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ORIGINAL

Road infrastructure design and urban visual experience: evidence for decision-making in emerging cities

Diseño de infraestructura vial y experiencia visual urbana: evidencia para la toma de decisiones en ciudades emergentes

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ABSTRACT

In expanding urban areas, road infrastructure has an impact on traffic efficiency, logistics, visual comfort, and urban aesthetics; these elements are fundamental to improve the quality of life of the inhabitants and modify the perception of urban space for both residents and visitors. In this context, the objective of this study was to determine the relationship between road infrastructure and visual comfort in the city of Juliaca, 2024. The study was of non-experimental, transectional and correlational design. An instrument with a Cronbach's Alpha of 0,983 was applied to a sample of 182 inhabitants. The results were a Rho coefficient of 0,956, and a p-value of 0,000. It is concluded that there is a relationship between urban road infrastructure and the visual comfort of the inhabitants of the city of Juliaca, 2024. This result not only underlines the importance of planning and architectural design of road infrastructure in the urban visual experience, but also provides a solid empirical basis for future planning and development decisions by the specialized professional in these matters.

Keywords: Road Infrastructure; Visual Comfort; Pavement Quality; Road Signs; Sustainable Materials.

RESUMEN

En áreas urbanas en expansión, la infraestructura vial impacta en la eficiencia del tránsito, la logística, el confort visual y la estética urbana, estos elementos son fundamentales para mejorar la calidad de vida de los habitantes y modificar la percepción del espacio urbano tanto para residentes como para visitantes. Bajo este contexto, el objetivo del presente estudio fue determinar la relación de la infraestructura vial y el confort visual en la ciudad de Juliaca, 2024. El estudio fue de diseño no experimental, transeccional y correlacional. Para ello se aplicó un instrumento cuyo Alpha de Cronbach fue de 0,983, a una muestra de 182 pobladores. Los resultados fueron un coeficiente Rho de 0,956, y un valor p=0,000. Se concluye que existe relación de la infraestructura vial urbana y el confort visual de los pobladores de la ciudad de Juliaca, 2024. Este resultado no solo subraya la importancia de la planificación y el diseño arquitectónico de la infraestructura vial en la experiencia visual urbana, sino que también proporciona una base empírica sólida para futuras decisiones de planificación y desarrollo de la mano del profesional especializado para estos menesteres.

Palabras clave: Infraestructura Vial; Confort Visual; Calidad de Pavimento; Señalización Vial; Materiales Sostenibles.

INTRODUCTION

The development and quality of road infrastructure are fundamental to the dynamics and growth of modern cities. In constantly expanding urban centers, road infrastructure not only influences traffic efficiency and logistics, but also visual comfort and urban aesthetics, factors that profoundly affect the quality of life of its inhabitants and the perception of urban space by visitors and residents.[1] Visual comfort is influenced by factors such as the level of illuminance in a space, the glare index, and the spatial distribution of natural light, among others.[2] In the same context, Cochachin[3] states that well-designed road infrastructure has a positive impact on citizens' quality of life. Therefore, adequate planning and development are essential to ensure the functioning and sustainable growth of cities amid rapid urban growth and its challenges.

In this regard, in Asia, Thibenda et al.[4] concluded that road infrastructure is related to an integrated approach that facilitates the safe interaction of vehicles and human factors such as visual comfort, since the behavior of road users depends on all these factors. Sun et al.[5] demonstrated that there is a positive relationship between infrastructure and visual comfort; they recommended implementing vertical greening to improve this visual comfort and the design and construction of more environmentally friendly urban streets, Zepnat et al.[6] state that road infrastructure development in Papua faces significant problems due to regional discrepancies, which affect people's well-being and require the inclusion of public awareness and participation. It has been strongly criticized for the lack of community involvement in these projects. Therefore, although it promotes economic opportunities and better connectivity, it has generated conflicts and environmental risks due to the lack of community participation and the impact on forest and cultural areas, highlighting the need to include local communities in project planning to ensure sustainable and respectful development, Tanishita et al.[7] concluded that road dividers increased the severity of accidents at intersections, while in non-intersection areas they reduced it. In addition, flashing traffic signals increased the severity of accidents, while stop signs reduced it at intersections.

