*Special Section: Interconnected Ibero-America: Territorial and Socio-Environmental Challenges*
v. 68, p. 521-540, Jul./Dec. 2026 http://doi.org/10.5380/dma.v68i.100972 e-ISSN 2176-9109

DMA Desenvolvimento e Meio Ambiente

UFPR Biblioteca Digital de Periódicos BDP | UFPR revistas.ufpr.br

# **The role of the university in sustainable mobility:** territorial governance challenges in Ecuador

## **O papel da universidade na mobilidade sustentável:** desafios de governança territorial no Equador

## **El rol de la universidad en la movilidad sostenible:** desafíos de gobernanza territorial en Ecuador

Jessica CHICA CARMONA[1*], Enrique FLORES-JUCA[1]

1 Universidad de Cuenca (UCuenca), Cuenca, Province of Azuay, Ecuador.

* Contact e-mail: jessica.chica@ucuenca.edu.ec

Article received on **August 22, 2025**

Final version accepted on **March 9, 2026**

Published on **October 9, 2026**

**Abstract:** Sustainable urban mobility constitutes one of the main socio-environmental challenges for the territorial governance of contemporary cities. This study analyzed the territorial governance challenges associated with the transition toward sustainable urban mobility in Ecuador and examined the potential role of universities as knowledge infrastructures to support these processes. The research was carried out through qualitative documentary analysis of regulatory frameworks, institutional documents and mobility information repositories. The results identify two structural limitations of the system: institutional fragmentation in the management of mobility and asymmetries in the availability of data for its planning and monitoring. While relatively consolidated information systems exist in road safety, significant gaps persist in key dimensions such as climate change and equity in the use of public road space. In this context, a conceptual model of university-linked mobility laboratories was generated to help integrate information sources, produce comparable indicators and strengthen institutional capacities for territorial planning. These findings provide a conceptual basis for the development of mobility laboratories and observatories that strengthen the governance and planning of sustainable mobility in the country.

*Keywords:* academia; urban laboratory; mobility laboratory; governance.

**Resumo:** A mobilidade urbana sustentável constitui um dos principais desafios socioambientais para a governança territorial das cidades contemporâneas. Este estudo analisou os desafios da governança territorial associados à transição para uma mobilidade urbana sustentável no Equador e examinou o papel potencial das universidades como infraestruturas de conhecimento para apoiar esses processos. A investigação foi desenvolvida por meio de uma análise documental qualitativa de marcos normativos, documentos institucionais e repositórios de informação sobre mobilidade. Os resultados identificam duas limitações estruturais do sistema: a fragmentação institucional na gestão da mobilidade e as assimetrias na disponibilidade de dados para o seu planeamento e monitorização. Embora existam sistemas de informação relativamente consolidados em matéria de segurança rodoviária, persistem lacunas significativas em dimensões-chave como as alterações climáticas e a equidade na utilização do espaço público rodoviário. Neste contexto, foi gerado um modelo conceptual dos laboratórios de mobilidade ligados às universidades para contribuir para integrar fontes de informação, gerar indicadores comparáveis e fortalecer as capacidades institucionais para o planeamento territorial. Estas conclusões fornecem uma base conceptual para o desenvolvimento de laboratórios e observatórios de mobilidade que fortaleçam a governação e o planeamento da mobilidade sustentável no país.

*Palavras-chave:* academia; laboratório urbano; laboratório de mobilidade; governação.

**Resumen:** La movilidad urbana sostenible constituye uno de los principales desafíos socioambientales para la gobernanza territorial de las ciudades contemporáneas. Este

Desenvolvimento e Meio Ambiente uses a Creative Commons Attribution 4.0 International License

estudio analizó los desafíos de gobernanza territorial asociados a la transición hacia una movilidad urbana sostenible en Ecuador y examinó el potencial rol de las universidades como infraestructuras de conocimiento para apoyar estos procesos. La investigación se desarrolló mediante análisis cualitativo documental de marcos normativos, documentos institucionales y repositorios de información sobre movilidad. Los resultados identifican dos limitaciones estructurales del sistema: la fragmentación institucional en la gestión de la movilidad y las asimetrías en la disponibilidad de datos para su planificación y monitoreo. Mientras existen sistemas de información relativamente consolidados en seguridad vial, persisten vacíos significativos en dimensiones clave como cambio climático y equidad en el uso del espacio público vial. En este contexto, se generó un modelo conceptual de los laboratorios de movilidad vinculados a universidades para contribuir a integrar fuentes de información, generar indicadores comparables y fortalecer las capacidades institucionales para la planificación territorial. Estos hallazgos aportan una base conceptual para el desarrollo de laboratorios y observatorios de movilidad que fortalezcan la gobernanza y la planificación de la movilidad sostenible en el país.

*Palabras clave:* academia; laboratorio urbano; laboratorio de movilidad; gobernanza.

## 1. Introduction

Sustainable urban mobility has become one of the main socio-environmental challenges for the territorial governance of contemporary cities (Brůhová Foltýnová et al., 2020; Ngossaha et al., 2024; Tarasenko et al., 2021). Addressing these challenges requires new forms of articulation between scientific knowledge, public institutions and the social actors involved in urban planning. In this context, universities acquire an increasingly relevant role as actors capable of contributing to the generation and articulation of knowledge for public decision-making. In recent decades, the role of these institutions has undergone a significant transformation in its conception and functions (Goddard et al., 2016). From their origin as centers for the transmission of knowledge, they have evolved into multidimensional institutions with active participation in processes of innovation, territorial development and social transformation (Etzkowitz & Leydesdorff, 2000; Taliento, 2022). This change is particularly reflected in the consolidation of the so-called third mission, which extends the traditional role of the university beyond teaching and research, incorporating its direct engagement with society and the territory (Compagnucci & Spigarelli, 2020; Garcia & Tuesta, 2025; Taliento, 2022). Within this framework, recent literature moves beyond instrumentalist visions, which analyze the role of the university as merely a provider of human capital, to redefine universities as key nodes in multilevel governance capable of articulating knowledge, actors and instruments to face complex challenges of contemporary development (Carrillo, 2022; Veltz, 2008).

In Latin America, urban mobility has become a central component of the socio-environmental dynamics of cities (Delclòs-Alió et al., 2023). The accelerated growth of motorization, dispersed urban expansion and the persistent dependence on individual transport have intensified structural problems such as congestion, air pollution, greenhouse gas emissions and road crashes (Aprigliano et al., 2023; Calatayud et al., 2021; Hinojosa-

Contreras et al., 2026). These dynamics not only affect the efficiency of transport systems, but also deepen territorial inequalities by limiting equitable access to urban opportunities and deteriorating the environmental quality of urban spaces (Villamil, 2022). In this context, mobility transcends its technical dimension to become a socio-environmental governance problem involving multiple territorial scales, institutional actors and public policy sectors.

