Aprovechamiento y presentación de potencialidades sostenibles en el modelo de movilidad urbana del centro de la ciudad de Ambato
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Revista Hábitat Sustentable Vol. 12, N°. 2. ISSN 0719 - 0700 / Págs. 66 -83
https://doi.org/10.22320/07190700.2022.12.02.05

Recibido 11/07/2022
Aceptado 19/12/2022

USE AND PRESENTATION OF SUSTAINABLE POTENTIALITIES IN THE AMBATO CITY CENTER URBAN MOVEMENT MODEL[1]

APROVECHAMIENTO Y PRESENTACIÓN DE POTENCIALIDADES SOSTENIBLES EN EL MODELO DE MOVILIDAD URBANA DEL CENTRO DE LA CIUDAD DE AMBATO

APROVEITAMENTO E APRESENTAÇÃO DE POTENCIALIDADES SUSTENTÁVEIS NO MODELO DE MOBILIDADE URBANA DO CENTRO DA CIDADE DE AMBATO

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1 Se agradece a la Universidad Técnica de Ambato y especialmente a la Facultad de Diseño y Arquitectura.

Revista Hábitat Sustentable Vol. 12, N°. 2. ISSN 0719 - 0700 / Págs. 66 -83
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RESUMEN

El proceso de urbanización intensificado de las últimas décadas deja en evidencia la necesidad de planificar las ciudades, considerando una adecuada movilidad de personas. El objetivo de este documento es realizar un análisis de las condiciones de movilidad del centro de la ciudad de Ambato desde un enfoque de sostenibilidad. La metodología utilizada se basó en una revisión teórica y un análisis de documentos e instrumentos oficiales, visitas de campo y fichas de observación. Los resultados se obtuvieron a partir del examen de variables objetivas y técnicas que muestran las potencialidades y debilidades del área de estudio para el desarrollo de los modos de transporte activos y menos contaminantes. Se presenta una reflexión sobre las características de peatones, ciclistas y transporte público masivo con el fin de proponer estrategias de gestión encaminadas a fortalecer el modelo de movilidad actual.

Palabras clave
medios de transporte, movilidad urbana, movilidad sostenible, mejoramiento urbano.

ABSTRACT

The intensified urbanization process of recent decades has highlighted the need to plan cities, suitably considering people's mobility. The goal of this article is to analyze the mobility conditions of Ambato city center using a sustainability approach. The methodology used was based on a theoretical review and analysis of official documents, fieldwork, and observation records. The results were obtained by analyzing objective and technical variables that show the study area's potentialities and weaknesses to develop active and less polluting modes of transport. A reflection on the characteristics of pedestrians, cyclists, and mass public transport is presented to propose management strategies that aim at strengthening the current mobility model.

Keywords
means of transport, urban mobility, sustainable mobility, urban improvement.

RESUMO

O processo de urbanização intensificado das últimas décadas evidencia a necessidade de planejar as cidades considerando uma mobilidade adequada das pessoas. O objetivo deste documento é realizar uma análise das condições de mobilidade do centro da cidade de Ambato a partir de uma abordagem de sustentabilidade. A metodologia utilizada baseou-se em revisão teórica e análise de documentos e instrumentos oficiais, visitas de campo e registros de observação. Os resultados foram obtidos a partir da análise de variáveis objetivas e técnicas que evidenciam as potencialidades e fragilidades da área de estudo para o desenvolvimento de modos de transporte ativos e menos poluentes. Apresenta-se uma reflexão sobre as características dos pedestres, ciclistas e transporte público de massa com o objetivo de propor estratégias de gestão que visem fortalecer o modelo de mobilidade atual.

Palavras-chave
meios de transporte, mobilidade urbana, mobilidade sustentável, melhoria urbana.

INTRODUCTION

The unquestionable need to move around urban settlements characterizes the dynamism of people's daily life. Mobility is the social right that satisfies the desire to move and allows access to work, housing, health, education, leisure, etc. This leads to high rates of mobility of people and goods in urban centers. In this context, mobility is understood as "the sum of individual displacements" (Miralles-Guasch, 2002) and, therefore, the way movement takes place within a specific area, a definition that contemplates not just those modalities that involve energy expense (Herce, 2009). Cities are fed, changed, and reproduce based on the mobility of their inhabitants (Kaufmann, 2008).

The general urban mobility model associates motorized and non-motorized modes of transport with the territorial dimension, the urban configuration, and the concentration of opportunities and/or services, since their morphology and structure condition the type and amount of flows generated (Romero Renau, 2011). However, rapid urban growth and the disconnection of planning factors trigger a deficient model reflected in vehicular congestion, low-quality transport services, lack of access to public transport, inappropriate spaces for pedestrians and cyclists, as well as impacts on the environment (Kamran, Farhan, Shujaat & Shah, 2019). Problems that result from the incompatibility of the urban fabric and recent infrastructures coupled with contemporary life (Elserafi, Elkerdany & Shalaby, 2017).

Therefore, an efficient suitable mobility model that meets the needs of the population, and an accessible system that facilitates the cities' activities are needed (Obregón-Biosca & Betanzo-Quezada, 2015). This is because cities are dynamic bodies and although places are similar and have a population whose conditions can be considered as such, they will never be the same, not even in the same region of a country (Gibsone, Jolly, Vilches & Parra, 2011).

Sustainability in urban mobility is based on prioritizing pedestrians, cyclists, and public transport, and its main objective is to promote intermodality and the integration of these modes of transport (Tanikawa-Obregón & Paz-Gómez, 2021) as they lead to less road congestion and contribute to reducing the environmental pollution. Traditionally, sustainability has just focused on environmental impacts. However, in recent years factors such as equity, economic impact, safety, health, and quality have been included (Hipogrosso & Nesmachnow, 2020); streets are starting to be reused to better accommodate mobility solutions, community activities, active modes, charging facilities, green spaces, and commercial activities (Tsavachidis & Petit, 2022).

It has been noted that the implementation of strategies to improve non-motorized transport mobility conditions has a positive impact on the intensity and diversity of urban functions, improving street safety and pedestrian environments (Orellana, Hermida & Osorio, 2017). Indeed, providing a higher quality of space for people is directly related to having more individuals on the streets, which generates a sense of community and connection between pedestrians and cyclists (Kuo & Sullivan, 2001, p. 359). The reduction of motorized transport also has an impact on improving the environmental and landscape quality (Säumel, Weber & Kowarik, 2016, p. 25). This is the case of Curitiba in Brazil and its center's decongestion and pedestrianization process, where successful interventions were made on the main commercial thoroughfares, XV de Noviembre Street and Rua de las Flores. The former was completely closed for vehicular traffic and transformed for exclusive pedestrian use, while furniture for urban shading and rest, differentiated lighting, and landscaping were installed, creating new meeting points and space for free urban coexistence. On the latter, the urban furniture and paving were adapted for people with reduced mobility, the visually impaired, and blind people (Velásquez, 2015). In this way, a new sense of mobility was implemented, oriented not just to move from one point to another but also to discover, identify, and appropriate the city (Suárez Falcón, Verano & García, 2016). Martos, Pacheco-Torres, Ordóñez, and Jadraque-Gago (2016) establish, in this sense, that neighborhoods are the best working areas for the application of sustainable strategies in the city, that intervening at the local level allows identifying specific needs that are the reflection of the conditions at a city level.