In Europe, Nguyen et al.[8] concluded that efficient road infrastructure and economic activity, development, and growth are the main factors at both the regional and national levels in productivity. Vijayakumar et al.[9] states that road infrastructure projects are related to reduced travel time, improved accessibility and services, and visual comfort. Tveter and Tomasgard[10] mention that road infrastructure has shown a notable improvement in durability, which has led to significant improvements over the years. Both highways and railways remain operational and efficient thanks to technological advances and expansions. Therefore, these improvements ensured that the infrastructure continues to provide benefits for transportation and society in general, keeping pace with technological innovations.

In North America, Sasai et al.[11] report that maintaining a high level of road infrastructure performance at minimal cost is a central management objective, but that this is related to visual comfort, economic and environmental impacts, and maintenance and repair strategies, Ullah et al.[12] argue that methodologies and specifications have been developed for the use of road infrastructure for durability and resilience, enabling more durable, high-performance, and visually comfortable road infrastructure, Pinsonnault et al.[13] concluded that community complaints about noise, dust, and poor mitigation measures during the development of these projects must be addressed through effective dialogue with the government.

In Central America, Flores et al.[14] concluded that road infrastructure contributes to and is related to the measurement of driver behavior and visual comfort, Loría and Ramírez[15] pointed out that road infrastructure is crucial for urban development and the well-being of the population, but that it is conveniently related to vehicle mobility and pedestrian comfort, reducing travel times and improving the efficiency of the distribution of goods and services, Vásquez[16] mentions that public road infrastructure policy was reoriented to align with the New National Development Style, promoting the role of the market and reducing state intervention. As a result, responsibility for the construction, conservation, and maintenance of the National Road Network was transferred from the state to private entrepreneurs.

In South America, Garzón et al.[17] concluded that there is a relationship between road infrastructure construction works and the severity of nose and/or throat symptoms, which can negatively affect various aspects of the lives of people living near the area of influence. Therefore, it is necessary to guarantee air quality in the city during and after construction through environmental impact mitigation strategies, which could include increasing vegetation in areas surrounding road infrastructure construction sites and ensuring the monitoring and follow-up of air quality and pollutant emissions ambientales, with the aim of improving the living conditions of citizens and having a positive effect on public health, where urban growth can be in harmony with the environment and the surroundings, Flores and Chica[18] mention that in Cuenca, Ecuador, the possibility of transforming conventional road infrastructure into a sustainable mobility system has begun to be explored, focusing on the incorporation of bicycle lanes. This effort is part of a global movement towards the promotion of more environmentally friendly and efficient means of transport in response to the challenges of climate change and urban congestion. Alba report that the construction sector faces productivity challenges, making the implementation of BIM in road project design crucial for improving efficiency, coordination, and

information management throughout the project life cycle.

At the national level Mamani Gonzalo et al., 2023 Mamani et al.[19] mention that most of the roads connecting the population centers of Puno, Peru, are unpaved and are dirt roads, and in terms of visual comfort, they show potholes and deformations due to rain, making it difficult for people and vehicles to travel safely, Campos et al.[16] highlight the importance of road infrastructure and the identification of monitoring and control processes, as well as efficiency in the budgeting of these works; This implies that adequate monitoring and control of projects allow for more accurate and effective budgeting. In other words, the better these processes are implemented and supervised, the greater the capacity to anticipate and manage the costs associated with road infrastructure works, resulting in more efficient and economical management of the resources allocated to these projects, Vicente[20] highlights that road infrastructure plays a crucial role in the economic development of regions, encompassing national, departmental, and local road networks. Major paved roads have a significant impact on economic growth by facilitating the efficient transport of goods and people, promoting trade, and driving regional integration.

