



# Traffic Congestion and Environmental Pollution in East Lima and its Consequences on the Quality of Life

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## Abstract

Traffic congestion has strong effects on the entire transport system, for the car it means a longer travel time and a higher consumption of fuel, for surface public transport it implies a decrease in commercial speed, a loss of regularity, an increase in operating costs and a loss of customers, in addition, generates high costs, as a consequence of the uncontrolled use of urban infrastructure, whose collapse in the service levels of said infrastructure, decreases the environmental quality of the urban environment such as the noise pollution, atmospheric pollution by the emission of gases (CO<sub>2</sub>, NO<sub>2</sub>, SO<sub>2</sub>, lead, etc.). The general objective of the research was to determine to what degree transport congestion influences environmental pollution in East Lima, as well as the health of its inhabitants and the city. It was determined that the causes of traffic congestion are: Infrastructure projects that reduce existing lanes and move traffic to adjacent areas; Inadequate action by the police to maintain order in transportation; Little respect for the rules; Organized transport around the private vehicle, which disadvantage more suitable modes of transport: such as the mass public, pedestrians, bicycles; On concentration of institutional activity incoherent with a fluid transportation system; Obsolete vehicle fleet; Vested interests that prevent necessary reforms. Noise is a type of pollution that affects the health of the population.

**Keywords:** extraordinary congestion costs, decrease in environmental quality, obsolete vehicle fleet. congestion black spots, transportation around the car.



## 1. Introduction

One of the main problems faced by the city of Metropolitan Lima (LM), is traffic congestion, where passengers take too long to travel, generates an overconsumption of fuels, as well as great environmental pollution: atmospheric and noise, fundamentally that significantly affects the physical and mental health of people and therefore their quality of life.

According to estimates by the National Institute of Statistics and Informatics (INEI) as of June 30, 2021, Metropolitan Lima would have a population of 9 million 847 thousand inhabitants; A city where there is a vehicle fleet of approximately 2.5 million vehicles, with 1 vehicle for every 4 inhabitants in said Park, the taxi service is 200 thousand. Being the Demand for trips per day greater than 26 million (in 2012 = 23 million, according to JICA). The rate of trips per inhabitant = 2.4. In this context, East Lima, which is an area of Metropolitan Lima (LM) made up of the districts of: Ate, Chaclacayo, Cieneguilla, El Agustino, La Molina, Lurigancho-Chosica, San Juan de Lurigancho and Santa Anita, has a population of 2,491,856 inhabitants according to the 2017 census.

By means of transport, 80% of trips are made by public transport, more on foot. 55% of trips are made by public transport. 85% of Public Transport trips are carried out by buses and combis. In the Metropolitan there are 700 thousand trips per day and in Line One of the Lima metro there are 500 thousand trips per day. The mass transport offer is linear. There is no transport network, which creates a congested city, where the priority is the car. In addition, according to the sources of information, the second

of the great problems of the city is related to public transport, behind public insecurity. This situation has led to the construction, by the authorities - believing that it is the optimal solution - of viaducts, bridges, road interchanges, expressways and overpasses as a formula to solve the constant congestion [1], however, there is Unfinished works, the main ones being the transport service called El Metropolitano which, despite the time that has elapsed, is at 70% of its capacity [2].

On the other hand, [2], who comments on an interview by Gil (2018), to the expert Aldo Bravo, where it is stated that users lose an average of four hours daily in Lima traffic. Likewise, it is estimated that the main traffic problem is the imbalance between supply and demand, where the number of trips is greater than those available.

On the other hand, [3] he points out that the consequences of congestion in Lima are: "waste of time; decrease in urban activity; negative mood of drivers and passengers; higher fuel consumption; greater budget in passages and appearance of new inadequate means of transport".

The survey [1] showed that 51.3% of Lima residents consider that traffic congestion was what most affected their quality of life. On the other hand, for [2], "the main causes of traffic congestion in Lima can be grouped into three groups: Inefficient Road infrastructure, growing vehicle fleet and unfinished works."

[4], pointed out that Lima has an "inadequate size of public transport, that transport must be carried out in vehicles that transport medium or large numbers of users." However, the reality is totally the opposite because the main form of



transport is combis, which accounts for 29.2% of all vehicles. [1,2].

Regarding "the inadequate design and condition of the tracks", [5] he points out that "Lima lacks urban planning and suffers from an overcrowding phenomenon, both factors together turn out to be the reason for the inadequate design."

Finally, "the bad traffic light system" was objected, stating that "within Lima there are between 1,200 and 1,500 traffic light intersections, but many do not have control and are not properly connected either" [1,4,5].

On the other hand, for the Ministry of Transport and Communications (MTC), the vehicle fleet in LM (including Callao) reached 1,752,919 vehicles in circulation in 2016, or 65.9% of the national total, automobiles being 807,529 units or 46.1%, only in LM and Callao, from where the greater the number of cars on the streets, the greater the probability of incidence in traffic congestion [5].

On the other hand, according to the National Police Traffic Directorate (PNP), a total of 242 points considered very critical due to the high traffic flow were

identified in LM and Callao. In Lima, only 380 signalized intersections have fiber optics and are controlled from a central office of the Municipality of Lima, the rest function at their free will or under the responsibility of the district communes without any level of coordination [5].

Another cause of traffic congestion and its consequences for [6], is the obsolete automotive fleet, who in the 12 Forum & Exhibitions, shared the Vehicle Park Situation in Peru in 2018: reporting in 2'981,302, the accumulated of units, 10.7 Hab./Vehicle), 13.6 years the average age of the units and 799,934 the accumulated number of imported used vehicles as of 2018; describing the presence of cost overruns in the use of fuels and fuels in Lima (S /. 1,025,508,179), the damaging effects of environmental pollution, the reduction of safety (which increases the propensity to traffic accidents due to mechanical failures) and in the travel times of the economically active population (EAP) of Lima (S /. 9,889,808,673).

The current park renewal rate is 5.5%, with an average park age of 13.61 years [6], See figure 1.

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**Figure 1.** Vehicle chaos and obsolete vehicle fleet.



### **Environmental pollution.**

Vehicular transport according to [7], is the main responsible for environmental pollution, since: "Among the main

pollutants emitted by motorized vehicles are CO, NO<sub>2</sub>, PM 10 and PM 2.5. Studies in mega cities have shown that PM 2.5



and NO<sub>2</sub> are the main pollutants with health risks...”.

According to [7], Lima shows great variability in the levels of environmental exposure. The highest level of contamination in Lima is observed in the east and north, although the levels of PM 2.5 are already at values that oscillate between 20 and 30 µg / m<sup>3</sup>, which are lower values than those observed at the beginning of the XXI century.

On the other hand, [8], consider that: the impacts of environmental pollutants also influence the production of a country, as would be the case of pollution by PM 2.5 that causes alterations in breathing during sleep, which it would cause a slow break leading to a decrease in worker performance, especially in industries located on avenues with high traffic.

The values of PM<sub>2.5</sub>, PM<sub>10</sub>, found during 2015 in Av. Abancay, continue to be above the national reference value. This leads to suggest that it is not only

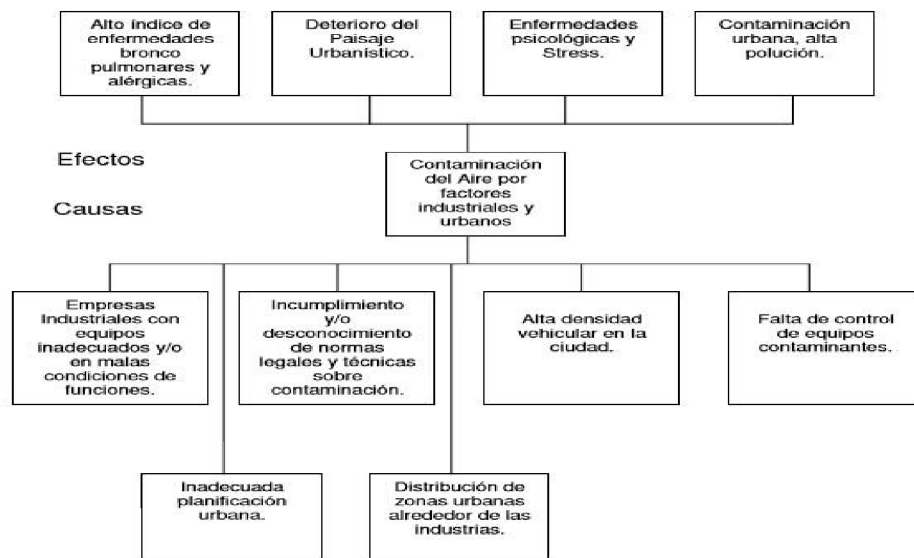
mobile sources that increase these values. In the case of NO<sub>2</sub> and SO<sub>2</sub>, a significant decrease was found at values below the reference limit, a fact that could be associated with the decrease in their concentration in diesel [9].

