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ROAD INFRASTRUCTURE AND ITS IMPACT ON URBAN MOBILITY IN CHICLAYO PERU, 2023

LA INFRAESTRUCTURA VIAL Y SU IMPACTO EN LA MOVILIDAD URBANA EN CHICLAYO PERÚ, 2023

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ABSTRACT

This study focuses on road infrastructure and its impact on urban mobility in Chiclayo, 2023, with an emphasis on evaluating current conditions and proposing improvements for more efficient and sustainable transit. The methods combine quantitative techniques and assessment of public perception through surveys, evaluating elements such as the effectiveness of rigid pavement, the integration of soil mechanics studies in planning, and the influence of environmental impact on transit. The results highlight a significant positive correlation between improving road infrastructure and optimizing urban mobility, indicating that investments in road improvements are essential to alleviate congestion and improve urban quality of life. Specific strategies are suggested to manage vehicular saturation, improve signage and safety, and promote the use of eco-friendly public transportation. The research confirms that adequate planning and investment in road infrastructure are crucial for fostering a sustainable and functional urban environment in Chiclayo.

Keywords: road infrastructure, risks, user satisfaction, road safety, mobility collapses.

RESUMEN

Este estudio se centra en la infraestructura vial y su impacto en la movilidad urbana en Chiclayo, 2023, con énfasis en evaluar las condiciones actuales y proponer mejoras para un tránsito más eficiente y sostenible. Los métodos combinan técnicas cuantitativas y de evaluación de la percepción pública a través de encuestas, evaluando elementos como la efectividad del pavimento rígido, la integración de estudios de mecánica de suelos en la planificación y la influencia del impacto ambiental en el tránsito. Los resultados destacan una correlación positiva significativa entre la mejora de la infraestructura vial y la optimización de la movilidad urbana, lo que indica que las inversiones en mejoras viales son esenciales para aliviar la congestión y mejorar la calidad de vida urbana. Se sugieren estrategias específicas para gestionar la saturación vehicular, mejorar la señalización y la seguridad y promover el uso de transporte público ecológico. La investigación confirma que una planificación e inversión adecuadas en infraestructura vial son cruciales para fomentar un entorno urbano sostenible y funcional en Chiclayo.

Palabras clave: infraestructura vial, riesgos, satisfacción del usuario, carretera segura, la movilidad colapsa.

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1. INTRODUCTION

Road mobility has experienced rapid evolution in recent years, driven by the implementation of new technologies in both road infrastructures and vehicles. This topic gained prominence during and after the pandemic due to its relevance in commuting, social interaction, and access to goods and services.

Internationally, Lizágarra Mollinedo (2006) delves into the factors contributing to the lack of environmental and social sustainability in current approaches to urban mobility. Her research highlights the negative consequences of transportation, relying on statis-tical data and theoretical contributions, and proposes principles for a sustainable urban mobility model. It emphasizes the importance of this challenge for 21st-century cities, underscoring that it is essential for maintaining or improving the quality of life in medium and large cities.

Meanwhile, Lupano and Sánchez (2009) compiled analytical and organizational perspectives from the "Seminar on Urban Mobility Policies and Urban Transport Infrastructure Services," held in March 2008 in Buenos Aires, Argentina. Organized by ECLAC, this event promoted a thorough debate on urban mobility policies, based on experiences from the Americas and Europe, and fostered an interdisciplinary approach that considers urban planning as a means to improve the quality of life and the environmental sustainability of transportation.

Additionally, Hinojosa Reyes (2017) evaluated the influence of urban infrastructure on mobility in the metropolitan area of Toluca, identifying both negative and positive im-pacts of urban transportation on the health of its inhabitants. Through an analysis that combined qualitative and quantitative methods, including Geographic Information Systems (GIS) based on spatial analysis, the study revealed adverse consequences in terms of road safety and health problems associated with sedentary lifestyles, such as diabetes and diseases linked to air pollution. These findings indicate that the current infrastructure is not sufficient to promote a healthy environment and suggest that, despite existing efforts, actions are insufficient and do not address the problem comprehensively.