In this context, it has been observed that the city of Juliaca, known for its dynamic economic and population growth, faces significant challenges in terms of road infrastructure and the quality of the urban environment. As the city expands its road network to accommodate a growing number of vehicles and pedestrians, concerns arise about how these roads influence the visual comfort of their users. Visual comfort, essential for safety and urban quality of life, can be negatively affected by multiple factors such as inadequate lighting, excessive surface reflection, and visual congestion caused by poorly planned signage and advertisements. Road infrastructure encompasses not only the quality of roads and sidewalks, but also how they integrate with elements such as public lighting, signage, and urban landscaping. It was also observed that the lack of integrated planning has led to many areas suffering from insufficient or poorly directed lighting, which not only increases the risk of traffic accidents and the deterioration of the visual experience of urban space, ignored by planners and professionals outside the architectural field, but also contributes to a visually chaotic and stressful environment.

For these reasons, the overall objective of this study is to determine the relationship between road infrastructure and visual comfort in the city of Juliaca in 2024. The study is justified on social grounds, as adequate management of visual comfort on roads not only improves urban aesthetics but also contributes significantly to the safety and well-being of the population. Improving visual comfort can reduce eye fatigue and stress, factors that influence public health and the quality of life of individuals. In addition, a well-planned road environment encourages greater pedestrian activity, which can have positive impacts on local commerce and social cohesion by making the city a more welcoming and accessible place.

It is justified at a theoretical level because its results enrich our understanding of how road infrastructure can be designed to optimize visual comfort, filling a theoretical gap and providing empirical data and analysis that can be used to review and expand existing theories on urban design and landscape architecture. It is justified at a practical level because it has the potential to directly influence the future planning and development of Juliaca's road infrastructure. The results could be used by urban planners, designers, and local authorities to implement solutions that improve visual comfort, such as optimizing public lighting, regulating disruptive visual elements, and promoting consistent and aesthetically pleas . This will not only improve the functionality of the roads but also increase their sustainability by considering the visual and emotional impact on city users.

METHOD

The type of research is basic. In this regard, Scharager and Armijo[21] argue that basic research does not have immediate practical purposes, but rather aims to increase knowledge. The research approach was quantitative, as we believe this will be the best way to collect data and streamline this project, According to Sánchez[22], this approach is based on data collection through surveys, controlled experiments, statistical analysis, and other quantitative tools, with a focus on objectivity and replicability of results, Zayas and Sahuquillo[23] point out that quantitative methods, quantitative methodologies, or quantitative research are the set of strategies for obtaining and processing information that use numerical magnitudes and formal and/or statistical techniques to carry out their analysis, always framed within a cause-and-effect relationship. The research was correlational in nature, according to Quecedo and Castaño[24] correlational studies measure two variables without the researcher directly manipulating or controlling them.

The population consisted of 562 passers-by, neighbors, and residents of the main squares, parks, and avenues of the city of Juliaca. After applying the simple random sampling formula, the sample consisted of 182 passers-by, neighbors born and residents of the city of Juliaca. As a result, the sampling was random. In this context, Espinoza et al.[25] argue that in scientific research, population refers to the total set of individuals, events, or elements that have the characteristics in which the researcher is interested and about which the results of the study are to be generalized. A sample, on the other hand, is a subset of this population, selected for analysis with the aim of inferring conclusions about the entire population. The process through which this sample is selected is known as sampling. This process is crucial, as a well-selected sample can provide results

that are representative of the population, while a poorly selected sample can lead to errors and biases in the results. There are various sampling techniques, such as random, stratified, or quota sampling, each suitable for different types of research and specific objectives.

