Assessment of the habitability of public spaces in the central urban area of a Peruvian city

Evaluación de la habitabilidad del espacio público en el área central urbana de una ciudad peruana

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Abstract

This research evaluates the livability of public space in the urban center of a Peruvian city, specifically Chiclayo. The study is non-experimental, with a quantitative and descriptive approach, and analyzes nine physical and environmental indicators using observation sheets and geospatial analysis. The results show that livability in the central area is poor, primarily due to limited pedestrian infrastructure and limited promotion of sustainable mobility. Equipped and sustainable public spaces (EPES), such as parks, pedestrian walkways, and wide sidewalks, represent only 2.95% of the total area. Regarding the environment, noise levels exceed the limits established by the ECA (Economic and Urban Development Act), the vegetation index per inhabitant is barely 4 m²/inhabitant, considered insufficient, and urban trees on main roads are very scarce. The conclusion is that it is urgent to implement interventions that improve sustainable spatial connectivity and increase urban green areas, in order to create more comfortable, walkable, and suitable public spaces for leisure and enjoyment.

Keywords: central area, public spaces, habitability indicators.

Resumen

Esta investigación evalúa la habitabilidad del espacio público en el centro urbano de una ciudad peruana, específicamente Chiclayo. El estudio es de tipo no experimental, con enfoque cuantitativo y descriptivo, y analiza nueve indicadores físicos y ambientales mediante fichas de observación y análisis geoespacial. Los resultados muestran que la habitabilidad en el área central es deficiente, principalmente por la limitada infraestructura peatonal y la escasa promoción de la movilidad sostenible. La dotación de espacios públicos equipados y sostenibles (EPES), como parques, paseos peatonales y veredas amplias, representa solo el 2.95 % de la superficie total del área. En cuanto al ambiente, el nivel de ruido supera los límites establecidos por el ECA, el índice de vegetación por habitante es de apenas 4 m²/hab, considerado insuficiente, y el arbolado urbano en las vías principales es muy escaso. Se concluye que es urgente implementar intervenciones que mejoren la conectividad espacial sostenible y aumenten las áreas verdes urbanas, con el fin de crear espacios públicos más confortables, caminables y aptos para el ocio y el disfrute de la población.

Palabras clave: área central, espacios públicos, indicadores de habitabilidad.

Introduction

The city is a space that responds to the needs of its inhabitants, constituting a place of opportunities and gatherings. In this sense, the model of a vital, safe, healthy, sustainable, and supportive city considers public space as the fundamental means to strengthen the sense of belonging and community. As Gehl (2014) indicates, the city must be designed for people, which is achieved when a greater number of individuals use public spaces, walk along the streets, and enjoy attractions and services throughout their journey, always with a sense of safety. Furthermore, it is essential to promote environmentally friendly mobility, encouraging the use of bicycles and walking, as well as values oriented toward the common good.

Consequently, public space is considered a key element for urban well-being, as it serves as a meeting place and a setting for social practices that enhance quality of life. Therefore, it must be livable; that is, it should meet citizens' needs and offer spatial, environmental, security, and equity conditions that allow for constant use, social cohesion, and community appropriation (Páramo et al., 2018).

From another perspective, ecological urbanism defines the livability of public space as the appropriate combination of characteristics that facilitate enjoyment of these places, including comfort, attractiveness, ergonomics, street size, vegetation, and thermal and acoustic control (Rueda, 2019). In the same vein, Borja (2012) points out that the scarce open spaces in cities are not designed for people, leading to issues of degeneration, abandonment, and loss, with a trend toward exclusion and privatization. The lack of robust public space, which promotes social cohesion and symbolic connection, results in the dilution of the city.

Moreover, the United Nations (ONU, 2016), during its conference on Housing and Sustainable Urban Development (Habitat III), highlighted that in many urban centers of developing countries, the space allocated to streets is less than 15%, decreasing to under 10% in peripheral areas and informal settlements. Additionally, over the last three decades, the area of public spaces has diminished due to their high valuation and sale for private construction. In contrast, successful cities in Europe, the Nordic countries, and the United States allocate up to 50% of their urban area to public spaces, distributing 35% for high-quality thoroughfares and the remaining 15% for other services and public activities. This design results in well-planned streets, integrated, safe, and maintained spaces, contributing to reduced crime and violence, increasing green areas, and generating economic and environmental benefits that enhance urban quality of life.