Between the periods 2007-2009 and 2013-2015, there is a significant reduction in the levels of PM<sub>2.5</sub>, PM<sub>10</sub>, NO<sub>2</sub> and SO<sub>2</sub> in Central Lima, a pattern not observed in the areas without rearrangement. This shows that the application of regulations in areas with high vehicular traffic is effective. However, the levels of pollutants such as PM<sub>2.5</sub> and PM<sub>10</sub> still do not reach the reference values recommended by WHO [8].

This contamination "has an impact mainly on the health of children and adults" [10].

The diagram in figure 2 shows the effects and causes of air pollution in cities, due to industrial emissions and urban transport.

**Figure 2.** Effects and causes of air pollution



## **External costs of transport and its environmental impact.**

### **Noise pollution**

Noise generated by traffic is a temporal sequence of the sum of sound levels emitted by passing vehicles. They come from the vehicle's system (engine, exhaust and transmissions); from friction caused by the vehicle's tire contacting the ground and air. The sound level also increases with the increase in speed and the deterioration of its state of conservation. Other relevant circumstances in the generation of this kind of noise are the volume and type of vehicle, the number of units that circulate and those that do so at the same time in a given place; type of road, type of pavement, among other factors [11].

The Organization for Economic Cooperation and Development (OECD) states that there is a predominance of noise generated by means of transport in relation to other sources of noise and that, depending on the development of the particular country, between 15 and 40% of the population is subjected to noise levels higher than 65 dB (A) derived from vehicular traffic [12].

### **Traffic Accidents.**

Regarding alcohol consumption and visual function in transport, [13] it is considered that visual function provides the driver between 80% and 90% of the information necessary to drive, but is affected with very low blood alcohol levels such as 0.020 gr./lt., so it describes that:

The main cause of functional impairment lies in the relaxing (depressant) effect of alcohol on the muscles responsible for fine control of the eye; muscle relaxation caused by rates between 0.20 and 0.50 gr./lt. It interferes with the control of the voluntary

movement of the eyeballs which reduces the ability to quickly search, focus and follow moving objects. (p.81).

According to the Mininter [13,14], in 2006 in Peru, considering the adjustment factor of 1.15, 4003 people died while 46, 832 were injured as a result of traffic accidents. Other sources place 451 deaths from road accidents, only in Metropolitan Lima.

"We are talking about driving with excessive speed, while intoxicated, driving in reverse, turning in prohibited places, not respecting the crossing reference and running the red light. Meanwhile, the pedestrian usually walks drunk on the roads and does not use of bridges or pedestrian crossings. Nor does it respect the traffic light "[15].

[16]. The Republic on December 31, 2019, titled: "Shared responsibility. One of the main causes is the lack of road safety education for both drivers and pedestrians

The Police Traffic Accident Investigation and Prevention Unit confirmed that, in 2019 in LM, 451 people were killed due to traffic accidents. While the recklessness of drivers - making a U-turn, driving into traffic, running a red light - is still the leading cause of accidents, the recklessness of pedestrians - not respecting the traffic light, not using the pedestrian bridges - occupies the 2nd. place.

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Our country tries unsuccessfully to reduce traffic accidents, and this is due to the lack of one of the six necessary components according to the World Road Association (WRA), which are:

- to. An organizational structure
- b. An integrated data system
- c. A political and social support
- d. Financing
- e. Technical specialization and research.

### **Monitoring and evaluation.**

#### **Automotive Driving Act**

The inadequacy of a naturally programmed 3km / hour body and psyche applied to controlling the mass, power and speed of any ordinary automobile today makes driving one of life's most complex, demanding and exhausting tasks. of human beings today:

- a) Driving is a technical activity, where its functional, harmonious and safe development depends on the protagonists previously learning, practicing and complying with legal, technical and experience rules that prescribe the use of means to obtain ends such as road safety (SV). Failure to abide by the rules for psychophysical disability, ignorance, inexperience, recklessness or negligence, is equivalent to creating the objective conditions for the claim to take place or occur effectively.

- b) Driving is an interactive activity, because the performance of each participant, whether pedestrian or automotive, influences and determines the performance of the others, just as they influence and determine the performance of the individual participant.

- c) Driving is a complex activity, from the physical, intellectual and technical point of view, as shown by the following data:

- Between simple and combined there are around 50,000 possible conductive maneuvers. Which means that the normal human existence is not enough to know and solve all the possibilities that can be presented in reality.

- According to studies in each km. The average driver's journey, he observes an average of 125 different situations and makes 12 decisions, every 10 kms. he commits three (3) mistakes and every 800 kms. you risk a serious incident.

- To circulate with a reasonable safety margin, the driver must learn and remember the meaning of some 150 road signs of a diverse nature, perceive them while he is driving, interpret, execute or abstain from what each one warns, orders or prohibits.

- The circulation environment must be constantly monitored to adapt its behavior to the changing conditions of its evolution. The lack of adaptation constitutes one of the causes of the highest incidence of accidents.

The complexity and richness of automotive driving is reduced and organized in the GDE (Goals Driver Education) Hierarchical Matrix or driver education by goals. See table 1.



**Table 1.** GDE hierarchical matrix.

Hierarchical levels of behavior	Knowledge and skills	Increasing factors	risk	Self appraisal
<b>IV. General level</b> Life projects and fundamental skills	Lifestyle, age, group, culture, social position, etc. in relation to driving skills.	. Search sensations . Irrigation acceptance. . Group rules . Peer pressure.	for	. Introspective competence . own preconditions. . Impulse control.
<b>III. Strategic level</b> Goals and context of driving	. mode choice . time choice . Role of motives . Itinerary planning	. Alcohol intake fatigue, stress, moods, rush hours. . young passengers . Slippery pavement		: Own motives and their influence on the elections. . Reflection . Self-criticism.
<b>II. Tactical level</b> Mastery of situations	. Traffic law . Cooperation . Perception of danger. . Automation	. Breach of the rules accompanied by slippery pavements . Presence of vulnerable users		. Judgment of driving skills . Own driving style
<b>I. Operational Level</b>	. Vehicle operation . Protection systems . Vehicle domain.	. Not wearing a seat belt . Mechanical system failures. . Worn tires.		. Judgment of the competences about the domain of the vehicle.

Source:Hatakka, Keskinen et al, 2002.

**Quality of life.** Science, technology and innovation (STI) has helped many countries to maintain their standards of development and quality of life on the world stage, as a result of these efforts, such important results have been achieved for society with multiple benefits such as the computer, the Internet, the global positioning system, the smartphone and artificial intelligence, most of these developments with their respective impact on the development of nations [17].

The countries that generate advances in STI are pioneers in using them and generating multiple advantages that range from medical care (vaccines, drugs, diagnostic and therapeutic treatments),

financial management (commercial transactions, banking services in real time and remotely), transportation and public services that are based on information and communication technologies (ICTs), which has allowed these countries to optimize processes and be more effective in different activities [17].