In response to these challenges, the urban planning literature has emphasized the importance of developing evidence-based planning approaches, in which the availability, integration and analysis of information become fundamental elements for the design of more efficient, equitable and environmentally sustainable mobility policies (Reichert, 2019). However, in many urban contexts, especially in the Global South, mobility information systems present significant limitations. Data are usually fragmented among the multiple institutions responsible for transport planning and management, with heterogeneous collection methodologies and scarce interoperability between levels of government (Jabareen, 2023). These conditions hinder the construction of comprehensive diagnoses and reduce the capacity of local governments to design, implement and evaluate sustainable mobility public policies.

In Ecuador, these challenges have begun to be addressed through the consolidation of a regulatory framework aimed at transforming the urban mobility model. The Constitution of the Republic (Asamblea Constituyente, 2008), the Organic Code of Territorial Organization, Autonomy and Decentralization, COOTAD (Asamblea Nacional, 2010) and, more recently, the National Sustainable Urban Mobility Policy, PNMUS, 2023–2030 establish guidelines aimed at reducing emissions, improving road safety and promoting a more equitable distribution of public space (Ministerio de Transporte y Obras Públicas, 2023). Significantly, the PNMUS incorporates mobility planning and research as a cross-cutting axis, pointing to the need to strengthen information systems and promote spaces for institutional experimentation, among them mobility laboratories with the participation of academia (Ministerio de Transporte y Obras Públicas, 2023). This regulatory recognition positions universities as strategic actors in the generation of technical knowledge and in the strengthening of institutional capacities for sustainable mobility planning.

However, the regulatory formalization of the academic role does not guarantee its effective materialization. The literature on universities and territorial development has shown that the implementation of the third mission depends on specific institutional conditions, stable governance frameworks and sustainable funding schemes that make it possible to effectively articulate academia with public and social actors (Etzkowitz & Leydesdorff, 2000; Compagnucci & Spigarelli, 2020; Goddard et al., 2016). In the Global North, universities have strengthened their influence on

public policy formulation, technological innovation and urban planning, consolidating themselves as generators of knowledge and promoters of sustainable solutions (Reichert, 2019; Veltz, 2008). In contrast, in Latin America there persists a significant gap between the transformative potential attributed to the university and its effective impact on the territories. Despite their proximity to complex social and urban problems, several studies point out that the region's universities continue to operate under institutional dynamics that privilege traditional academic production, often disconnected from local challenges (Thomas & Pugh, 2020). This situation evidences the existence of limited mechanisms of institutional articulation that would allow scientific knowledge to be integrated into public decision-making, particularly in complex fields such as urban mobility (Goddard et al., 2016).

Despite the growing recognition of the role of universities in territorial development, there is still limited knowledge about the institutional and informational conditions that shape their participation in the governance of sustainable urban mobility, particularly in contexts of decentralization and heterogeneous territorial capacities such as the Ecuadorian one. In this context, the present article aimed to identify the territorial governance challenges associated with the transition toward sustainable urban mobility in Ecuador, and thereby to analyze the potential of universities to act as knowledge infrastructures oriented toward the integration of information and the strengthening of institutional capacities for public decision-making in contexts of complex territorial governance.

## 2. Urban laboratories: infrastructures for the transition toward sustainable mobility

A laboratory is a structured space for research, experimentation and innovation, which brings together multidisciplinary actors in order to address complex problems (Karvonen & van Heur, 2014). In the case of urban laboratories, their purpose is to face the multiple challenges of cities, especially those linked to sustainability, governance, innovation, and mobility through the active participation of local authorities, citizens, academia and the private sector (Bulkeley et al., 2019; Piziak et al., 2023). In this context, an urban laboratory constitutes a key tool for improving the quality of life of inhabitants, as it operates in real urban environments, where interventions based on evidence and direct feedback can be designed, tested and refined (Piziak et al., 2023). Its main strength lies in a methodology grounded in open innovation, experimentation and citizen participation, which makes it possible to generate collaborative solutions that strengthen decision-making and respond to concrete local needs. Thus, urban laboratories function as dynamic co-creation platforms

oriented toward building more inclusive, resilient and sustainable cities (Nesti, 2018).

Depending on their configuration and objectives, Bulkeley et al. (2019) classify urban laboratories into three categories: strategic, civic and organic (Table 1).

Within this framework, the creation of urban laboratories has increased notably in recent years in response to the need to address urban challenges through more collaborative, experimental and adaptive approaches. This situation has generated a growing interest in understanding their configurations, forms of governance and dynamics of participation. For this reason, Piziak et al. (2023) carried out an analysis of 24 urban laboratories in different geographical contexts, evidencing a marked concentration of cases in the Global North (87%). Half of the laboratories are managed by scientific institutions, namely universities. Only 13% of the laboratories have local authorities as their managing entity; the remaining laboratories were founded by non-governmental organizations or by the community itself. In each of the urban laboratories surveyed, the founding entity ultimately became its managing entity. Piziak et al. (2023) highlight the

**Table 1** Characteristics of urban laboratories: strategic, civic and organic.

| Concept | Characteristic | Strategic | Civic | Organic |
|---|---|---|---|---|
| Contextualization | Leading actors/ agencies involved in the conception and configuration of the Urban Living Lab (ULL) | Government (e.g., European Union, national government) and companies (multinational, national, or with predominant economic interests, regardless of their physical location) | Municipal government and higher education institutions | Civil society (e.g., environmental NGOs and community groups) |
| | Relationship between the city and the laboratory | The city constitutes the stage or testing ground for the objectives and aspirations of the strategic actors. | The city is configured as a public or civic space through the collaboration and experimentation that take place within it. | The city constitutes the context within which experimentation emerges and develops. |
| Orientation toward change | Priorities | Creation of a replicable model or of global best practices for the laboratory's products. | Urban transformation, whether economic and/or oriented toward sustainable development. | Adapted to the local context and diverse. |
| | Techniques | Competitive. | Developmental. | Tailor-made (customized). |
| | Funding | Generally through one-off funding from external sources. | Co-funding provided by the municipality and other civic partners (internal sources). | Improvised and incremental. |

SOURCE: Translated from Bulkeley et al. (2019).

importance of the quadruple helix model, which articulates collaboration among government, academia, business and civil society as the basis for the effective functioning of urban laboratories. In this scheme, the university plays a strategic role not only as a generator of knowledge, but also as a facilitator of processes of social innovation, urban experimentation and capacity building. Its active involvement strengthens the legitimacy of interventions, promotes methodological rigor and contributes to a better articulation between applied research and decision-making in the territory.

