

Municipal Strategies for Public Management and Sustainable Mobility: the Case of San Miguel, Peru

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The Sustainable Development Goal of Sustainable Cities and Communities seek to turn these cities into safe, inclusive, sustainable, and resilient places. The study aims to determine the relationship between public management strategies and sustainable mobility in San Miguel, 2023. The study population included public officials linked to mobility policies and public transport users. A quantitative approach and a non-experimental cross-sectional design were used. Data collection was carried out through surveys, focusing on planning, implementing, and evaluating sustainable mobility policies and their relationship with the environment, accessibility, and road safety. The findings indicated a significant relationship between public management strategies and improvements in sustainable mobility. The analysis included the calculation of correlation with a matching approach using random resampling on three occasions, obtaining an average value of $\rho = 0.818$, which validates a strong statistically significant correlation. It highlights the relevance of implementing integrated policies that promote sustainable development and establish periodic monitoring to evaluate the impact, allowing for continuous adjustments and improvements.

1. Introduction

The 2030 Agenda promotes the achievement of safer, more resilient, and sustainable cities (ONU, 2023) to respond to problems such as traffic congestion, road safety, and climate change. Governments must establish sustainable mobility policies to improve the quality of life of their citizens. Studies have evaluated these policies, such as in Seoul (Ku et al., 2021), which presents the economic and environmental benefits of green policies (reduction of costs, pollutants, and positive impact from the use of bicycles); in Vietnam, the effects of mitigation measures on the reduction of greenhouse gases (GHG) and pollution were evaluated (Tran, 2019). It is essential to strategically plan for the change of focus to effective public management, facilitating decision-making regarding energy technologies, carbon emissions, and actions aimed at achieving sustainable mobility (Chofreh et al., 2019), aligned with an analysis of economic factors (Chofreh et al., 2020). Air quality monitoring (Lotrecciano et al., 2019) is important to implement regulatory devices that allow accessibility to public transport; Moscoso et al., (2020) state that in Latin America there are important challenges in equitable access to active mobility, road safety, and GHG mitigation, based on the cases of Bogotá and Mexico (Franco, 2021), Stockholm and Curitiba (Franco, 2023) a model of vehicular congestion pricing policies was simulated according to socioeconomic variables that allowed improvements in the quality of life of its citizens. In Peru, the district of San Miguel - Lima, due to population density, uncontrolled growth, and air pollution (MINAM, 2019); There are significant challenges in terms of transport infrastructure, accessibility and efficiency of public transport, problems such as traffic, pollution and lack of safe pedestrian infrastructure, so local governments must respond to the National Plan for Adaptation to Climate Change in Peru seeking to stabilize GHG concentrations in the climate system, also the Action Plan for the improvement of air quality in Lima and Callao 2021 - 2025, seeks to safeguard air quality through national regulation (MINAM, 2021).

The study aims to determine the relationship between public management strategies and sustainable mobility in San Miguel, 2023, from a novel methodological approach by combining surveys of public officials and transport users, using the Delphi method to validate the instruments and Spearman correlation analysis to

assess the relationship between variables, improving the understanding of how public management promotes sustainable mobility and contributes to the quality of life in urban areas (Gurdon, 2023).

2. Methodology

This quantitative, non-experimental, cross-sectional study analyzes the relationship between public management strategies and sustainable mobility in the district of San Miguel in 2023, using data collected from municipal officials and public transport users. The study involved seven officials and a sample of 183,091 users (INEI, 2019), applying two validated instruments: the Sustainable Mobility Policy Evaluation Survey (EPM) to measure policy implementation and effectiveness, and the Public Transport User Perception Survey (EPUT) to assess satisfaction, accessibility, environmental impact, and safety. The analysis focused on six sustainable mobility strategies promoted by the municipality—promotion of bicycles, promotion of public transportation, reduction of car use, sustainable mobility infrastructure, educational awareness policies, and traffic control technologies—and established their relationships with the dimensions of environmental sustainability, urban accessibility, and road safety.

Instrument validity was ensured via the Delphi method, a systematic process that seeks expert consensus through rounds of consultation and feedback, with four experts evaluating clarity and relevance. Reliability analysis using Cronbach's Alpha yielded values of 0.841 (EPM) and 0.698 (EPUT), indicating strong and acceptable consistency, respectively.

