Economic Relationship Of The Determination Of The Equivalent Light Vehicle Factor For The Urban Road System Of Tungurahua- Ecuador

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Abstract
This study was conducted with the purpose of establishing the economic relationship of identifying the Equivalent Light Vehicle Factor (ELV) in the urban road system in a canton of the Tungurahua province, Ecuador. The research design was quantitative, descriptive, and cross-sectional according to its temporal period. Data collection was carried out using observation forms, vehicle count records, and direct observation. Information triangulation was employed to determine the economic relationship with the ELV factor. It was identified that the average headway times per vehicle type ranged from 1.79 to 14.41 seconds for bicycles and buses, respectively. Additionally, the equivalent vehicle factor, categorized by vehicle type, recorded values ranging from 0.24 to 1.91. Considering the light vehicle as the reference with a value of 1, the bus demonstrated twice the impact on road capacity compared to the light vehicle. The economic relationship with the determination of the ELV factor is based on the operating costs borne by the driver, as well as the public investment required for road and street construction and maintenance.

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Introduction

An urban road system is the set of essential elements for the movement of pedestrians and means of transport in the area of large cities or urban conglomerates. Having the elements of the urban road infrastructure in optimal conditions is a factor for the economic and social development of nations. Although the mobility of goods, products and people through the road system of a city is a key activity in man's daily life, it can lead to complications in the social, economic and environmental sustainability spheres [1]. In this regard, vehicular traffic, defined as the volume of vehicles that travel on a street, is an essential element for the analysis of the level of road service. However, vehicular traffic varies according to specific areas and is mixed in nature composed of various types of means of transport, being necessary the use of factors that allow homogenizing and comparing the values of vehicular flow [2]. In the context of the Pelileo canton of the province of Tungurahua, vehicular traffic is characterized by the movement of different types of vehicles, with different operating conditions, that is, they circulate at different speeds, accelerations, decelerations and on different lanes or roads.

The mixed vehicular flow of this canton constitutes a limitation in the design or redesign of urban roads, since there are no adequate factors that allow homogenizing the vehicular traffic data for the study of the capacity of a lane, duration of trips and saturation flow rates. Therefore, the analysis of road performance of the streets with factors that facilitate the use of data from different types of vehicles is key, such as the equivalent light vehicle (ELV) factor, which allows estimating the capacity of all means of transport taking the light vehicle as a reference. On the other hand, the results of road service capacity have a great impact on the management of city resources, so the strategic planning and control of vehicle flows are key issues in modern societies, from an economic and social perspective. Since redesign or correction activities can be costly for governorates and for users, a key tool for this purpose are projects for the economic analysis of vehicular flow control.

The present work is developed with the objective of determining the relationship between the equivalent light vehicle factor and economic aspects, in a canton of the province of Tungurahua-Ecuador.

Urban road system corresponds to the set of streets, avenues, signage and all the appropriate infrastructure for the mobility of vehicles and pedestrians in urban areas and large cities. Its importance at the social level is related to its impact on the economic and social development of urbanization. It should be noted that urban roads are classified into highways, arterial roads, local, residential and other non-vehicular alternates [3].

Streets are defined as the fundamental element of urban space that allows the transit of vehicles and people and are considered multidimensional spaces made up of numerous structures and dimensions. To promote the circulation of pedestrians and means of transport, it has several components and lanes. An essential part is made up of sidewalks and corresponds to the area that is located on the sides and are designated for the movement of man and other activities of these [4].

Driveways and lanes, a roadway is a part of the street intended for the circulation only of vehicles and all means of transport and is in the middle of two sidewalks. Lanes are segments in which a roadway is distributed and are classified into vehicular and auxiliary lanes. The first are those selected for the movement of all motor vehicles. While the auxiliary lanes are areas within the roadway assigned either for vehicle parking, bicycle circulation, public transport or cargo [5].

Intersections are defined as the crossing point between two or more streets or avenues, allowing the link between different routes or vehicular volumes that are part of a road system. Depending on the complexity and volume of vehicular traffic, intersections can be simple, multiple, controlled and uncontrolled. The design of these must suppose the conditions to increase the visualization of pedestrians and drivers, for which strategies such as adequate geometry, optimization of time in traffic light phases and the increase of the area for pedestrians are proposed [6].