It is important to generate CTI according to our needs, taking into account the challenges that must be faced such as the appearance of new infectious diseases, guaranteeing food security, maintaining water resources, optimizing the use of energy sources, facing climate change, environmental crises, cyber and terrorist attacks, among many future and present challenges, which require STI



solutions that allow sustainable development and growth with a view to being a better country that provides effective solutions to its problems and transferable at a global level [17].

The research question is, then, to what extent does traffic congestion in East Lima contribute to environmental pollution and how do both have significant consequences on the quality of life of the population of said LM area?

Peru according to the World Health Organization [8]. It has become a highly urban country, where the highest degree of urbanization occurs in Lima, which is one of the five cities with the highest outdoor air pollution in the world (p.195).

[18], in the conclusions of their research work, they argue that vehicular traffic in Osorno causes a deficient productivity of companies, a delay in the arrival of workers that makes production not optimal, implying loss of time, expenditure of resources and money for the employer and deduction of assets for the workers. (p.71).

[19], report that increasing traffic congestion results in: low walking speed; such that, by reducing the speed of circulation on a road in service, they make the asphalt concrete mix decrease its stiffness and resistance to fatigue. P. e, reducing the speed from 60 km / h to 30 km / h generates an approximate 15.6% decrease in the stiffness of the analyzed asphalt concrete mix and 39.7% in its resistance to fatigue.

Likewise, vehicular traffic causes a deterioration in the health of workers, manifested in: low performance, irritability, stress, change of mood, conflict on the street, at home and even at work. They point out that an important cause of traffic congestion is the increase in the number of vehicles [18].

### **Nationals.**

In a survey by Lima Como Vamos, it was found that vehicle pollution (70.9%) is the main cause of city pollution. The levels of environmental and noise pollution generated by overconsumption of fuel, caused by congestion, and bad habits of drivers, as well as by improper use of the horn, have a drastic effect on users. In the study carried out by Marketwin and published by PAD-Piura, it was revealed that 72% of the Lima residents surveyed feel excessively stressed by the oppressive traffic in the city [20].

It is possible that there are more car accidents due to fatigue; and due to the desire to have our brain distracted, we resort to the use of the cell phone, which is totally incorrect [21].

[22], in a published interview analyzes the II Report of the European Environment Agency on environmental noise (EEA) and affirms that environmental noise, and in particular that due to road traffic, continues to be an important environmental problem that affects both the health and well-being of millions of people in Europe; where 20% of its population, more than 100 million people, is exposed to prolonged noise levels that are harmful to health. He warns based on forecasts that the number of people exposed to noise is unlikely to decrease significantly in the future due to urban growth and increased traffic.

[23], defines vehicular congestion as "(...) the condition that prevails if the introduction of a vehicle in a traffic flow increases the circulation time of the others, they affirm that" congestion arises when the demand approaches the capacity of the infrastructure used and the transit time increases to a value much



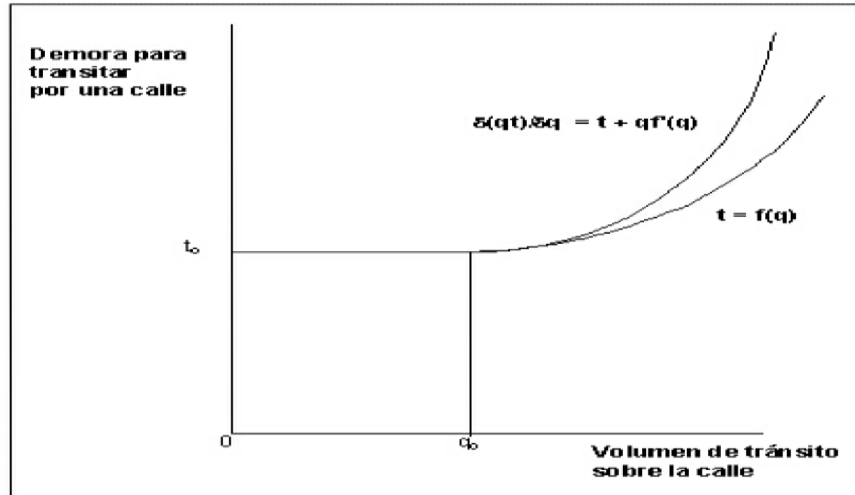


higher than that prevailing in conditions of low demand. .

Figure 3 shows, through the function  $t = f(q)$ , the time (t) necessary to travel on

a street, at different traffic volumes (q). The other curve,  $d(qt) / dq = t + qf'(q)$ , is derived from the previous one.

**Figure 3.** Schematic Representation of the Concept of Traffic Congestion



Source: Traffic Congestion- The Problem and How to Deal with It. [2. 3].

On the same subject, [24] they affirm that: congestion is a state of traffic conditions in which there is a mutual hindrance between the users of the same infrastructure. It is difficult to determine from when there is congestion, but it is customary to detect it when you have to wait more than one cycle to cross an intersection (p.15).

Congestion has detrimental effects on the entire transport system: for the automobile it means longer travel time, greater fuel and fuel consumption and uncertainty; for public transport it implies a decrease in commercial speed, loss of service regularity, increased operating costs and loss of customers; for the city as a whole it is a degradation of the quality of life, an increase in noise pollution and air pollution and a weakening of economic and social activity in cities [24].

Congestion generates extraordinary costs, as a consequence of the uncontrolled use of urban infrastructure,

whose collapse of its service levels increases the time consumed in the journeys; increases vehicle operating costs; the environmental quality of the urban environment decreases and the accident rate increases [24].

Extreme congestion: It is an extraordinary congestion at rush hour that is often caused by an incident that occurs just moments before the rush hour begins. However, at peak times fewer serious accidents are observed as the speed of the vehicles is lower.

Traffic congestion and health. Traffic congestion adds an extra percentage of stress and is not easy to handle since it is not up to us to avoid it; the increase in neurotransmitters, makes the person present physiological changes in their blood pressure, raising many times the minimum and increasing the possibility of headache and dizziness; the heart rate may rise as well. Some muscles are compromised by the posture we maintain



while sitting or standing in a transport vehicle, cervical and lumbar pain are frequent [21].

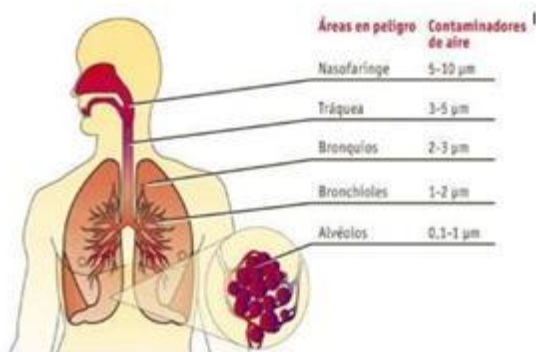
The so-called “rush hour” is the time interval where the greatest traffic congestion is recorded, it is not homogeneous in all areas and there are even roads that have their own traffic schedule [25].

Influence of urban environmental pollution on health: 70% of the inspired air reaches the pulmonary alveoli; particles, gases, fumes, microorganisms, viruses, fungi, allergens, humidity, volatile

substances, pass into the trachea, bronchi and alveoli, causing acute or chronic respiratory disease. Motor vehicles are the major source of carbon monoxide, nitrogen oxide, unburned hydrocarbons, ozone and other photochemical oxidants, lead, total suspended particles of sulfur dioxide and volatile organic compounds, they can cause irritative inflammatory effects on the respiratory system. Lead enters the body through the respiratory tract, and small respirable particles can reach lung tissue. [26]. See figure 4.

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**Figure 4.** Respirable particles smaller than 4 microns.



[27] reports that in his study he verified the transport network by Google Earth, and made field measurements on capacity, speed and volume-delay functions that describe road congestion. In the case of congestion, a minimum and a maximum influence of the bus flows is measured, as well as the plan to segregate a lane of the road for a rapid bus system.