Various efforts have sought to measure the characteristics of public space. For example, the Urban Ecological Agency of Barcelona (AEB, 2010) proposed livability indicators organized into three areas: urban morphology (road accessibility, space for vehicles and pedestrians), attracting activities (mixed uses, diversity, and green spaces), and environmental conditions (thermal comfort, air quality through monitoring CO2, PM10 particles, and noise levels).

The United Nations Human Settlements Programme (ONU-Hábitat, 2018), from a sustainable perspective, assesses urban prosperity using a matrix that considers road infrastructure as a structuring factor of public space. It measures road interconnection based on the number of intersections and road density, indicators that, if adequate, ensure a walkable and accessible city. Furthermore, quality of life is evaluated through proximity to public gathering spaces (EPES) and green area per capita, promoting urban diversity and equity in the location of these spaces, ensuring accessibility for the entire population.

In the Latin American context, Páramo et al. (2016) defined nine categories to measure the livability of public space: environmental sustainability, mobility, services, cultural dynamics, safety, governmental dynamics,

social dynamics, economy and consumption, and infrastructure. These categories include 92 indicators, some quantitative —with formulas and objective measurements— and others qualitative, capturing citizens' perceptions.

Overall, these approaches confirm that public space is a key indicator of urban livability, and its qualities must be measured from three dimensions: physical, social, and environmental. The balance among them is essential for achieving quality urban spaces.

From this perspective, the city of Chiclayo, located in northern Peru, faces accelerated growth that exceeds its original structure, with unsustainable urban expansion that affects the quality of its public spaces and leads to their degradation. The increase in urban occupancy in the center has deteriorated existing public spaces, which have lost their function as socioeconomic and cultural connectors for the population (Aparicio et al., 2021).

In line with this, Lorren (2022) notes that the central area of Chiclayo shows notable abandonment, with commercial, institutional, recreational, and leisure activities negatively impacting the surrounding public spaces. Additionally, routes to parks and small plazas have been replaced by visits to shopping centers, diminishing social cohesion and the value of these spaces for citizens.

Given that the central area of Chiclayo is the traditional and original space of the city, a meeting place for residents and visitors, it requires efficient urban management. Therefore, this research aims to evaluate the livability of public spaces in this area, measuring indicators under the framework of a sustainable and healthy city, such as sustainable mobility, green area per inhabitant, road connectivity, accessibility, proximity, and vegetation index. Thus, the study seeks to delve into this issue and provide a foundation for future responses aimed at fostering a healthy, safe, human, and sustainable city.

Methodology

The research method employed is non-experimental, cross-sectional, and descriptive, with a quantitative approach. A field study was conducted to develop the following actions:

a. Identification of the central area of Chiclayo: This involved gathering information on its morphology, boundaries, number of blocks, quantity of lots, types and number of gathering spaces, as well as the population residing in this area.
b. Measurement of nine indicators: These indicators are related to the physical and environmental livability of public spaces in the central area, following the detailed methodology outlined below.

To calculate road density, the length of each segment of the road system in the sector was measured, summing all lengths expressed in kilometers. The density of intersections was obtained by counting each road crossing. Both indicators were analyzed using visual cartographic methods and cartometric techniques, extracting information such as distances, coordinates, and areas based on the cadastral map of Chiclayo (Lizmova, 2007).

The area allocated to roadways was determined through a field survey, recorded in observation sheets, measuring the area occupied by the road system within the sector. This data was digitized in AutoCAD and subsequently exported to ArcGIS for precise extraction of areas and surfaces (Fontán, 2012).

Regarding modal distribution, a visual count of transportation modes was conducted at eight high-traffic intersections for 10 minutes during three time slots (morning, noon, and night). The types of transport and the number of trips were recorded using specific vehicle counting sheets.

The area allocated to pedestrians was calculated by measuring sidewalks, pedestrian streets, boulevards, and promenades in relation to the roadway section. The percentage of pedestrian space relative to the total area of the segment was determined for classification.