Road signage corresponds to the set of visual elements located in streets, roads or public intersections to inform drivers and pedestrians about vehicular movement and can be differentiated between horizontal and vertical. First, horizontal signage encompasses [7].

The signs or marks painted on the roads facilitates the safe movement of people on the road; they are differentiated into longitudinal and transverse lines and symbols or legends. On the other hand, vertical signage corresponds to all symbols that are not placed on the streets and can be preventive, regulatory and informative [8].

Vehicular Flow, it is defined as the movement of a certain number of vehicles on a road or road network in each period of time. This phenomenon is immersed in society and is present in daily life, in all parts of the world. Due to the characteristics of each nation, vehicular flow is not a homogeneous variable that can be directly contrasted, since it is made up of the various types of vehicles that move on a road, such as light vehicles, motorcycles, bicycles, public transport vehicles and heavy vehicles [9].

Vehicular traffic refers to the dynamic process generated by the movement of cars and other types of transport in movement along a road. Its general concept addresses situations of normal vehicular movement and congestion scenarios, because congestion situations have an impact on the environment and coexistence in large cities, this topic has been the subject of great interest in recent years. Among the physical properties of vehicular traffic that can be recovered by direct observation are the grouping of vehicles, stop and go values, interval between free flow and congested regimes [10; 11].

Highway Capacity Manual The heterogeneous nature of vehicular traffic represents a limitation in studies of vehicle management and traffic engineering, since the data and information collected do not have a common measurement scale and are expressed in terms of the different types of vehicles, preventing the reality of the phenomenon under study from being transmitted correctly [12].

In this sense, given that traffic conditions, mechanical properties of different vehicles and vehicular flow depend on the place where they are developed, the use of a conversion factor or coefficient that allows the information to be compared is key. In Ecuador, the Highway Capacity Manual (HCM) coefficient, developed by the American standard with the same name, is generally used. HCM is defined as an adjustment factor for the calculation of the capacity of a road or service level and covers different levels of analysis depending on the mode of transport, coverage of the analysis by specific sections or points and traffic conditions [13].
The equivalent light vehicle factor (ELV) as a concept widely used in transportation management and vehicle load analysis. This index facilitates the homogenization of data on the capacity or level of vehicle service of different types of vehicles on the road infrastructure in terms of a common unit such as the light vehicle [14].
Since heavy vehicles have a greater impact on paving and road wear than light vehicles. The ELV factor facilitates the study of the impact of any type of vehicle in terms of equivalent light vehicles, allowing the contrast of the effect of the traffic of different types of vehicles on a road, thus having a reference unit for a better understanding and analysis [15].
This equivalent light vehicular flow factor must be analyzed in a similar context of operating conditions linked to the level of service, vehicle composition, traffic conditions, road infrastructure and vehicle capacity [16].
The use of motor vehicles is currently a necessity for the development of a large part of human activities and contributes to economic and social development. However, it also has economic impacts at the individual and collective level. At the individual level, the issue of operating costs, repairs and fuel costs represents a latent concern [17].
This being the case, the possibility of predicting the repair costs that will occur during the use of the vehicle is key; in this way, specialists can estimate the economic efficiency of performing private transport services. It should be noted that the effectiveness of a means of transportation depends on many interconnected operational factors, such as frequency of use, transportation service fees, personnel costs, maintenance material costs, taxes, and insurance [18].
The economic impact of the use of vehicles is related to the investment of public resources for the construction, maintenance and repair of road infrastructure. Likewise, traffic congestion situations can generate economic losses due to their influence on the level of productivity of society [15].

Methodology

The present work, according to the focus of the research, is quantitative, since numerical or quantifiable data of vehicular capacities and other data obtained through audiovisual sources are collected. According to the level of research, it is descriptive, since it collects processes and describes information from the vertical and horizontal signage at the intersections of interest, as it is presented in its context.
According to the forecast over time, the study is cross-sectional, since the information is collected in a certain period. In this sense, the vehicular flow data and signage information are collected at a single point in time, without considering the changes according to time.
On the other hand, according to the location of the study, the work is fieldwork, since the data on vehicular traffic and signaling elements are collected directly at the intersections targeted by the study corresponding to Antonio Clavijo and Quis Quis streets, Confraternidad and Pitahayas Avenue and Confraternidad Avenue and Padre Jorge Chacón Avenue to carry out the recording of the traffic of all the vehicles that travel and calculate the times Headway.

