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SYSTEMATIC REVIEW

Active Transport Infrastructure in Peripheral Zones: An Integrated Approach to Urban Equity and Sustainability

Infraestructura de Transporte Activo en Zonas Periféricas: Un Enfoque Integrado para la Equidad y la Sostenibilidad Urbana

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ABSTRACT

Introduction: active transport infrastructure including pedestrian and cycling networks is essential to promote urban equity and sustainability, especially in peripheral zones marked by social vulnerability and structural limitations. In the Cuban context, where territorial disparities and infrastructure obsolescence persist, rethinking inclusive mobility models becomes urgent.

Objective: this article aims to analyze, through a systematic review, the trends, approaches, and theoretical gaps surrounding active transport infrastructure in peripheral zones, emphasizing its contribution to territorial equity and urban sustainability in Cuba.

Method: a systematic literature review was conducted using databases such as Scopus, Redalyc, SciELO, and Google Scholar, focusing on publications from 2018 to 2023. Inclusion criteria targeted studies on urban planning, sustainable mobility, territorial equity, and spatial justice. A thematic analysis matrix and conceptual mapping tools were used to synthesize findings.

Results: the review revealed a lack of Cuban studies focused on peripheral zones, with technical approaches dominating the discourse. Five key categories emerged: accessibility, connectivity, community participation, infrastructural resilience, and spatial justice. International studies offer replicable models, though contextual adaptation is required. An integrated analytical framework is proposed, linking physical, social, and environmental dimensions.

Keywords: Active Transportation; Territorial Equity; Urban Sustainability; Peripheral Areas; Inclusive Infrastructure.

RESUMEN

Introducción: la infraestructura de transporte activo que incluye redes peatonales y ciclísticas constituye un componente esencial para promover la equidad y la sostenibilidad urbana, especialmente en zonas periféricas caracterizadas por vulnerabilidad social y limitaciones estructurales. En el contexto cubano, donde las brechas territoriales y la obsolescencia de la infraestructura son desafíos persistentes, se vuelve urgente repensar modelos de movilidad inclusiva.

Objetivo: este artículo tiene como propósito analizar, desde una revisión sistemática, las tendencias, enfoques y vacíos teóricos en torno a la infraestructura de transporte activo en zonas periféricas, con énfasis en su contribución a la equidad territorial y la sostenibilidad urbana en Cuba.

Método: se aplicó una revisión sistemática de literatura científica publicada entre 2018 y 2023, utilizando bases de datos como Scopus, Redalyc, SciELO y Google Scholar. Se emplearon criterios de inclusión relacionados con estudios urbanos, movilidad sostenible, planificación territorial y justicia espacial. Se construyó una matriz de análisis temático y se utilizaron herramientas de mapeo conceptual para sintetizar los hallazgos.

Resultados: la revisión evidenció una escasa presencia de estudios centrados en zonas periféricas cubanas, predominando enfoques técnicos sobre planificación vial. Se identificaron cinco categorías clave: accesibilidad, conectividad, participación comunitaria, resiliencia infraestructural y justicia espacial. Los estudios internacionales ofrecen modelos replicables, pero requieren adaptación contextual. Se propone un marco integrado de análisis que articula dimensiones físicas, sociales y ambientales.

Palabras clave: Transporte Activo; Equidad Territorial; Sostenibilidad Urbana; Zonas Periféricas; Infraestructura Inclusiva.

INTRODUCTION

Academic critique and research background

The literature on urban mobility has evolved toward more integrative approaches, recognizing the role of active transportation as a catalyst for equity and sustainability.[1,2] However, in the Cuban context, studies tend to focus on motorized road infrastructure, relegating the analysis of pedestrian and cycling networks to the background.[3] This omission limits the understanding of territorial dynamics in peripheral areas, where active transportation represents not only a functional necessity but also a tool for social inclusion.

Authors such as Torres et al.[4] have addressed sustainable mobility from technical perspectives, but without delving into the socio-spatial implications of active infrastructure. In contrast, international studies.[5,6] Have developed theoretical frameworks that link urban planning with spatial justice, proposing indicators of accessibility, resilience, and citizen participation. This systematic review seeks to fill that gap by articulating the physical, social, and environmental dimensions of active transport in peripheral areas of Cuba.[7,8,9,10,11,12]

METHOD

This research was conducted using a systematic review approach, following the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines, adapted to the Cuban urban context. Articles published between 2018 and 2023 were selected from academic databases such as Scopus, Web of Science, SciELO, Redalyc, and Google Scholar. The inclusion criteria were: studies focused on active transport, urban planning, territorial equity, sustainability in peripheral areas, and citizen participation.

