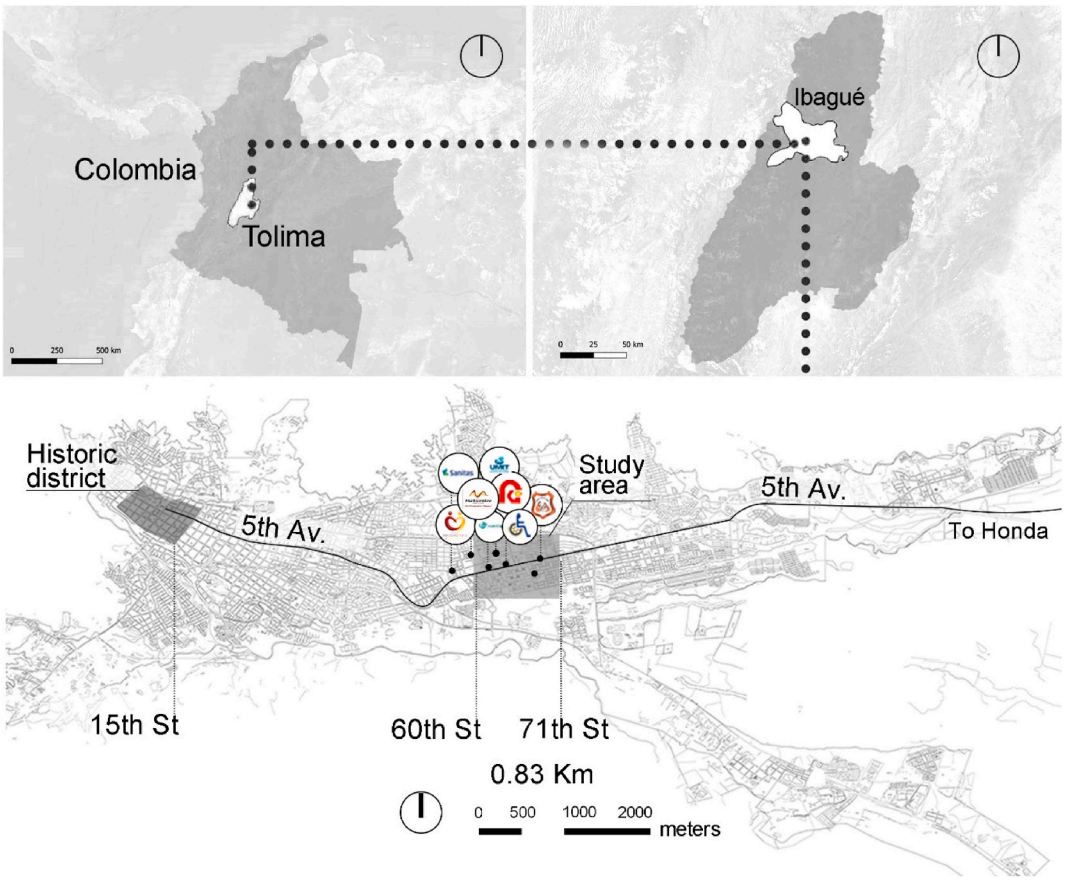

Fig. 1. Location and study area.

3.2. Transit Oriented Development

The TOD standard includes a recognition system that awards bronze, silver and gold levels to projects developed under performance consistent with TOD objectives [42]. As eligibility criteria, it proposes having a complete network of open-access pedestrian pathways, being a unique project, not having blocks or areas larger than 2.5 ha restricted from public access, being located near a high-quality Transit station, affecting at least two adjacent pedestrian blocks. However, its application in the study area does not seek such recognition, it only aims to evaluate the existing conditions for the principles of walking and connecting, to provide data and tools that can guide future interventions focused on inclusion.

The principle of walking is valued under the conditions of accessibility and attractiveness, taking into account that it can be the most enjoyable, safe and productive way to move [42], therefore, it is focuses on three key implementation goals. In objective A, the pedestrian network is safe, complete and accessible considering "safety as a central parameter of the inherent safety of driveways, intersections and other potential conflict points" [43]. It includes safe crossings at strategic points that link the origin and destination and with local public transport. It measures the completeness and safety of pedestrian pathways and crossing systems [44] to ensure that "pedestrian protection should be the main focus of urban design near public transport" [45].