Instruments

In the present work, the instrument for collecting information was direct observation and information record sheets. On the one hand, the observation sheet facilitated the recording of data on the width of lanes, roads and sidewalks, state of road infrastructure, signage, intersection class, and service. On the other hand, the vehicle capacity sheet was used to identify and record the number of vehicles that move in all directions through the urban road system of Pelileo-Tungurahua at a given time. For this, the class of vehicles and a period of 20 minutes were considered, as stipulated by the current regulations for hours of great vehicular influx.

Headway Calculation

Headway time, also known as separation time, corresponds to the period elapsed for two consecutive light vehicles to pass through the same point on a road in the same direction. The time lapse is expressed in seconds and is related to vehicular traffic and traffic speed. The method considers the criterion that light vehicles have a shorter separation time or Headway with respect to heavy vehicles and that there is a considerable volume of vehicles in circulation [19].
The calculation of Headway time is based on the following formula:

$$\mathrm{VLE_i} = \frac{\mathrm{H_i}}{\mathrm{H_c}} \tag{1}$$

Where:

- $\boldsymbol{VLE_i}$ =Class I equivalent light vehicle.
- $\boldsymbol{H_i}$ = Average class i headway times.
- $\boldsymbol{H_c}$ = Average headway times of light vehicles.

On the other hand, the time Hi corresponding to the interval in which a type i vehicle reaches the same point as a light vehicle, is calculated with the following formula:

$$\mathrm{H_i} = \frac{\sum_1^n t2 - t1}{n} \tag{2}$$

Where:

- t1 = Time it takes for a light vehicle to pass a reference zone
- t2 = Time taken by a type i vehicle following a light vehicle, to pass through the same point
- n = Number of valid beats

On the other hand, the following inclusion criteria were considered for the choice of roads:

- Uninterrupted vehicular flow
- Areas with greater vehicular flow
- Roads or streets without parking areas that generate interruption of travel
- Mixed vehicular flow, made up of different types of vehicles

Population and sample

The population considered were eight intersections with the highest influx of vehicular flow in the Pelileo canton, Tungurahua province. To select the intersections, an analysis of the Headway time criteria was carried out, which are shown in Table 1.

Table 1. Sample Selection Requirements

Criteria	Intersections							
	Intersection 1	**Intersection 2**	**Intersection 3**	**Intersection 4**	**Intersection 5**	**Intersection 6**	**Intersection 7**	**Intersection 8**
Proximity to tourist areas			x	x	x		x	x
Absence of traffic lights	x		x	x				x
Free vehicular flow with no long lines		x	x	x	x			x
High-volume vehicular flow	x	x	x	x	x		x	x
Absence of parking in the area			x	x	x			x
Variety of vehicular flow with great heterogeneity	x		x	x				x
Hours with greater vehicular flow		x	x	x			x	x

Source: Own elaboration

The intersections that will be part of the sample and that met all the relevant criteria for the Headway study were 3 and correspond to the so-called intersections 3, 4 and 8.

Results

Road infrastructure

Table 2. Condition of the roads of the study intersections

Sense	Surface Material	Road Condition	Roadway (m)	Sidewalk (m)	Number of lanes	Floor (m)	Vertical signage	Horizontal signage
Intersection 1								
Street1 N-S	Concrete	Regular	11.6	2	2	2.4	Bus stop	Pedestrian crossing
Street1 S- N	Concrete	Regular	9	2	2	-	-	Pedestrian crossing
Street2 O-E	Concrete	Regular	6	2.5	2	-	Seems	Pedestrian crossing
Intersection 2								
Street1 E- O	Concrete	Well	10.5	1.5	2	1	-	Pedestrian crossing
Street1 O-E	Concrete	Well	10.5	1.5	2	1	-	Pedestrian crossing
Street2 N-S	Paving stone	Well	8	1.2	2	-	Seems	Pedestrian crossing
Intersection 3								
Street1 E-O	Asphalt	Well	14	2	4	-	Approach to	Pedestrian crossing

Street1 O-E	Asphalt	Well	14	2	4	-	traffic lights (Not in operation)	Pedestrian crossing
Street2 S- N	Asphalt	Well	16	2.5	4	1		Pedestrian crossing Direction arrows

Source: Own elaboration

Regarding the road condition of the intersections studied, as presented in Table 2, at the first intersection the two streets are made of concrete and the condition is regular. Within the vertical signage, it has the bus stop on the main street from north to south and disco stops on the secondary street, while, in the horizontal signage, the pedestrian crossing stands out in all streets.
On the other hand, at the second intersection, the main street is made of concrete and is in good condition; it does not have vertical signage and has a pedestrian crossing as horizontal signage. The secondary street is cobblestone, is in good condition and has a stop disc and pedestrian crossing as vertical and horizontal signage, respectively.
The third intersection has asphalt streets that are in good condition, the main and secondary streets lack vertical signage due to traffic light malfunction and have the pedestrian crossing as vertical signage in both streets.