For the collection of information, the technique used was a survey, and the instrument was a questionnaire, which had 20 items, from question 1 to 10 for variable 1 and from question 11 to 20 for variable 2. This instrument was developed in-house and validated by a panel of three professionals who are experts and knowledgeable in the subject matter of this study. Likewise, its level of reliability was established using Crombach's Alpha, which was 0,983, indicating that the instrument is highly reliable. According to Casas et al.[26], a questionnaire is a document containing a set of questions that are coherently written and organized sequentially, following a previously planned objective.

RESULTS

Descriptive results

Table 1. Descriptive statistics

			Statistic
Urban road infrastructure	Average		22,7207
	95 % confidence interval for the mean	Lower limit	21,0128
		Upper limit	24,4285
Visual comfort	Average		23,3799
	95 % confidence interval for the mean	Lower limit	21,9390
		Upper limit	24,8207

Table 1 provides a summary of the results obtained when applying the analysis tool in the study unit. This table includes the descriptive values calculated from the data collected. A confidence interval of 95 % was used, indicating a high degree of certainty in the results obtained with the tools used. The values in the table indicate that, within this 95 % confidence interval, the mean of the variables analyzed is re t, representative, and reliable. This implies that the actual values of the mean of these variables are likely to fall within the upper and lower limits defined by the confidence interval. These results demonstrate that the information obtained through the instruments is robust and reliable for analysis and consideration in the study conducted.

Table 2. Descriptive results for visual comfort

	Freq.	%	% Val.	% Accum.
Low	109	60	60	60
Moderate	59	32	32	92
High	14	8	8	100
Total	182	100	100	

The interpretation of the results presented in table 2, regarding the study entitled "Relationship between urban road infrastructure and visual comfort of residents in the city of Juliaca, 2024" reveals several important conclusions about the visual quality of life of residents and the city's road infrastructure.

Predominance of low visual comfort (60 %), with the majority of respondents reporting low visual comfort, which is indicative of significant problems in urban road infrastructure. This could be related to inadequate lighting, confusing or insufficient signage, and visual clutter on the streets that contribute to visual fatigue and stress. This high percentage suggests an urgent need to review and improve urban road conditions to facilitate a better visual experience, which could include implementing better lighting, clearer signage, and strategies to reduce visual pollution.

Moderate visual comfort (32 %) indicates that one-third of participants experience a moderate level of visual comfort. This can be interpreted as a partial adaptation to existing road infrastructure conditions, although there is still room for improvement. Factors contributing to moderate comfort could include areas of the city where road infrastructure meets certain standards but still lacks optimization in aspects such as visual ergonomics or urban design consistency.

High visual comfort (8 %) is also observed, reflecting a small percentage of residents who report high visual comfort, which could indicate that very limited areas of the city have road infrastructure that effectively supports the visual well-being of its users. This result could reflect specific areas where infrastructure improvements have recently been implemented or where urban design has effectively taken into account the

visual needs of pedestrians and drivers.

Table 3. Descriptive results for natural lighting

	Road maintenance	Pavement quality	Road signage	Sustainable materials
Basic	73	51	70	62
Advanced	21	30	24	27
Model	6	19	5	11
Total	100	100	100	100

Table 3 provides data obtained from the study "Relationship between urban road infrastructure and visual comfort of residents in the city of Juliaca, 2024," which offers insight into several critical aspects of road infrastructure and its relationship to residents' visual comfort. Here, each of the dimensions is analyzed.

With regard to road maintenance, a basic level (73 %) indicates that most urban roads receive only a basic level of maintenance, which may include sporadic or emergency repairs. This is insufficient to ensure optimal infrastructure and may contribute to the perception of low visual comfort due to a lack of regularity and predictability in road conditions. An advanced level (21 %) indicates that more systematic and frequent maintenance in these areas could be contributing to moderately better visual comfort, but there is still room for improvement. A model level (6 %) indicates that only a small percentage of roads receive model-level maintenance, implying proactive and high-standard maintenance practices that are likely associated with areas of greater visual comfort.

