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ORIGINAL

Data analysis of vehicular noise pollution and its perception in the cities of Juliaca and Puno, Puno region - 2021

Análisis de datos de la contaminación sonora vehicular y su percepción en las ciudades de Juliaca y Puno, región Puno - 2021

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ABSTRACT

Noise pollution generated by vehicular traffic can have a significant impact on the quality of life of residents, affecting their physical and emotional well-being. To determine the relationship between vehicular noise pollution and the perception of the population in the cities of Juliaca and Puno, a descriptive and correlational study was carried out. Data were collected using registration forms and questionnaires, using 10 representative sampling points on the roads with the highest traffic and surveying 584 randomly selected people. The results revealed sound pressure levels that exceed the limits established by regulations in both cities. Minimum values of 67,84 dB in Puno and 68,03 dB in Juliaca, and maximum values of 83,86 dB and 78,83 dB, respectively, were found. In addition, a positive but low correlation (r = 0,142) was identified between noise pollution and population perception. These findings highlight the exposure of the population to vehicular noise pollution levels that exceed the permissible limits, which can have negative consequences for health and well-being. It is necessary to implement effective measures to reduce noise pollution and improve the quality of life of residents in both cities. These results provide valuable information for the development of appropriate mitigation strategies.

Keywords: Noise Pollution; Correlation And Population Perception.

RESUMEN

La contaminación sonora generada por el tráfico vehicular puede tener un impacto significativo en la calidad de vida de los residentes, afectando su bienestar físico y emocional. Con el propósito de determinar la relación entre la contaminación sonora vehicular y la percepción de la población en las ciudades de Juliaca y Puno, se realizó un estudio descriptivo y correlacional. Se recolectaron datos mediante fichas de registro y cuestionarios, utilizando 10 puntos de muestreo representativos en las vías de mayor tráfico y encuestando a 584 personas seleccionadas al azar. Los resultados revelaron niveles de presión sonora que exceden los límites establecidos por la normativa en ambas ciudades. Se encontraron valores mínimos de 67,84 dB en Puno y 68,03 dB en Juliaca, y valores máximos de 83,86 dB y 78,83 dB, respectivamente. Además, se identificó una correlación positiva pero baja (r = 0,142) entre la contaminación sonora y la percepción de la población. Estos hallazgos destacan la exposición de la población a niveles de contaminación sonora vehicular que superan los límites permitidos, lo que puede tener consecuencias negativas para la salud y el bienestar. Se hace necesario implementar medidas efectivas para reducir la contaminación sonora y mejorar la calidad de vida de los residentes en ambas ciudades. Estos resultados proporcionan información valiosa para el desarrollo de estrategias de mitigación adecuadas.

Palabras clave: Contaminación Sonora; Correlación Y Percepción De Población.

INTRODUCTION

This electronic medical journal addresses the environmental impact caused by noise and its detrimental effect on today's society worldwide. Noise pollutants represent environmental problems that affect the health of the population, with consequences still unresolved in terms of environmental health.[1] These energies are potentially harmful to the environment and can cause immediate or progressive hazards when exposed in sufficient quantities.[1] The relationship between environmental problems and population growth in urban areas and industrial sectors generates pollution in soil, water, and atmosphere, including noise.[2] The World Health Organization (WHO)[3] establishes that noise pollution is linked to a series of physiological, psychological, and economic disturbances, and its impact is significant in both developed and underdeveloped countries, with a growing trend in the latter.[2]