A search protocol was applied with keywords combined using Boolean operators: ("active transport" OR "sustainable mobility") AND ("peripheral areas" OR "territorial equity") AND ("urban infrastructure" OR " " "participatory planning"). A total of 87 articles were identified, of which 42 met the criteria for methodological quality and thematic relevance.

For the analysis, a thematic matrix was constructed that allowed the studies to be categorized according to five dimensions: accessibility, connectivity, resilience, community participation, and spatial justice. In addition, a conceptual map was developed that articulates the predominant theoretical approaches and their implications for the Cuban context.

Table 1. Thematic categories identified in the systematic review

Category	Brief description	Frequency in studies
Accessibility	Ease of access to pedestrian and bicycle networks	High (35/42)
Connectivity	Integration of active networks with the urban system	Medium (28/42)
Infrastructural resilience	Ability to adapt to climate events and urban deterioration	Low (15/42)
Community participation	Citizen involvement in design and maintenance	Medium (26/42)
Spatial justice	Equitable distribution of resources and territorial opportunities	High (33/42)

This methodological approach allows not only for the systematization of existing knowledge, but also for the identification of theoretical gaps and opportunities for intervention in the design of public policies for peripheral areas of Cuba.

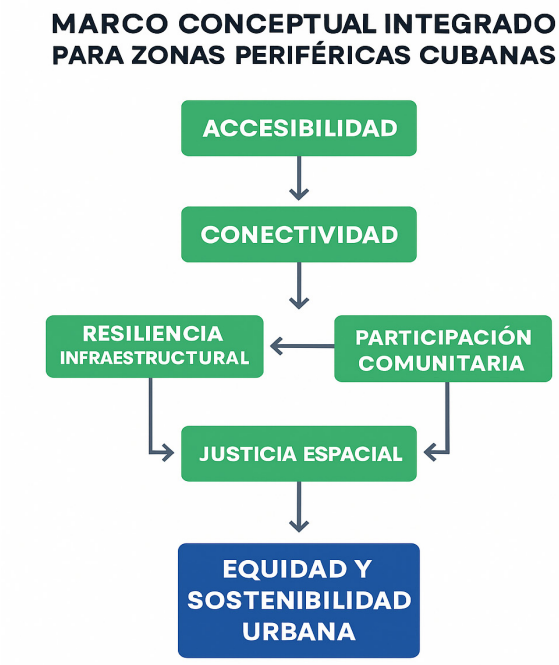

Figure 1. Conceptual map of the methodological approach

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RESULTS

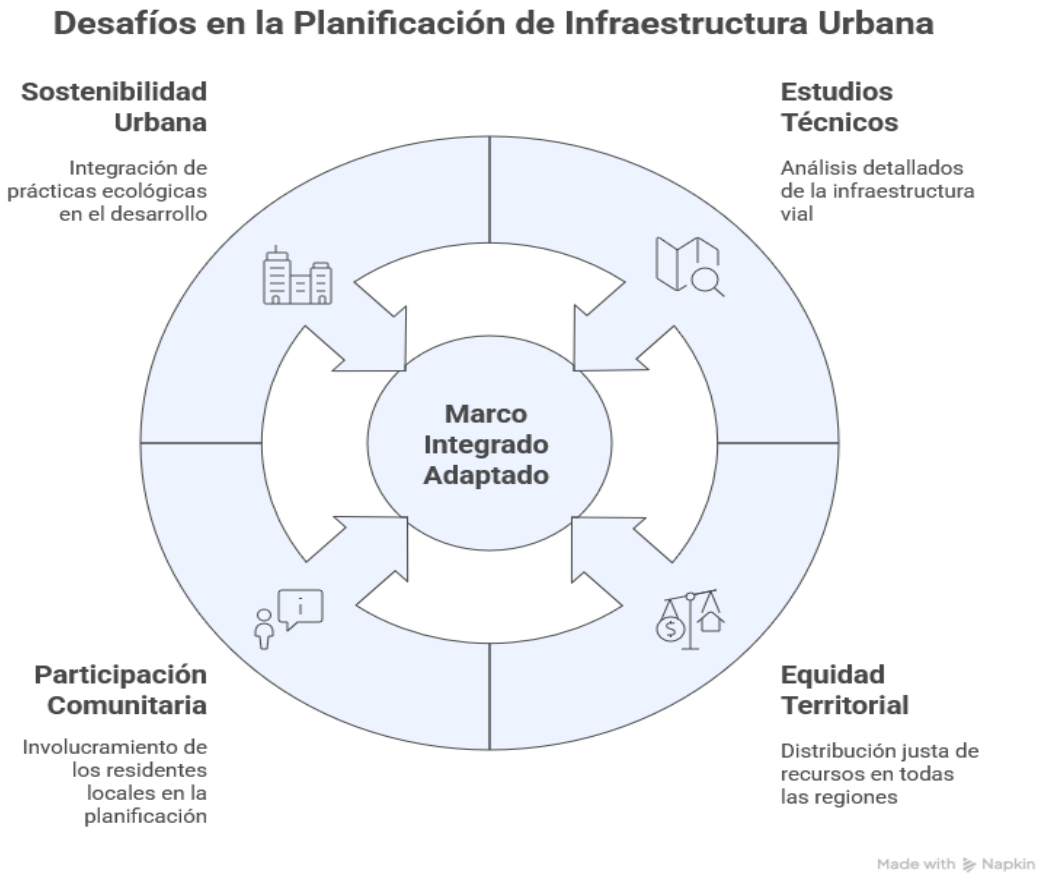

Figure 2. Theoretical gaps in Cuban studies on active transportation

The systematic review identified recurring patterns and theoretical gaps in the approach to active transport infrastructure in peripheral areas. The results are grouped into three levels: international findings, Latin American regional findings, and findings specific to the Cuban context.

At the international level, studies that integrate criteria of territorial equity, urban resilience, and citizen participation in the design of pedestrian and bicycle networks stand out.[5,6] In Latin America, countries such as Colombia, Chile, and Mexico have developed active mobility master plans with an inclusive approach.[1,6] In Cuba, however, the literature reviewed shows little coordination between urban planning and active mobility in peripheral areas.[3,7]

Table 2. International best practices that can be replicated in Cuba

Country	Notable strategy	Potential for adaptation in Cuba
Colombia	Network of bike paths integrated with public transportation	High
Chile	Active mobility plan with a gender focus	Medium
Mexico	Pedestrian infrastructure in marginal areas	High
Netherlands	Universal design for active mobility	Low (requires high investment)
Brazil	Community participation in urban design	High