In the Peruvian national context, the road network is a set of key elements for the safe and efficient transit of vehicles, crucial for the country's land connection and the transportation of people and goods (Medina et al., 2018). In this regard, Salvador Figueroa et al. (2017) high-light a significant restructuring of organizations and an increase in investments in road infrastructure, strategies aimed at positioning Peru as a competitive leader regionally and internationally. This development would favor an environment conducive to eco-nomic prosperity and contribute to the overall growth of the country.

According to De Solminihac et al. (2019) the research addresses all the essential components to facilitate safe and comfortable vehicle traffic, while minimizing any negative impact on the environment. This includes aspects such as circulation surfaces, structures (bridges and tunnels), protection devices, signage, water management systems, slopes, embankments, and aesthetic elements that harmonize with the landscape. According to Estela (2020) there an urgent need to improve road infrastructure to reduce congestion and optimize urban mobility in Chiclayo. After a thorough analysis of the current situation, we propose a detailed solution to address the identified problems.

After having developed the problematic reality, the following research question is established: How does road infrastructure affect urban mobility in the city of Chiclayo, 2023?

The methodology of our research was developed from the observation of a specific problem in the road network, leading us to formulate a study prototype. This approach allowed us to identify deficiencies and subject them to rigorous analysis, resulting in the construction of a theoretical model based on scientific theories. This model not only proposes viable solutions with practical applications but also offers tools and alternatives to address road problems in a practical and applied context (Reque, 2019).

The general objective is to propose a model for road infrastructure renewal in Chiclayo to achieve more efficient urban mobility, reduce traffic congestion, promote the use of public transportation systems for pedestrians, and thus contribute to sustainable development and the increased well-being of the city's inhabitants.

Furthermore, the specific objectives are as follows: (1) Detail traffic management strategies and route design to reduce vehicular saturation in key areas of the city. (2) Identify a well-designed road plan with appropriate signage, lighting, and pedestrian crossings to help prevent accidents and ensure the protection of road users, including pedestrians and cyclists. (3) Evaluate the introduction of ecological and environmentally friendly public transportation alternatives to reduce air pollution and greenhouse gas emissions.

The study hypothesizes a cause-and-effect relationship between road infrastructure and the impact it generates on urban mobility in Chiclayo, which will be verified using quantitative techniques and survey instruments. The results will allow us to conduct an analysis that demonstrates the vital importance of road infrastructure in improving the circulation of urban areas and the sustainable development of Chiclayo.

2. STUDY AREA

The city of Chiclayo, located in the Lambayeque region in northern Peru, is a strategic urban center with a growing population and increasing demand for mobility services. Road infrastructure underpins Chiclayo's economic and social development by enabling mobility, trade, and reducing congestion.

According to the Instituto Vial Provincial de Lambayeque (2022) Chiclayo's Road network connects 88.12% of the populated centers in the province, benefiting 99.22% of the population. However, the same report indicates that 43% of these roads are in regular or poor condition, which negatively impacts urban mobility. This diagnosis led to the development of the 2023–2027 Road Plan, aimed at improving connectivity and transitability across the province, promoting economic integration and access to basic services.

In addition, the Peruvian News Agency Andina (2021) reported that Chiclayo ranks sixth among Peruvian cities facing serious challenges in urban mobility, prompting initiatives to improve public transportation and connectivity between urban centers, in alignment with national mobility and inclusion policies.

Alcántara de Vasconcellos (2010) proposes a methodology to analyze mobility from both social and economic dimensions, highlighting how patterns of displacement influence not only accessibility but also equity and urban sustainability. Applying these criteria to cities like Chiclayo allows for a better understanding of how infrastructure investments can support balanced urban development and reduce inequalities in access.

Tavera (2019), in a comparative study of road infrastructure within the Pacific Alliance countries, underscores the importance of high-quality road systems in enabling international trade. Although focused on Colombia, the lessons drawn emphasize the need for efficient transport corridors and logistics platforms, which are also highly relevant for regional hubs like Chiclayo, especially considering its commercial and agricultural potential.