According to data from the National Superintendence of Public Registries (SUNARP), in 2021, 157100 units of cars, rural vans, pickups, and other light vehicles were registered as sold in Peru, which represents an increase of 40 % compared to 2020.[4] Likewise, a 3,4 % growth in sales was observed in the pre-pandemic year 2019. Regarding heavy-duty vehicle sales, a significant variation is reported in the year 2021, with a total of 15,680 units sold of trucks and tractor-trailers, showing an increase of 45,5 % compared to 2020, and 27 % compared to 2019.[4,5] This increase in demand for light and heavy vehicles during 2021 can be attributed to the dynamism in domestic demand, the recovery of employment rates, the extraordinary income from AFP CTS funds, and the reactivation of different economic sectors in Peru, such as construction, commerce, mining, and agribusiness. These factors drove the need to acquire different types of vehicles for the transport of inputs and goods in the country.[6]

In a study focused on the capital Lima, the perception of the population of the district of Barranca for the generation of noise due to vehicular traffic was investigated. To collect data, surveys were conducted among the population of the study area. The results confirmed that noise caused by vehicular traffic affects people's daily activities. The surveys consisted of five questions with four response ranges.[7] Descriptive statistical analysis, based on frequencies, and inferential analysis were used to determine the relevance of each factor.[8] The results revealed that 58,2 % of the respondents indicated that vehicular noise did not affect them, while others considered that it did have a negative impact, highlighting lack of concentration and demotivation as the highest priority problems. In addition, the effects of anxiety, fatigue, and aggression were observed.[9] In the Puno region, specifically in the main cities such as Puno and Juliaca, there has been significant growth in economic activities such as construction, commerce, and tourism, which has generated an increase in vehicular traffic due to the daily activities of the population.[10] Given this scenario, municipal authorities, through ordinances such as Municipal Ordinance No. 088 - 2021 - C/MPP and Ordinance No. 05 - 2018, have established regulations to prohibit urban activities that generate noise on public roads and pose risks to the population. These measures seek to prevent negative effects such as nuisance, unhealthiness, or danger for the inhabitants of both cities.[11] Because of the problems described above, research was conducted in the cities of Juliaca and Puno to determine the relationship between vehicular noise pollution and the perception of the population in the cities of Juliaca and Puno.

METHODS

The research methodology used in this study[12] was characterized as non-experimental and transactional. Data collection consisted of measuring noise levels and conducting surveys on the main roads with high vehicular flow in the study area. These measurements were then compared with the Peruvian noise regulations of the ECA.[13] The study followed a cross-sectional design, in which the variables of interest were observed within the predefined research environment. Data were collected over a specific period, providing a snapshot of the situation. Fieldwork included recording noise data in selected urban locations in Puno and Juliaca, as well as conducting surveys of people affected by traffic noise. Subsequently, a comprehensive analysis was carried out, including the interpretation of noise level records, processing of survey data, and application of statistical methods.[14]

In this study, a deterministic approach was used to select the samples in the main entrance roads to the cities of Juliaca and Puno. Samples were delimited for the population perception variable, considering the number of houses in the study areas. The total population consisted of 1117 dwellings, with 605 dwellings in Juliaca and 512 dwellings in Puno affected by noise. Although the use of a formula to determine the sample size was mentioned, it is necessary to provide more details on the specific methodology used. This rigorous approach to sample selection provided a solid basis for the analysis and interpretation of the results about vehicular noise pollution and the perception of the population in these cities. To collect data for the vehicular noise pollution variable, sound pressure values were recorded following the procedure of the National Noise Monitoring Protocol (R.M. N° 227-2013-MINAM) and the Environmental Quality Regulation for Noise (DS N° 085-2003-PCM). The data records were made according to the location of the sampling points and the types of soil or activity zones, as shown in table 1.