In the case of pollution, the exact influence of bus flows is used to measure fuel consumption and emission of pollutants for the alternative of reducing public transport buses and also the alternative of implementing a fast bus

system with buses. to gas. It is obtained that, reducing the bus fleet by half, increases the speed of the transport network between 2 and 7% daily and between 9 and 14% at 11 am, and that it produces 46% of the benefits of promoting fuels clean and inspection as maintenance. If the number of buses were reduced by 50%, the speed would increase by 7% in the transport network. In other words, acting on bus flows is very ineffective in combating congestion [27].

According to Senamhi, the Air Quality Table (Inca) -Senamhi is used to classify air quality at the Monitoring points. See table2.



**Table 2.** Air quality table used to measure Environmental Pollution.

Air quality	INCA	Care	Recommendations
<b>Good</b>	0-50	Air quality is satisfactory and does not represent a health risk	The air quality is accepted and complies with the air ECA. You can do outdoor activities.
<b>Moderate</b>	51-100	The sensitive population (children, the elderly, pregnant mothers, people with respiratory and cardiovascular diseases) could experience some health problems	The air quality is accepted and complies with the air ECA. You can do outdoor activities but with certain restrictions for the sensitive population.
<b>Bad</b>	101-VUELC	Sensitive population could experience health problems. The general population could be affected.	Stay tuned for air quality reports. Avoid exercise and outdoor activities.
<b>Threshold of Care</b>	> VUELC	The concentration of the contaminant can cause effects on the health of any person and serious effects on the sensitive population, such as children, the elderly, pregnant mothers, people with obstructive pulmonary, chronic and cardiovascular diseases.	Report to the health authority to declare the levels of alert states in accordance with Supreme Decree No. 009-0023-SA and its amendment Supreme Decree No. 012-2005-SA.

**Effects of noise on human health: Hearing effects**

The damage that occurs in the ear depends on two fundamental factors: the intensity of the sound and the time of exposure of the person to said sound. Based on these characteristics, we find the following effects:

Acute acoustic trauma: produced by a very intense and short-lived noise, which can cause the eardrum to rupture.

Chronic acoustic trauma: destruction of sound receptor cells and therefore hearing loss.

Auditory fatigue: intense noise first causes a decrease in the hearing threshold (that is, sounds of greater intensity are needed to be able to hear

them). It recovers with rest, but if the breaks are not adequate, it leads to chronic acoustic trauma, that is, hearing loss.

**Non-auditory effects**

a) Physiological effects: Increased heart rate, Vasoconstriction, Acceleration of the respiratory rate, decreased activity of the digestive organs Decreased brain activity (with the consequent effect on performance)

b) Psychological effects: Aggression, Anxiety, Decreased attention, Interferences with sleep; something very serious, since the interruption of sleep hinders the repairing action of the same



and therefore the well-being and the capacity for work, permanent fatigue.

c) Interferences in activities the presence of noise affects the performance of activities and work directly, since it prevents concentration.

d) Interferences in communication the high noise level prevents communication, causing the voice level to increase and therefore, increase the noise. This fact also generates isolation of the people.

[28] argue that the coupling between urban growth and transport growth is the consequence of wrong transport planning strategies that bet on the construction of infrastructure to satisfy an insatiable demand for individual motorized mobility. Traffic congestion in Lima is so chaotic that it is estimated that a person spends between two to three hours of their day in traffic heading to work, according to a study by the Universidad del Pacífico. This time could be reduced thanks to the urban improvement project in Lima with Big Data.

Therefore, the main objective of this research is to determine the contribution

of traffic congestion to environmental pollution in East Lima, and how both significantly influence the quality of life of its population; and as secondary objectives 1: Determine the extent to which traffic congestion in East Lima is responsible for environmental pollution, 2: Analyze how traffic congestion in East Lima affects the quality of life of the population and 3: Determine the measure and form of how environmental pollution in East Lima affects the quality of life of the population of said area.

## 2. Materials and Method

Scope of the study, In East Lima, also called New East Lima. In Figure 5, it appears green. It is made up of the districts: Lurigancho-Chosica, San Juan de Lurigancho, Chaclacayo, Ate, Santa Anita, El Agustino and San Luis.

The Research Universe will be the critical points of traffic congestion and environmental contamination identified by the Traffic Police in LM, which are 242, it is a finite population. Proportional random sample in finite population.

Figure 5. Lima Metropolitana.



The Analysis Unit was the critical points or crossings of traffic congestion. The sample was proportional random with a confidence level of 95% and absolute error of 5%, where the population size was 242 and applying the formula for finite samples, 42 critical points were obtained. The procedures and techniques for data collection will be the survey by email to the experts and the telephone interview.

### Questionnaire for the survey directed to experts.

Questionnaire format for experts.  
C120 CTCAYCV jsf. On traffic congestion, environmental pollution and quality of life

**Question 1.** In which theme (s) of urban transport in Lima Metropolitana, are you specialized or the entity you represent?

- a. Journalism, opinion pollster, NGO, etc.
- b. Business or professional union: Lima Chamber of Commerce (CCL), CIP, of Foreign Trade, Association of urban planners of Peru, etc.
- c. Public official of the MTC, MML, PNP Transit Directorate
- d. Independent consultant, University professor or scientist

**Question 2.** Could you indicate the five most important causes of traffic congestion in Metropolitan Lima?. To help your answer, we have reached you the groups of causes, within which you will frame, please, your answers

- a. Poor management and planning of the mobility of Metropolitan Lima or transport oversupply
- b. Indiscriminate use of the car, increase in the vehicle fleet or obsolete fleet
- c. Land use planning or road infrastructure
- d. Business model in transportation and illegality

e. Institutional weaknesses or civic culture

**Question 3.** Do you think that traffic congestion, in itself, contributes significantly to the environmental pollution of Metropolitan Lima?

- a. Very significantly
- b. Significantly
- c. Moderately significant
- d. Barely significant
- e. Nothing Significant

**Question 4.** Considering that traffic congestion contributes significantly to environmental pollution in Metropolitan Lima.

Which of the contaminations does it contribute the most significantly?

- a. To air pollution
- b. To noise pollution
- c. To the contamination of the waters
- d. To the contamination of the landscape (walls and walls of houses and buildings, trees and gardens).
- e. Thermal radiation caused by running engines.

**Question 5.** In general, taking for granted that the Lima Metropolitan vehicle fleet is responsible for the probable 70% of air pollution, according to its reliable sources, I would validate that it is in the following range, as a percentage:

- a. 70 + - 1, or 69 - 71
- b. 70 + - 2, or 68 - 72
- c. 70 + - 3, or 67 - 73
- d. 70 + - 4, or 66- 74
- e. 70 + - 5, or 65 - 75

**Question 6.** Taking into account that environmental pollution, caused by urban transport in Metropolitan Lima, affects everyone. Which age group (age), according to you and your reliable sources does it affect the most?



- a. Kids
- b. Youths
- c. Adults
- d. Older adults
- e. Seniors

**Question 7.** What damage to health do you think causes the most, according to your reliable sources, noise pollution caused by urban transport in Metropolitan Lima?

- a. In the ear (deafness)
- b. Stress
- c. To the nervous system
- d. Emotional anxiety
- e. To character and personality

**Question 8.** What groups of the population involved in urban transport in Metropolitan Lima do you think noise pollution affects the most?

- a. To drivers and collectors
- b. To the passengers
- c. To pedestrians
- d. Traffic police and municipal inspectors
- e. Informal traders.

**Question 9.** Do you agree to drastically sanction according to laws, regulations and municipal ordinances those drivers of the public and private urban transport of Metropolitan Lima, who unnecessarily honk their horns (horns) or illegally use a highway or circular horn?

- a. Strongly agrees
- b. Agree
- c. Little agree, the authorities are timid
- d. Disagree, impunity prevents it
- e. Strongly disagree, corruption prevents it

**Question 10.** In your opinion, what health effects does the air pollution generated by the urban transport of Metropolitan Lima cause, which are considered severe?

- a. Respiratory infections

- b. Heart diseases
- c. Stroke
- d. Lung cancer
- e. Acute respiratory, pneumonia
- f. Allergic rhinitis

**Question 11.** From your point of view and according to your reliable sources, what pollutants emitted into the air by the Lima Metropolitan automobile fleet are the most harmful to the health and quality of life of the population?