To analyze proximity to urban activities and public gathering spaces (EPES), 15 spaces in the central area were identified, including parks, plazas, and sidewalks of five meters or more. A 300-meter influence radius was projected (Castelao et al., 2019) to observe land uses, predominant activities, and areas of higher concentration.

Noise level measurements were taken at 15 strategic points of road crossings during daytime and nighttime hours, using a calibrated 3M SOUNDPRO SE/DL sound level meter. Monitoring followed the protocol established in Ministerial Resolution 227-2013-MINAM (2013), which includes a cartographic procedure for creating noise maps, integrating the measurements and coordinates in ArcGIS software.

To develop the Normalized Difference Vegetation Index (NDVI) for the central area, digital photointerpretation was performed using a high-resolution satellite image from the PeruSAT-1 satellite, with five spectral bands. ArcGIS 10.5 was utilized with the image in TIFF format, applying the formula NDVI = (NIR - RED) / (NIR + RED), as per López-Pérez et al. (2015).

Regarding urban trees, the location of each tree species was identified using high-resolution satellite images from the PeruSAT-1 satellite. Data on length per road segment were collected, and the tree indicator

formula (number of trees divided by segment length) was applied, allowing for the classification of segments according to established ranges (Fontán, 2012; Lusett & Bartorila, 2017).

Finally, all the information collected about public spaces was processed using Excel spreadsheets, along with specialized software such as ArcGIS for georeferencing, AutoCAD, and Adobe Photoshop.

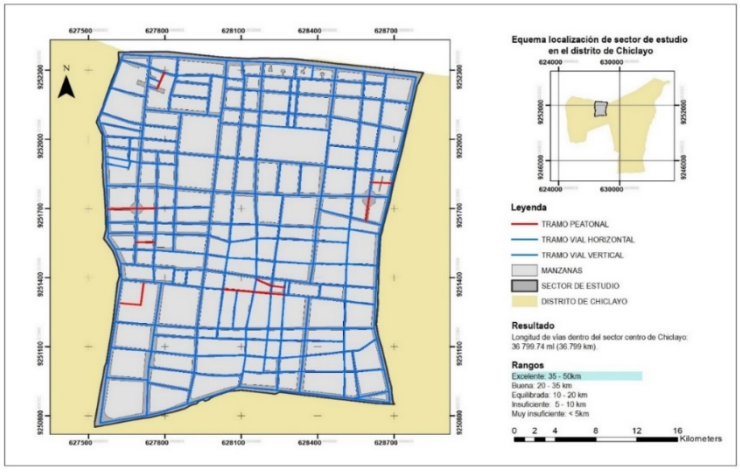
Results and discussion

Road Density

This indicator measures the total length of roads within the center of Chiclayo, considering segments in a straight and uninterrupted line, expressed in kilometers per square kilometer. As shown in Figure 1, the total road density reaches 36,799.74 meters. Of this total, 97.10% corresponds to streets designated for vehicular traffic, while pedestrian paths represent only 2.90%. The analysis indicates that the center of Chiclayo has approximately 35 km² of total road length. This result is considered optimal and is directly related to urban connectivity, as it exceeds the parameter recommended by ONU-Hábitat (2018), which establishes a value of 20 km/km². This threshold suggests that a greater supply of streets and roads, distributed in short lengths, favors pedestrian movement and consequently enhances accessibility within the urban area.