Table 1. Vehicle sound level measurement stations in the city of Puno

EM[1]	City	VI[2]	ZECA[3]	Coordinates	
				North	East
P1	Puno	Intersection Av. El Sol y Jr. Lampa	Zone Commercial, residential	8249363,00	390511,00
P2	Puno	Intersection Av. La Torre y Jr. Lampa	Zone Commercial, residential	8249180,86	389967,47
P3	Puno	Intersection Jr. Los Incas y Av. La Torre	Zone Commercial, education	8248799,68	390122,94
P4	Puno	Intersection Av. El Sol y Jr. Los Incas	Zone Commercial, education,	8248922,91	390435,29
P5	Puno	Intersection Av. Simón Bolívar, Av. Floral	Zone Commercial, recreation	8249363,00	390511,00
P6	Juliaca	Intersection Av. 4 de Noviembre y Av. Tacna	Zone Commercial, recreation	8285681,61	378989,45
P7	Juliaca	Intersection Av. Tacna y Jr. Tumbes	Zone Commercial, recreation	8285763,98	379172,27
P8	Juliaca	Jr. Mariano Núñez	Zone Commercial	8286487,77	378648,81
P9	Juliaca	Intersection Jr. San Martin y Jr. Mariano Núñez	Zone Commercial	8286664,17	378584,42
P10	Juliaca	Intersection Jr. Tumbes y Jr. San Martin	Zone Commercial	8286744,94	378800,97

[1]Monitoring station; [2]Roads intervened; [3]ECA zoning.

The sound pressure level was measured using an integrator-type sound level meter. The measurements were taken directly and in situ from October to December 2021, covering different hours and days of the week. Field sheets were prepared to record the data obtained. On the other hand, data on the population's perception was obtained through interviews and questionnaires. The surveys were carried out both with pedestrians and with individuals who work and live in the study area. It is important to mention that the surveys were conducted during the monitoring measurements and after each noise monitoring session. However, for a more complete understanding of the study, it is recommended to provide additional details on the selection of participants, the representativeness of the sample, and the validation of the instruments used. For the sampling points, the important roads with the highest vehicular traffic were determined, setting 10 sampling points close to interceptions and street crossings. The measurement schedule was established considering the daily activities of the site, at peak hours such as morning, noon, and night, from 7:00 a.m. to 9:00 a.m., from 11:30 p.m. to 01:30 p.m., and from 05:00 p.m. to 07:00 p.m. During the week, two measurement days were carried out, one on a working day and the other on a weekend, in addition to considering the economic activity (Saturday fair) in both cities. These measurements were carried out from October to December 2021.

RESULTS

In the study area of the cities of Juliaca and Puno, the main roads connecting the two cities were identified, which have a high flow of public and private vehicular transport. As established by Ministerial Resolution 227-2013-MINAM, noise levels should be interpreted as average equivalent continuous sound pressure levels Leq(A). Therefore, the values collected in the field were obtained directly using integrator type sound level meters, which are capable of accurately measuring this type of levels.

The results of the minimum, maximum and equivalent sound pressure values obtained from the different sampling points in the cities of Juliaca and Puno are presented and interpreted in figure 1. In Puno, of the ten sampling points, four zones classified as commercial and residential, and one zone designated as commercial and recreational were identified. In Juliaca, four zones were classified as commercial and recreational, and one zone was classified as commercial. These categorizations are contrasted with the standards established by the Environmental Quality Regulations (ECA) for noise control.

Regarding the equivalent continuous sound pressure level in the morning shift, the information collected in the cities of Puno and Juliaca is presented. In the city of Puno, it was observed that the intersection of Av. Simón Bolívar and Av. Floral registered the highest sound pressure level with a value of 83,86 dB, while the measurement point located at the intersection of Jr. Los Incas and Av. La Torre presented the lowest value with 67,84 dB. On the other hand, in the city of Juliaca, it was found that the intersection of Av. 4 de Noviembre and