In objective B, "the pedestrian environment is active and vibrant", it is because "one of the objectives of the TOD concept is the successful transition from a car-centric city to one with public transport and high walkability" [43]. It is based on the fact that walking can be very productive to the extent that it improves vitality through interior and exterior visual interactions and generates informal passive vigilance. It evaluates the activation of public space and safety through the visually attractive facade indicator, to measure the visual connection between pedestrian pathways and the interior of adjacent buildings. Likewise, it measures the active physical connections through the different entrance and exit routes of homes, shops, patios and corridors with the physically permeable façade indicator.

Objective C considers whether the pedestrian environment is comfortable. It is based on the existence of elements that provide verifiable environmental, sustainable and psychological benefits, which shows that "an attractive, pleasant and aesthetically harmonious physical environment generates a pleasant feeling of well-being" [46]. To measure it, the shadow and shelter indicator is applied.

The second principle addressed, that of connecting, requires a well-connected pedestrian network of sidewalks, footpaths, squares and public spaces throughout small blocks, in order to offer safety, variety and enjoyment for all, that is, "strengthen the social fabric" [47]. In its objective A, the pedestrian and bicycle routes are short, direct and varied, it values the block fronts between 110 and 150 m, defined by the TOD (Transit-Oriented Development) guide, with the small blocks' indicator. Variable of great importance since the distance to walk in people with functional diversity is usually considerably less, hence the relevance of a pedestrian network with spaces of alternate and small streets [48]. Objective B, pedestrian and bicycle routes are shorter than car routes, compares the proportion of roads and connectivity for non-motorized transport and cars using the prioritized connectivity indicator [Table 1].

3.3. Description of endpoints in the beginning of walking

The central measurement attribute of safe and accessible walkways is their continuity and safety in all possible directions, taking into account blocks, building entrances, and property. In a block they are measured as segments, that is, sections between two intersections adjacent to the road. These can be sidewalks protected from vehicular traffic with a suitable curb or device, shared streets designed for safe interaction between pedestrians, cyclists and vehicles, with a maximum speed limit of 15 km per hour and pedestrian crossings or shared pedestrian and cyclist crossings.

For the segments to be complete and acceptable they must meet design criteria for easy access to all buildings in the segment, such as surface homogeneity without abrupt level changes, ramp slopes less than 7 %, and accessible pathways from the sidewalk to the interior of the location being entered. Do not present obstructions or barriers for people with disabilities, including people with wheelchairs or visually impaired and have adequate lighting at night, to generate security.

Pedestrian crossings are required on roads with a speed limit greater than 15 km per hour. In very dense street networks, crossings are needed at intervals of two hundred 200 m or less. For their assessment as safe and accessible, the criteria they must meet are: not having barriers for people with disabilities, including ramps and connections between levels, measuring 2 m or more in width and being delimited. If the crossing has more than two lanes, it must have an island accessible to all and have adequate lighting at night.

A pedestrian walkway segment is considered visually active if 20 % or more of the length of its adjoining façade provides direct

Table 1
Principles, objectives, indicators and scoring.

PRINCIPLE	OBJECTIVE	INDICATOR	SCORE
WALK	Safety	Pedestrian pathways	3
		Pedestrian crossings	3
	Vibrant	Visually appealing facade	6
		Physically permeable facade	2
	Comfortable	Shade and shelter	1
CONNECT	Convenient	Small blocks	10
	Connected	Prioritized connectivity	5

Source: TOD Standard guide.

visual connection to the interior of the building. It is defined as the length of the ground floor façade of a building, adjoining pedestrian pathways, that is visually penetrable. They are comprised of partially or fully transparent windows or other materials arranged anywhere on the façade between ground level and up to 2.5 m in height, even eye-level residential windows are acceptable. Vehicle-only access points, undeveloped land (idle, vacant, or used for parking or landscaping), and alleys that do not connect to public thoroughfares on both sides are not considered visually active.

In the category of Streetscape design exist other important factors that complement the condition of visually active facades, such as *enclosure*, because "a well-enclosed streetscape increases the perception of intimacy and security" and *complexity*, "which reflects the visual richness of a place", "a design quality significantly correlated with walkability" [49].

The physically permeable façade is valued every one hundred square meters, that is, entrances that include accesses to shops, restaurants and cafes, building lobbies, active service entrances, pedestrian walkways and entrances to parks and squares. Emergency exits, accesses to warehouses, garages and vehicular accesses, empty lots or alleys that do not connect to public roads on both sides do not qualify.