Figure 1

Road density in the central area of Chiclayo

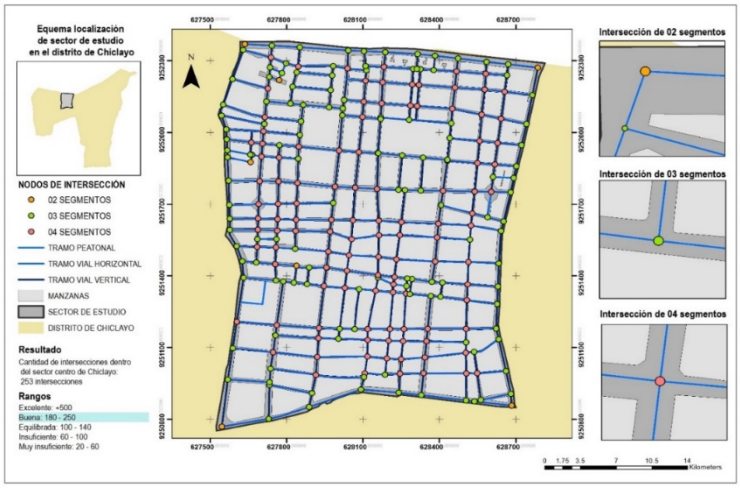


Intersection Density

This indicator quantifies the number of road intersections within the center of Chiclayo. Results reveal a density of 253 intersections per square kilometer. Figure 2 shows that three-segment intersections predominate, representing 51.44%, followed by four-segment intersections at 45.45%. According to the ranges considered adequate for a prosperous and well-connected city, it is recommended to have between 100 and 140 intersections per square kilometer. In this context, the center of Chiclayo is situated in a favorable range, between 180 and 250 intersections per square kilometer, which positively contributes to the walkability and accessibility of its streets.

Figure 2

Intersection density in the central area of Chiclayo



Gutiérrez-López et al. (2019) argue that road density is a key indicator of urban connectivity, integrated into the calculation of the walkability index by valuing the number of intersections and nodes as fundamental elements for strengthening sustainable movement in the city. Additionally, urban morphology directly influences the accessibility and connectivity of the road network, as road density and its spatial interconnections facilitate pedestrian transit, promoting varied routes and reducing travel distances due to the presence of short blocks. Notable examples of cities with high values in this indicator include Venice, with 665 intersections per km²; Tokyo, with 381; and Paris, with 161. In contrast, Irvine, California, exhibits a low value of only 5 intersections per km². This evidence suggests that the number of intersections should be related to block size, as shorter distances are more pedestrian-friendly and enhance mobility (Bourdic et al., 2012).

In the same vein, Welle et al. (2015) emphasize that connectivity and block size are key elements for designing safe streets. They indicate that when a block is too long, motorized vehicles tend to travel at higher speeds, posing a risk to pedestrians, who often cross the street outside intersections, in the middle of the block. Regarding connectivity, these authors note that it is efficient when travel distances are reduced, which requires adequate road density and interconnection. This allows for prioritizing foot or bicycle traffic, integrating with an arterial road network intended for motorized vehicles for longer trips. Thus, short, direct, connected, and safe roads are promoted.

Surface allocated to roadways

This indicator was obtained by calculating the percentage that the total surface area of roads represents in relation to the total area of the center of Chiclayo. As shown in Table 1, the percentage corresponding to blocks in the center is 71.16%, while that allocated to roads reaches 28.84%. This result falls within a balanced range in the evaluation, indicating that the proportion of roads is appropriate for the analyzed urban context.

It is noteworthy that the roadway surface in the study area directly influences citizens' accessibility, considering factors such as the shape, width, and connectivity of streets. A prosperous city typically presents a balanced percentage, where approximately 30% of the surface corresponds to roads, facilitating efficient mobility and positively impacting the form, time, and distance of travels.

Table 1

Road surface in the central area of Chiclayo

Formula Code	Data	m²	Percentages
Ssector	Sector area	1 667 424.88	100%
Smz	Block area of the sector	1 186 516.80	71.16%
Svías	Area allocated to roads	480 908.08	28.84%