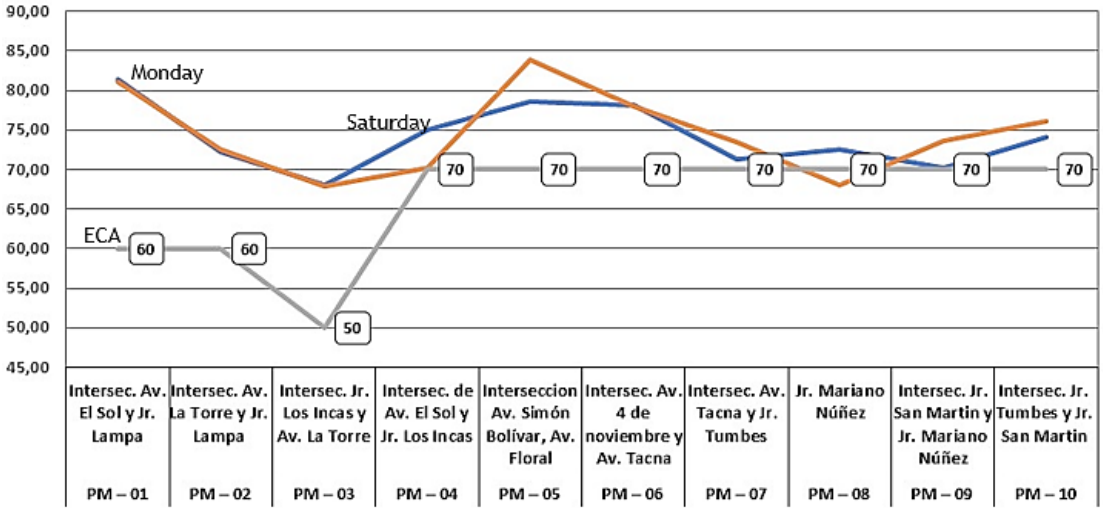

Figure 1. Emission of sound pressure levels due to vehicular traffic during the morning shift

Av. Tacna registered the highest sound pressure level with a value of 78,08 dB, while the sampling point with the lowest sound pressure level was located on Av. Mariano Núñez with 68,03 dB. These results highlight the differences in sound pressure levels between the different locations studied in both cities.

For the emission of sound pressure levels generated by vehicular traffic during the midday shift, the analysis is shown in figure 2, information was collected in the city of Puno. It was found that the highest Leq value was recorded at the intersection of Av. El Sol and Jr. Lampa, reaching 82,74 dB. On the other hand, the lowest Leq value was observed at the intersection of Jr. Los Incas and Av. La Torre, with a level of 65,89 dB. As for the city of Juliaca, the maximum sound pressure value was obtained at the intersection of Av. 4 de Noviembre and Tacna Avenue, with a level of 78,83 dB. On the other hand, the lowest Leq value was detected on Jr. Mariano Núñez Avenue, with a level of 69,48 dB. These results provide a detailed view of the sound pressure levels generated by vehicular traffic in the cities of Puno and Juliaca during the mid-day shift.

About the emission of sound pressure levels generated by vehicular traffic during the midday shift, significant data have been obtained in the cities of Puno and Juliaca. In the city of Puno, the maximum Leq value was recorded at the intersection of Av. El Sol and Jr. Lampa, reaching 82,74 dB. On the other hand, the minimum Leq level was observed at the intersection of Jr. Los Incas and La Torre Avenue, with a value of 65,89 dB. As for the city of Juliaca, the highest sound pressure value was recorded at the intersection of 4 de Noviembre Avenue and Tacna Avenue, with a Leq of 78,83 dB. In contrast, the lowest Leq range was detected on Jr. Mariano Núñez, with a value of 69,48 dB. These results provide a detailed view of the sound pressure levels generated by vehicular traffic in both cities, which is relevant for the analysis and management of noise pollution in these urban environments.