- a. Particulate materials PM10 AND PM2.5
- b. Ozone (O3)
- c. Nitrogen oxides (NOx)
- d. Lead (Pb).
- e. Carbon Monoxide (CO).
- f. Sulfur dioxide (SO2)

**Question 12.** What fraudulent and irregular actions by drivers do you believe, always according to your reliable sources, cause a greater degree of traffic accidents in Metropolitan Lima?

- a. Human error or driving distr
- b. aida (cellular)
- c. Excess speed (from 50 to 65 km.) Or mechanical failures
- d. Driving under the influence of alcohol or other substances
- e. No use of helmets, seat belts and child restraint systems ( ) Unsafe Road infrastructure ( )
- f. Omission of traffic regulations and signs (lack of road safety education) ( )

**Question 13.** Do you think that water pollution caused by rains and overflows, from the tracks and sidewalks of Metropolitan Lima contaminated by urban traffic and PM10 and PM2 particles? 5, are a significant problem?

- a. Very significant
- b. Significant
- c. Little significant
- d. Nothing significant



**Question 14.** What misconduct of pedestrians have the most impact on traffic accidents in Metropolitan Lima?

- a. Do not use pedestrian bridges
- b. Walk on tracks instead of on the sidewalk
- c. Walking while intoxicated or distracted (cell phone)
- d. Failure to obey traffic signals or traffic lights.
- e. Getting into moving vehicles or at non-established stops

**Question 15.** Which or which of the externalities to urban transport in Lima Metropolitan, negatively affect the quality of life of the population?

- a. Informal, chaotic and non-established whereabouts.
- b. Outpatient commerce at bus stops and congested cruise ships
- c. Obsolete vehicle fleet that produces noise, stops due to failures mechanical and pollutant emission

- d. Abandoned or unfinished works
- e. Permissive population culture to traffic violations

**Question 16.** What omissions or misconduct by municipal and traffic authorities have the most impact on congestion, environmental pollution and accidents?

- a. Corruption.
- b. Failure to comply with the inspection and sanction of offenders
- c. The powers of the municipalities and the traffic police are not necessarily respected or they are simply not fulfilled.
- d. The inspection during vehicular traffic is not strict.

### 3. Results

#### Results of the Survey of Urban Transport Experts.

Table 3 shows the responses of the experts surveyed for each of the 16 questions in the questionnaire.

**Table 3.** Results of the previous survey of experts.

QUESTION	A	B	C	D	E	F	TOTAL, MENTIONS	MOST CHOSEN OPTION	%MOST CHOSEN OPTION
01	-	1	-	6	-	-	07	D,6	85.71
02	4	2	2	1	6	-	15	E,6	40.00
03	4	2	1	-	-	-	06	A,4	66.67
04	5	3	-	-	-	-	08	A,5	62.50
05	3	1	1	-	2	-	07	A,3	42.86
06	4	-	1	2	-	-	07	A,4	57.14
07	1	3	2	-	1	-	07	B,3	42.86
08	2	1	5	4	2	-	14	C,5	35.71
09	4	2	1	-	1	-	08	A,4	50.00
10	6	2	1	1	-	-	10	A,6	60.00
11	3	-	1	1	3	1	09	A,3	33.33
12	1	2	2	-	1	3	09	F,3	33.33
13	2	2	2	1	-	-	07	A,B,C,2	28.57
14	3	1	1	4	-	-	09	D,4	44.44
15	5	-	3	1	2	.	11	A,5	45.45
16	2	4	2	1	-	-	09	B,4	44.44
							143	71	49.65



**Source:** Elaboration of the Project Team.

Answer P1: The profile of the urban transport expert in 86% is that of an independent consultant, University professor or scientific researcher of urban transport.

Answer P2: For the consultants, the most important causes of traffic congestion in Metropolitan Lima are institutional weaknesses and citizen culture in 40%; Following as the second most important cause, the management and deficient planning of the mobility of Metropolitan Lima or oversupply of transport, in a smaller percentage.

Answer Q3: Traffic congestion, as such, contributes very significantly to the environmental pollution of Metropolitan Lima, in the opinion of those surveyed, by 66.67%.

Answer Q4: For the panel of experts, traffic congestion contributes more significantly to air pollution, 62.5%.

Answer Q5: Taking for granted that the automotive fleet of Metropolitan Lima is responsible for the probable 70% of air pollution, as indicated by the studies carried out, the respondents estimated that the automotive fleet pollutes the air between 69 and 71%, for 43% of the panel.

Answer Q6: Taking into account that environmental pollution caused by urban transport affects everyone, for whom it is most harmful is for children by 57.14, according to respondents.

Answer Q7: The type of health damage that causes the most noise pollution, caused by urban transport in Metropolitan Lima, is Stress, for 43%. following the damage to the nervous system in a smaller percentage.

Answer Q8: Within the population groups involved in the urban transport of Metropolitan Lima, who are most

affected, noise pollution is pedestrians in 36% and traffic police and inspectors in 29%

Answer Q9: Respondents strongly agree with drastically sanctioning, according to laws, regulations and municipal ordinances, those drivers of public and private urban transport, who unnecessarily honk their horns or illegally use a road or circle horn, by 50%.

Answer Q10: The panel of experts considers 60% that the air pollution generated by the urban transport of Metropolitan Lima produces severe respiratory infections and 20% heart diseases.

Answer Q11: The pollutants emitted into the air by the Lima Metropolitan automobile fleet, which are the most harmful to the health and quality of life of the population, are: PM10 and PM2 particulate materials. 5, 33% and Carbon Monoxide (CO), 33% also from the point of view of the panel of experts.

Answer Q12: For the panel of experts, the fraudulent and irregular actions of drivers that cause a greater degree of traffic accidents in Metropolitan Lima are: Omission of traffic regulations and signs (lack of road safety education), by 33% , Excess speed (from 50 to 65 kms.) Or mechanical failures, by 22% and driving under the influence of alcohol or other substances 22%

Answer Q13: Respondents believe that water pollution caused by rains and overflows, from the tracks and sidewalks of Metropolitan Lima contaminated by urban traffic and PM10 and PM2 particles? 5, are a very significant problem in 29% significant for the other 29% and not very significant for the next 29%.

Answer Q14: From the point of view of the experts, the misconduct of





pedestrians that have the greatest impact on traffic accidents in Metropolitan Lima are: 44% not following traffic signals or traffic lights and not using bridges pedestrian, by 33%.

Answer Q15: The externalities to urban transport in Metropolitan Lima that negatively affect the quality of life of the population, in the opinion of the experts, are: Informal, chaotic and non-established bus stops, by 45% and obsolete automobile fleet that it produces noise, stops due to mechanical failures and emission of pollutants, in 27%.

Answer Q16: The omissions or misconduct of the municipal and traffic authorities that have a greater impact on congestion, environmental pollution and accidents, are: Failure to comply with the inspection and sanction of offenders, 44%, Corruption, 22 % and the competencies of the municipalities and the traffic police are not necessarily respected or they are simply not fulfilled, 22%.

**Results of the Documentary Investigation.**

**It has been found that the main generators of urban vehicular traffic congestion are:**

- a) Vehicle accidents (collisions, damaged vehicles, minor accidents);
- b) Demonstrations or social marches, which have been generated in recent weeks;
- c) The construction of works in various districts and / or in the city within the framework of the electoral campaign [25].
- d) The approximately 30,000 bars that exist in LM, a situation that Lima East does not escape.

- e) Unauthorized parking on the streets, despite the signs against these anomalies
- f) Outpatient trade including sales carts on the slopes
- g) The existence of many cars.

**Weak organizational culture of Drivers and Pedestrians that is expressed in:**

- a) Drivers who do not respect the zebra crossings and generate jams in the corners in order to move faster.
- b) 67% of fatal accidents were run over.
- c) 7% of traffic accidents registered by PNP 2016 were caused by Pedestrian Recklessness
- d) No one respects pedestrians on Zebra crossings.
- e) Many drivers cause road junctions and there are no campaigns to eradicate them.
- f) The pedestrian is not put in the first place so that there are NO more deaths from being run over [29].