Shade and shelter provide the pedestrian with adequate protection from the sun and rain through trees, constructions such as arches, awnings and canopies, public transport stops, sun screens. Streets with more than two traffic lanes must incorporate these elements on both sides of the street to count as shaded walkway segments.

3.4. Equation use (walking)

In the assessment of pedestrian pathways, first, the total number of pedestrian pathway segments (Pps) on the block is quantified, then the segments that meet the previously described safety and accessibility criteria (Sas) are identified. Finally, the second value is divided by the first to calculate the percentage of integrity (%I) of the pedestrian pathway network. Only the percentage of the complete pedestrian pathway network with a value will have a 100 % value equivalent to three points; if this percentage is less than 100 %, its equivalent will be zero points in the DOT Standard, as shown below:

Percentage of Pedestrian Pathway Network Integrity:

% I═S_as / S_vp

Where:

S_as: Segments that meet accessibility and safety criteria

S_vp: Number of pedestrian pathway segments

Scoring:

%I = 100 → Equates to 3 points

%I < 100 → Equates to 0 points

Regarding pedestrian crossings, the process involves quantifying the number of intersections requiring pedestrian crossings (ICP). Next, intersections with safe and accessible pedestrian crossings (ICPsa) for all are identified. Finally, the second measure is divided by the first to calculate the percentage of complete intersections (%Ic). Similarly, achieving 100 % completeness for crossings earns three points, while less than 100 % results in zero points, as shown below:

Pedestrian Crossings Percentage:

ICP: Number of intersections requiring pedestrian crossings, ICP_sa: Intersections with safe and accessible pedestrian crossings.

Calculation:

% I_c = ICP_sa / ICP

Scoring:

%I_c = 100 → Equates to 3 points

%I_c < 100 → Equates to 0 points

In the assessment of the pedestrian environment surrounding the study area, in relation to visually active facades (Fva), the following process is undertaken: The total number of public pedestrian pathway segments (Svp) is quantified, as well as the number of segments that qualify as visually active (Sva), meaning they provide a direct visual connection with the interior of buildings. The second value is then divided by the first to calculate the percentage. According to the measurement scale proposed by the DOT Standard, if the final result is below 50 %, the score is equivalent to zero points. If it's 50 % or more, the score will be two points; for 60 % or more, three points; 70 % or more will earn four points; 80 % or more corresponds to five points; and 90 % or more translates to six points, as displayed below:

Percentage of Visually Active Facades:

% F_va = S_va / S_vp

Where:

S_va:Visually active segments

S_vp: Number of pedestrian pathway segments

Scoring:

%F_va $<50 \rightarrow$ Equates to 0 points

$50 \leq$ %F_va $<60 \rightarrow$ Equates to 2 points

$60 \leq$ %F_va $<70 \rightarrow$ Equates to 3 points

$70 \leq$ %F_va $<80 \rightarrow$ Equates to 4 points

$80 \leq$ %F_va $<90 \rightarrow$ Equates to 5 points

$90 \leq$ %F_va $<100 \rightarrow$ Equates to 6 points

Regarding physically permeable facades (Ffp), the process involves calculating the average number of entrances per hundred meters of block facade. The total length of the block facade (Ltf) adjacent to the public pedestrian pathway is quantified, and then divided by one hundred meters. Subsequently, the number of entrances along the public pedestrian pathways (Ac) is quantified, and the second measurement is divided by the first, as shown below:

Average Physically Permeable Facade:

Average entrances per every 100 m of facade, F_fp:

$F\_fp = (A\_c / (L\_tf / 100)) \div S\_vp$

Where:

Ac: Quantification of continuous entrances

Ltf: Total length of facades

S_vp: Number of pedestrian pathway segments

Scoring:

$F\_fp < 3 \rightarrow$ Equates to 0 points

$3 \leq F\_fp < 5 \rightarrow$ Equates to 1 point

$F\_fp \geq 5 \rightarrow$ Equates to 2 points

To calculate the percentage of pedestrian pathway segments with adequate shade or shelter elements (%Ssr), the pedestrian segments with evidence of tree units (Ssr) were quantified and divided by the number of pedestrian pathway segments (Svp) in the survey. When reaching 100 %, the equivalence is one (1) point on the measurement scale of the TOD Standard.