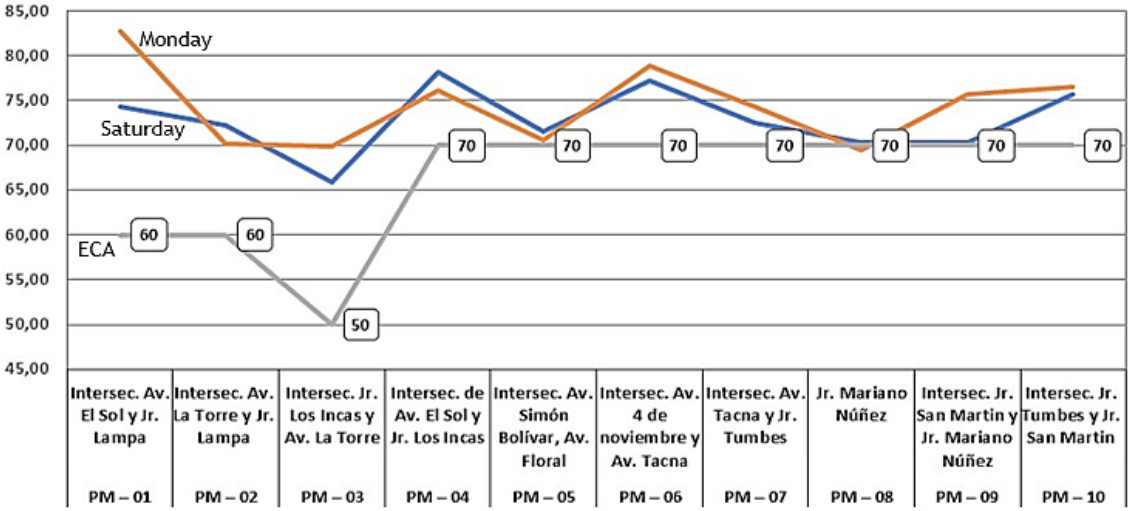

Figure 2. Emission of sound pressure levels due to vehicular traffic Half a day

During the night shift, the data presented in figure 3 were analyzed, which provides information on the

equivalent continuous sound pressure level generated by vehicular traffic. In the city of Puno, the point with the highest sound pressure Leq was identified at the intersection of Av. El Sol and Jr. Lampa, registering 82,88 dB, while the point with the lowest Leq value was found at the intersection of Jr. Los Incas and Av. La Torre, with 67,82 dB. On the other hand, in the city of Juliaca, the highest Leq value was obtained at the intersection of Av. 4 de Noviembre and Av. Tacna, reaching 79,49 dB, while the point with the lowest Leq value was located at Av. Mariano Núñez, registering 69,03.