**Results of the Pareto Analysis regarding the Causes of the Urban Transport Problem.** See table 4.

The causes are shown in detail at the discretion of the experts, where the individual frequencies and percentages of each cause are shown, as well as the accumulated values and percentages. There were 350 ratings in total (100%), spread across a total of 14 selected causes (100%) at the end of the brainstorming sessions. Through the Pareto Analysis Methodology or 80-20 Analysis, decisions are reached to segment the causes into: very important, and barely important.

**Table 4.** Causes of the urban transport problem / Rule 80-20.

No. of Causes	% No. of Causes	% Of Mentions	Of the Segment
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Nine (9)	64.3	80.6	Very important
Five (5)	35.7	19.4	Important
Fourteen (14)	100	100	

**Traffic Congestion and Environmental Pollution in East Lima** (Ate, elAgustino, Chaclacayo, Lurigancho-Chosica. San Juan de Lurigancho, Cieneguilla, la Molina and Santa Anita).

The most problematic hotspots in East Lima are: Central East-West Highway, Vía de Evitamiento Norte -Sur and Ramiro Priale Este-Oeste, Carlos Wiese with its

intersections, shopping centers, markets and factories, with a population close to The 2 million inhabitants with heavy transport vehicles, public service, the Central Railroad, motorcycle taxis and private vehicles, constitute routes of intense and chaotic traffic that cause air pollution, noise, stress and accidents, a situation that is shown in the table 5.

**Table 5.**Critical points of traffic congestion and environmental pollution

Lugar	Distrito	Provincia	Departamento
Puente Atarjea	El Agustino	Lima	Lima
Puente Nuevo	El Agustino	Lima	Lima
Ovalo Santa Anita	Santa Anita	Lima	Lima
Cruce Av. La Cultura y Av. Metropolitana	Santa Anita	Lima	Lima
Carretera Central y Av. Huanchihuaylas	Ate	Lima	Lima
Av. Esperanza y Av. Mariátegui	Ate	Lima	Lima
Av. San Luis y Av. Arriola	San Luis	Lima	Lima

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Regarding noise, the Environmental Assessment and Enforcement Agency in 2015 published the results of the environmental noise measurement campaign developed in Metropolitan Lima and Callao, covering 49 districts in 250 points, according to the results of the final report, 90.21% of the points measured exceeded the Noise Quality Standards, with ATE being the third district with the highest sound pressure level.

**4.1. ATE district.**

The road structure of the District of Ate is currently very congested. The large number and density of vehicles that circulate on the Central Highway contribute to the proliferation of polluting

gases produced by the combustion of hydrocarbons. The deficit of green areas per capita is also high, if all available green areas were enabled, they would cover only 2.7 m2 per inhab. that does not cover the 8.0 m2 per capita recommended by the World Health Organization (WHO).

**4.2. Traffic Congestion and Environmental Pollution in Santa Anita.**

The District Municipality of Santa Anita (MDSA) prepared its Annual Plan for Environmental Assessment and Enforcement PLANEFA - 2018, in accordance with the Organic Law of Municipalities, No. 27972, Art 80 °, which contemplates Sanitation, Health and



Municipal Health. The (MDSA), in order to regulate and control the emission of smoke, gases, noise and other polluting elements of the atmosphere and the environment, as well as the disposal of solid waste, proposes the actions of Surveillance, Control, Monitoring, Evaluation, Supervision and Inspection to comply with the environmental standard in Sta. Anita.

The central highway borders the district and, to a lesser extent, the Ramiro Priale highway, considered as the main part of the west-east transversal axis and the North-South axis, Panamericana sur-  
 via de avoida- Panamericana Norte de Lima. Between Central Lima and East Lima there is a traffic of 775 thousand trips per day, this indicates that the central highway and to a lesser extent the Ramiro Priale highway, the largest number of trips are made, registering a permanent and intense traffic (Plan of Concerted Local Development Santa Anita 2017-2021)

Transportation Features in Santa Anita: Numerous operators and public transportation routes; excessive accident rate; excessive public transport vehicle fleet, oversupply, and obsolescence of the fleet; vehicular congestion and main polluter of the environment

Environmental Diagnosis - Air / Emission of Gases and Noise from Mobile Sources.

Air quality pollution in the Santa Anita district is mainly from anthropological sources, such as; transportation, due to

the increase in the number of vehicles and urbanization, due to the increase in population, these being the main contributors to the increase in noise in the district [31].

According to data from SENAMHI, the presence of PM10 particulate matter is verified, whose values exceeded the value recommended by the WHO (50ug / m3). Another indicator of pollution is the emissions of gases, smoke and annoying noise. According to the Air Quality Surveillance Report, El Agustino - Santa Anita of the Lima IV Health Directorate, the average level of Total Particles in Suspension (PTS) qualifies in a state of emergency, according to quality standards WHO annual air flow. Pollution is aggravated by intense urban mobility and the existence of an automobile fleet with overuse of transport modes in the city; the increase in the number of trips and motorized modes on interdistrict roads; high levels of congestion; increase in the number of local trips requiring improvements in local roads.

**4.3 Traffic Congestion and Environmental Pollution in the Agustino District.**

Puente Nuevo- Av. Riva Agüero with Vía de Evitamiento is also a critical point of traffic congestion in East Lima, as well as the Atarjea bridge.

Regarding the environmental pollution of the air measured in the E-4 station of Digesa, in 2017 of PM10, it is shown in table 6.

**Table 6.**Concentration of atmospheric pollutants in the E-4, 2019.

Month	PM 10 (ug/m3)
January	58.47
February	67.97



March	69.58
April	82.27
May	95.74
June	63.4
July	83.36
August	55.41
September	83.36
October	74.91
November	57.86
December	62.87
<b>Average</b>	<b>71.27</b>

Source: DIGESA DS N° 003-2017-MINAM

**4.4. Traffic Congestion and Environmental Pollution in the District of San Juan de Lurigancho.**

Traffic congestion on the main roads of San Juan de Lurigancho, such as Av. Próceres de la Independencia. There is also a lack of bicycle lanes in the district.

A new interactive map that monitors environmental pollution in real time in the world, qualifies as "unhealthy for some people" the air that is breathed in the Lima districts of Ate and San Juan de Lurigancho. The reading of each city on the map is based on the concentration of fine particles (PM 2.5) classified by the Air

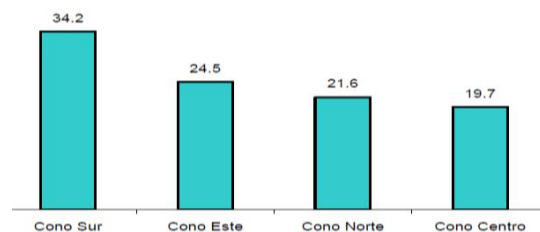
Quality Index China based on EPA (USA) standards, which relates this scale with the way it affects public health. The vehicular and pedestrian traffic is not good on the Huaycoloro bridge, which is 26 meters long, in the district of Lurigancho-Chosica, with a range of about 250,000 people per day.

**Accident rate in East Lima.**

The INEI in 2010, reports the results of a survey in police stations, on traffic accidents, where East Lima ranks second in Metropolitan Lima. see figure 6.

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**Figure 6.** Police station survey on traffic accidents.



**4. Discussion**

While [32], emphasizes that LM despite having less motorization among the cities of the region, presents high rates of congestion due to poor management of

traffic, public transport and infrastructure; For this study and according to table 3, the causes are primarily institutional weaknesses and civic culture, over poor management and



planning of LM mobility or oversupply of transport. Supposed oversupply with which we agree. Influencing the "institutional weaknesses", a climate of impunity is appreciated, which makes the stakeholders of interest strongly agree with drastically sanctioning, according to laws, regulations and municipal ordinances those drivers of public and private urban transport, who touch their horns unnecessarily or illegally use highway or curb horns. Being the misconduct of the municipal and traffic authorities the ones that most promote congestion, environmental pollution and accidents, by not complying with the inspection and sanction of offenders and corrupt and that the competences of the governing bodies of Traffic are not respected.