In this context, Bulkeley et al. (2019), after analyzing 40 urban laboratories in Europe, conclude that municipal authorities, knowledge institutions (academia) and community organizations govern under conditions of limited autonomy and restricted resources, while strategic political and economic interests lack the legitimacy to enact urban projects. Therefore, the effectiveness of an urban laboratory depends to a large extent on having clear methodologies, robust participatory processes and sustained articulation among the various actors involved.

In this context, a sustainable urban mobility laboratory is configured as a versatile environment for applied research, experimentation and the development of solutions aimed at improving transport, traffic and road infrastructure systems. These spaces are designed to innovate, test and evaluate technologies, policies and methodologies in both real and simulated environments. At the global level, they have emerged as strategic instruments in urban transformation processes, as they enable the articulation of diverse actors and the generation of technical knowledge under controlled conditions.

Their experimental character and their capacity to integrate information technologies, data analysis and citizen participation make them strategic spaces for the design and evaluation of innovative solutions. Most of these laboratories are managed by universities or research centers, which guarantees a rigorous methodological approach and an effective articulation between academic knowledge and public action. At the international level, there are outstanding experiences such as the MIT-SMART in Australia, the Bauhaus.MobilityLab or the TUM Mobility Lab in Germany, the Smart Citizen or the Sustainable Mobility and Railway Engineering Laboratory in Spain, the Mobility Lab in Estonia, or the Mobility Lab Graz in Austria. These initiatives combine ICT tools, geolocation systems and environmental monitoring with online participatory models, generating open data that make it possible to observe, evaluate and anticipate urban patterns related to traffic, pollution and energy use (Frey et al., 2022; Nesti, 2018; Olaverri-Monreal, 2021; Piziak et al., 2023).

In the Latin American context, urban mobility laboratories are still scarce and show limited development compared with other regions. There are relevant initiatives promoted by multilateral organizations, such as the Urban Mobility Observatory led by CAF and the IDB or the ECLAC

Cities Lab, which have contributed to the analysis and generation of data in several cities of the region. In Ecuador, some initiatives oriented toward monitoring urban mobility are also identified, particularly observatories developed in cities such as Quito and Guayaquil. However, these platforms usually operate mainly at regional or metropolitan scales, focusing on the compilation of indicators and comparative diagnoses, with still limited articulation with local universities and research centers. Experiences promoted from academia, for their part, have emerged mainly as research projects or experimental platforms. Among them are the Smart City Lab of the Universidad Técnica Particular de Loja, the Mobility Laboratory of the Escuela Politécnica Nacional, EmoLab of the Universidad Politécnica Salesiana, the Global Change Laboratory of Ikiam, the Cities Laboratory of the Pontificia Universidad Católica del Ecuador and the Urban Mobility Laboratory and environmental monitoring initiatives developed by the Universidad del Azuay. Although these spaces have generated relevant contributions in applied research and the production of urban data, in many cases they have operated as initiatives linked to specific projects, with limited conditions of institutionalization and continuity over time.

The consolidation of sustainable mobility laboratories as permanent institutions requires addressing three key dimensions. In the institutional sphere, it is necessary to establish inter-administrative agreements that include stable funding mechanisms and long-term cooperation schemes between universities and local governments. In the technical sphere, it is fundamental to adopt standardized protocols backed by international standards, such as ISO norms, that make it possible to establish comparable metrics and homogeneous methodologies for monitoring urban mobility. Finally, from the governance perspective, a collaborative structure based on the quintuple helix model is required, in which the university acts as the articulating node of knowledge (Carayannis et al., 2012). As recent studies point out (Bulkeley et al., 2019; Piziak et al., 2023), laboratories managed from academia show greater capacities to sustain participatory processes, produce applied scientific evidence and maintain institutional continuity, factors that strengthen their impact on sustainable urban mobility planning and public policies.

## 3. Methodology

The present study adopted a qualitative, exploratory approach oriented toward analyzing the institutional, informational and governance conditions that influence the implementation of the sustainable mobility policy in Ecuador. The research focused on identifying how territorial governance challenges such as institutional fragmentation and asymmetries in the availability of information condition mobility planning and management

processes, as well as the potential role of universities in the articulation of actors and the generation of knowledge through mobility laboratories.

### 3.1. Scope of application

The scope of analysis of this research corresponds to the urban system of Ecuador, made up of the country's 221 cities, which constitute the territorial units responsible for urban mobility planning and management. The PNMUS establishes that its guidelines and goals must be implemented by the municipal decentralized autonomous governments, so the analysis is developed considering the totality of the country's urban territories.

According to data from the National Institute of Statistics and Censuses (INEC, 2022), Ecuador has an approximate population of 16.9 million inhabitants, of whom 63% reside in urban areas. The urban structure presents a highly concentrated distribution: the cities of Quito and Guayaquil concentrate close to 33% of the national population and are classified as large cities; a second group corresponds to intermediate cities, among them Cuenca, Santo Domingo, Ambato, Portoviejo, Machala and Durán, which together host approximately 14% of the population. The rest of the urban system is made up mostly of small cities, which represent close to 96% of the country's total number of cities and concentrate around 53% of the population.

Considering the heterogeneity of the Ecuadorian urban system and the differences in institutional capacities among large, intermediate and small cities, the analysis of the territorial scope makes it possible to examine the challenges associated with the implementation of sustainable mobility policies and with the generation of comparable information systems for urban planning. The methodological analysis was structured into three components that correspond to the main analytical axes of the study: institutional governance, information systems and mobility laboratories. Each component made it possible to address a specific dimension of the research problem.

### 3.2. Information sources

The research was based on the analysis of various documentary sources related to the governance of the mobility system in Ecuador. The sources included national regulations, public policy documents, institutional reports and statistical repositories linked to transport planning and sustainable urban mobility. Among the main documents analyzed are the Constitution of the Republic of Ecuador, the Organic Code of Territorial Organization, Autonomy and Decentralization (COOTAD), the Organic Law on Land Transport, Traffic and Road Safety, and the PNMUS 2023–2030. Likewise, technical reports and statistical databases produced by the institutions responsible for the management of the mobility system were reviewed, particularly the National Institute of Statistics and Censuses

(INEC), the Ministry of Infrastructure and Transport and the National Transit Agency (ANT). These sources made it possible to identify the distribution of institutional competencies, the traffic management models and the availability of information related to the different axes of the sustainable mobility policy. In addition, a bibliographic review of academic literature on mobility governance, urban planning and urban innovation laboratories was carried out, in order to contextualize the results of the study and analyze the potential role of universities in the articulation of knowledge for territorial planning.