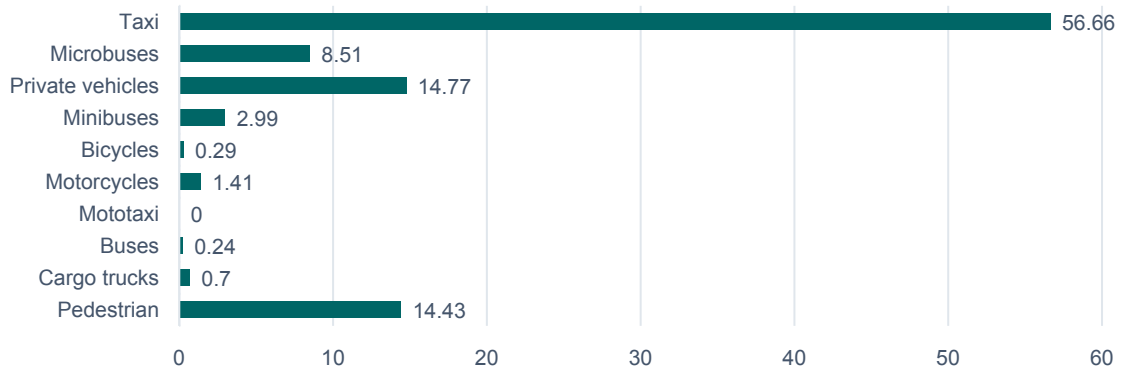
Note. Ranges: Excellent: >10% total area | Good: 20% total area | Balanced: 30% total area Insufficient: 40% total area | Very Insufficient: 50% total area

Modal distribution

This indicator identifies the different modes of mobility and the quantity of units of each type circulating in the study sector, based on counts conducted on main and secondary streets in the center during peak times for one hour. Figure 3 presents the consolidated mobility flows, where taxis predominate with 10,831 units, representing 56.66% of the total vehicles counted. Private cars follow, with 2,823 vehicles, equating to 14.77% of the total. Pedestrian mobility is considerable, while bicycle use is minimal, primarily due to the lack of adequate infrastructure, such as bike lanes. Thus, modal distribution in the area is predominantly vehicular, focusing on taxis, microbuses, and minibuses, which constitute the public transport of passengers.

Figure 3

Modal distribution in the central area of Chiclayo



This indicator is classified as very insufficient for achieving adequate connectivity and a sustainable urban environment. In this regard, Ruiz-Apilánez & Solís (2021) state that the design of the road network conditions how people move within the city, with automobiles being the main factor defining the current road structure. Therefore, it is imperative to shift the urban development model toward a healthy, safe, and comfortable environment, promoting sustainable mobility. To achieve this goal, it is necessary to redesign streets, incorporating walking and cycling as safe and comfortable alternatives that encourage physical activity and reduce sedentary behavior. The authors affirm that adequate infrastructure is fundamental for increasing bicycle use and walking in the modal distribution, thereby improving sustainability and quality of life in the city.

Surface allocated to pedestrian use

This indicator measures the percentage of roadway surface allocated to pedestrian use compared to that designated for motorized mobility, considering the total street section. As shown in Table 2, the studied sector predominates with 224 segments, representing 55.17% of the total road system, with pedestrian occupancy below 30% of the roadway section. This is followed by 135 segments with pedestrian occupancy between 30% and 50%, which accounts for 33.25% of the total roadway.

These results demonstrate that the space allocated to pedestrians, whether on sidewalks or roadways, is limited compared to the space assigned to motorized vehicles. This is because the roadway sections of the streets are not designed to prioritize pedestrian movement, as the width of sidewalks is less than the minimum allowed of 1.20 meters. Additionally, in several cases, the number of vehicle lanes exceeds what is necessary for traffic flow. Therefore, it is essential to reinforce the promotion of walking as an equitable and universal mode of mobility. Walking, compared to other modes of transport, is more efficient in terms of the urban space required (Sanz, 2016).

Table 2

Space allocated to pedestrians in the center of Chiclayo

Table Space allocated to pedestrians			
Accessibility	**Range**	**No. of segments**	**%**
Excellent	>75% occupancy of roadway section	12	2.96
Good	50%-75% occupancy of roadway section	21	5.17
Sufficient	50% occupancy of roadway section	14	3.45

Insufficient	30%-50% occupancy of roadway section	135	33.25
Very Insufficient	<30% occupancy of roadway section	224	55.17

Proximity to urban activities and EPES

This indicator calculated the proximity of public gathering spaces (EPES) within a 300-meter action radius, evaluating their relationship with facilities based on the diversity of land uses and urban activities present in their area of influence.

As shown in Figure 4, most of the central area of the studied sector has extensive coverage, thanks to the spatial distribution of the 15 existing gathering spaces, which include parks, plazas, promenades with sidewalks greater than five meters, and pedestrian streets. Specifically, 88.5% of the total area under study is covered and close to these activities, while the remaining 11.5% lacks coverage or proximity.