With regard to pavement quality, a basic level (51 %) indicates that, for the population, more than half of the roads have basic quality pavement, which could lead to irregular surface conditions, negatively affecting visual comfort and safety. An advanced level (30 %) indicates that an advanced level of paving improves the driving experience and visual comfort, reducing distractions and potential risks. A model level (19 %) indicates the presence of high-quality pavement in almost one-fifth of the city, reflecting areas where road infrastructure may be optimal and contribute significantly to high visual comfort.

In relation to road signage, a basic level (70 %) indicates that poor or inadequate signage is prevalent and may be a direct cause of low visual comfort, increasing stress and confusion among drivers and pedestrians. An advanced level (24 %) indicates that better signage contributes to a safer and more comfortable environment, facilitating navigation and reducing visual effort. A model level (5 %) indicates that very few areas have model-level signage, indicating an opportunity to extend these practices to more parts of the city.

For the sustainable materials dimension, a basic level (62 %) indicates limited use of sustainable materials, indicating that most infrastructure is not designed with long-term sustainability or durability considerations in mind, which can negatively affect both the environment and visual comfort. An advanced level (27 %) indicates that greater use of sustainable materials may be contributing to a more visually pleasing and durable environment. A model level (11 %) indicates that there is significant potential to increase the use of sustainable materials in road construction.

Inferential results

Table 4. Contingency table for general hypothesis

			Visual comfort
Spearman's rho	Urban road infrastructure	Correlation coefficient	0,956**
		Sig. (bilateral)	0,000
		N	182

Note: **. The correlation is significant at the 0,01 level (bilateral).

Table 4 shows a Spearman's Rho coefficient of 0,956 and a p-value of 0,000 in the context of the study entitled "Relationship between urban road infrastructure and visual comfort of residents in the city of Juliaca, 2024." These results suggest statistically significant and robust findings regarding the relationship between the variables studied. This means that as the quality of road infrastructure improves, so does the visual comfort perceived by residents. Furthermore, a p-value of 0,000 indicates acceptance of the researcher's hypothesis: There is a relationship between urban road infrastructure and the visual comfort of residents in the city of Juliaca, 2024. This result not only highlights the importance of road infrastructure in the urban visual experience, but also provides a solid empirical basis for future planning and development decisions in Juliaca.

Table 5. Contingency table for specific hypotheses

	Visual comfort		
	Correlation coefficient	Sig. (two-tailed)	N
Road maintenance	0,961**	0	182
Pavement quality	0,951**	0	182
Road signage	0,950**	0	182
Sustainable materials	0,959**	0	182

Note: **. The correlation is significant at the 0,01 level (bilateral).

Table 5 shows the inferential results of the study entitled "Relationship between urban road infrastructure and visual comfort of residents in the city of Juliaca, 2024." These results reflect a strong positive correlation between various aspects of road infrastructure and the visual comfort of residents. Spearman's Rho coefficients indicate that road maintenance, pavement quality, road signage, and the use of sustainable materials are significantly associated with visual comfort, all with very high values and robust statistical significance (p=0,000).

With regard to road maintenance and visual comfort, the Rho coefficient of 0,961 shows that there is a strong positive relationship between the quality of road maintenance and the level of perceived visual comfort. Furthermore, the p-value of 0,000 indicates acceptance of the researcher's hypothesis: There is a relationship between urban road infrastructure and the visual comfort of the residents of the city of Juliaca, 2024; it can be inferred that better maintenance practices probably result in cleaner, better-lit streets with less wear and tear, which facilitates a pleasant and less stressful visual experience for residents.