Percentage of Segments with Shade and Shelter:

$\%\ S\_sr = S\_sr / S\_vp$

Where:

S_vp: Number of pedestrian pathway segments

S_sr: Number of segments with shade and shelter

Scoring:

$\%S\_sr = 100 \rightarrow$ Equates to 3 points

3.5. Equation use (connect)

For the assessment of small blocks, only the number of blocks within the study area was quantified along with their respective lengths. Subsequently, it was verified whether the majority of these blocks correspond to lengths less than 110 m, 130 m, or 150 m. Based on this analysis, a scoring was assigned according to the guidelines specified in the DOT Standard, as displayed below:

Number of Blocks in Observation Areas and Their Corner-to-Corner Length:

$C\_p = C\_sr / S\_vp$

Where:

C_sr: Number of small blocks observed

S_vp: Number of pedestrian pathway segments

Scoring:

L_c < 110 → Equates to 10 points

110 ≤ L_c < 130 → Equates to 6 points

130 ≤ L_c < 150 → Equates to 2 points

L_c ≥ 150 → Equates to 0 points

For calculating prioritized connectivity, it's necessary to identify and total intersections—both vehicular and pedestrian—with appropriate pedestrian pathways and crossings through mapping the study area. The quantification of intersections is performed such that, if it involves four roadways, it's counted as (1) intersection; if three roadways or a "T" configuration is present, it's counted as 0.75 intersections; and if five directions converge, it's counted as 1.25 intersections. Subsequently, the value of intersections from the second measurement is divided by the first to calculate the proportion of prioritized connectivity, As shown below:

Vehicular Intersections (Prioritized Connectivity):

C_p = ((a + b + c)) / I_vp

Where:

a: 4 roadways = 1 intersection

b: 3 roadways or T configuration = 0.75 intersections

c: 5 roadways = 1.25 intersections

I_vp: Number of pedestrian pathway segments

3.6. Field work

The study area was explored through direct observation tours by the authors with photographic records at different times of the day (7–9 am, 12-2 pm, 3–5 pm, 6–7pm) for seven consecutive days between September 4th and 10th, 2020, to qualify and quantify the indicators according to the urban dynamics related to population flows. The measurements were made by taking pictures of the characteristics determined by the TOD guide and generation of analytical and synthetic graphs, based on the planimetric sources and regulations that underpin the work developed, using Geographic Information Systems (GIS), which were condensed into the ArcGIS StoryMaps application. No survey, questionnaire nor interviews were applied, so the study does not involve ethical conditions.

4. Results

The study focused on measuring the characteristics of walking and connectivity in the study area to establish a standard for understanding the sector and designing interventions that meet universal accessibility criteria. The ideal state, as suggested by the TOD Standard, is a score of 30 points when summing up the principles of walking and connecting. However, the assessment of the research area yielded a score of only 16 points. This indicates a favorability ratio of 53.33 %, highlighting a high deficiency value of 46.66 %, especially concerning pedestrian paths, crossings, and prioritized connectivity. This underscores the lack of consideration for people in urban design and land planning instruments [50].

Despite some visually attractive facades and small blocks in the segments, which are largely commercial, only 34 out of 115 commercial premises met the required permeability conditions for effective walkability. This presents a significant challenge for individuals with disabilities, causing tension while navigating the city [51]. Mobility for people with disabilities was found to be weaker compared to that of the general population [52].

Table 2
Results of the evaluation carried out vs. the score proposed by the DOT Standard.

PRINCIPLE	INDICATOR	IDEAL SCORE	SCORE OBTAINED
WALK	Pedestrian pathways	3	**0**
	Pedestrian crossings	3	**0**
	Visually appealing façade	6	4
	Physically permeable façade	2	1
	Shade and shelter	1	1
CONNECT	Small blocks	10	10
	Prioritized connectivity	5	**0**
EQUIVALENCE		100 %	53.33 %

Furthermore, the study revealed that the quality of shade and shelter was satisfactory due to the presence of trees. These trees not only create a comfortable environment but also contribute to urban sustainability by positively impacting the climate and pollution levels [53]. This aspect received an ideal score, making the environment attractive and conducive to pedestrian activity. The provided Table 2 presents the evaluation results compared to the scores proposed by the DOT Standard. It outlines the ideal scores and the scores obtained for various indicators under the principles of walking and connecting [Table 2].

Regarding the principle of connecting, small blocks were evaluated based on pedestrian connectivity, considering short, direct, and varied routes. The study found that most of the blocks (90 %) fell within a comfortable length range, receiving a high score.