In this context, Muñoz (2018) argues that effective urban mobility systems are directly linked to economic growth and improved quality of life. He highlights how efficient transport not only enhances connectivity but also reduces overall living costs and increases labor productivity. For a city like Chiclayo—marked by growing urban pressure and logistical demands—these insights reinforce the importance of designing infrastructure that prioritizes accessibility, equity, and long-term economic benefits.

At the regional level, Mendiburu Rojas (2022) focused on creating an investment plan to improve the infrastructure of Chiclayo, with the aim of meeting the needs of residents and fostering sustainable development. The plan includes the expansion of existing roads, construction of new routes, and development of public spaces such as parks and squares, thus promoting social well-being and strengthening the community.

Likewise, Peralta Villalobos (2021) evaluated the condition of insufficient road infrastructure in José Leonardo Ortiz, a district of Chiclayo. After conducting an economic and social feasibility analysis, she concluded that constructing new streets and sidewalks in targeted areas would directly benefit approximately 2,997 inhabitants, improving their access and quality of life.

Toro Huamán (2021) analyzed road infrastructure planning in the San Francisco de Asís sector of Chiclayo. The study incorporated traffic analysis, topographic surveys, environmental impact assessments, and hydrological studies, ultimately leading to the development of a road design that

aimed to enhance vehicular and pedestrian mobility and contribute to regional socio-economic progress. Vallejos and Bayona (2021) emphasize that road infrastructure in Peru is not only a technical requirement for transit but also a fundamental element for the exercise of constitutional rights. They argue that deficiencies in infrastructure planning, combined with disorganized and informal transportation systems, compromise both the right to mobility and physical integrity. Their recommendations are particularly pertinent for Chiclayo, where traffic disorder and limited pedestrian infrastructure often pose safety hazards.

Road safety is also a critical component of the local context. According to the 2023 report by the National Road Safety Observatory, fatal traffic accident hotspots were identified across the Lambayeque region. The analysis—conducted by the Peruvian National Police's Accident Prevention and Investigation Unit—provides key insights for targeted interventions in areas with high accident rates.

Espino Vargas and Del Carpio Ramos (2008), in a study at the Universidad Señor de Sipán, highlighted user dissatisfaction with public transportation in Chiclayo, primarily due to a lack of reliable information. They proposed the creation of a Local Intelligence Agency to manage the relationship between supply and demand, thereby supporting sustainable mobility and improving the urban quality of life.

The relevance of innovation in local infrastructure is also evident through the study by Pérez and Cubas (2022), who advocated for the implementation of Building Information Modeling (BIM) methodologies in road infrastructure projects. This digital approach enhances project planning, design efficiency, and execution time, providing a forward-looking alternative for municipalities such as Chiclayo.

Finally, Obregón and Paz Gómez (2021) emphasize the importance of promoting active mobility in cities across Latin America. They suggest that pedestrian and cyclist inclusion in urban planning—following models from Nordic countries—can help foster more inclusive and sustainable urban environments. This perspective aligns with the growing demand for safer, greener, and people-centered transportation infrastructure in Chiclayo.

3. MATERIALS AND METHODS

3.1. Research type and design

This study is classified as applied research. Applied research, also known as practical or empirical research, is characterized by its focus on the application of already acquired knowledge and the acquisition of new knowledge through the implementation and systematization of research-based practices. This type of study is crucial for solving specific problems and generating direct solutions applicable in concrete fields (Cordero, 2009; Cauas, 2015).

The approach of this research is quantitative, opting for a non-experimental cross-sectional design. This design allows for data collection at a single moment, at a specific time, which is ideal for studies seeking to measure or describe variables without manipulating the environment in which they occur. This approach is suitable for analyzing and understanding the current situation of road infrastructure and urban mobility in Chiclayo, providing an accurate snapshot of the conditions and perceptions existing at the time of the study.

3.2. Population, sample, sampling and unit of analysis

In the current study, a population of 100 individuals residing between Salaverry and José Leonardo Ortiz avenues in the city of Chiclayo was examined. This population consists of two equal groups: 50 pedestrians and 50 drivers who regularly transit through these areas and are adults of both sexes. The inclusion criteria focused on adults of both genders who frequent these areas, while individuals under 18 years of age and those who do not regularly transit through the specified streets of Chiclayo were excluded.