Lizárrga (2006), on the other hand, mentions that the main limitation behind implementing a new and sustainable model, is society, as a whole, since it is a participant in the process of changing consumer behavior and the mobility model. For this reason, citizens, the government, and public and private companies must promote actions, policies, and programs that contribute to the new sustainability perspective. However, to achieve this goal, communication channels between different levels of the planning process must be optimized to ensure fluent collaboration

between stakeholders (Kamargianni, Georgouli, Tronca & Chaniotakis, 2022). Spain, through the Ministry of Transport, Mobility, and Urban Agenda [MITMA], demonstrates how a paradigm shift in public administration strengthens communication channels, holding an Open Mobility Dialog to consider all the social actors involved. The field of action of each one is linked, regulated, and delimited through strategies, establishing integrating objectives and the future goals to be achieved. The document "Mobility Strategy 2030: safe, sustainable and connected" sets out strategic lines of action and highlights the application of new investment policies, structured considering projects' social profitability criteria, prioritizing investment programs based on the fundamental needs of the city, the available resources, and social consensus (MITMA, 2021, p. 65). In addition, the social and labor aspects line is shown, which addresses the professional challenges of the transport and mobility sector, since new business models must not pose a threat to the system's balance (MITMA, 2021, pp. 73-74).

Public participation becomes essential to promote sustainability in developing countries (Martos *et al.*, 2016). Interventions should focus on all levels, from the regulation of group behaviors to the regulation of habits for the transport of individuals, additionally contemplating a mechanism to promote best practices and social awareness in terms of sustainability (Uribe Bedoya, Valencia, Ramos & Yovera, 2020).

In this context, it is stated that urban mobility:

> Is the result of a set of transport and circulation policies that seek to provide broad and democratic access to urban space, through the prioritization of non-motorized and collective modes of transport, in an effective, socially inclusive, ecologically sustainable way, based on people and not on vehicles. (Boareto, 2003, p. 49)

In this sense, it is necessary to refer to the most popular measures to contribute to sustainability in urban mobility. Yan, Levine, and Marans (2019) argue that parking policies, and strategies on cost and availability, are efficient to regulate the use of private vehicles. Although the automobile was the protagonist of mobility issues in the last century, contemporary urban planning has introduced policies to reduce individual trips and encourage other forms of transport, applying restrictions and free movement days as in Bogotá, Brussels, Chengdu, Copenhagen, Dublin, Milan, and Paris (Richter, Hagenmaier, Bandte, Parida & Wincent, 2022). The need for a fundamental change in public transport investment patterns should be noted, based on the principle of avoiding or reducing trips by integrating land use and transport planning (Charan & Venkataraman, 2017). According to Kamargianni *et al*. (2022), it is essential to improve public transport and its infrastructure, promoting active mobility and energy-efficient modes, optimizing accessibility of areas relegated to the periphery into the urban dynamic body, such as the case of the metrocable in Medellín (Bocarejo *et al.*, 2014).

To bring the context under study into the South American reality, Santiago de Chile is mentioned as one of the greatest examples of applying initiatives that favor active modes of mobility. The strategy of increasing sidewalk width, removing parking spaces, and reducing road width, won numerous awards that had previously been given to developed cities such as New York, London, and Paris (Herrmann-Lunecke, Mora & Sagaris, 2020). Although it initially raised concern for traders, drivers, and residents, the pedestrianization of streets has spread throughout the main cities of Chile. Arellana, Saltarín, Larrañaga, and Álvarez (2019) highlight the potential of walkability maps as a planning and management tool, which allows evaluating pedestrian infrastructure and identifying the problems faced by pedestrians to move around.

Regarding socio-economic development, sustainable urban mobility affects the remarkable transformation of the urban environment by revitalizing commerce, squares, thoroughfares, and life in the city. Its role in the economy does not just refer to the movements of people to their work, but to citizens who live there, not just passing through, and who are part of the context where they do this. The local economy, by improving connectivity in the city and facilitating access to mobility, is enhanced, access to opportunities is increased, and the doors to education, work, and health are opened, not only for urban inhabitants but also for those from rural areas. So much so that, more and more European cities have incorporated these criteria to achieve a balance between mobility and accessibility needs, making it possible to enjoy the city through safe travel that favors social cohesion and economic development (Mataix, 2010).

> In short, transport systems are under great pressure from socioeconomic and environmental systems. The former requires the rapid growth of transportation, while, the latter needs the system not to exceed the environmental capacity. (Ling, Ma & Jia, 2022, p. 17)

Although this highlights the technical intervention of planners and authorities, mobility should in turn be understood as the territorial right to move, relegating the schematic vision of transport and infrastructure modes to a secondary plane, to introduce the paradigm that they are a means and not, in themselves, the end of a mobility plan (Gibsone *et al.*, 2011). However, despite having an accessible system with a range of mobility alternatives, as is the case of Madrid, the preference for private vehicles prevails, which shows the lack of competitiveness of public transport, mainly caused by insufficient coverage at an intercity level, and deficiencies related to the speed of travel, frequencies, reliability, and interconnection of public transport (Muñoz, Simón de Blas & Jiménez, 2014).

When talking about indicators that allow measuring the efficiency of the mobility system, several proposals should be highlighted that evaluate different social, environmental, and economic factors. Quiroga (2009), for example, refers to an environmental component and another of sustainable development. The former identifies the states of environmental dynamics in urban centers, while the latter evaluates the interrelation of economic, social, and environmental measures. Gaviria (2013) proposes the identification, prioritization, and construction of sustainability indicators based on a literature review, conducting surveys, brainstorming, comparing with other areas, and analyzing the knowledge acquired in previous interventions. Jiménez (2008), meanwhile, works on the construction of indicators by defining strategies, establishing relevant and measurable aspects, and formulating and validating indicators, goals, and measurement periodicity. Likewise, Rodríguez (2016) analyzes mobility indicators in the fields of transport, environment, socio-economic development, urbanism, employment, housing, and optimization of public space. The aforementioned authors agree that for a sustainable mobility indicator to be implemented, it must be measurable, verifiable, reproducible, and relevant. Although, it is necessary to avoid the proliferation of disorganized indicators, disproportion, opportunism, and the measurement of social or environmental situations based on economic indicators (Caniffi, 2022).