These results highlight the need for a multidimensional approach that links physical infrastructure with the social and environmental dynamics of peripheral areas. The scarcity of Cuban studies with an integrated approach suggests an academic and political gap that this article seeks to highlight.

DISCUSSION

The findings of this systematic review reveal a significant gap between international approaches to active transport infrastructure and the reality in Cuba. While countries such as Colombia and Chile have moved toward participatory models that integrate criteria of territorial equity, Cuba continues to adhere to a centralized planning logic that limits adaptability and social inclusion.[1,6]

The scarcity of Cuban studies addressing active transport from a multidimensional perspective suggests a disconnect between academic research and territorial needs. This disconnect translates into fragmented, unresilient infrastructure with low community

participation.[3,7] Furthermore, the lack of specific indicators to assess spatial equity in peripheral areas hinders the formulation of effective public policies.[13,14,15,16]

The discussion suggests that adopting a participatory approach would not only improve physical infrastructure but also strengthen the social fabric in peripheral areas. This paradigm shift requires political will, technical training, and institutional openness to incorporate collaborative methodologies into urban planning.[17,18,19,20]

Emerging trends in scientific literature

Recent literature on active transportation in peripheral areas shows a clear evolution toward intersectional approaches that link mobility with gender, public health, climate change, and urban governance.[8,9] In addition, there is a growing use of participatory methodologies and digital tools for collaborative infrastructure design.[10]

In the Cuban context, these trends are not yet fully reflected in scientific production, which opens up opportunities for future research that integrates local knowledge, technological innovation, and territorial justice.[21,22,23]

The proposed conceptual framework articulates five fundamental dimensions for the analysis of active transport infrastructure in peripheral areas: accessibility, connectivity, infrastructural resilience, community participation, and spatial justice. These dimensions are interrelated in a dynamic system that allows for the evaluation not only of the physical quality of the infrastructure, but also of its social and territorial impact.

This integrated approach is based on three theoretical pillars: participatory urban planning,[8,11] territorial equity,[6,12] and urban sustainability.[9,13] In the Cuban context, this framework allows for the identification of structural gaps and opportunities for intervention adapted to local conditions.[24,25]

CONCLUSIONS

The systematic review of active transport infrastructure in peripheral areas reveals a profound need for transformation in urban planning approaches in Cuba. Unlike international models that integrate territorial equity, resilience, and citizen participation, the Cuban context is characterized by centralized planning that is limited in its adaptability and disconnected from local social dynamics.