According to Ludeña (2021) it is essential to differentiate between a population and a sample; the sample is a subset selected to represent the entirety and allow for the analysis of its unique characteristics. In this case, a sample of 100 people was selected through convenience non-probabilistic sampling, composed of an equal number of drivers and pedestrians.

This sample will be used to explore and draw conclusions about the broader population, understanding and generalizing its characteristics within the urban context of Chiclayo in the year 2023 (Torres et al., 2006). The sample was evenly

distributed with 50% of drivers and 50% of pedestrians, ensuring a balanced representation of the groups of interest in the study.

3.3. Data collection techniques and instruments, validity and reliability

Data collection in the study on urban mobility in Chiclayo focused on rigorous techniques and instruments to capture the dynamics of road infrastructure and its im-pact. Data collection techniques are systematic criteria that reveal the structure of the studied phenomena and establish specific behaviors (Acevedo, 2022).

For this specific analysis, the survey was chosen as the primary technique due to its effectiveness in providing descriptive and relational responses between variables (Hernández et al., 2010). A structured questionnaire was designed around a Likert scale to assess aspects of road infrastructure and its impact on urban mobility. This questionnaire included nine items for each variable, targeting both pedestrians and drivers, with closed-ended responses ranging from "Never" (1) to "Always" (4).

3.4. The validity of the instrument was evaluated by specialists in civil engineering and education

Fernando Demetrio Llatas Villanueva, Ermitanio Torres Risco, and Ronald Torres Camach, who ensured that the items were appropriate for measuring the impact of road infrastructure on urban mobility.

In terms of reliability, the Cronbach's Alpha coefficient was applied, which demonstrated a high level of internal consistency with a result of 0.807, indicating very good reliability. This method confirmed the uniformity and precision of the results obtained, ensuring that the instrument is suitable for obtaining reliable and accurate information about the dynamics of urban mobility in Chiclayo. This methodical approach guarantees that the collected data are of high quality and that the conclusions derived from them will be solid and well-founded.

Table 1. Reliability Statistics for Road Infrastructure and Urban Mobility Impact Variables. Source: Own elaboration.

Cronbach's Alpha	N of items
,807	100

3.5. Procedures

The research procedure on road infrastructure and urban mobility in Chiclayo began with the request for authorization from the Public Infrastructure Management of the Provincial Municipality of Chiclayo. This request was necessary due to concerns about existing issues in the city's road infrastructure. Approval allowed for the devel-opment of a series of questions that formed the basis of a survey designed to capture the perceptions of pedestrians and drivers about these issues in their daily lives.

For data collection, a physical questionnaire was used, completed by each participant. This questionnaire consisted of 18 items, divided equally between two main variables: road infrastructure and impact on urban mobility. To ensure the validity of the instrument, the collaboration of three experts was enlisted, two in civil engineering and one in education, all with master's degrees and relevant experience in their respective fields.

The reliability of the questionnaire was verified by applying Cronbach's Alpha co-efficient after administering the questionnaire to the participants. The data collected from 100 respondents resulted in a high level of reliability, with a coefficient of 0.807.

The obtained data were systematically organized into a database using Microsoft Excel 2016. Subsequently, this data was analyzed using SPSS software version 29.0.1.0, performing both descriptive and inferential analyses to validate reliability and draw relevant conclusions from the collected information.

Finally, the conclusions and recommendations derived from the study were presented to the Public Infrastructure Management of Chiclayo. The aim of this report was to provide an evidence base that the Management can use to make informed decisions and improve strategies related to road infrastructure and urban mobility, in response to the results obtained in the research.

3.6. Ethical aspects

In the development of this research on road infrastructure and urban mobility in Chiclayo, relevant ethical aspects have been rigorously followed, ensuring that the study was conducted with utmost integrity. A thorough literature review was conducted, selecting relevant and current studies according to the guidelines of the seventh edition of the APA format. This review not only ensured the academic relevance of the study but also its methodological accuracy by choosing appropriate and well-described research techniques.