This case study focuses on Ambato, the fourth most populated city in Ecuador, which, due to its industrial and commercial role, is considered a pole of economic development for the region. The urban hub has a centralized urban definition, with buildings of public and financial institutions, commercial areas, and historical architecture, as such the trips made within the city have the center as their destination. The intense urbanization process and the high vehicle dependence have led to mobility being projected towards unsustainable scenarios. Public policies and urban planning have favored the development of a functionalist city model, through large avenues that have been designed based on the constant use of the car. When, in reality, accessibility should be sought through safe, egalitarian, and autonomous urban spaces (Guevara, J. Flores & M. Flores, 2022), that provide residents, regardless of the mode of transport, certainty of public service, adequate infrastructure that favors mobility of people with some type of limitation, citizen meeting spaces, to turn the act of moving into a pleasant, affordable, efficient, and safe citizen experience. Urban centers are full of activities, and land uses that generate different types and modes of mobility, thus originating a complex relationship that involves a high degree of organization to be able to manage the movement and satisfy all users (Elserafi *et al.*, 2017).

For all the above, the goal of this research is to characterize the current mobility conditions of pedestrians, cyclists, and public transport, from a sustainability perspective. The potentialities and weaknesses of the ruling model are evidenced using technical analysis of objective variables. The contribution focuses on offering actions that require the least public investment, namely, based on management strategies to promote an effective modal change in daily travel patterns, where active mobility and the least polluting means prevail.

METHODOLOGY

To achieve this goal, a mixed approach was applied, based on bibliographic and field research. The commercial area of the urban center was marked as the study area. Starting from the cadastral plan and *in situ* visits, the type of equipment was identified and classified, establishing zones by the services offered (commercial, government, historical, services, and recreation). A closed polygon was configured delimited by avenues and main streets, trying to cover entire blocks. The coverage radii were analyzed to establish the size of the area, using digital tools, determining the topographic conditions to know the maximum and minimum gradients.

The actors involved in the investigation were pedestrians, cyclists, and public transport. Regarding pedestrians, information on the infrastructure, such as sidewalk width, network

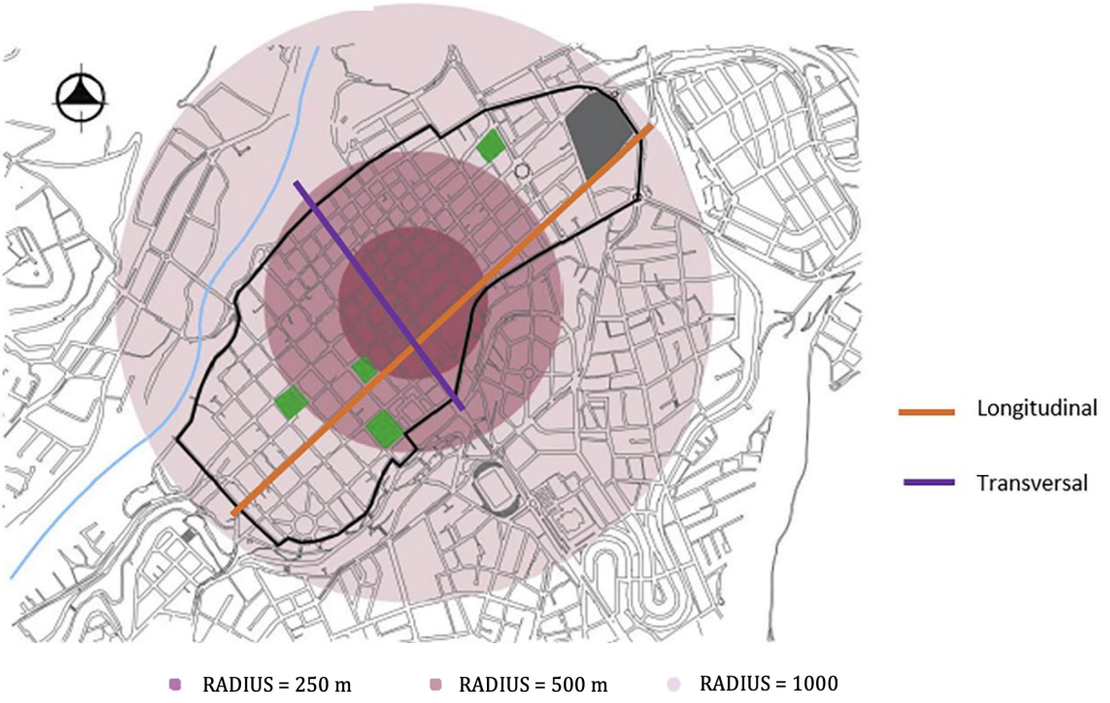

Figure 1. Delimitation of the study area, reference distances, and coverage radii. Source: Preparation by the authors.

continuity, status, accessibility, and service level, was collected using observation sheets. For Pedestrian Intensity, "The Ambato Sustainable Urban Mobility Plan (SUMP)" was taken as a basis, which establishes, in the structural conclusions, that Monday has the highest number of trips and that the places with the greatest mobility issues are markets and squares (Fundación Ciudad Humana, 2021). This information led to choosing the sidewalks around the five markets in the study area. There are three marked time slots during the day, which are considered the ones with the greatest vehicular influx: 6 to 8 am, 12 to 2 pm, and 5 and 7 pm. The latter is considered the most critical due to the end of the working day and the closure of shops (Goyes, 2018, p. 31). Consequently, a pedestrian count was made, for one month, on sidewalks alongside the markets, and in the conditions that have the greatest issues: Mondays from 5 to 7 pm. The capacity was checked every 15 minutes (I15). The width of the sidewalk without a curb (At) was measured and the space occupied by informal stalls was subtracted, obtaining the effective width (Ae). With these data, the unit pedestrian intensity (I) on each sidewalk was determined using the formula (1) set out in the "Highway Capacity Manual 2000" (Transportation Research Board, 2000).

$$I = \frac{I15}{15 * Ae} = \text{Pedestrian/minute/meter} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Regarding cycling, an analysis was made of the study area's conditions to promote its development since the necessary infrastructure is currently not provided.

Regarding public transport, routes, frequencies, schedules, the conditions of units, universal accessibility, capacity, occupancy by service line, peak hours, and service promotion were analyzed, based on reports and official documents provided by the Municipality of Ambato.

Once the information was collected and analyzed, reflections were raised on the current conditions of non-motorized modes and public transport, from a conceptual perspective of sustainability in urban mobility. Fundamental guidelines, which served as input to propose strategies that look to efficiently take advantage of the city's conditions and the means to mobilize within it.