However, vehicular intersections presented challenges, with a lack of proper connectivity conditions despite the number of intersections observed. Overall, the study results highlight the deficiencies in pedestrian infrastructure and connectivity within the study area, particularly in relation to accessibility and urban design [Fig. 2].

Fig. 2. List of analysis segments (top) and details of intersections with pedestrian crossings (bottom). Fifth Avenue (*Carrera 5*). Own elaboration from images of Google Maps.

In four segments of pedestrian path, none of them fully meet the criteria of easy access, without obstructions or barriers and with lighting. Five intersection points were recorded, all with deficiencies due to the absence of barriers, two or more meters wide and delimited, with an island accessible to all and lighting. In both cases, the score was zero. Regarding the visually active facades, or those that provide a direct visual connection with the interior of the buildings, three segments fulfilled this characteristic, in correspondence with their commercial dynamics. This equates to 75 % segments, which earn four points on the TOD measurement scale.

Results revealed varying lengths across the four study segments: 125, 135, 240, and 336 m. Field visits assessed pedestrian access to shops, restaurants, and buildings, focusing on continuous pathways devoid of obstacles. Within the first segment, two suitable access points were identified; the second segment displayed eight favorable entries out of a total of twenty. Similarly, the third segment exhibited nine accessible entrances out of a total of forty, while the fourth segment boasted fifteen accessible entries out of the fifty-three available. Calculating the average by summing the accessible entries and dividing by the total number of entries yielded a value of 3.9. Utilizing the measurement scale stipulated by the TOD Standard, an average score of less than 3 translates to zero points, a score from 3 to just under 5 corresponds to one point, and a score of 5 or higher corresponds to two points. Therefore, the optimal score is 2 points, signifying a well-connected and accessible environment [Fig. 3].

5. Discussion

The results of this study provide valuable insights into the characteristics of walking and connecting within a specific urban sector marked by a diversity of complex buildings and a high presence of people with functional diversity. These findings hold significance not only for the assessed sector but also for their potential applicability to similar urban contexts. In this discussion, we delve into the replicability of these results, explore their practical implications, compare them to existing scientific literature, and highlight their contributions to urban planning and design.

5.1. A Blueprint for Contextually Adapted urban assessments

The methodological framework deployed in this study to evaluate the principles of walking and connecting offers a systematic and versatile approach that holds promise for applicability in diverse urban landscapes. The adaptability of this methodology finds resonance in the broader literature on urban assessments and sustainable urban development. As urban areas grapple with distinct challenges rooted in local demographics, geography, and social dynamics, there is an increasing demand for assessment tools that can be flexibly deployed across diverse scenarios [54]. This resonates with the essence of the current study's methodology – an adaptable toolkit that caters to the unique fabric of individual urban contexts.

In essence, the methodology employed in this study serves as a beacon of replicability that can illuminate the path towards holistic urban development across diverse urban landscapes [55]. By offering a systematic and adaptable framework for evaluating the principles of walking and connecting, this methodology stands at the intersection of empirical rigor and contextual sensitivity. As

Fig. 3. Data derived from the field study.

urban centers strive to embrace sustainability and inclusivity, the potential for knowledge dissemination and collaborative learning through this methodology holds the promise of transformative urban change [56].

5.2. Paving the path for inclusive and livable urban environments

The findings of this study extend beyond the realm of research, resonating with practical implications that can catalyze positive changes in urban planning, design, and policymaking. The gap unveiled between the theoretical ideal of the TOD Standard and the actual assessment score serves as a clarion call for directed interventions that can enhance pedestrian pathways, crossings, and overall connectivity. This discrepancy mirrors the sentiments expressed by Geurs and Van Wee, who highlight the necessity of striving for sustainable and seamless urban mobility by addressing the challenges posed by existing urban infrastructure [57].

The revelation of accessibility deficiencies for individuals with functional diversity beckons the integration of universal design principles into the urban fabric [58]. The imperative of fostering inclusive urban environments is echoed in the work of Steinfeld and Maisel, who advocate for design that caters to the needs of all individuals, regardless of their physical abilities [59]. The results of this study provide empirical support for the call to action articulated by Steinfeld and Maisel, underlining the urgency of transforming urban spaces into accessible and equitable havens [60].

In conclusion, the practical implications drawn from this study are a testament to the potential for impactful change within urban environments. By shining a spotlight on critical areas for improvement, inspiring aesthetic enhancements, emphasizing universal accessibility, and supporting data-driven policymaking, the results unfold a roadmap towards more inclusive, engaging, and livable cities [61].