The ethical principles that guided this research were based on respect for persons, altruism, and justice. This involved a commitment to non-maleficence, ensuring that subjects' participation in the research did not result in harm. Additionally, participants' autonomy was promoted, allowing them to make informed decisions about their involvement without pressure or external influence. Fair and equitable treatment for all participants, especially those surveyed at the intersections of José Leonardo Ortiz and Salaverry, was maintained.

According to Vallejos and Bayona (2021) in the ProSciencies journal, the importance of the road safety manual is emphasized. This document is an essential management tool for authorities and professionals involved in the development of road safety plans and programs, as well as in conducting audits and inspections. From the pre-investment stage to the post investment stage, the manual establishes criteria and technical parameters that must be mandatory complied with at the national level. Recommendation is for competent authorities to intensify monitoring compliance with these regulations, ensuring that reasonable and effective solutions are implemented in the design and maintenance of road infrastructure.

This ethical and methodological approach provides a solid foundation for the conclusions and recommendations of the study to be taken seriously and responsibly by local authorities, thus promoting significant improvements in road infrastructure and urban mobility in Chiclayo.

4. RESULTS

The quantitative analysis, based on surveys applied to 100 residents of the city of Chiclayo (50 drivers and 50 pedestrians), revealed key perceptions regarding various aspects of road infrastructure and its influence on urban mobility. The results are presented thematically to provide an integrated understanding of the data, with references to the respective tables for clarity.

First, a significant concern was observed regarding the environmental impact on the usability of the city's main streets. A total of 82% of respondents stated that environmental factors "almost always" or "always" hinder road viability; this reflects a widespread perception of pollution, congestion, and urban disorder as obstacles to efficient traffic flow (see Table 2).

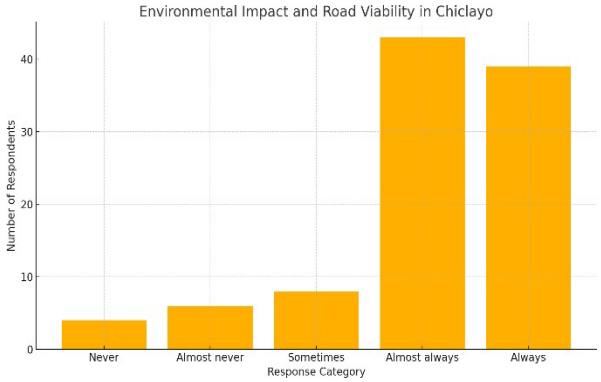

Figure 1. Perceptions of environmental impact on road usability in Chiclayo.

Table 2. Environmental impact hinders the viability of the main streets in the city of Chiclayo. Frequency Percentage Source: Own elaboration

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	N°	%
Never	4	4%
Almost never	6	6%
Sometimes	8	8%
Almost always	43	43%
Always	39	39%
TOTAL	100	100%

In terms of technical planning before the execution of road projects, most participants expressed positive views. Seventy-five percent believed that topographic studies are frequently taken into account when paving urban streets (see Table 3); 67% affirmed the regular inclusion of basic technical

studies and proper material selection (see Table 5). However, only 53% considered that soil mechanics analyses are applied consistently (see Table 4); this suggests inconsistencies in the integration of geotechnical criteria, which could affect the long-term durability and effectiveness of road infrastructure.

Table 3. Topography was considered as a fundamental study for the paving of the city's roads, allowing their transitability.

	N°	%
Never	4	4%
Almost never	8	8%
Sometimes	13	13%
Almost always	39	39%
Always	36	36%
TOTAL	100	100%

Table 4. Soil mechanics is considered for paving the main transit routes in the city of Chiclayo.

	N°	%
Never	5	5%
Almost never	7	7%
Sometimes	35	35%
Almost always	30	30%
Always	23	23%
TOTAL	100	100%

Table 5. Basic studies are considered in the design of road pavement, sidewalks, and in the use of appropriate materials.