RESULTS AND DISCUSSION

The urban setup is established by a reticular checkerboard layout, with a central square as the heart of the town, surrounded by the church, town hall, and the mayor's residence (Jurado, 2004). The study area is 1.15 km^2. Figure 1 shows the territorial dimension of the analyzed urban area that, longitudinally, has a distance of 1.8 km with an average gradient between 1.2% to 3.1% and a maximum of 7.2%; transversely, it has a distance of 0.84 km with an average gradient

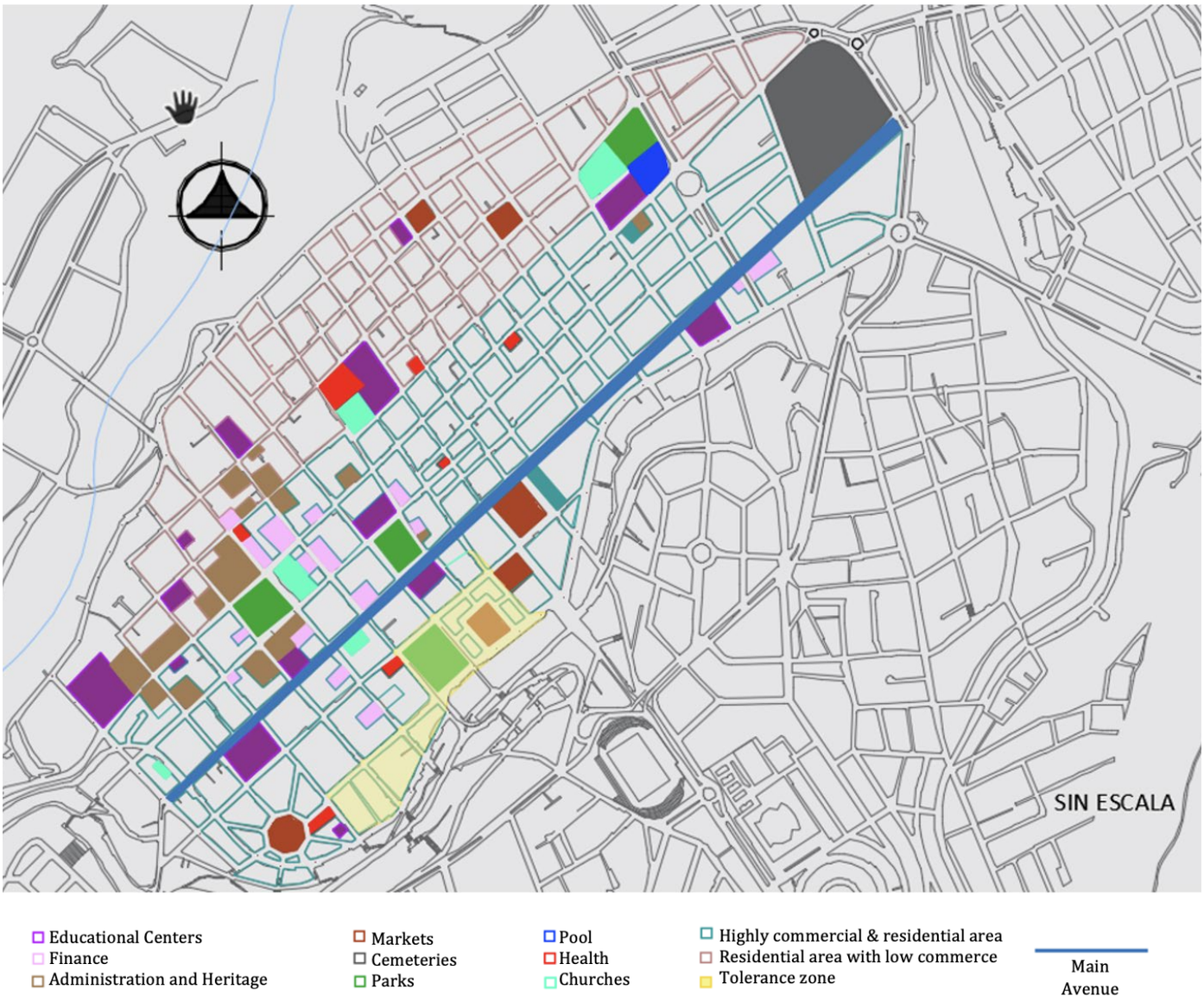

Figure 2. Equipment typology. Source: Preparation by the authors.

between 1.4% to 3.4% and a maximum of 10%. These maximum values do not exceed 100 meters. Coverage radii are shown, which completely cover the area within a 1 km radius, to better understand the territorial dimension.

In terms of equipment, Figure 2 shows that approximately 60% of the study area is commercial infrastructure, in its entirety or combined. The mixticity of the buildings is presented, mainly, as shops on the ground floor and housing or services on the upper levels. The main avenue of the centrality, apart from completely housing commerce, is the main entrance to the city from the north. In the area, there are 12 randomly distributed educational units and more than 15 financial institutions located on main and secondary streets; health typologies are distributed throughout the area without any established pattern; the squares and markets are located very close to one another; while government institutions are located in the heritage area around Montalvo Park. The private services area is found throughout the analysis polygon. However, it is particularly concentrated in the southwest. Religious architecture is also present, seen in 5 churches located on representative streets of the city. The 4 parks are highly transited, mainly due to their historical value and location on the main streets at the heart of the city. It should be mentioned that there is a tolerance zone located on one of the main avenues, next to 12 de Noviembre park, where there is a concentration of short-stay hostels and hotels. All public facilities are located close to each other, which, together

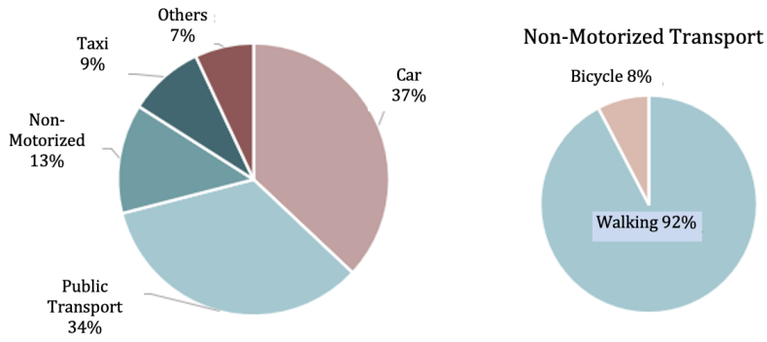

Figure 3. Modal distribution. Source: Fundación Ciudad Humana (2021).

Sidewalk	Service Level
10	A
11	C
12	C
14	D
15	C
16	B
17	C
18	B
19	C
20	C
21	C

Sidewalk	Service Level
22	D
23	B
24	B

The service level cannot be calculated as the informal street traders have completely taken over the sidewalks.