### 3.3. Analysis procedure

The research was carried out through documentary analysis, a qualitative technique that makes it possible to examine information from regulations, institutional reports, statistical databases and academic literature in order to understand institutional processes and public policies. Documentary analysis is widely used in governance and public policy studies, since it allows the institutional structure and the dynamics of policy implementation to be interpreted from official documents and secondary sources (Bowen, 2009).

The analytical process was organized into three stages. First, institutional governance was examined through the analysis of regulatory frameworks and institutional documents, with the aim of identifying the distribution of competencies among the different levels of government involved in mobility management. Second, the information systems available for monitoring the indicators established in the PNMUS were evaluated, in order to identify differences in data availability among the different dimensions of the mobility system and among city types. Finally, the articulation of actors for the production of knowledge was analyzed on the basis of a comparative review of experiences of mobility laboratories and urban observatories linked to universities, with the purpose of examining their potential as knowledge infrastructures oriented toward data integration and the strengthening of territorial planning processes.

## 4. Results

The results presented show that the governance of mobility in Ecuador faces two structural challenges: institutional fragmentation in the management of the mobility system and asymmetries in the availability of information for its planning. In this context, the articulation of actors capable of integrating information from different levels of government acquires a central role in strengthening decision-making processes regarding sustainable mobility.

### 4.1. Institutional fragmentation in mobility governance

The results show that the governance of mobility in Ecuador is characterized by a highly fragmented institutional structure, in which the competencies

related to road infrastructure, traffic control and transport organization are distributed among different levels of government and institutional actors. This fragmentation constitutes one of the main challenges for the territorial governance of sustainable mobility, since it generates difficulties of inter-institutional coordination and limits the capacity of local governments to plan the mobility system in a comprehensive manner. In aggregate terms, 191 of the country's 221 municipal governments (86.5%) depend partially or totally on external institutions for the operational control of traffic and the generation of information on mobility events (Ministerio de Transporte y Obras Públicas, 2023), which evidences a significant gap between regulatory decentralization and the effective institutional capacities for managing the system.

This institutional configuration responds to the decentralization model established in the COOTAD, which assigns to the municipal GADs the responsibility of planning, regulating and managing traffic and land transport within their jurisdictions (Asamblea Nacional, 2010). However, the governance of the mobility system is not organized around a single administrative logic, but is structured around three differentiated institutional dimensions: the management of road infrastructure, traffic control and transport regulation. The coexistence of these dimensions introduces overlaps of competencies and generates challenges for inter-institutional coordination, particularly in territories where different levels of government intervene simultaneously.

In the case of road infrastructure, competencies are distributed according to hierarchy and territorial location. State roads form part of the national road network and are administered by the central government, while rural-provincial roads correspond to the provincial governments and urban roads are under the responsibility of the municipal governments (Asamblea Nacional, 2013). As a result, infrastructures managed by different levels of government may coexist within the same canton, which introduces difficulties for the integrated planning of mobility and for the coordination of interventions in the territory.

Traffic regulation and control respond to a different territorial logic. Once municipal governments formally assume this competency, they exercise control functions over most of the cantonal territory, including both urban and rural areas. The only exception corresponds to state roads, where these functions remain under the jurisdiction of the central government through the ANT. Nevertheless, the decentralization of this competency has developed heterogeneously across territories. According to the management model defined by the National Council of Competencies (CNC) and the ANT, the country's 221 municipalities are classified into three management models (A, B and C) according to their operational capacity and the level of assumption of competencies (Ministerio de Transporte y Obras Públicas, 2023).

Management model A corresponds to the municipalities that have fully assumed the operational competency for traffic through the creation of their own corps of Civil Traffic Officers. Currently 30 cantons (13%) operate under this model, which allows them to exercise direct control over the regulation and recording of mobility-related events within their jurisdiction. However, even in these territories limitations persist in information management, since the state roads that cross the cantons remain under national jurisdiction, generating discontinuities in mobility data records. Management model B represents the predominant scenario in the country. In this case, 112 municipalities (51%) hold competencies to plan and regulate transport, but the operational control of traffic continues to be exercised by national institutions such as the Ecuadorian Transit Commission (Comisión de Tránsito del Ecuador). This separation between planning and operational control functions introduces additional fragmentation into the production of information, since municipal governments must depend on external institutions to access data on traffic dynamics in their own territories. For its part, management model C, present in 79 municipalities (36%), is characterized by a partial or total delegation of traffic competencies due to technical and institutional limitations. In these territories, local governments usually delegate administrative functions such as vehicle registration or vehicle inspection to inter-municipal associations (mancomunidades) or other entities, while the operational control of traffic remains completely under external institutions. This scenario reflects the greatest institutional limitations for the local management of mobility, which coincides with the lowest levels of the municipal Operational Capacity Index, whose national average reaches 18.03 points out of 100 (Ministerio de Transporte y Obras Públicas, 2023).

A third dimension corresponds to the organization of public transport, whose planning and regulation is structured mainly at the cantonal scale (Asamblea Nacional, 2010). This implies that municipal governments must organize transport systems that connect both urban areas and rural parishes within the same administrative territory. However, much of the institutional debate and public policy has focused on urban mobility, which tends to render invisible the mobility dynamics that unfold in rural and peri-urban territories.

Taken together, the coexistence of these three institutional logics: road infrastructure organized by levels of government, traffic control decentralized in a heterogeneous manner, and transport structured at the cantonal scale, configures a governance system characterized by high levels of institutional fragmentation. This structure limits coordination among actors and conditions the capacity of local governments to plan mobility from a comprehensive and sustainable perspective (Figure 1).