	N°	%
Never	4	4%
Almost never	9	9%
Sometimes	20	20%
Almost always	33	33%
Always	34	34%
TOTAL	100	100%

Regarding the quality and perceived effectiveness of rigid pavement, 61% of respondents stated that it facilitates pedestrian and vehicular traffic (see Table 6); likewise, 69% affirmed that the main streets and avenues of Chiclayo are currently built using this type of material (see Table 7). These responses indicate a general perception of widespread use and utility of rigid pavement; however, a third of respondents expressed less favorable opinions, which may reflect deficiencies in maintenance, design standards, or implementation practices.

Table 6. The use of rigid pavement on roads allows for adequate pedestrian and transporter traffic.

	N°	%
Never	3	3%
Almost never	13	13%
Sometimes	23	23%
Almost always	46	46%
Always	15	15%
TOTAL	100	100%

Table 7. The main streets and avenues of the city of Chiclayo are designed and implemented with rigid pavement.

	N°	%
Never	7	7%
Almost never	7	7%
Sometimes	17	17%
Almost always	31	31%
Always	38	38%
TOTAL	100	100%

When asked about potential public policies to improve urban mobility, respondents showed strong support for sustainable strategies. Seventy-four percent expressed agreement with increased investment in public transportation as a solution to reduce traffic congestion (see Table 8); additionally, 70% supported the implementation of urban tolls to help finance road improvements and manage traffic flows (see Table 9). These figures highlight a favorable attitude among citizens toward structural changes that prioritize collective transport, financial sustainability, and environmental efficiency.

Table 8. Would you support investment in expanding public transportation to reduce traffic congestion?

	N°	%
Never	4	4%

Almost never	9	9%
Sometimes	13	13%
Almost always	43	43%
Always	31	31%
TOTAL	100	100%

Table 9. Do you think urban tolls should be implemented to reduce congestion and finance improvements in road infrastructure?

	N°	%
Never	5	5%
Almost never	10	10%
Sometimes	15	15%
Almost always	43	43%
Always	27	27%
TOTAL	100	100%

With regard to public budget management, perceptions were divided. While 47% of respondents believed that the funds allocated for road improvement are well used, the remaining 53% expressed skepticism or disagreement (see Table 10); this points to the importance of increasing transparency and accountability in the administration of public infrastructure investments.

Table 10. Do you think budgets for road improvement are well spent?

	N°	%
Never	4	4%
Almost never	12	12%
Sometimes	37	37%
Almost always	33	33%
Always	14	14%
TOTAL	100	100%

Pedestrian behavior also revealed a significant pattern: 74% of participants indicated that they prefer crossing the street between vehicles rather than using pedestrian bridges (see Table 11). This preference suggests problems related to accessibility, safety perception, or design of pedestrian infrastructure, and signals the need to reassess urban planning strategies to promote safer and more appealing options for foot traffic.

Table 11. I prefer crossing the street between vehicles rather than using the pedestrian bridge.

	N°	%
Never	3	3%
Almost never	6	6%
Sometimes	17	17%
Almost always	44	44%
Always	30	30%
TOTAL	100	100%

Finally, statistical analysis confirmed the existence of a strong and significant relationship between road infrastructure and its impact on urban mobility. The Pearson correlation coefficient showed $r = 0.730$, with a bilateral significance of $p < 0.001$, indicating a high positive correlation between both variables (see Table 12). Complementary to this, the Chi-square test revealed a statistically significant association ($\chi^2 = 552.161$; $df = 380$; $p < 0.001$), reinforcing the reliability of the findings (see Table 13). These results empirically support the research hypothesis: improvements in road infrastructure are closely related to enhancements in urban mobility across the city of Chiclayo.

Table 12. Correlation between road infrastructure and impact on urban mobility.

			Road Infrastructure	Impact on Urban Mobility
Pearson's Rho	Road Infrastructure	Correlation coefficient	1	.730**
		Sig. (two-tailed)		<.001
		N	100	100
	Impact on Urban Mobility	Correlation coefficient	.730**	1
		Sig. (two-tailed)	<.001	
		N	100	100

Table 13. Chi-square tests.