Traffic congestion contributes very significantly to environmental pollution, in the opinion of the experts surveyed, in 67%, to air pollution in 62%, that the LM Automotive Park pollutes the air between 69 to 71% to Criterion of 43% of our panel and for whom it is most harmful is for children; the observatory "Lima How We're Going" also found in a survey that vehicle pollution (70.9%) is the main cause of air pollution. In Lima-East, the concentration of atmospheric pollutants measured by the E-4, of the Hipólito Unanue Hospital during 2019, yielded a monthly average of PM10 of 71.27 $\mu\text{g} / \text{m}^3$ , above the maximum permissible limit (LMP) of 50 $\mu\text{g} / \text{m}^3$ . In the same station, a monthly average of PM2.5 was found at 36  $\mu\text{g} / \text{m}^3$  above the LMP of 25  $\mu\text{g} / \text{m}^3$ , this particulate material being the most dangerous for health. As well as carbon monoxide (CO).

This study considers that air pollution generated by urban transport produces severe respiratory infections and even heart disease and more stress.

The type of damage to health that causes the most noise pollution, caused by urban transport in LM, is Stress for 43% and to hearing. Being the most affected pedestrians in 36%, traffic police and inspectors in 29%, on the other hand, the OEFA (2015), published the results of the environmental noise measurement campaign developed in 49 districts in 250 points, according to the final report, 90.21% of the points measured exceeded the Noise Quality Standards, being ATE de Lima Este the third district with the highest level of sound pressure, which explains the conditions of stress, hearing, etc.

Prolonged exposure to noise can affect health in different ways, causing discomfort, sleep disorders, damaging effects on the cardiovascular and metabolic systems, and cognitive deficits in children.

While it is true that air pollution causes many more premature deaths than noise, it appears that noise affects indicators of quality of life and mental health to a greater extent. In fact, according to WHO data, noise is the second environmental cause of health problems, just behind air pollution (suspended particles).

Regarding the causes that originate traffic congestion and applying Analysis 80-20, in table 4, it is observed that nine (64.3%) out of 14 causes (100%) represent 80.6% of the mentions about traffic congestion. traffic and are: Poor management of mobility planning, indiscriminate use of the car, business model in the transport sector, road infrastructure, increase in the number of cars, land use planning, quality of mass public transport, institutional weaknesses and oversupply of transport. This group of causes is considered very important, and the attention of the authorities should be focused on them.



Regarding the accidents according to table 3, the fraudulent and irregular actions of drivers that cause a greater degree of traffic accidents in LM are: Omission of traffic regulations and signs (lack of road safety education); speeding (over 50 to 65 km / hr); mechanical failure and driving under the influence of alcohol or other substances. There is also the misconduct of pedestrians that have a greater impact on traffic accidents, which are: Not obeying traffic signals or traffic lights and not using pedestrian bridges mainly.

According to figure 6, for the INEI in 2010, in Lima Este, it was 24.5% of fatal accidents. Various transport agencies estimate the number of deaths between 400 to 450; What should be noted is that experts adjust this figure by a factor of 1.15, which means that during the 30 days after the fatal accident, 15% of the seriously injured die.

The fitted model:  $MFA = NFLM \times PFLE \times FA = NFLF$ .

Where: MFA = Adjusted deceased model; NFLM = N ° deceased LM; PFLE =% deceased Lima East; FA = Adjustment factor, 15% for 30 days

If eg:  $NFLM = 403$

$MFA = NFLM \times 0.245 \times 1.15 = 403 \times 0.245 \times 1.15 = 113.54$ ; 114 approx. In East Lima.

Finally, from Table 3, the externalities to urban transport that negatively affect the quality of life of the population are: Informal, chaotic and non-established bus stops and obsolete automobile fleet that produces noise, stops due to mechanical failures and emission of pollutants.

In relation to result B.1, it is to survey the construction of works in various districts and in the city within the framework of electoral campaigns (Strebel, 08.29.18); as well as the Lima

Metro 2 project on the central highway and is affecting the traffic of: Ate, Santa Anita and San Luis. The 30,000 bars that exist in the urbanizations; unauthorized parking on the streets, despite the signs; the ambulatory commerce that invades the tracks and the existence of many private automobiles and cars -taxi, which have the highest occupancy rate of space per passenger.

The result B .2, according to [29], can be synthesized in that the organizational culture is weak in both drivers and pedestrians, which is expressed in drivers who do not respect pedestrian crossings and generate traffic jams at corners , without media campaigns to reverse them; they do not put the pedestrian first, as happens in powerful cultures, which causes fatal accidents due to run over; Also, traffic accidents registered by the PNP in 2016 were caused by the recklessness of pedestrians, who do not use the pedestrian bridges. Which is close to the present study that indicates as deeper causes "institutional weaknesses and weak citizen cultures."

Regarding result B.3, table 4, the analysis is as follows:

The first cut-off point of 74.3% (reference 75%) of the cumulative percentage of the Pareto classification, or the most important group with eight (8) causes (when it should be only with 15% or approximately two (2) causes), Here it is observed that the Pareto principle is not fulfilled, since for 74.3% of the accumulated responses of the experts there are 60% of causes. This indicates that the transportation problem in terms of congestion, environmental pollution, accidents, costs and quality of life is extremely complex.

[33] ensures that the basic solution to reduce congestion is to increase the



supply, increasing roads, tuning the traffic lights. "Solutions associated only with infrastructure are not the only thing, it is a combination of increased supply and reduced demand." With regard to the corridor, he proposes that it should be segregated like the Metropolitan, to prevent the user from paying more and the private bus from competing for space. We agree with the reduction in demand, reducing the reasons for travel.

Regarding the degree of impairment of the driver's visual function, [13] sustains that the main cause of functional deterioration lies in the relaxing (depressant) effect of alcohol on the muscles responsible for fine control of the eye; muscle relaxation caused by rates between 0.20 and 0.50 gr./lt. It interferes with the control of the voluntary movement of the eyeballs which reduces the ability to quickly search, focus and follow moving objects. (p.81).

## 5. Conclusions

To reduce noise pollution, apply asphalt on the tracks to reduce noise; the use of silent tires in public transport vehicles; expanding the infrastructure for electric vehicles in cities; promoting active mobility, whether on foot or by bicycle; the pedestrianization of the streets; putting in place so-called 'quiet zones' (the environment not affected by noise pollution), where people can escape the noise of cities.

Implement mixed strategies to mitigate noise and air pollution from traffic as a way to multiply the effect of noise mitigation measures, while optimizing costs and efforts. The number of people who are exposed to harmful levels of noise could significantly decrease not only through specific measures, but also by seeking synergies to achieve:

technological improvements, ambitious noise policies, better urban and infrastructure planning and attitudinal changes in people.

## 6. References

- [1] Lima Cómo Vamos. Observatorio ciudadano (2018). Encuesta Lima Cómo Vamos 2018. IX Informe de Percepción sobre calidad de vida en Lima y Callao. Las BBDD de todos los estudios de percepción se encuentran disponibles en el portal del IOPPUCP, institución encargada de realizar la aplicación en campo de la encuesta de LCV. [www.limacomovamos.org](http://www.limacomovamos.org).
- [2] Soria, G. (2019). La congestión vehicular de Lima: Cuando y donde menos lo esperas. Publicaciones la Económica
- [3] Chamorro, M. (2018). El transporte en Lima Metropolitana. (primera ed.). Empresa Editora Macro E.I.R.L. Lima.
- [4] Dextre, J. C. y Chinchay, R. (2017). Analizaron la situación de la infraestructura vial de Lima en un informe para TV Perú (2017).
- [5] Posada, C. (2018). Aumento Continuo del Parque Automotor, un Problema que urge Solucionar. La Cámara, febrero 26, 2018. Instituto de investigación y Desarrollo de Comercio Exterior de la Cámara. [https://www.cameralima.org.pe/repositorioaps/0/0/par/r816\\_3/comercio%20exterior.pdf](https://www.cameralima.org.pe/repositorioaps/0/0/par/r816_3/comercio%20exterior.pdf)
- [6] Tarazona, E. (2019). "La Renovación del Parque Automotor y el Chararreo Vehicular". 12 Foro y Exhibiciones de Estaciones de servicio 2019. Ing. Ellioth Tarazona Alvarez Gerente de División Legal Asociación Automotriz del Perú-AAP 28 de febrero de 2019. AAP.
- [7] Wheida A, Nasser A, El Nazer M, Borbon A, Abdel Wahab M, Alfaro SC.