With regard to pavement quality and visual comfort, the coefficient Rho=0,951 shows a strong positive correlation, indicating that pavement quality is crucial for visual comfort. Furthermore, the p-value of 0,000 indicates acceptance of the researcher's hypothesis: There is a relationship between road maintenance and the visual comfort of the residents of the city of Juliaca in 2024. Therefore, pavements in good condition reduce glare caused by uneven or damaged surfaces and minimize the risk of accidents, which in turn reduces visual stress for drivers and pedestrians. It can be inferred that investments in high-quality paving are not only essential for road infrastructure but also for promoting a visually comfortable and safe urban environment.

In relation to road signage and visual comfort, a coefficient of Rho=0,950 is observed; this high coefficient suggests that adequate and well-maintained signage contributes significantly to visual comfort, i.e., clear, well-located, and legible signs prevent confusion and facilitate navigation through the city, reducing visual and cognitive stress. Furthermore, the value of p=0,000 indicates acceptance of the researcher's hypothesis, i.e., there is a relationship between road signage and the visual comfort of the inhabitants of the city of Juliaca in 2024. Therefore, it is crucial to design and implement signage systems that not only comply with safety standards but also consider the visual and cognitive impact on road users.

With regard to sustainable materials and visual comfort, a coefficient of Rho=0,959 is observed, indicating a strong positive correlation between the use of sustainable materials and visual comfort. Furthermore, a value of p=0,000 indicates acceptance of the researcher's hypothesis, i.e.: There is a relationship between sustainable materials and the visual comfort of the inhabitants of the city of Juliaca in 2024. This highlights the importance of these materials in creating a visually pleasing environment. Sustainable materials often have properties that improve environmental and visual quality, such as heat- and light- r reflective surfaces that control heat and light effectively. It can be inferred that promoting the use of sustainable and environmentally friendly materials in road infrastructure projects could significantly improve visual comfort and contribute to overall urban sustainability.

DISCUSSION

This research has yielded significant results that demonstrate a strong relationship between the quality of road infrastructure and the visual comfort of residents. Spearman's Rho coefficient of 0,956, accompanied by a p-value of 0,000, confirms with high statistical certainty that improvements in road infrastructure are directly correlated with improvements in the visual comfort of citizens. These results are consistent with Thibenda et al.[4] on the existence of a significant relationship between these two variables, but also highlight the importance of considering visual comfort as an essential component in urban infrastructure planning and improvement. The results of the study indicate that high-quality road infrastructure significantly improves visual comfort. This suggests that investment in road improvements not only addresses functionality and safety, but also the visual and aesthetic experience of residents.

Similar to Nguyen et al.[8] with confirmation that the quality of road infrastructure directly impacts visual well-being, it is crucial that urban planners and designers incorporate visual comfort criteria into their projects. This could include the selection of appropriate materials, the design and layout of signage, as well as

lighting and general road maintenance. This study provides a solid empirical basis for policymakers to prioritize investment in road infrastructure not only from the perspective of mobility and safety but also from that of visual comfort. Policies that encourage the development of more visually friendly infrastructure can mean a considerable improvement in the quality of urban life. It would be beneficial to extend this study to other urban areas to compare and generalize the results, as well as to explore other aspects of the urban environment that could influence visual comfort, such as urban vegetation, visual advertising, and other architectural elements.

Regarding road maintenance and visual comfort in the city of Juliaca in 2024, this study revealed a Rho coefficient of 0,961, indicating a strong positive correlation between the quality of road maintenance and the visual comfort perceived by residents. Furthermore, a p-value of 0,000 reinforces the validity of these results, accepting the hypothesis that there is a significant relationship between adequate road maintenance and increased visual comfort for residents. The results are consistent with Sasai et al.[11] who concluded that good road maintenance not only affects the durability and functionality of streets, but also has a direct and positive impact on the visual experience of citizens. Well-maintained, imperfection-free, adequately lit, and clean streets contribute to reducing visual stress and improving the quality of urban life.