Data analysis employed JASP software, applying Spearman's rank correlation (ρ) due to non-normal data distribution. This method assesses relationships between ranked variables, with values from -1 (negative correlation) to 1 (positive correlation). The results confirmed a strong, statistically significant correlation between public management strategies and sustainable mobility dimensions.

3. Results and discussion

3.1 Descriptive analysis of surveys among public officials and transport users.

Based on the 194 sustainable mobility policies divided into 4 areas (environmental effects, accessibility, road safety, and efficiency) which should be applied globally (Sustainable Mobility for All, 2019) the municipality of San Miguel proposed and implemented 5 policies associated with its management, these were: Promotion of the use of bicycles, Infrastructure for sustainable mobility, Education and awareness policies, promotion of public transport and reduction of car use; Thanks to financing from the World Bank of sixteen million soles, it allowed the implementation of a "superblock", which promotes all these policies by improving the infrastructure, directly impacting the four areas of sustainable mobility.

The descriptive results obtained in the EPM survey applied to officials show a moderate level result; in the dimension planning of sustainable mobility policies, it was mild and low because for obtained an average of 2.85, the analysis of the perception of the planning process the average was 2.71. The official participation level in the proposed policies showed a value of 3. For the dimension execution of sustainable mobility policies, the officials showed a moderately high level, in the analysis it was found that the implemented policies showed an average of 2.43, the compliance with implementation deadlines obtained an average value of 3.43 and the effectiveness in improving sustainable mobility was 3.86. It is important to highlight that only 67% of the policies were fully implemented.

So far, the results reflect that management strategies in San Miguel have a significant impact on aspects leading to universal accessibility, efficiency, safety, and environmental sustainability for compliance with the Sustainable Development Goals (SDG), actions that improve road infrastructure, promote clean technologies and promote a modern transportation system help in the transition to sustainable mobility (Sustainable Mobility for All, 2019). However, the data also show critical areas that need optimization to effectively comply with having accessible and sustainable public transportation networks, more efficient conditions that allow people to generate economic and social opportunities and regulations that provide greater security within the district (Moscoso et al., 2020).

The results of the efficiency and scope of these policies suggest an improvement in terms of execution and administration and point out problems with the scope and timely compliance of their implementation compared to other cities such as Mexico or Bogotá, which respond more adequately to the growing demand of users (Franco, 2023).

The results of the Public Transport User Perception Survey (EPUT) revealed a moderate overall evaluation, with high perceptions in the dimensions of environmental impact ($M = 3.66$) and accessibility ($M = 3.25$), but moderate to low levels of satisfaction, comfort, and safety ($M = 2.64, 2.66, \text{ and } 2.75$, respectively). These findings suggest that users positively value the environmental benefits associated with the shift toward cleaner transport systems, like the European Union experience where the environmental footprint decreased by 19.5%. However, they also highlight service quality limitations that require attention. In this context, investment in green

infrastructures such as electric vehicle charging stations and air quality monitoring systems—emerges as a necessary strategy to strengthen environmental sustainability and mitigate pollution in high-traffic areas with PM2.5 levels exceeding recommended limits (Lotrecchiano et al., 2019).

Since the perception of accessibility is neutral, evidencing deficiencies in the need to better implement education and awareness policies such as low-speed zones and safe pedestrian zones; technologies such as smart traffic lights, a greater number of cameras on public transport routes, and continuous traffic monitoring systems will also reduce risks and generate confidence in the public transport system, encouraging its responsible use and strengthening security in urban spaces (Gurdon, 2023)

Among public transport users, serious deficiencies in the quality of service are reflected, due to the overload of passengers and the poor condition of the vehicles. It is possible that, by adopting policies aimed at improving infrastructure, modernizing fleets, and reducing times, the user experience will be increased. These policies will also help to decongest the routes and significantly increase the general perception of transportation in the San Miguel district (Wu et al., 2024).