Characteristics of the service levels:
A: The pedestrians are free to choose their speed and route, without being forced to change these due to the presence of other users.
B: The choice of speed is free and the route is only changed to overtake.
C: The pedestrian flow is stable; however, the speed reduces and maneuvering capacity starts to be restricted.
D: Restrictions in speed, with the likelihood of friction and interaction between pedestrians, requiring constant changes in speed and position

Figure 4. Service levels on critical sidewalks. Source: Preparation by the authors.

Figure 5. Public transport routes and unit typologies. Source: Preparation by the authors.

with the accessibility they offer, can improve the satisfaction of the local community (Billones *et al.*, 2021).

Modal distribution. Figure 3 shows that the most used mode is the car, with 37%, followed by public transport, with 34%. 13% use non-motorized transport, 9% use taxis, and 7% use other modes of transport, such as school buses and informal vehicles. For non-motorized transport, 92.31% walk, and 7.69% use bicycles.

Pedestrians. The downtown area has a pedestrian network with approximately 668 sidewalks. 77.7% have a width greater than 1.60 m (recommended minimum), 19.6% do not meet this condition, and 5.4% either have no sidewalk or just part. The continuity of the network is particularly affected by the presence of heritage buildings since the planning lines exceed current ones and force users to walk on the road. 99.8% of the sidewalks are made of concrete and 0.2% of decorative cobblestone. There are no construction defects and 100% of the sidewalks are accessible. Crossings give continuity to the pedestrian network; in the urban area they are marked by "zebra crossings" on the main roads, such as avenues, and, in turn, are complemented with pedestrian traffic lights that help people with some type of visual or hearing impairment to cross. The sidewalks of the main roads have ramps with a slope that allow the rapid incorporation of pedestrian flow into the network and comply with the parameters established by the NTE INEN 2855 standard (Accessibility of people to the physical environment. Lowered curbs and ramps).

Pedestrian intensity. Figure 4 shows the analysis of the Modelo, Artesanal, Central, Urbina, and Primero de Mayo Markets with the respective service levels on their sidewalks, from levels A to D. Sidewalk number 10 is the only one with a service level A, considered ideal, given the large area it offers, which allows pedestrians the freedom to choose their speed and route, without being forced to change it because of the presence of other users. Sidewalks 16, 18, 23, and 24 have a service level B, considered adequate since the choice of speed remains free and their route is modified when overtaking. Sidewalks 11,

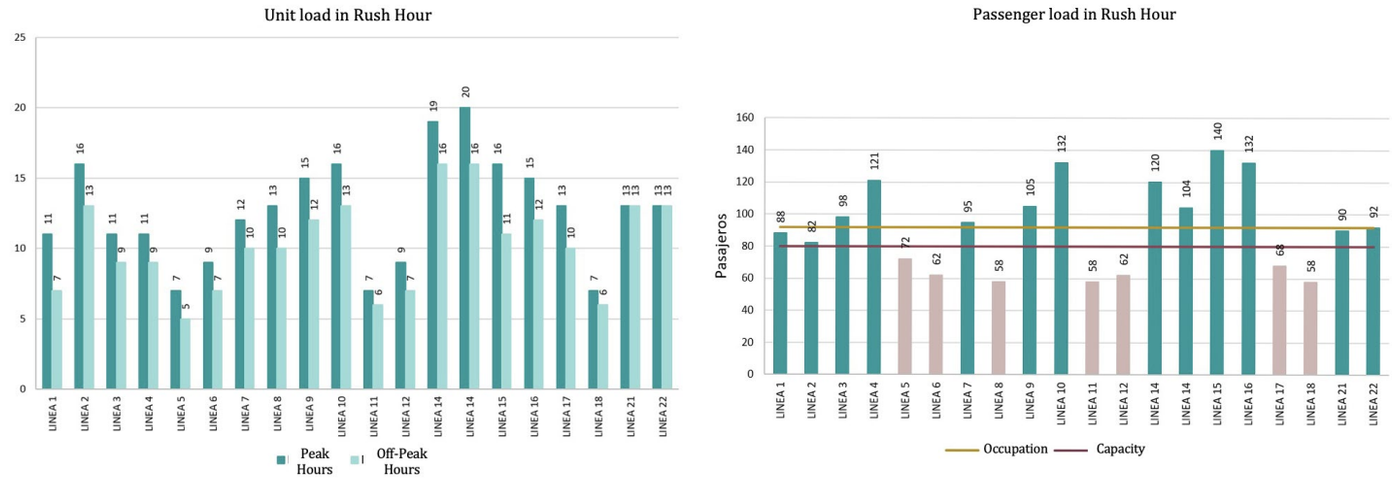

Figure 6. Passenger loads and public transport units in the study area. Source: Aldás (2017, pg. 45 and 67).

12, 15, 17, 19, 20, and 21 exhibit a service level C, maintaining a stable pedestrian flow. However, this is affected by interaction with other users, as such the speed decreases and the ability to maneuver begins to be restricted. Sidewalks 14 and 22 are the most critical, with a service level D. They have speed restrictions and friction and interaction between pedestrians are likely, as such, speed and position changes are required constantly. Of the 14 sidewalks analyzed (10-24) alongside the central, artesanal, and modelo markets, they have acceptable service levels, even at peak hours. Despite reaching D levels, the capacity of sidewalks meets the pedestrian demand. As for the sidewalks adjacent to the Primero de Mayo Market (1-9), these are completely occupied by informal traders' stalls, forcing pedestrians to walk along the road. Thus, it is established as a highly critical area due to the high pedestrian influx and the insecurity that traveling as a pedestrian represents. It was not possible to calculate the service level of the sidewalks.

Regarding infrastructure for cyclists, there is no specific space for its development, and the few citizens who come to the urban center by bicycle transit on the road without any type of protection or priority.

Public transport is the second most used way to get around. It is led by 392 buses from 5 private cooperatives. 22 registered routes cover the city of Ambato, but there are no exclusive lanes for their operation. There are 21 routes within the study area; however, 14 of them move around the peripheries of the equipment and only 7 cross the downtown area using the main roads. The hours of service are from 6 am to 10:30 pm from Monday to Sunday, although this depends on each line. The frequencies vary from between 2 to 14 minutes (Rivera, Mayorga, Vayas, C. Freire & L. Freire, 2017). The places for passengers to get on and off are located at a maximum distance of 300 m from each other. Zellner, Massey, Shiftan, Levine, and Arquero (2016) mention that when the system's initial and final connection is very distant it is strongly criticized by users, making its choice unlikely. The signage of the bus stops is arranged horizontally on the roadway using vertical signs. None of these have suitable equipment to inform about schedules or frequencies, or to provide protection from inclement weather. It should be added that all the lines converge at 12 de Noviembre Park, it is the universal stop, where one can access any route. The peak hours of public transport are set in 3 slots: in the morning from 6 to 7:45 am; at noon from 11:30 am to 1:30 pm; and in the afternoon from 5 to 7 pm (Aldás, 2017).