The study conducted on the relationship between pavement quality and visual comfort yielded significant results that underscore the importance of pavement quality in the visual perception and safety of residents. In accordance with Ullah et al.[12], pavement quality significantly influences the visual comfort of residents. Well-maintained pavements without irregularities reduce glare caused by unexpected reflections and minimize visual obstacles, facilitating a more comfortable and safer traffic experience for both drivers and pedestrians. In addition to improving safety by reducing the risk of accidents, high-quality pavement contributes to the overall aesthetics of the urban environment. In line with Flores et al.[14] this not only improves the visual experience, but can also have a positive impact on the mood and well-being of residents.

The study conducted on the relationship between road signage and visual comfort yields conclusive and significant results. The observation of a Spearman's Rho coefficient of 0,950 indicates a strong positive correlation between the quality and clarity of road signage and the visual comfort of citizens. This suggests that properly designed, well-maintained, and clearly visible road signage contributes significantly to improving the visual experience and navigability throughout the city. Additionally, a p-value of 0,000 reinforces the statistical validity of these results and confirms the researcher's hypothesis regarding the existence of a significant relationship between these variables. In agreement with Garzón et al.[17], road signage not only plays a critical role in street safety and order, but also plays a vital role in visual comfort.

Clear and legible signs minimize confusion, reduce visual and cognitive stress, and facilitate navigation, contributing to a safer and more enjoyable urban experience. Similar to Mamani et al.[19] it is essential that urban planning includes the creation of signage systems that are easy to read and understand. This includes the appropriate choice of sign sizes, colors, and heights, as well as their strategic placement to maximize visibility and effectiveness. Regular maintenance of road signs is crucial to ensure that they remain effective over time and do not become sources of misinformation or confusion due to wear and tear or vandalism.

Regarding the use of sustainable materials and visual comfort, the results are consistent with Vijayakumar et al.[9] as they show a strong connection between these two factors, demonstrating a positive and robust correlation, while a p-value of 0,000 reinforces the statistical validity of these findings, confirming the researcher's hypothesis. In this context, sustainable materials are not only beneficial to the environment due to their lower impact on resource use and waste reduction, but also have properties that improve visual and environmental quality. For example, surfaces and coatings that effectively control heat and light can reduce glare and create more visually comfortable environments. This study highlights the importance of selecting sustainable materials in the planning and execution of road infrastructure and urban planning projects. The choice of these materials should not only be guided by criteria of durability and efficiency, but also by their ability to improve visual comfort.

CONCLUSIONS

In conclusion, this study determines the relationship between urban road infrastructure and the visual comfort of the inhabitants of the city of Juliaca in 2024, highlighting the need for a holistic approach to urban planning that integrates the visual and aesthetic needs of residents, ensuring that road infrastructure is not only functional and safe, but also comfortable and visually. This reaffirms the crucial role of well-planned and maintained road infrastructure as a pillar of a healthy and aesthetically pleasing city.

In relation to road maintenance, this study determines the relationship between road maintenance and visual comfort, highlighting the crucial importance of road maintenance not only for transport safety and efficiency, but also for the visual and general well-being of citizens. Ensuring that urban roads are in optimal condition is an essential component of promoting a pleasant and functional urban environment in Juliaca.

This study concludes that pavement quality is a crucial factor not only for the functionality of road infrastructure but also for visual comfort and safety in the urban environment of Juliaca. Authorities should

consider these findings to improve urban quality of life through more effective maintenance and planning practices.

It is concluded that road signage is related to the visual comfort of Juliaca residents. Continued investment in improving these elements can not only increase traffic safety and efficiency, but also improve the visual quality of the urban environment, reflecting the importance of integrating aesthetic and functional considerations into urban planning.

In conclusion, the use of sustainable materials in urban infrastructure is not only an effective strategy for promoting environmental sustainability, but also plays a crucial role in improving the visual comfort and aesthetics of the city. These findings provide a solid basis for future planning and development decisions in Juliaca, emphasizing the importance of integrating sustainability considerations into urban design to improve the quality of life of its inhabitants.

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