The main contributions of this research can be summarized on three levels:

- Theoretical**:** an integrated conceptual framework is proposed that articulates five key dimensions: accessibility, connectivity, infrastructure resilience, community participation, and spatial justice. This framework allows for the analysis of active infrastructure from a multidimensional perspective, overcoming fragmented technical approaches.
- Methodological**:** the application of a systematic review using PRISMA criteria adapted to the Cuban urban context demonstrates the feasibility of building rigorous knowledge from international and regional sources, identifying gaps and opportunities for replicability.
- Practical**:** international best practices that can be adapted to Cuba are identified, especially those that promote community participation, modal integration, and territorial equity. These practices offer a roadmap for the redesign of public policies in peripheral areas.
- Academic**:** a multidimensional conceptual framework is proposed that can be used by researchers in urban planning, sociology, public policy, and territorial planning.
- Political-practical: recommendations are offered for the redesign of public policies in Cuba, aimed at territorial equity, citizen participation, and urban sustainability.

This article contributes to the academic debate on urban mobility in peripheral contexts, proposing a transformative vision that links infrastructure, territory, and citizenship.

RECOMMENDATIONS

1. Empirical studies in Cuban peripheral areas**:** field research is needed to document the real conditions of accessibility, connectivity, and community participation in marginal neighborhoods.
2. Social impact assessment: **it** is necessary to measure how active infrastructure influences social inclusion, public health, and territorial equity.
3. Integration of local knowledge: it is recommended to incorporate participatory methodologies that value community knowledge in urban design.
4. Regional comparative analysis: studies that contrast Cuban experiences with other Latin American cities can enrich academic and political debate.
5. Use of geospatial technologies: the application of GIS and digital tools can improve territorial diagnosis and collaborative planning.

Lines of action for urban managers

- Participatory territorial diagnosis: Implement collective mapping processes to identify active mobility needs.
- Pilot plans in vulnerable areas: Develop demonstration projects that integrate pedestrian and cycling infrastructure with citizen participation.
- Technical and community training: Train local professionals and leaders in inclusive planning and urban sustainability.
- Monitoring with specific indicators: Establish continuous evaluation systems to measure the performance of active

infrastructure.

This approach not only allows us to rethink physical infrastructure, but also to transform the relationships between citizens, territory, and mobility. When designed with inclusion in mind, active transport infrastructure can become a driver of spatial justice and urban resilience.

This article has developed a theoretical, methodological, and applied framework for addressing active transport infrastructure in peripheral areas, with an emphasis on the Cuban context. Through a rigorous systematic review, academic gaps, structural limitations, and opportunities for adapting international models have been identified.

The proposal for an integrated approach based on accessibility, connectivity, resilience, participation, and spatial justice allows us to rethink urban mobility from the perspective of territorial equity and sustainability. This work aims to contribute to the strengthening of urban research in Cuba and the formulation of more inclusive public policies.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHORSHIP CONTRIBUTION

Conceptualization: Leider Inocencio Saraiba Núñez, Orlando Figueredo Maldonado.
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Drafting - original draft: Leider Inocencio Saraiba Núñez, Orlando Figueredo Maldonado.
Writing - proofreading and editing: Leider Inocencio Saraiba Núñez, Orlando Figueredo Maldonado.

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ANNEXES

Table 3. Classification of sources by approach

Source (author/year)	Main approach
Gehl[11]; Banister[13]	Theoretical
Litman[12]; Cervero et al.[14]	Methodological
Nieuwenhuijsen[9]; Arriaga et al.[15]	Applied
Triana et al.[3]; Rodríguez et al.[16]	Applied
Fernández et al.[17]; Martínez et al.[18]	Applied
Cuban Ministry of Transport[19]	Methodological

Table 4. Comparison between Cuban and Latin American peripheral areas

Dimension	Cuba	Latin America (Colombia, Chile, Mexico)
Accessibility	Limited, fragmented	High in areas where interventions have been carried out
Connectivity	Weak modal integration	Moderate to high
Infrastructural resilience	Low, vulnerable to deterioration	Medium, with adaptation plans
Community participation	Low, institutionalized	High in collaborative projects
Spatial justice	Unequal distribution	In the process of improvement

Table 5. Suggested indicators for evaluating active infrastructure in peripheral areas

Indicator	Description	Measurement method
Pedestrian accessibility index	Proximity to basic services via safe routes	GIS + surveys
Level of modal connectivity	Integration with public transport and urban networks	Network analysis
Community participation	Level of involvement in design and maintenance	Interviews + observation
Infrastructural resilience	Ability to adapt to climatic events	Technical assessment
Spatial equity	Territorial distribution of active infrastructure	Maps + statistical analysis