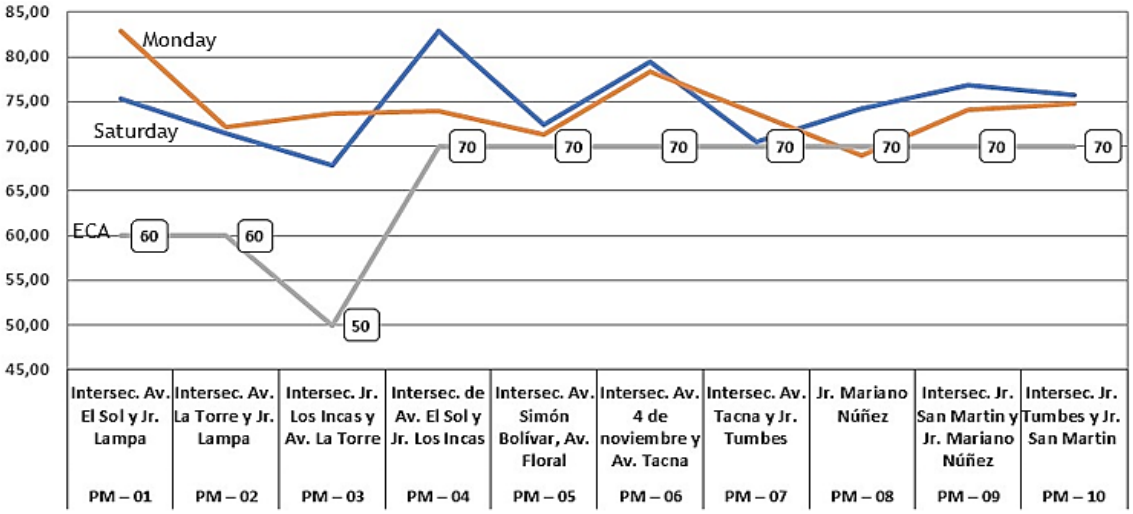

Figure 3. Emission of sound pressure levels due to vehicular traffic at night

In the city of Puno, the highest sound pressure point was identified at the intersection of Av. El Sol and Jr. Lampa registered a Leq value of 82,88 dB. On the other hand, the measurement point with the lowest Leq value was found at the intersection of Jr. Los Incas and Av. La Torre, with a level of 67,82 dB. As for the city of Juliaca, the highest Leq value was observed at the intersection of Av. 4 de Noviembre and Av. Tacna, with 79,49 dB, while the point with the lowest Leq value was located at Av. Mariano Núñez, registering 69,03 dB.

When relating the perception data of the 11 questions related to noise perception in the study area with the quantitative values using Pearson's correlation, the following coefficients were obtained for the morning, noon, and night hours on Saturday: r = 0,151, r = 0,205 and r = 0,420, respectively.

These values indicate a low to moderate positive correlation between the perception of vehicular noise pollution levels in the inhabitants of the cities of Juliaca and Puno. In addition, it has been observed that this pollution has physical, psychological, and social effects on the majority of the population. These results ratify the presence of noise pollution generated by vehicular traffic and its impact on the physical, mental, and social health of the inhabitants of the cities of Juliaca and Puno.

This study focused on measuring noise pollution levels in the cities of Puno and Juliaca, specifically on the main roads connecting the two cities. Continuous sound pressure level Leq(A) measurements were taken at 10 monitoring points, revealing that 100 % of these points exceeded the ECA standard for commercial zone noise. The results obtained coincide with previous research, such as that of Hernández Ocampo, who found sound pressure levels above the limits allowed in another city, which may have negative consequences on people's health.[15,16]

The growth of the vehicle fleet is identified as the main cause of this noise pollution in Puno and Juliaca. Differences in noise levels were observed between weekdays (Monday) and weekends (Saturday) in both cities. In Puno, the highest level of 83,86 dB was recorded at Av. La Torre and Jr. Lampa, while in Juliaca, a value of 78,83 dB was obtained at the intersection of Av. 4 de Noviembre and Av. Tacna.

These results indicate that commercial activity, especially the Saturday fair, contributes to increased vehicular traffic and, therefore, to higher noise pollution levels. In addition, the population's perception of vehicular noise pollution was analyzed through surveys. It was found that a significant percentage of the population experiences physical, psychological, and social affectations due to noise. Among the most common affectations are fatigue, progressive hearing loss, stress, and sleep disturbances. Communication difficulties and decreased work performance were also observed.

These results reinforce the existing evidence on the negative impacts of noise pollution on people's health and well-being. It is important to highlight the need to take measures to mitigate this problem in the cities studied, considering public awareness of the detrimental effects of the noisy environment.

CONCLUSIONS

The relationship between vehicular noise pollution and the perception of the population in the cities of Juliaca and Puno.

A low correlation (r = 0,142) was found between both variables; however, the surveys confirmed the existence of vehicular noise pollution in both cities. Sound pressure levels exceeded the limits established by regulations on the roads surveyed, especially on Mondays and Saturdays.

In addition, a significant correlation was observed between sound pressure levels and the perception of residents, who reported physical, psychological, and social effects due to vehicular traffic noise.

These results highlight the importance of addressing both the physical, psychological, and social aspects of vehicular noise pollution, and the need to implement effective measures to control and reduce it, especially during weekends. In conclusion, this study contributes to the existing knowledge on the relationship between vehicular noise pollution and population perception, providing relevant evidence for the implementation of mitigation strategies in the cities of Juliaca and Puno.

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