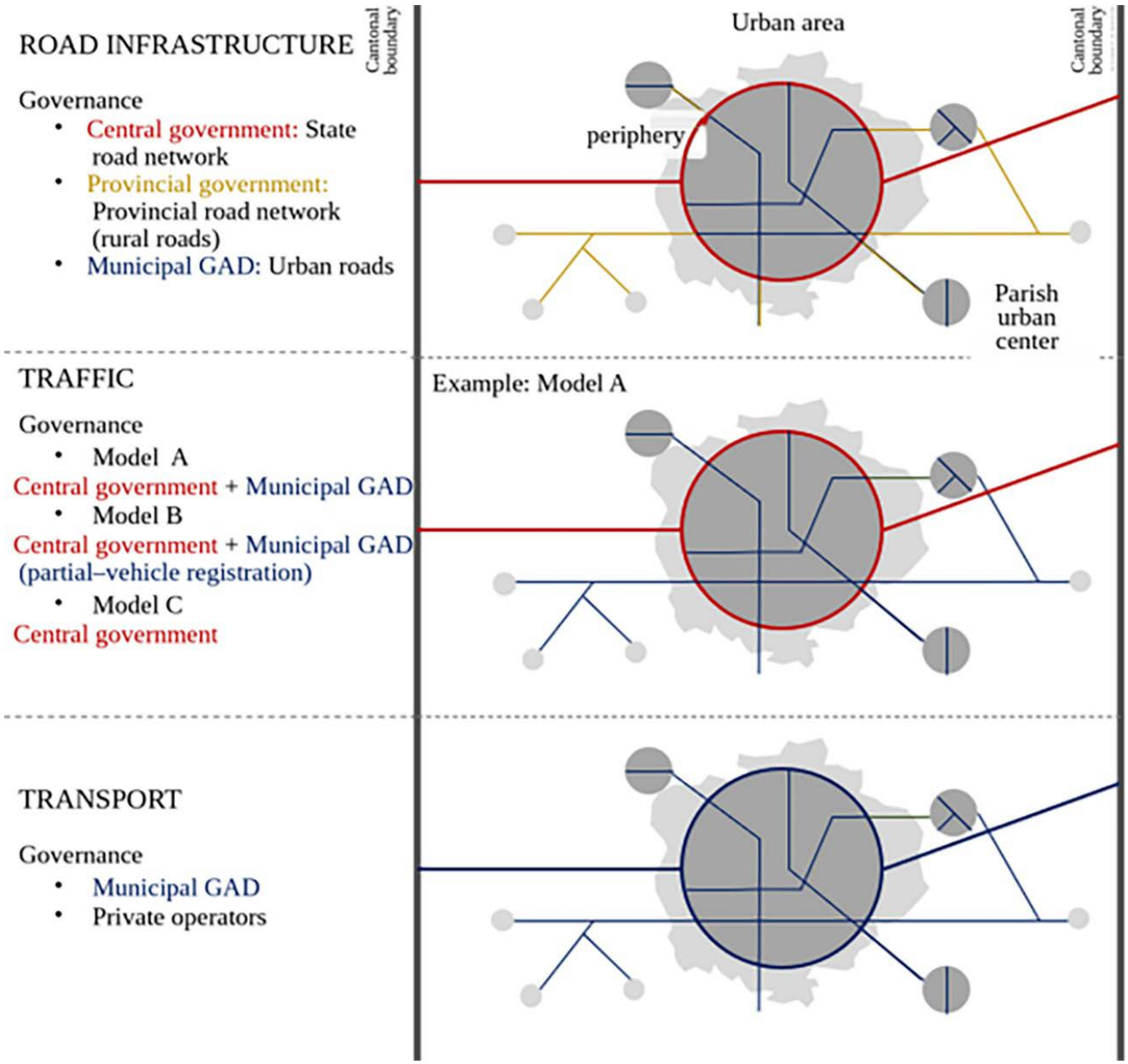



**Figure 1**
Scheme of actors involved in mobility.

## 4.2. Asymmetries in the availability of information for sustainable mobility

The analysis of the information systems associated with mobility in Ecuador shows an unequal distribution of data among the different axes of the PNMUS. Although this policy establishes indicators to monitor dimensions such as road safety, emissions reduction and equity in the use of public road space, the data required for their measurement are not homogeneously available across territories or across dimensions of the mobility system. The results show that the greatest availability of information is concentrated in the field of road safety. In this axis there are institutionalized administrative records, systematized mainly by the National Institute of Statistics and Censuses (INEC) and the ANT, which

makes it possible to have relatively consistent data on road crashes and traffic-related mortality at different territorial scales. This availability has made it possible to consolidate more stable monitoring systems for the indicators related to public health and road safety.

In contrast, the axes linked to climate change in mobility and equity in the use of public road space present greater data gaps. According to the available information repositories, records usually come from specific studies developed by local governments, cooperation projects or academic research, which generates heterogeneous databases that are difficult to compare across territories. These differences are also manifested among city types. While larger cities tend to have more systematic records associated with traffic and transport management, in intermediate and small cities the availability of information usually depends on one-off studies or specific projects, which limits the monitoring of indicators linked to climate change and equity in the use of public road space.

Added to this situation is a misalignment between the territorial scale at which mobility systems operate and the scale at which part of the available information is produced. While the policy raises the need for indicators applicable at the urban level, some data relevant to sustainable mobility are generated at different administrative scales. For example, indicators such as energy consumption or transport emissions are produced mainly at the national scale, while records such as vehicle registration are available at the provincial level. In contrast, transport planning takes place mainly at the cantonal scale, where mobility dynamics between urban and rural areas are articulated. In this context, the cantonal scale is particularly relevant for the analysis of mobility, since it makes it possible to integrate the functional interdependencies between these territories (Flores-Juca et al., 2023). This misalignment between scales limits the possibility of using part of the available information in territorial planning processes and in the monitoring of the sustainable mobility objectives established by public policy (Table 2).

**Table 2** Availability of information according to PNMUS axes and objectives.

| Policy axis | Responsible institution | Data scale | Data availability by city type | | |
|---|---|---|---|---|---|
| | | | Large | Intermediate | Small |
| Public health and safe mobility | INEC<br>ANT<br>Cantonal GAD | National/ Provincial/ Cantonal | High (public data) | High (public data) | High (public data) |
| Climate change in mobility | Ministry of Energy and Mines<br>Cantonal GAD | National/ Local | High (public data) | Medium (specific data) | Low (no data) |
| Equity in public road space | Cantonal GAD<br>Provincial GAD<br>Private operators | Local (ad-hoc studies) | Medium (specific data) | Low (no data) | Low (no data) |

## 4.3. Universities as knowledge infrastructures for mobility governance

The results presented show that the governance of mobility in Ecuador faces limitations associated both with the institutional fragmentation of the system and with the asymmetries in the availability of information for its planning. In this context, the implementation of the sustainable mobility policy requires mechanisms capable of integrating data produced by multiple institutions and territorial scales.