(2017). Tackling the mortality from long-term exposure to outdoor air pollution in megacities: Lessons from the Greater Cairo case study. *Environ Res.*160: pp.223-231

[8] Tapia, V, Carbajal, L. Vásquez, V. et al (2018). Reordenamiento vehicular y contaminación ambiental por material particulado (2,5 y 10), dióxido de azufre y dióxido de nitrógeno en Lima Metropolitana, Perú. *Rev Perú MedExp Salud Publica.* 2018;35(2):pp. 190-7. doi: 10.17843/rpmesp.2018.352.3250.

[9] Shima, M. (2017). Health Effects of Air Pollution: A Historical Review and Present Status. *NihonEiseigakuZasshi.* 2017;72(3): pp.159-165.

[10] Laborde A, Tomasina F, Bianchi F, Bruné MN, Buka I, Comba P, et al. (2015). Children's Health in Latin America (2015). The Influence of Environmental Exposures. *Environ Health Perspect,* 123(3): pp. 201-209.

[11] Pérez, C.I. (2019). Niveles de Ruido Ambiental en 4 Zonas del Distrito de Ate en los Meses de Enero- abril del 2019. Trabajo de práctica profesional en la UNAS, Tingo María

[12] López, M. Mendoza, J. Téllez, R. (2009). Desarrollo de una propuesta de modelo e indicador de ruido generado por la operación del transporte carretero en México. [En Línea]: Instituto Mexicano de Transporte, (<https://www.imt.mx/archivos/Publicaciones/PublicacionTecnica/pt324.pdf>, 05 May. 2019)

[13] Tabasso, C. (2018). Alcohol y volante: Alianza trágica. En, Dextre et al (2018), pp.74-102. Fondo Editorial de la Pontificia Universidad Católica del Perú. Lima.

[14] Dextre, J.C. et al (2008). Vías Humanas. Un enfoque multidisciplinario y humano de la seguridad vial. (primera

ed.). Fondo Editorial de la Pontificia Universidad Católica del Perú. Lima.

[15] Machuca, G.A. (2019). "Hablamos de conducir con excesiva velocidad, en estado de ebriedad, conducir en retroceso, .... Declaración al El Comercio de Germán Amancio Machuca, jefe de la Unidad de Investigación de Accidentes de Tránsito de la PNP.

[16] Díaz, R. (2019). "Responsabilidad compartida. Una de las principales causas es la falta de educación vial tanto en conductores como peatones"; fuente: Unidad de Investigación y Prevención de Accidentes de Tránsito de la Policía,

[17] Pardo, C.I. (2019). El papel de la ciencia y la tecnología en la calidad de vida. Escuela de Administración de la Universidad del Rosario y Dirección Ejecutiva del Observatorio Colombiano de Ciencia y Tecnología (OCyT.).

[18] Brule, A. M., Hornig, B.M. y Martinez, J.M. (2017). Congestión de Tráfico Vehicular en Osorno. Impacto en la Productividad y Salud Laboral de los Trabajadores. Trabajo para optar el Título de Ingeniería Comercial. Universidad Tecnológica de Chile, Sede Osorno.

[19] Rondón, H.A. Reyes, F.A. y Urazan, C.F. (2013). Efecto de la disminución de la velocidad vehicular en la durabilidad de una capa asfáltica. *Ingeniare. Rev. chil. ing.* vol.21 no.1 Arica abr. 2013. Pp. 139-146. <http://dx.doi.org/10.4067/S071833052013000100012>

[20] Gestión. (2018). El 72% de los limeños termina estresado a causa del tráfico, según un estudio. *Gestión.* Recuperado de <https://gestion.pe/peru/lima-72-ciudadanosestresa-causa-traffic-estudios-nndc-245062>

[21] Osores, J. P. (2018). Lidar con el tráfico (USI). Perú 21 del 18/03/2018 <https://peru21.pe/opinion/doctor21->





jean-paul-osores/li diar-

trafico399956?href=tepuedeinteresar).

[22] Agencia Europea de Medio Ambiente (AEMA,2020). El ruido ambiental en Europa -2020. Entrevista a la experta Eulalia Peris sobre el Informe de la AEMA Environmentalnoise in Europe — 2020, publicada en el número de marzo de 2020 del boletín de la AEMA 01/2020.

<https://www.eea.europa.eu/es/articles/la-contaminacion-acustica-es-un>

[23] Bull, A. (2003). La congestión de tránsito. El problema y como enfrentarlo. Cuadernos de la Cepal 87. Naciones Unidas – Cepal - GTZ, Santiago de Chile.

[24] Cendrerros, B. y Truyols, S. (2007). Introducción al transporte. Delta Publicaciones - 2007, Madrid.

[25] Strebel, I. (2018). Conoce qué puntos de Lima presentan mayor congestión vehicular. CEO de la App "Voz Veloz", medio informativo digital. Facebook 29.08.18

[26] Rivera P. (2012). Modelo de identificación de factores contaminantes atmosféricos críticos en Lima – Callao TESIS para optar el grado académico de magíster en Ingeniería Industrial UNMSM

[27] línea Martínez, M. (2017). Transporte público de buses versus congestión y contaminación en Lima y Callao. Economía Vol. XL, N° 79, semestre enero-junio 2017, pp. 4786 /

[28] Figueroa, R., Martín, P. y Sánchez, J.I. (2015). Aceleración de la urbanización global y movilidad sostenible. Estudios Regionales en Economía, Población y Desarrollo. Cuadernos de Trabajo de la Universidad Autónoma de Ciudad Juárez, No. 29, septiembre-octubre de 2015, pp. 3-34, México.

Openapps.uacj.mx/RePEc/cjz/ca41cj/Cuadernos%20UACJ%2029.pdf]. [11-06-2017]

[29] Malpartida, J. (2017). “El Caos Que Todos Queremos Erradicar”. El Comercio de Lima 5/11/17.

[30] Franco, C., Méndez, G. A. y Espitia, J. (2015). Evaluación de escenarios de ´0 descongestión vehicular en Bogotá D.C. mediante Dinámica de Sistemas. En: Ingeniería, Vol. 20, No. 1, pp. 209–231.

[www.scielo.org.co/pdf/inge/v20n2/v20n2a04.pdf] [11-06-17]

[31] Ordoñez, C. y Norabuena, M. (2019). Boletín Mensual de Vigilancia de la calidad del Aire - Lima Metropolitana 2019.

<http://repositorio.senamhi.gob.pe/handle/20.500.12542/137>.

[32] Alegre, M. J. (2018). Problema del congestionamiento vehicular y sus posibles soluciones. Entrevista de Renzo Vásquez, Coordinador digital de la Zona General de El Comercio, a la directora del Observatorio Lima como vamos, sobre la Encuesta 2018:” IX Informe de percepción sobre calidad de vida en Lima y Callao”, pp.102.

<http://www.limacomovamos.org/uploads/2018/12>

[33] Bravo, A. (2018). Usuarios pierden hasta 12 años de su vida por congestión vehicular en Lima. Entrevista de Fiorella Gil Mena del diario Gestión del 04/12/2018 a Aldo Bravo experto en ingeniería de tránsito de la UPC, <https://gestion.pe/economia/usuarios-pierden-12-anos-vida-congestion-vehicular-lima-251738-noticia>.