These results confirm that there is adequate coverage and proximity of urban activities in the central area, facilitated by the closeness of these facilities, which can be accessed on foot. In this regard, Sanz (2016) emphasizes that walking in public spaces significantly contributes to social cohesion and coexistence, strengthens urban fabric, and fosters citizenship, constituting its most relevant sustainable contribution. Therefore, proximity to facilities and urban attractors reaffirms the importance of promoting spaces for social and urban integration.

Figure 4

Proximity of EPES to urban activities in the central area of Chiclayo



Noise levels

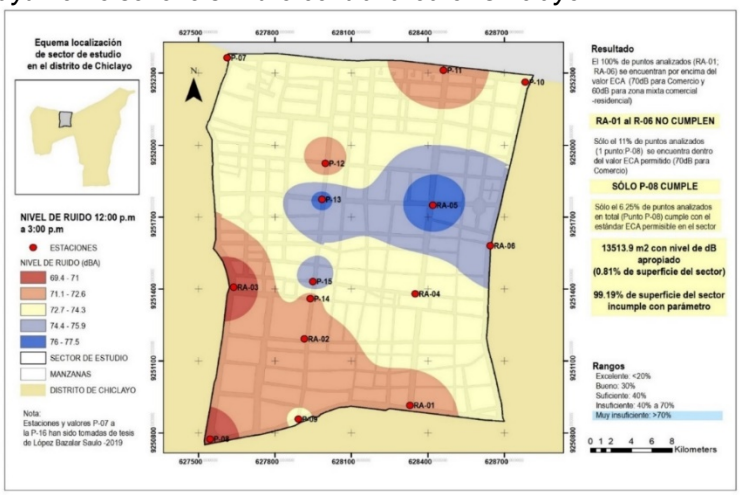
Figure 5 presents the map of daytime noise levels in the central area, where the results obtained from the main monitored streets show values ranging from 71 to 77.5 dB. These levels exceed the limits established for urban use, which is unsatisfactory as they surpass the standards for environmental noise quality (ECAS). This situation is primarily attributed to the constant use of horns by vehicles, negatively impacting the health and tranquility of residents.

In this regard, Alfie & Salinas (2017) note that environmental noise constitutes one of the major problems in cities, with traffic—characterized by horns, engines, and the sound of tires rolling on pavement—being the direct source of this auditory pollution. The negative health effects include hearing damage, psychological disturbances, decreased performance, and concentration issues.

Therefore, the authors advocate for the "walkable city model" as a strategy to mitigate this problem. They highlight that the implementation of pedestrian corridors in Mexico successfully reduced noise pollution, promoted less use of motor vehicles, and increased green areas and public spaces, thereby improving urban quality of life.

Figure 5

Representative map of daytime noise levels in the central area of Chiclayo



Vegetation Index

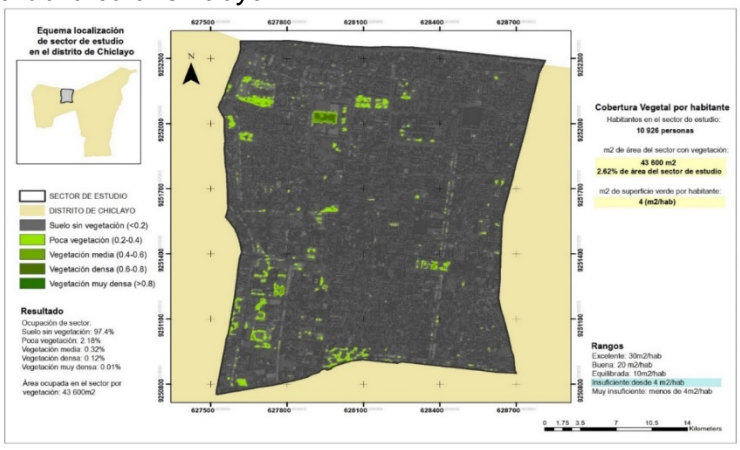
Figure 6 displays the quantification of the vegetation index distributed across the surface of central Chiclayo, taking into account the quantity, availability, and distribution of green areas. It is observed that 162.37 hectares of the central area lack vegetation, representing 97.38% of the total surface area. Conversely, areas with vegetation range from sparse to very dense, collectively totaling 4.37 hectares, equivalent to 2.62% of the total surface area.