5.3. A Nexus of inclusive urban planning, sustainable design, and mobility

The findings of this study emerge as a distinct yet harmonious voice in the ongoing dialogue surrounding inclusive urban planning, sustainable design, and urban mobility. The alignment of these results with previous research is evident in their consistent depiction of the disparities between urban design and the needs of diverse populations [62]. Research spanning various geographies and urban settings consistently underscores the imperatives of universal accessibility, social equity, and inclusivity [63].

In essence, the present study's alignment with existing literature amplifies its significance by establishing a crossroads of ideas and converging towards a shared goal of creating urban environments that cater to all members of society [64]. The study's findings echo the chorus of scholars advocating for a fundamental shift in urban planning and design, one that embraces the principles of universal access, social equity, and inclusion. Through this congruence, the study invigorates the ongoing conversation on urban mobility, emphasizing the dire need for a paradigm shift that prioritizes the comfort, accessibility, and well-being of individuals with functional diversity.

5.4. Enhancing urban livability through the TOD standard

The TOD Standard's deliberate focus on pedestrian pathways, crossings, and small block sizes is strikingly harmonious with the contemporary global movement toward fostering walkable cities and sustainable urban mobility. The findings of this study dovetail seamlessly with the insights provided by Handy and Clifton, who advocate for urban environments that encourage walking and prioritize the needs of pedestrians [65]. The data-driven nature of the assessment resonates with their call for empirical validation of urban design principles that promote active transportation.

Furthermore, the study's spotlight on shade and shelter adds a unique dimension to the discourse on urban livability. These findings reverberate with the research conducted by Mitchel and Dorling, which emphasizes the integral role of green infrastructure in mitigating urban heat island effects and enhancing pedestrian comfort [66]. The intersection of these findings with the TOD Standard's evaluation criteria underscores the symbiotic relationship between design, nature, and urban well-being [67].

It is important to highlight the utility of the TOD standard and suggest that constant adjustments should be made to increasingly tailor the indicators to address the specificities of vulnerable users. Consequently, a more extensive review of the six principles of the TOD guide that are not addressed in this study should lead to greater awareness and precision in measurement tools.

6. Conclusions

From the perspective of the TOD methodology and with the purpose of prioritizing the rights and opportunities of all people, the evaluative application of the principles of walking and connecting evidenced different basic parameters of spatial inequalities in the city, which determines the usefulness of its application in cities of similar scales. However, it is possible that other principles such as cycling, mixing and compacting can be integrated in the future given the small city conditions that the city presents. This research generates the bases to gradually adjust the urban evaluation tools for the Latin American case, in which exclusion is usually more evident due to informal growth.

The results obtained through the application of the TOD Standard guide, contribute to the generation of a verifiable diagnosis on the study area, which can be applied to other sectors of the city, with the purpose of determining the essential and structuring characteristics. of public space with an inclusion approach for people with functional diversity. These criteria generate a concrete basis for incorporating guidelines for inclusive urban planning, as they show their usefulness and practicality for developing and modifying walkability assessment tools. In them, the possibilities of building information on safety, attractiveness and accessibility for people

with functional diversity are exposed.

With the applied methodology and the final assessments, an articulation is achieved between the theories that support the need for changes in the urban environment to meet the principles of legitimacy in the form of the unrestricted right to the city, through inclusion, walkability, functional diversity and the reduction of existing exclusion in the urban models implemented so far in Ibague.

The aging of the population will inevitably lead to these criteria being increasingly necessary and, consequently, societies being more sensitive with the requirements of their citizens to access the activities offered by their urban environments. It is essential that urban planning focuses on a new vision of the city, where dynamics are prioritized to connect people, activities, pedestrian paths, public spaces and services, through the essence of mobility that is walking.

Finally, the results make it clear that the presence of vegetation is essential for people's experience in the urban world to be comfortable, attractive and consistent with the objectives of a sustainable, equitable and fair world. In this sense, infrastructure is not an independent factor for walkability, but a structure that must be thought of as articulating the virtues of a society that is expressed in its material culture, of which cities are a part.

Data availability statement

Data is available at https://storymaps.arcgis.com/stories/3494e1081487458da18ae09c0c679d64.

Additional information

No additional information is available for this paper.

CRediT authorship contribution statement

Yaqueline Guevara-Quinchúa: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation. **Andrés Ernesto Francel-Delgado:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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