The analysis of institutional experiences in Latin America shows that, in scenarios characterized by information dispersion and multilevel governance, universities have begun to play a relevant role in the generation and systematization of mobility data. In several cases, the so-called university-linked mobility laboratories or observatories act as technical platforms of articulation between local governments, national agencies and actors of the transport system, contributing to the production of information and to the development of analytical tools for urban planning (Table 3).

The analysis of institutional experiences shows that university laboratories can play a relevant role in mobility data governance, particularly in contexts where information is dispersed among multiple institutions and territorial scales. In these scenarios, universities can act as technical nodes capable of articulating actors, integrating information sources and producing applied knowledge that contributes to strengthening sustainable mobility planning processes.

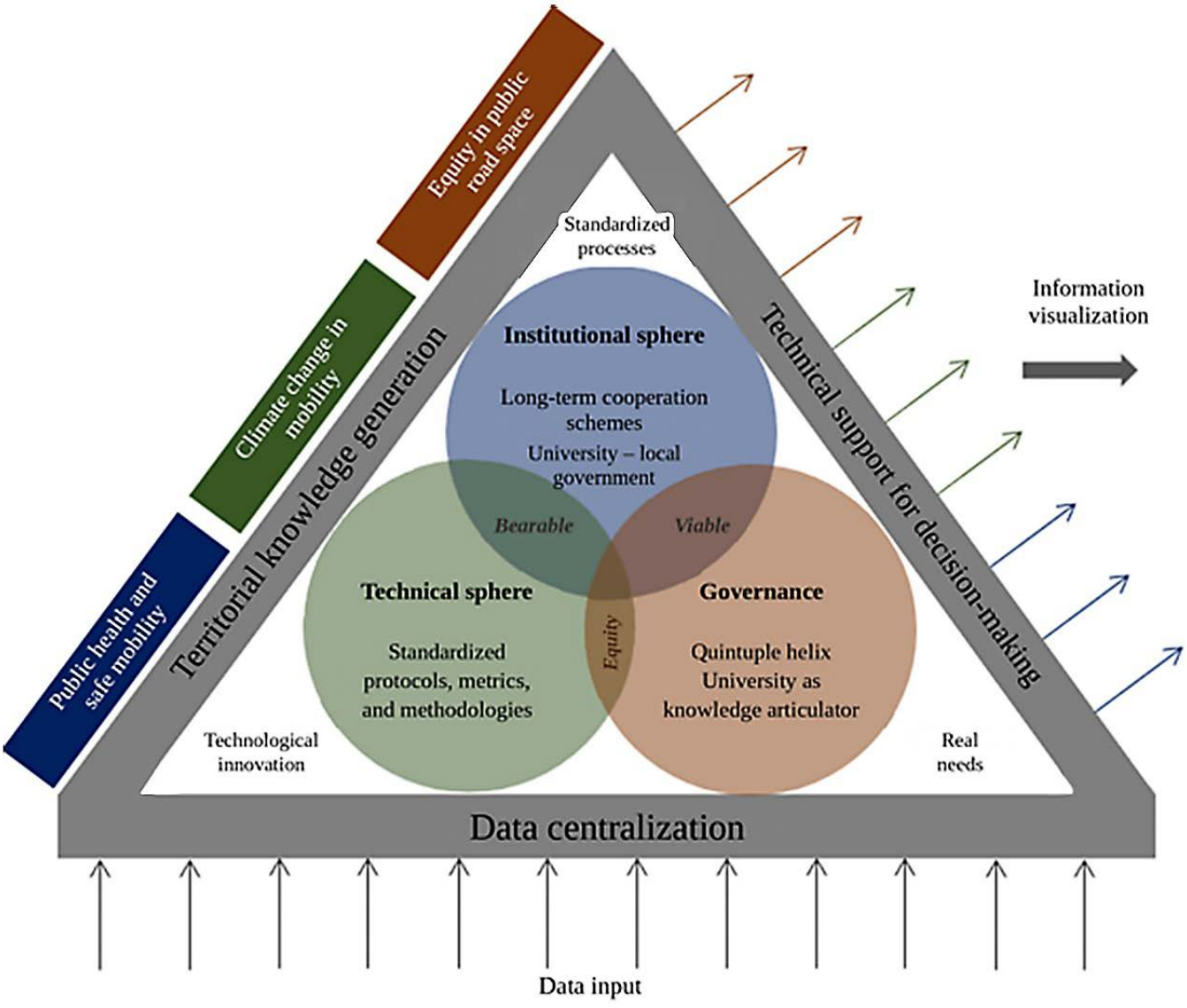
**Table 3** Experiences of university-linked mobility laboratories.

| Laboratory | Institution | Country | Year | Consolidation process | Funding |
|---|---|---|---|---|---|
| Senseable City Lab – Mobility Observatory | MIT | USA | 2004 | Began as an urban research laboratory; later developed urban data analysis platforms and partnerships with cities | University + technology companies + research projects |
| Urban Mobility Lab | TU Delft | Netherlands | 2016 | Urban experimentation platform connecting academic research with local governments and pilot projects | University + European research funds |
| UrbanLab | Universidad de los Andes | Colombia | 2014 | Transport data analysis, modeling and urban mobility studies | University + local government |
| CEDEUS | Pontificia Universidad Católica de Chile | Chile | 2013 | Interdisciplinary research center that develops studies on urban mobility, public transport and territorial planning in collaboration with local governments and ministries | University + local governments |
| IERSE – Environmental and territorial observatory | Universidad del Azuay | Ecuador | 2013 | Environmental and territorial monitoring that generates data on pollution, environment and the city | University + local government |

Based on the results obtained in this research, mobility laboratories can be conceptualized as knowledge infrastructures oriented toward three main functions. The first corresponds to data integration, through the consolidation of information from different institutional sources related to road safety, public transport, energy consumption, emissions and the use of road space. The second function is oriented toward the generation of territorial knowledge, through the construction of baselines and comparable indicators that make it possible to monitor the performance of mobility systems in relation to the objectives defined by public policy. Finally, a third function corresponds to technical support for local governments, through the preparation of territorial diagnoses, spatial analyses and visualization tools that facilitate evidence-based decision-making processes.

Figure 2 presents the conceptual model derived from this analysis. In this scheme, mobility laboratories are conceived as spaces of institutional articulation inspired by the Urban Living Labs approach and by a governance model based on the quintuple helix. This structure makes it possible to

**Figure 2**
Conceptual model of sustainable mobility laboratories.



connect institutional actors, integrate information from different sectors and support the development of evidence-based sustainable mobility policies.