Chi-square tests			
	Valor	gl	Asymptotic Significance (bilateral)
Pearson's Chi-square	552.161[a]	380	<.001

Likelihood Ratio	278.015	380	1.000
Linear-by-Linear Association	52.818	1	<.001
Number of valid cases	100		

a. 420 cells (100.0%) had an expected count less than 5. The minimum expected count is 0.01.

5. DISCUSSION

The findings of this study empirically support the hypothesis that improving road infrastructure is significantly associated with increased efficiency in urban mobility in Chiclayo. Statistical analysis demonstrated a strong positive correlation between the variables analyzed ($r=0.730$; $p<0.001$) confirming that as the quality of infrastructure improves, traffic flow also increases; this reinforces the conceptual model proposed by De Solminihac et al. (2019) which emphasizes the importance of integrating circulation surfaces, safety elements and environmental criteria to ensure safe and fluid transit.

Nonetheless, it is important to note that the Chi-square test ($\chi^2 = 552.161$; $df = 380$; $p < 0.001$) used to analyze the relationship between road infrastructure and urban mobility presented a methodological limitation: 100% of the expected cell counts were below 5. This violation of the test's assumptions weakens the validity of its conclusions. In future research, it would be advisable to consider alternative statistical methods, such as Fisher's exact test (for smaller contingency tables) or log-linear modeling for multidimensional categorical data. Despite this, the robustness of the findings is reinforced by the Pearson correlation coefficient, which confirmed a strong and statistically significant relationship between the two variables.

According to the 2023 Diagnostic Report of the Lambayeque Provincial Road Institute, Chiclayo has a road network that connects 88.12% of its populated centers, benefiting 99.22% of the urban population. However, 43% of these roads are in regular or poor condition, which compromises the fluidity of urban transportation and contributes to an estimated loss of 42 minutes per person per day in commuting time

One notable aspect is the widespread perception of structural limitations. For instance, 82% of respondents stated that environmental and urban conditions frequently hinder the viability of the city's main roads; although based on subjective assessments, this perception aligns with Lizágarra Mollinedo (2006) who warned that unsustainable urban planning approaches are a central factor in the deterioration of urban mobility. These results call not only for technical solutions but also for systemic and participatory urban planning processes that anticipate and mitigate such obstacles.

Public support for the expansion of public transportation (74%) and the implementation of urban tolls (70%) demonstrates a clear inclination toward collective mobility solutions; these preferences are aligned with the regional proposals of Lupano and Sánchez (2009) who advocate for policies that promote equity and sustainability through the development of public transit systems. The population's willingness to adopt structural changes suggests a favorable context for implementing policies such as improved bus networks, fare subsidies, or redesigned pedestrian crossings and transport hubs.

Although the general utility of rigid pavement was (affirmed by 69% of respondents) concerns persist regarding the coherence of planning criteria. Only 53% considered that soil mechanics studies are applied consistently; this suggests gaps in the diagnostics prior to construction that could compromise the durability of road works. These findings resemble those of Hinojosa Reyes (2017) in Toluca, where poor planning was linked to road safety risks and public health problems. The lesson is clear: infrastructure must be grounded in comprehensive diagnostics (including geotechnical and topographic studies) to ensure sustainable outcomes.

From a governance perspective, public perception of budget management was divided: 53% of respondents expressed distrust in the use of funds allocated to road infrastructure; this reinforces what Bizerra Osorio (2016) stated — understanding community expectations is essential for project legitimacy. Institutional transparency and citizen participation must be considered indispensable elements for strengthening public trust and the long-term sustainability of interventions.

Behavioral patterns also revealed critical challenges. A concerning 74% of respondents stated they prefer crossing streets between vehicles rather than using pedestrian bridges; this behavior reveals potential deficiencies in the design, accessibility, or perceived safety of pedestrian infrastructure. As Obregón and Paz Gómez (2021) emphasize, urban planning must prioritize active mobility and address design flaws that discourage safe practices.