The type of public transport is the bus (Figure 5), and the units have less than 10 years of service, with a capacity of approximately 80 passengers: 41 seated and 39 standing. 96.9% of the units have cameras connected to the public security system, 6% do not have signage for preferential seating, and 100% do not have access ramps between the sidewalk and the bus (Rivera *et al.*, 2017). The average occupancy, during rush hour, is approximately 92 passengers, which exceeds the maximum established capacity.

35% of the lines are below capacity, while 65% exceed this value (Figure 6). The lines with the highest demand have 140 passengers (Aldás,

2017). The maximum number of buses per line in the city center is 19 to 20, during rush hour. The minimum number is 5 to 7. When counting all the routes under analysis, it was established that there are 253 buses in service traveling during rush hour in the urban area and 205, during the rest of the day, namely, there is a 23% increase during critical hours.

The study area includes the dynamic city center, which has enough equipment to define a highly transited area. The configuration of the urban grid made up of blocks shows a logical and orderly implementation, which favors orientation when moving. The streets have moderate gradients, benefiting walking, since the longitudinal extension does not exceed 2 km and transversely reaches 1 km. According to Bañon Blázquez and Beviá García (2000), the average pedestrian speed is 4km/h and the maximum time a person would be willing to walk does not exceed 30 minutes, in favorable weather conditions. Therefore, to travel through the heart of the city would take approximately 30 minutes longitudinally and 15 minutes transversely. Considering that the average temperature is around 14.6°C, it is possible to indicate that the city center presents a high potential for implementing strategies that favor pedestrians and cyclists. The analysis of the current urban settlement and modes of transport refers to a city that has not yet integrated land use planning with mobility planning.

Pedestrians are the fundamental base of the mobility pyramid, so they constitute the priority because any displacement requires walking, either to reach public transport or the car. In Ambato, 92% of non-motorized transport corresponds to pedestrian displacements. The network has acceptable conditions for transit, both in width, continuity, and service status. The pedestrian intensity on the critical sidewalks has service levels of A, B, C, and D, although the latter is highly affected by informal commerce that takes over the pedestrian public space and displaces citizens to walk alongside the vehicles. Consequently, the main problem affecting this mode is the informal trade and the lack of regulation by the administrative entity. From the sidewalks analyzed, it can be established that, under adequate conditions, they cover the pedestrian demand; however, the application of measures that intend to enhance this modality has not been evidenced. Such is the case of widening the sidewalk and eliminating parking spaces, as in Santiago de Chile, as well as the pedestrianization of streets. There are no technological systems, such as walkability maps, that attempt to compile information to establish the best strategy for the city.

The bicycle only represents 7.69% of the trips, since it has no infrastructure, evidencing the lack of a better distribution of public space for the implementation of a bicycle path. Despite the small territorial dimension where the urban area is located, and the favorable topographic and climatic characteristics, insecurity and lack of a priority culture towards this mode make citizens feel threatened, due to their vulnerability to motorized transport. This limits its use to purely recreational activities and makes it problematic as a daily means of transport in the urban area. It is important to emphasize that facilitating the development of this modality is a priority to achieve sustainability in the current model because it is a modern, accessible, and effective vehicle for short distances and is more efficient than the automobile since it is less noisy, does not produce pollution, the surface destined for its use is reduced, parking requires less space, traffic jams decrease, it has greater access to equipment and improves the users' health. Although, like any mode of transport, it demands services and the application of public policies that guarantee a safe, comfortable infrastructure that meets the demand, as well as public parking, connection with public transport, and other means.

The mobilization by car represents 37% that, in contrast to the 13% of non-motorized transport, reflects a behavior that is highly dependent on the private vehicle. Indeed, by 2018, the province came out top, nationally, in the motorization rate, with 186 vehicles per 1000 inhabitants (INEC, 2019). It is clear that the preference is due to the comfort, security, flexibility, privacy, and freedom it offers. However, it is inefficient, since it transports fewer people, occupies more public space, worsens vehicle congestion, pollutes the environment more, and considering the number of people transported, causes noise and traffic accidents.

Vehicle occupancy shows that 40% of cars only carry one passenger (Fundación Ciudad Humana, 2021, p. 46). The travel reasons are for everyday activities such as: going to work and/or educational facilities, accessing health or leisure facilities, even when the distances are relatively short between the origin and destination since there are no sustainable alternatives that allow handling this preference efficiently. In addition, current conditions favor the entry of the car into

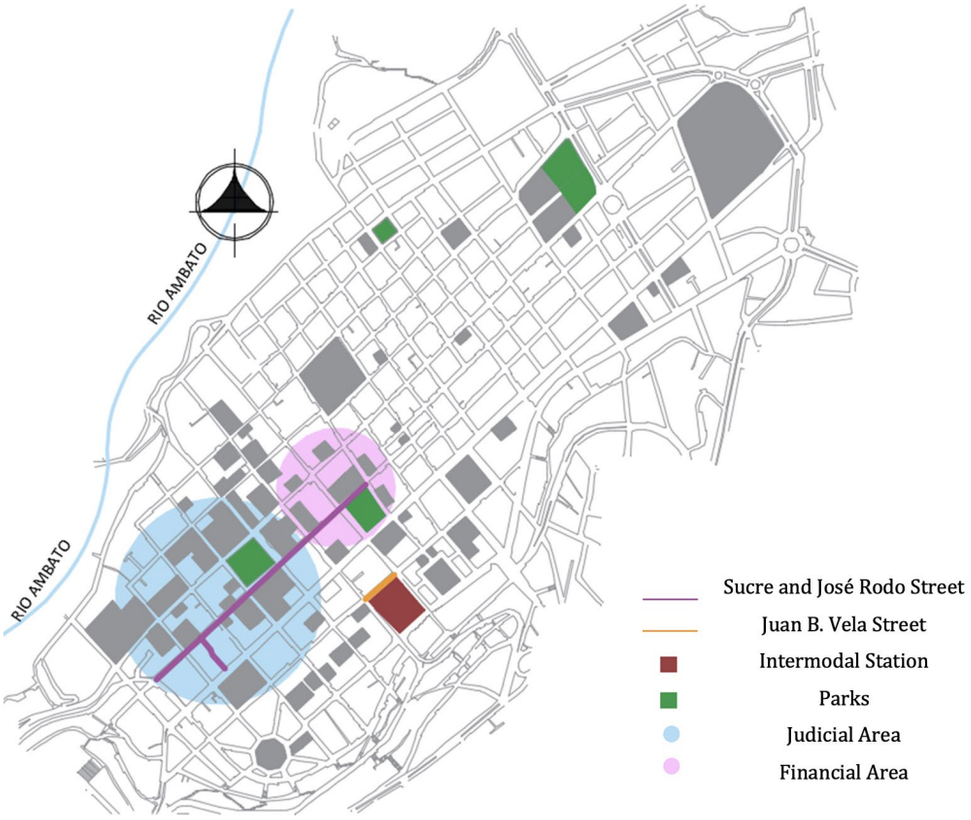

Figure 7. Potential pedestrianization areas. Source: Preparation by the authors.