Vehicle capacity

The registration of the vehicular flow count at the three selected intersections was carried out according to the type of vehicle in circulation, whether light or heavy, motorcycles or bicycles. Table 3 shows the count of vehicles for each intersection.

Table 3. Vehicle capacity in different directions of intersections

Intersection	Access	Light	Buses	Trucks	Motorcycle	Bicycles	Total
1	Street 1 North-South	231	5	9	16	0	261
	1South-North Street	173	4	7	10	1	195
	2nd Street West-East	154	0	5	12	0	171
	TOTAL	558	9	21	38	1	627
2	Street 1 East-West	273	14	15	11	0	313
	Street 1 West-East	333	19	24	18	1	395
	Street 2 North-South	27	0	1	4	0	32
	TOTAL	633	33	40	33	1	740
3	Street 1 East-West	271	8	4	6	2	291
	Street 1 West-East	234	6	4	9	1	254
	Calle 2 South-North	143	6	5	7	2	163
	TOTAL	648	20	13	22	5	708

Source: Own elaboration

As shown in Table 3, a total of 627 vehicles circulated at intersection 1, 740 vehicles were registered at the second intersection and a total of 740 vehicles were displaced at the third intersection. It can be noted that at intersections there was a greater frequency of light vehicles.

Headway Analysis

The analysis of Headway times measured in seconds of the intersections, regardless of the type of vehicle, was carried out from recordings of the roads of interest. With the help of Adobe Premiere, the time elapsed from when the front bumper of a vehicle passes through a certain point until the rear bumper of another consecutive vehicle passes through the same point was recorded. The calculated difference of these two beats corresponds to the Headway time. The descriptive statistical analysis of these times by intersection in light vehicles is presented in Table 4.

Table 4. Descriptive analysis of the Headway times of light vehicles

Intersection	Descriptive Data				
	Media	Minimal	Maximum	Account	Error
1	9.68	2.9	24.56	225	0.32
2	5.91	1.25	16.4	214	0.24
3	6.76	1.14	20.15	214	0.34

Source: Own elaboration

As shown in Table 4, the Headway times of light vehicles at intersection 1 had an average of 9.68 seconds. The data that follow a normal distribution correspond to 225 times and are within the range of 2.9 to 24.56 seconds. At intersection 2, the mean Headway times were 5.91 seconds, a total of 214 data points had a normal distribution and were in the range between 1.25 and 16.4 seconds. For its part, intersection 3 recorded an average Headway time of 6.76 seconds; The count of 214 data had a normal distribution and were in the range between 1.14 and 20.15 seconds.

Headway Times by Vehicle Type

To analyze the Headway times by type of vehicle, the count of each vehicle by intersection was carried out, as shown in Table 5. It should be noted that the count does not rule out vehicles with times that are not within the normal distribution according to Chebysev's Theorem.

Table 5. Counting Vehicle Types by Intersection

Intersection	**Vehicle Type**					
	Light	**Buses**	**Trucks**	**Motorcycle**	**Bicycles**	**Total**
1	262	2	6	12	2	284
2	253	7	12	23	1	297
3	245	6	16	9	0	278
Total	760	15	34	44	3	859

Source: Own elaboration

As can be seen in Table 5, of a total of 859 vehicles counted at the three intersections, 760 (88.47%) were light vehicles, followed by 44 (5.12%) motorcycles and 34 (3.96%) trucks. Since the number of other vehicles is not comparable to the number of light vehicles at each intersection, the study of Headway times by type of vehicles was carried out by adding the three intersections, as presented in Table 5.

For the study of Headway times by vehicle type, only vehicles with times that have a normal distribution according to Chebyshev's Theorem were considered; therefore, the total vehicle count decreased in Table 6.