However, this study has several limitations. First, the use of a non-probabilistic sample restricts the generalizability of the results. Second, the data are based on subjective perceptions, not on direct observation or traffic flow measurements. Moreover, the cross-sectional nature of the study prevents identifying causal trends over time. Finally, variables such as income level, access to transportation, or walkability indices were not included; these could have offered a more nuanced understanding of urban mobility experiences.

Based on the results obtained, several practical recommendations emerge. Municipal authorities should prioritize the implementation of topographic and geotechnical studies in every road project. Urban mobility policies must leverage public support for transport reforms by incorporating environmental criteria and promoting inclusive infrastructure for pedestrians and cyclists. Additionally, communication strategies should be implemented to address public mistrust; these may include publishing transparent investment reports and enabling participatory planning mechanisms.

In summary, this study highlights the central role of road infrastructure in urban development; it underscores the interrelation between physical design, citizen perception, and the efficiency of mobility. It concludes that only a multidimensional approach (technical, environmental, participatory, and behavioral) will enable the transformation of Chiclayo into a city with more sustainable, inclusive, and efficient urban mobility.

6. LIMITATIONS AND FUTURE RESEARCH DIRECTIONS

While this study contributes important empirical findings on the relationship between road infrastructure and urban mobility in Chiclayo, it is essential to recognize several limitations that restrict the generalizability and scope of its conclusions.

First, the study employed a non-probabilistic, convenience-based sampling method, which limits the ability to extrapolate the results to the entire urban population of Chiclayo. The sample size (n=100) was also relatively small, and the geographic focus was restricted to areas between Salaverry and José Leonardo Ortiz avenues, excluding other districts with different transit characteristics.

Second, the research relied on self-reported perceptions collected through structured surveys. While this provides valuable insight into public opinion, it may be subject to bias, such as social desirability or limited respondent knowledge regarding technical aspects of infrastructure. No direct measurements of traffic flow, travel time, or accident rates were conducted to contrast perceptions with objective data.

Third, the cross-sectional design of the study limits its capacity to detect causal or temporal dynamics. The relationships identified—although statistically significant—reflect a snapshot in time and do not account for seasonal variations, infrastructure projects in progress, or policy changes over time.

Fourth, important contextual variables were not included, such as socioeconomic status, accessibility for vulnerable populations (elderly, disabled), multimodal connectivity, and the spatial distribution of mobility services. These dimensions could provide a more nuanced and equitable understanding of urban mobility challenges.

Future research should consider adopting longitudinal or mixed-methods designs, integrating qualitative interviews, direct observation, GIS-based spatial analysis, and traffic modeling. Moreover, increasing the sample size and employing probabilistic sampling techniques will enhance the representativeness and validity of future studies. It is also recommended to explore institutional governance, inter-municipal coordination, and citizen participation in infrastructure planning.

7. CONCLUSIONS

Road infrastructure plays a decisive role in the functionality and sustainability of urban systems; this study has shown that the effectiveness of mobility strategies in Chiclayo depends not only on technical and structural elements but also on social perceptions, environmental impact, and user

behavior. Ensuring inclusive, safe, and accessible urban roads contributes directly to sustainable development and quality of life.

The statistical analysis confirmed a statistically significant and moderately strong relationship between road infrastructure and urban mobility (Pearson's $r = 0.730$, $p < 0.001$; Cramér's $V = 0.531$), suggesting that improvements in road design, planning, and material usage are associated with more efficient traffic flow and better pedestrian conditions. These results justify rejecting the null hypothesis and support the need for investment in public infrastructure as a catalyst for positive urban transformation.

Furthermore, the results imply that investments should not be limited to technical studies but must incorporate community needs, environmental assessments, and long-term planning tools such as Geographic Information Systems (GIS); the observed support for public transport investment and urban toll implementation reveals a willingness among citizens to accept structural changes in favor of collective benefit, efficiency, and sustainability.

It is recommended that public policy strategies focus on expanding pedestrian infrastructure, implementing intelligent signaling systems, and improving the transparency of budget allocation in road projects. Additionally, future research should explore variables such as public safety, accessibility for vulnerable populations and multimodal connectivity to build a more comprehensive model of urban mobility in intermediate cities like Chiclayo.

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