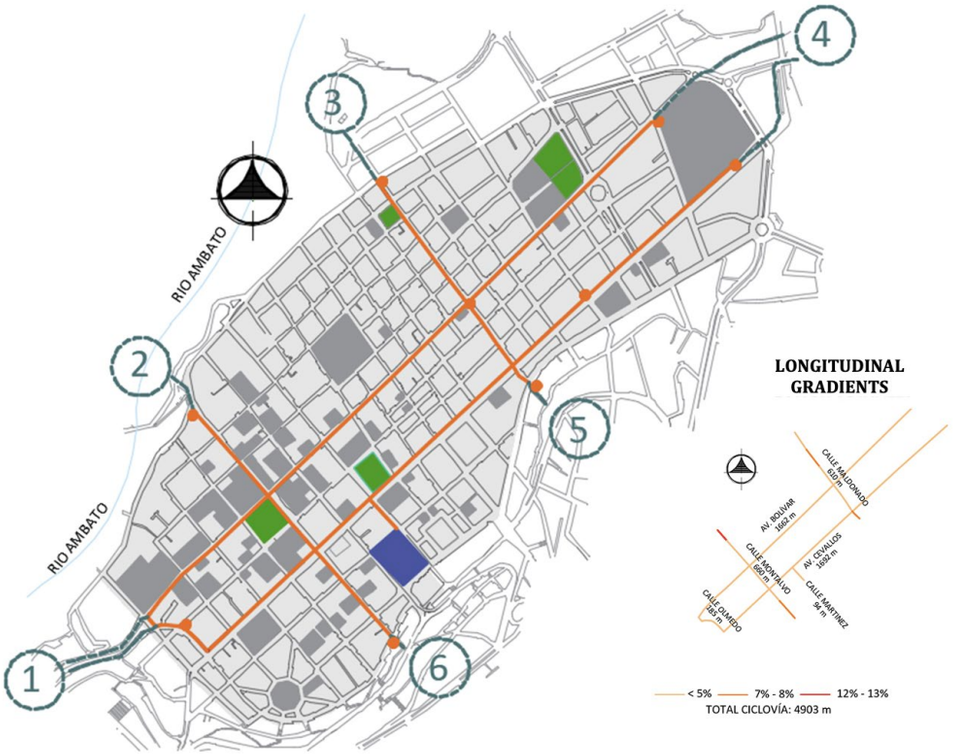

Figure 8. Cycle Path Proposal. Source: Preparation by the authors.

the urban center through the provision of public space for its circulation and fairly widely available parking, even though the efficiency of cost strategies and reduction of parking availability to reduce the use of private vehicles has been demonstrated.

Public transport, starring buses, leads the modal distribution. The efficiency of the system is directly related to the ability and time to mobilize passengers, in safe and comfortable conditions. Although the travel times of each line were not analyzed, it was possible to establish the existence of saturated routes to the extent that their occupancy exceeds the maximum capacity at rush hour by 75%, which is unacceptable, unsafe, and lacks quality. A public service must remain attractive to potential users, but there is no physical or digital information on routes and frequencies, the route taken by the bus is not detailed, it does not move on an exclusive lane, the equipment of the stops does not protect citizens from weather conditions, the service can only be paid with cash and weekly or monthly cards are not available. Regarding social inclusion, no unit has disabled ramps. It should be added that the system is managed by private institutions that administer the service from a purely economic perspective. Although what has been mentioned only refers to the system's current weaknesses, some strengths are evident such as a relatively new fleet, the bus stops are correctly distributed to access the urban equipment and there is a maximum distance between them of 300 meters (Figure 5), which facilitates a rapid change of line.

There is one "universal stop" at 12 de Noviembre Park (Figure 5), where 85.71% of lines pass, establishing itself as a point with high potential to be an intermodal station, where its strategic location on one of the city's main avenues, its size, and its symbolic importance for citizens, has made this place the best known and used to access public transport. However, because it is attached to the tolerance zone, its urban image is decadent, as it represents a highly unsafe place.

As a result, the following management strategies are proposed to promote sustainability in the urban mobility model in Ambato (Figure 9):

- Creation of exclusive paths for pedestrians. Pedestrianization is an alternative that promotes social equity and rehabilitation of the public space: the city is returned to the people. It is people and not vehicles that energize the urban center, they relate, interact, discover, and explore the area, but they must move in a comfortable, autonomous, and unrestricted way. The fact of establishing completely pedestrian roads increases the level of safety for pedestrians by eliminating contact with motorized traffic; in addition, the vehicle volume decreases due to the modal change of the roads. This intervention must respond to a public transport equipment and services connection logic, configuring a continuous pedestrian network. Figure 7 shows the possible intervention areas in Juan Benigno Vela, José Rodo, and Sucre streets, given the constant presence of pedestrians, throughout the day. As it is the judicial and financial area, there are buildings intended exclusively for offices, restaurants, and commercial premises, which define the route of the sector with the necessary daily services of the people who work in the city. It should be noted that the roads are located about 200 m away from the general bus station; a potential that allows maintaining the connection between the different travel modes and the rest of the equipment.

- Cycle Path. Although the infrastructure for this modality is not available, the necessary space can be offered by restructuring existing roads, implementing a basic, logically connected network that can show the expected demand for a future large-scale investment throughout the city. Figure 8 shows the pre-configuration of the cycle path, with two longitudinal sections: Cevallos Avenue and Bolívar Street, due to their high commercial level, where all kinds of businesses, hotels, restaurants, markets, parks or recreational areas, the legal, financial area, etc. are concentrated. The connection between the two sections is made through 2 transversal streets: Montalvo Street and Maldonado Street, which cross the city center from the highly commercial area to the residential and low commercial area. The proposal connects the study area with the rest of the city at 6 points, which are the entrances/exits to the different territorial planning platforms, covering the north, south, east, and west.

- Control of informal trade in the areas surrounding the markets. To establish a mechanism to regulate informal trade, not to eliminate it, but rather, to organize it into suitable spaces that do not affect pedestrian traffic, to develop commercial activity in a dignified way.