## 5. Discussion

The results of this research show that the implementation of sustainable urban mobility policies in Ecuador is conditioned by two structural factors: institutional fragmentation in the governance of the mobility system and asymmetries in the availability of information for its planning. These findings coincide with previous research pointing out that the transition toward sustainable mobility systems does not depend solely on technological or infrastructure innovations, but also on the capacity of institutions to coordinate actors, integrate information and generate evidence-based planning processes (Reichert, 2019).

In the Ecuadorian case, the decentralization model for traffic and transport has transferred important competencies to municipal governments; however, the results show that this distribution of responsibilities has not always been accompanied by homogeneous institutional capacities to exercise those competencies. This situation generates a multilevel governance characterized by institutional overlaps and by a strong dependence on external entities for the generation of information on mobility. Similar findings have been identified in other Latin American countries, where the decentralization of transport functions has coexisted with technical and financial limitations in local governments for managing complex urban mobility systems.

Added to this institutional fragmentation are the asymmetries in the information systems used to monitor sustainable mobility objectives. The analysis carried out shows that data availability is concentrated mainly in the field of road safety, while key dimensions of sustainable mobility, such as transport emissions or equity in the use of public road space, present greater information gaps. This pattern evidences a persistent orientation of data systems toward the management of vehicular traffic, which limits the possibility of evaluating mobility from a comprehensive perspective that incorporates the environmental and social dimensions of the transport system.

In this context, the results suggest that the transition toward more sustainable mobility systems requires strengthening the institutional mechanisms for information integration. The dispersion of data among multiple institutions and territorial scales hinders the construction of comparable diagnoses that can guide public decision-making. Several studies have pointed out that urban data governance has become a central component for the planning of complex public policies, especially in fields such as mobility, where multiple actors and institutional sectors converge.

The findings of this research indicate that universities can play a relevant role in this process as knowledge infrastructures oriented toward the integration and analysis of territorial information. This role is aligned with the literature on the university third mission, which recognizes the capacity of universities to contribute to the resolution of public problems through the articulation of research, innovation and territorial development (Compagnucci & Spigarelli, 2020; Goddard et al., 2016). In contexts characterized by multilevel governance and information dispersion, universities can act as intermediate nodes capable of connecting institutional actors, developing analysis methodologies and generating territorial indicators that support public planning.

This function is particularly relevant within the framework of territorial innovation approaches such as Urban Living Labs, in which different actors collaborate to generate applied knowledge and experiment with solutions to complex urban problems. In the field of sustainable mobility, these spaces make it possible to integrate academic, institutional and social capacities to develop analytical tools that contribute to improving urban governance processes. From this perspective, university mobility laboratories can be understood as territorial innovation platforms that facilitate the production of applied knowledge and strengthen evidence-based planning processes.

At the same time, the articulation of these spaces can be interpreted through the quintuple helix model, which proposes the interaction between university, government, the productive sector, civil society and the environment as the basis for the generation of sustainable solutions (Carayannis et al., 2012). In the case of urban mobility, this interaction makes it possible to integrate different types of knowledge: technical, institutional and social, in order to address the challenges associated with the transition toward more sustainable transport systems.

Taken together, these results suggest that the strengthening of information systems and the articulation among institutional actors constitute fundamental conditions for improving the territorial governance of sustainable mobility. In this scenario, universities can contribute to reducing the existing gaps in the production and analysis of mobility data, facilitating the integration of information and the development of analytical tools that support public decision-making.

## 6. Conclusions

The transition toward more sustainable urban mobility systems requires not only adequate regulatory frameworks, but also information that makes it possible to understand how mobility systems function in the territories and to evaluate the progress of public policies. This study showed that, in the Ecuadorian case, the governance of the mobility system faces limitations

associated both with institutional fragmentation and with the unequal availability of data for its planning and monitoring.

The results show that, although public policy has incorporated indicators oriented toward promoting safer, more equitable and environmentally sustainable mobility, the information needed to measure these objectives is not homogeneously available across territories or across dimensions of the mobility system. This situation makes it difficult to evaluate whether the policies implemented are generating effective improvements in transport systems and limits the capacity of local governments to steer their decisions toward more sustainable mobility models. In this context, the strengthening of territorial information systems and the articulation among institutional actors emerge as key conditions for improving the governance of sustainable mobility. In particular, universities can play a relevant role as spaces for the production and articulation of applied knowledge, contributing to integrating information sources, generating comparable indicators and supporting public planning processes. Future research could delve deeper into the analysis of the technical and budgetary capacities of local governments to implement sustainable mobility policies, as well as into the institutional mechanisms that make it possible to translate the available information into concrete actions to transform the mobility system.

## 7. Funding

This research is part of the research project MOVIDATA: Mobility statistics for a sustainable city, which was funded by the Office of the Vice-Rector for Research (Vicerrectorado de Investigación) of the Universidad de Cuenca, Cuenca-Ecuador.

## References

Aprigliano, V., Barros, G. T., Santos, M. V. S. M., Toro, C., Rojas, G., Seriani, S., da Silva, M. A. V., & de Oliveira, U. R. (2023). Sustainable Mobility Challenges in the Latin American Context. *Sustainability*, *15*(20), 14748. https://doi.org/10.3390/su152014748

Asamblea Constituyente. (2008). *Constitución de la República del Ecuador*. Registro Oficial 449, 20 de octubre de 2008. https://repositorio.itsup.edu.ec/documento/ver/1733960873.pdf

Asamblea Nacional. (2010). *Código Orgánico de Organización Territorial, Autonomía y Descentralización (COOTAD)*. Registro Oficial Suplemento 303, 19 de octubre de 2010. https://www.oas.org/juridico/pdfs/mesicic4_ecu_org.pdf

Asamblea Nacional. (2013). *Estatuto Orgánico por procesos del Consejo Nacional de Competencias*. https://derechoecuador.com/registro-oficial-no-61-viernes-18-de-octubre-de-2013-edicion-especial/#gsc.tab=0

Bowen, G. A. (2009). Document Analysis as a Qualitative Research Method. *Qualitative Research Journal*, *9(*2), 27–40. https://doi.org/10.3316/QRJ0902027

Brůhová Foltýnová, H., Vejchodská, E., Rybová, K., & Květoň, V. (2020). Sustainable urban mobility: One definition, different stakeholders' opinions. *Transportation Research Part D: Transport and Environment, 87,* 102465. https://doi.org/10.1016/j.trd.2020.102465

Bulkeley, H., Marvin, S., Palgan, Y. V., McCormick, K., Breitfuss-Loidl, M., Mai, L., von Wirth, T., & Frantzeskaki, N. (2019). Urban living laboratories: Conducting the experimental city? *European Urban and Regional Studies, 26*(4), 317–335. https://doi.org/10.1177/0969776418787222

Calatayud, A., Sánchez González, S., Bedoya Maya, F., Giraldez Zúñiga, F., & Márquez, J. M. (2021). *Congestión urbana en América Latina y el Caribe: Características, costos y mitigación.* Inter-American Development Bank. https://doi.org/10.18235/0003149

Carayannis, E. G., Barth, T. D., & Campbell, D. F. (2012). The Quintuple Helix innovation model: global warming as a challenge and driver for innovation. *Journal of Innovation and Entrepreneurship, 1*(1), 2. https://doi.org/10.1186/2192-5372-1-2

Carrillo, F. (2022). *A modern guide to knowledge.* Edward Elgar Publishing.