Additionally, the green space index per inhabitant in the study area is only 4 m² per person, a value considered inadequate. In this context, Barboza et al. (2021) assessed the relationship between access to green spaces and mortality in 978 European cities, aiming to meet the recommendations of the World Health Organization (WHO). Their results indicate that while 62% of the population lives near green areas, the vegetation index (NDVI) remains below the optimal levels established by the WHO. However, they emphasized that an increase in NDVI could prevent up to 20% of annual deaths per 100,000 inhabitants, representing 2.3% of total mortality from natural causes.

This is because public green spaces are associated with increased physical activity, social cohesion, and reduced stress, which enhance overall health and well-being. Therefore, they conclude that increasing green areas in European cities contributes to reducing mortality from natural causes, promoting the creation of sustainable, livable, and healthy cities.

Figure 6

Vegetation index in the central area of Chiclayo



Tree coverage by street segment

This indicator identifies the street segments that have an adequate number of trees, as well as those where tree coverage is absent. In the road system of the study area, a total of 429 segments were recorded, of which 340, equivalent to 79.5% of the total, have a very insufficient number of trees. Additionally, 10.96% of the segments are classified as insufficient in terms of tree coverage. This situation highlights the predominance of tree-less streets, as only 27 segments, representing 6.29% of the total, have a balanced number of trees. Finally, 14 segments (3.26%) are considered good, and only one was rated as excellent.

This reality is concerning, as urban trees provide significant environmental benefits, especially in air quality, by reducing pollutant concentration and secondary source emissions. Furthermore, they help mitigate the effects of urban heat islands, which pose health risks to residents. In this regard, mature trees with diameters of up to 45 inches are considered the most efficient for reducing air pollution and energy consumption, compared to younger trees, as thermal comfort and cooling largely depend on the size of the tree and the extent of its canopy (Isaifan & Baldauf, 2020).

Conclusions

The habitability of public spaces in the central area of Chiclayo is inadequate, limiting their capacity to promote a sustainable and functional urban environment. Of the nine indicators evaluated, only three reached acceptable values, highlighting the urgent need to develop projects that enhance these spaces through strategies that foster social inclusion, comfort, and equity.

On the other hand, urban elements such as compact layout, favorable road morphology—reflected in road density and intersections—and proximity to urban activities represent opportunities to encourage walkability and strengthen social cohesion, thereby improving accessibility and vitality in the city center.

However, six indicators require significant improvements to achieve adequate habitability in public spaces, particularly in physical and environmental aspects. Among these deficiencies are a modal distribution that does not favor sustainable mobility, insufficient pedestrian infrastructure, high noise levels, and an inadequate index of vegetation and urban tree coverage.

In this context, there is an opportunity to enhance habitability through integrated interventions aimed at revitalizing the urban center, accompanied by public policies that promote greater equity in access to urban infrastructure. Moreover, it is essential to strengthen citizen participation in planning processes to ensure that projects effectively respond to the needs and expectations of users.

To promote a walkable, green, and accessible center, it is necessary to prioritize sustainable modes of transportation, such as walking and cycling, reducing dependence on cars. Therefore, it is proposed to expand and improve pedestrian infrastructure, as well as to incorporate bike lanes that connect the center with the main roadways of the city, ensuring accessibility and comfort. These actions will contribute to reducing noise pollution and increasing green areas and urban tree coverage, which in turn protects against climate change and improves the physical and mental well-being of the population.

Furthermore, while this research provided insight into the current situation of habitability in public spaces in the central area, it is recommended to continue exploring additional physical and environmental indicators, as well as to incorporate social indicators to identify urban practices and user perceptions regarding the appropriation and valuation of these spaces.

Ultimately, urban planning in the central area presents a challenge for local governance, which must actively integrate citizen participation. The recovery of public spaces will not only enhance this key and busy area of the city but will also provide healthy, comfortable, and walkable environments conducive to leisure, enjoyment, and collective well-being.

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