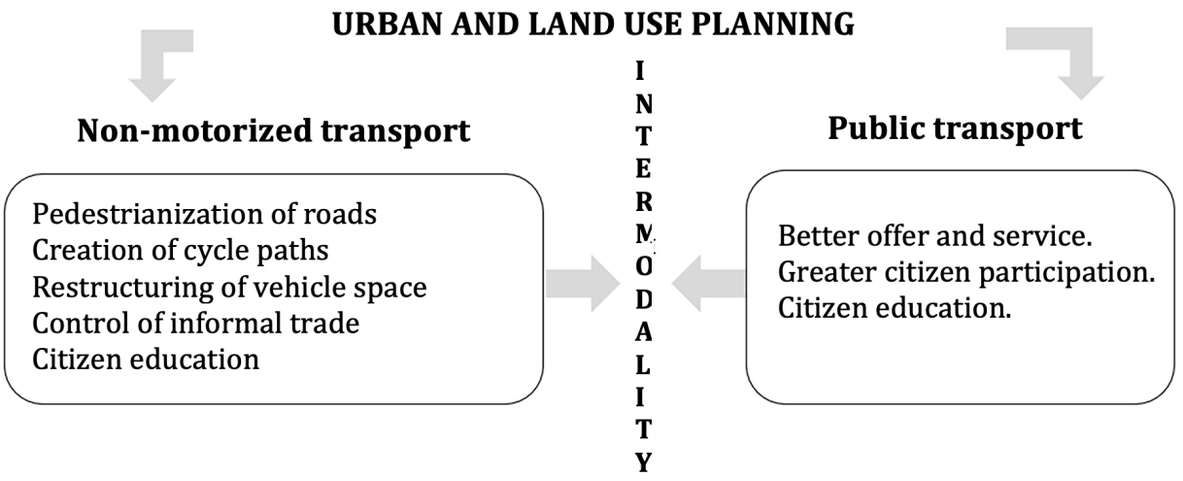

Figure 9. Management strategies generation base map to promote sustainability in the Ambato urban mobility model. Source: Preparation by the authors.

- Strengthening of public transport. Evaluate the operation of lines throughout the city, correcting the route, frequencies, and schedules according to demand, to improve the efficiency of the service and, in turn, reduce vehicle congestion on roads due to the high presence of units. To re-establish the route of buses through the city center to transit along the widest roads, or to establish an exclusive lane for their mobilization. Improve the method, as it currently consumes more time than it should, offering daily, weekly or monthly services. Connection with non-motorized means should be prioritized.

- Increased public participation in the public transport offer. Although the service is offered by the private company and regulated by the municipality the responsibility for the quality and efficiency of the system must be assumed by the State, because only the latter, as a controlling and regulating entity, can guarantee social inclusion, universal accessibility, and the safety/security that citizens require.

- Implementation of an intermodal station in the 12 de Noviembre Park to coherently integrate the most efficient means of mobilization, quickly facilitating the modal change. Multimodality is necessary to face urban complexity. However, it requires high consumption of urban space, forcing considering the social impact of the system on the existing structure (Murata, Delgado & Suárez, 2017). The separate planning of transport modes does not allow for integrating the service, meaning that public transport is not attractive to users (Agarwal, Kumar & Zimmerman, 2019).

- Restructuring vehicle space on the main streets of the highly commercial area. Routes should be designed for cars that connect the center with the rest of the city. However, it is necessary to reestablish the space given to cars and pedestrians. If more space is offered to people, they will start to inhabit, causing a gradual vehicle decongestion. Sustainability in transport implies not just managing transport from an ecological perspective, but also establishing effective system planning to ensure road safety (Balasubramaniam, Paul, Hong, Seo & Kim, 2017).

- Urban planning and land use. The fact that there is a tolerance zone so close to the important equipment degrades the urban image and suppresses the attraction for walking in the sector. That is why it is necessary to relocate this area based on land use and management plans that establish suitable activities for an urban center that intends to focus its planning toward sustainability.

- Awareness, information, and citizen education. Citizen behavior is the biggest challenge to overcome in the implementation of a new model, as such it is necessary to hold awareness programs that educate people about the personal and collective benefits of achieving sustainability in urban mobility. It will be essential to transform the culture of mobility based on respect for the rules,

and not based on punishment, to build a community that contributes to reducing traffic accidents, and that promotes the sustainable use of the car and means of transport (Gibsone *et al.*, 2011). Currently, the role assigned to citizens is rather marginal, since they must be considered actors and not just beneficiaries, consumers, or data generators (Franco, 2021).

CONCLUSIONS

This document evidences the starting point of a city that is targeting a transition process focused on sustainable urban mobility. The current state has been revealed: an outdated model based on planning using the private vehicle and its main effects on the built environment and sustainable habitat. In this context, the analysis of the current conditions prior to decision-making was presented to initiate a process of imminent change, which obliges building an experimental trial and error path, which will be perfected with a more socially and environmentally efficient human mobility.

The main contribution of this article is to understand the reality of urban mobility in Latin American intermediate cities, based on the analysis of common objective variables, which allows delving deeper into the context of the region for future studies to apply measures.

A second contribution refers to proposals to foster sustainability that require less public investment so that the most efficient modes of transport are strengthened, based on an improvement in management, restructuring of services, and planning.

Thus, the mobility analysis of the heart of Ambato was presented here, from a sustainability perspective, highlighting the potential that the study area has for implementing strategies that favor the large-scale development of pedestrianization and cycling. However, it becomes essential to analyze how and why Ambateños move, from a multidisciplinary approach that includes sociology, economics, urban planning, and design, including the participation of the public administration as an organizing and controlling entity.

Reflections on mass public transport were also raised, which fall upon strategies to improve the system, capable of improving the quality, efficiency, and reliability of the service, based on integrated management between public and private administration. And along with this, help to reduce the predilection for the car in short-distance urban commutes. The backbone of a city with a sustainable approach is an efficient public transport system, as it is this that allows reducing environmental pollution, decongesting roads, and reducing travel times, namely, directing the current scenario towards a sustainable habitat.

It would be inconceivable to establish pedestrians and cyclists as the only modes of urban transport, although they should be prioritized as feeders and distributors of public transport. Its efficiency and optimal interconnection are essential factors to face vehicular congestion. Only when public transport is faster, safer, more comfortable, and cheaper than private vehicles, will it achieve greater acceptance among citizens. There is no intention to eliminate the car, but rather to use it for long-distance trips.

Certainly, the role of the public administration is directly related to the success or failure of any intervention that aims to improve society's mobility habits, since it is these entities that are responsible for planning, managing, executing, and monitoring the urban system. The plans developed must have a comprehensive approach that contemplates the role of the city and implements measures for pedestrian mobility, cycling, public transport, freight transport, as well as the use of clean technologies. In the case of the study area, the control of informal trade is highlighted as a priority since it is evident this is the main problem affecting non-motorized transport.

The task that remains for the research agenda falls within an analysis of private transport and freight transport, to show the service level of the road network and the existing vehicular congestion rates. Likewise, a demand and capacity analysis is required for the design of cycling infrastructure.

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