Compagnucci, L., & Spigarelli, F. (2020). The third mission of the university: A systematic literature review on potentials and constraints. *Technological Forecasting and Social Change, 161*, 120284. https://doi.org/10.1016/j.techfore.2020.120284

Delclòs-Alió, X., Kanai, C., Soriano, L., Quistberg, D. A., Ju, Y., Dronova, I., Gouveia, N., & Rodríguez, D. A. (2023). Cars in Latin America: An exploration of the urban landscape and street network correlates of motorization in 300 cities. *Travel Behaviour and Society, 30,* 192–201. https://doi.org/10.1016/j.tbs.2022.09.005

Etzkowitz, H., & Leydesdorff, L. (2000). The dynamics of innovation: from National Systems and "Mode 2" to a Triple Helix of university–industry–government relations. *Research Policy, 29*(2), 109–123. https://doi.org/10.1016/S0048-7333(99)00055-4

Flores-Juca, E., Chica, J., Mora-Arias, E., & García, J. (2023). Reinterpretando el papel de la movilidad en las zonas periurbanas: un análisis multiescala en Cuenca – Ecuador. *Revista de Geografía Norte Grande, 84*. https://ojs.uc.cl/index.php/RGNG/article/view/23029

Frey, C., Hertweck, P., Richter, L., & Warweg, O. (2022). Bauhaus.MobilityLab: A Living Lab for the Development and Evaluation of AI-Assisted Services. *Smart Cities, 5*(1), 133–145. https://doi.org/10.3390/smartcities5010009

Garcia, A. J. G., & Tuesta, Y. N. (2025). La tercera misión universitaria hacia la ransferencia de conocimiento, la innovación, el emprendimiento y el desarrollo sostenible: una revisión sistemática de la literatura. *Revista de Administração de Empresas, 65*(3). https://doi.org/10.1590/s0034-759020250301

Goddard, J., Hazelkorn, E., Kempton, L., & Vallance, P. (2016). *The Civic University.* Edward Elgar Publishing. https://doi.org/10.4337/9781784717728

Hinojosa-Contreras, R., Gielen, E., Palencia-Jiménez, J.-S., & Cantarino-Martí, I. (2026). Urban sprawl in Latin America: A systematic review of the existing literature and emerging insights. *Land Use Policy, 165*, 107980. https://doi.org/10.1016/j.landusepol.2026.107980

Instituto Nacional de Estadística y Censos. (2022). *8vo. Censo de Población y 7mo. de Vivienda.* https://cubos.inec.gob.ec/AppCensoEcuador/

Jabareen, Y. (2023). The increasing emission divide between cities of the Global North and Global South: Towards adjustable mitigation scenarios at the city level. *Urban Studies, 60*(12), 2369–2383. https://doi.org/10.1177/00420980231152846

Karvonen, A., & van Heur, B. (2014). Urban Laboratories: Experiments in Reworking Cities. *International Journal of Urban and Regional Research, 38*(2), 379–392. https://doi.org/10.1111/1468-2427.12075

Ministerio de Transporte y Obras Públicas. (2023). *Política Nacional de Movilidad Urbana Sostenible 2023-2030*. https://www.studocu.com/ec/document/bachillerato-ecuador/business-management-sl/politica-nacional-de-movilidad-urbana-sostenible-del-ecuador-2023/93230066?sid=007b343e-a347-463c-9b1f-f15ce930c5e91785889257

Nesti, G. (2018). Co-production for innovation: The urban living lab experience. *Policy and Society, 37*(3), 310–325. https://doi.org/10.1080/14494035.2017.1374692

Ngossaha, J. M., Ngouna, R. H., Archimède, B., Negulescu, M.-H., & Petrişor, A.-I. (2024). Toward Sustainable Urban Mobility: A Multidimensional Ontology-Based Framework for Assessment and Consensus Decision-Making Using DS-AHP. *Sustainability, 16*(11), 4458. https://doi.org/10.3390/su16114458

Olaverri-Monreal, C. (2021). Sustainable Mobility and Railway Engineering Laboratory [ITS Research Lab]. *IEEE Intelligent Transportation Systems Magazine, 13*(1), 243–248. https://doi.org/10.1109/MITS.2020.3037569

Piziak, B., Bień, M., Jarczewski, W., & Ner, K. (2023). Exploring Urban (Living) Labs: A Model Tailored for Central and Eastern Europe's Context. *Sustainability, 15*(16), 12556. https://doi.org/10.3390/su151612556

Reichert, S. (2019). *The Role of Universities in Regional Innovation Ecosystems.* European University Association. https://www.eua.eu/images/pdf/eua_innovation_ecosystem_report.pdf

Taliento, M. (2022). The triple mission of the modern university: Component interplay and performance analysis from Italy. *World, 3*(3), 489–512. https://doi.org/10.3390/world3030027

Tarasenko, D., Tarasenko, O., & Tishchenko, M. (2021). Sustainable city mobility indicators. *Scientific Opinion: Economics and Management, 73*(3). https://doi.org/10.32836/2521-666X/2021-73-7

Thomas, E., & Pugh, R. (2020). From 'entrepreneurial' to 'engaged' universities: Social innovation for regional development in the Global South. *Regional Studies, 54*(12), 1631–1643. https://doi.org/10.1080/00343404.2020.1749586

Veltz, P. (2008). Territoires et universités: les enjeux d'une redécouverte. In *Aménagement du territoire* (pp. 247–260). Presses universitaires de Caen. https://doi.org/10.4000/books.puc.10416

Villamil, H. (2022). Gestión del ordenamiento territorial sostenible en Latinoamérica: Una revisión sistemática de literatura. *Revista Venezolana de Gerencia, 27*(28), 417–434. https://doi.org/10.52080/rvgluz.27.98.3