3.2 Hypothesis testing

The normality test was performed for public management strategies, the Shapiro-Wilk test was applied ($n=7$), giving a normal distribution result; for the case of sustainable mobility, the Kolmogorov-Smirnov test was used ($n=405$) resulting in the data not following a normal distribution. Since one variable follows a normal distribution and the other, along with its dimensions, does not follow this distribution, non-parametric methods were employed in this study (Rho-Spearman). To investigate the association between public management strategies and sustainable mobility dimensions, a matching technique using random resampling was used due to the size disparity between the samples, extracting 7 sustainable mobility data to match the public management strategies. This procedure was also applied to the three sustainable mobility dimensions. Since random matching can introduce variability, multiple matchings were performed, and the results were averaged to obtain a more robust estimate.

3.3 Inferential results

Spearman's correlation was calculated for the 12 matches between the variables and their dimensions. Table 1 presents the results of the first three matches between public management strategies and sustainable mobility.

Table 1: Matching between Sustainable Mobility and Public Management Strategies

Matching	Item	Public Management Strategies	Sustainable Mobility	Rank X	Rank AND	D	d ²	ρ	t	Sig.
1	1	15	15	3.5	4.5	-1.00	1.00	-0.821	-3.221	0.014
	2	17	12	6	2	4.00	16.00			
	3	19	14	7	3	4.00	16.00			
	4	12	20	1	7	-6.00	36.00			
	5	16	10	5	1	4.00	16.00			
	6	15	15	3.5	4.5	-1.00	1.00			
	7	14	17	2	6	-4.00	16.00			
2	1	15	13	3.5	2	1.50	2.25	0.795	2.927	0.033
	2	17	17	6	5	1.00	1.00			
	3	19	20	7	7	0.00	0.00			
	4	12	12	1	1	0.00	0.00			
	5	16	15	5	4	1.00	1.00			
	6	15	18	3.5	6	-2.50	6.25			
	7	14	14	2	3	-1.00	1.00			
3	1	15	14	3.5	3.5	0.00	0.00	0.964	8.141	0.001
	2	17	15	6	5	1.00	1.00			
	3	19	25	7	7	0.00	0.00			
	4	12	10	1	1	0.00	0.00			
	5	16	16	5	6	-1.00	1.00			
	6	15	14	3.5	3.5	0.00	0.00			
	7	14	12	2	2	0.00	0.00			

Table 2. Matching between environmental dimension, accessibility dimension, and road safety dimension with public management strategies

Matching Item	Public Management Strategies (PMS)	Environmental dimension (ED)	Accessibility dimension (AD)	Road safety dimension (RSD)	Rank X	Rank Y		P	ρ		t	t	PMS-AD	Sig. PMS-AD	PMS-ED	Sig. PMS-ED	PMS-RSD	Sig. PMS-RSD	
						PMS	AD		RSD	AD									RSD
1	15	5	9	3	3.5	5	5.5	5											
2	17	5	12	4	6	5	7	7											
3	19	5	9	3	7	5	5.5	5											
1	12	4	6	2	1	1.5	1	2	0.821	0.83	0.813	3.332	3.332	3.117	0.032	0.032	0.032	0.032	0.032
5	16	5	8	3	5	5	3.5	5											
6	15	5	8	2	3.5	5	3.5	2											
7	14	4	7	2	2	1.5	2	2											
1	15	4	7	2	3.5	3	3	2.5											
2	17	5	3	3	6	6	1.5	6											
3	19	5	3	3	7	6	1.5	6											
2	12	3	9	2	1	1	6	2.5	0.777	-0.821	0.884	2.758	-3.221	4.227	0.048	0.048	0.011	0.01	
5	16	4	8	3	5	3	4.5	6											
6	15	5	8	2	3.5	6	4.5	2.5											
7	14	4	10	2	2	3	7	2.5											
1	15	3	8	3	3.5	2	4	4											
2	17	4	9	3	6	4.5	5	4											
3	19	5	12	5	7	7	7	7											
3	12	1	7	2	1	1	2.5	1	0.786	0.804	0.83	2.84	3.019	3.332	0.045	0.045	0.031	0.028	
5	16	4	10	3	5	4.5	6	4											
6	15	4	3	3	3.5	4.5	1	4											
7	14	4	7	3	2	4.5	2.5	4											

Table 2 shows the results between public management strategies and their respective dimensions; in the case of public management and sustainable mobility strategies, a strong negative correlation was observed in one sample ($\rho = -0.821$), and strong positive correlations in two other samples ($\rho = 0.795$ and $\rho = 0.964$), all statistically significant, according to the value of the test statistic $|t| > (ta/2, n-2) = 2.571$, with a significance level $\text{Sig.} < 0.05$, therefore, if the correlation is positive, when public management strategies increase, sustainable mobility tends to increase. If it is negative when public management strategies increase, sustainable mobility tends to decrease. These indications are in line with the study by Azzali & Sabour (2018) who studied a university campus in Qatar, finding a strong relationship between current mobility and sustainability, which significantly impacts the university community.

They also found community preferences for more sustainable transportation solutions that would avoid traffic, parking shortages, and GHG emissions.

Subsequently and similarly, the results indicated the existence of positive and significant correlations between public management strategies and sustainable mobility dimensions with strong positive correlations in all samples, with ρ values between 0.777 and 0.821, all statistically significant, demonstrating that when public management strategies increase, an improvement in the state of the environment is observed about sustainable mobility. These relationships will allow responding with public management strategies to aspects such as those presented by Chatziioannou et al. (2020) for the case of Mexico City, which implemented comprehensive mobility plans to evolve to more sustainable modes of transport and address externalities such as automobile dependence, air pollution, and climate change, providing adequate infrastructure and educating the population to change habits.

Following and similarly the public management strategies and the accessibility dimension, a strong negative correlation was observed in one sample ($\rho = -0.821$), and strong positive correlations in two other samples ($\rho = 0.830$ and $\rho = 0.804$), all statistically significant, so it is inferred that an improvement in public management strategies increases accessibility. If it is negative, when public management strategies increase, a reduction in accessibility is observed in sustainable mobility, Ravagnan et al. (2022) present in their writing a close link between policies and access to sustainable mobility, for this it is necessary to have multi-level governance that allows the integration of resources, connection to green and blue transport networks for immersion of the user to low-speed systems such as Glasgow and Newcastle, integrating urban design with sustainable development objectives, reducing inequalities in access, and promoting the appropriation of public space with greater citizen participation.

Finally, values between public management strategies and road safety dimensions, all samples showed strong positive correlations, with ρ values between 0.813 and 0.884, all statistically significant, it is evident that when public management strategies increase, an improvement in road safety is observed about sustainable mobility. Therefore, road safety must be integrated with the objectives of accessibility and sustainability of the transport system as proposed in the research by Laa et al. (2022) which presents the model of guarantee for the public mobility service in Austria that proposes improvements in the infrastructure for walking and cycling with safe lanes and well-designed sidewalks, reducing the risk of traffic accidents. In addition, the reduction in the use of private cars with speed limits (30 km/h) will allow migration to services that guarantee the physical safety of users, with equity and accessibility. The implementation of these proposed policies implies a cultural change to reduce the costs of monitoring transport in real time.

4. Conclusions

This study shows that public management strategies play a crucial role in promoting sustainable mobility in the district of San Miguel, despite having only implemented 67% of them. The quantitative findings obtained reveal a significant positive correlation ($\rho=0.818$) between public management and the improvement in sustainable mobility. This value highlights the impact that municipal policies have on fundamental aspects of urban mobility, such as accessibility, safety, and environmental impact.

Furthermore, 67.4% of respondents consider the negative environmental impact of transport to be high or very high and the positive correlation, with Spearman's ρ values ranging from 0.777 to 0.821, allows us to infer the urgency of policies that reduce emissions and promote the use of zero-emission vehicles. The success of similar initiatives in cities such as Bogotá and Mexico City suggests that San Miguel could obtain significant benefits from the adoption of green infrastructure and the promotion of non-motorized transport.

Accessibility is strongly influenced by Spearman's ρ values ranging from 0.804 to 0.830, therefore, an increase in policies that allow for increased accessibility to services will impact the perception and satisfaction of local users. On the other hand, the perception of safety in transport remains low ($\bar{x} = 2.75$), this data suggests that citizens not only need better transport services, but also conditions that increase their safety. The implementation of traffic control technologies, such as smart traffic lights and surveillance cameras, could contribute to raising this perception, aligning with the practices of other cities (Vienna and Newcastle) that have managed to reduce accident rates and improve user safety.

This work highlights in its findings the importance of effective public management, with sustainable mobility policies implemented comprehensively and constantly monitored, thus contributing to the quality of life of the inhabitants of San Miguel, creating a more sustainable, resilient, and inclusive urban environment.

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