Table 6. Headway Times by Vehicle Type

Vehicle Type	Descriptive data				
	Media	Minimal	Maximum	Account	Error
Light	7.55	1.14	20.56	659	0.19
Buses	14.41	2.93	30.83	15	2.15
Trucks	8.23	1.55	19.03	29	1.00
Motorcycle	3.94	0.47	11.06	38	0.48
Bicycles	1.79	1.22	2.17	3	0.29

Source: Own elaboration

For a total of 744 means of transport, the Headway times for light vehicles, as suggested in Table 6, registered an average of 7.55 seconds; The data with normal distribution correspond to a total of 659 and are in an interval of 1.14-20.56 seconds. For buses, the average Headway time was 14.41 seconds, with a total of 15 data points falling in the range between 2.93-30.83 seconds. For trucks, the average Headway time was 8.23 and the time range was 1.55-19.03 seconds for 29 data. The average Headway time for motorcycles was 3.94 seconds, with a range between 0.47-11.06 seconds for 38 data. Finally, the average Headway time for the bikes was 1.79 seconds, with a range between 1.22-2.17 seconds for three data.

Equivalent Light Vehicle Factor (ELV)

On the other hand, the calculation of the equivalent light vehicle factor (ELV) was carried out from the Headway times of each type of vehicle, using equations 1 and 2 the results described in Table 7 were obtained.

Table 7. Equivalent light vehicle factor by vehicle type

Vehicle Type	**Headway Weather (seconds)**	**Factor ELV**
Light	7.55	1.00
Bus	14.41	1.91
Truck	8.23	1.09
Motorcycle	3.94	0.52
Bicycle	1.79	0.24

Source: Own elaboration

As shown in Table 7, the equivalent light vehicle (ELV) factor calculated by car type at the three intersections under study was found in a range between 0.24 and 1.91. It is highlighted that the bus obtained a higher ELV factor corresponding to 1.91, this finding suggests that the displacement of buses at the intersections analyzed influences road capacity twice as much in contrast to light vehicles. This fact is related to the geographical characteristics of Tungurahua,

the dimensions of this type of vehicle, the traffic conditions and the low accelerations.
For its part, the ELV factor for trucks was 1.09, which indicates that the displacement of these has a 9% higher impact than light vehicles. This fact is based on aspects such as load capacity, vehicle weight, lower speed and accelerations; and factors of the road's infrastructure such as its geometry and slope are added.
In this order of ideas, the lowest ELV factor with respect to trucks was that of motorcycles with a value of 0.52. This value allows us to point out that the movement of motorcycles affects the circulation capacity 48% less than light cars, a fact that is based on their smaller size, weight and ability to overtake other vehicles.
Finally, the lowest ELV factor was for bicycles, with a value of 0.24. The impact on traffic capacity was 76% lower than for light vehicles. It should be noted that the factor was obtained in the context of free flow, which lacks bicycle lanes and extensive displacements, so the valid situations are limited. Their limited impact is related to the dimensions of the bicycles, which facilitate their parallel movement with other vehicles.

Economic relationship
The study of the road capacity of the different road systems depends on various factors such as road infrastructure, vehicular traffic status, vehicle characteristics and types of roads. In this sense, within the road infrastructure there is an implicit factor of great social relevance for government entities and for each person, related to economic expenditure [20].
In this sense, road infrastructure is a crucial part of a nation's heritage and facilitates the economic development of citizens. Being essential its transversal nature, that is, it is an event that occurs only at a given time, the infrastructure can affect economically at a personal and collective level. In this regard, an efficient transport network is a key factor in the operability and profitability of economic activities intensive in the transport of people and products, since the costs of products or services that require transport depend significantly on the cost of vehicular travel [21].
On a social level, the impact of a large volume of vehicle flow can incur in situations of traffic or vehicular congestion, which in turn influences the development of housing estates and their citizens. In the social sphere, these situations can influence the quality of life, environmental and noise pollution, as well as the costs of vehicle maintenance and infrastructure, which in all cases represent economic expenses [22].
The impacts of the use of vehicles mainly affect the individual time of each person, and at the financial level on personal expenses for operating costs of means of transportation, such as fuel or repairs. In any case, the effects are aggravated in both situations, if there are scenarios of traffic congestion. Whether the vehicle movement activity is carried out for personal purposes or as a transportation service, the economic and personal consequences of traffic congestion are faced by drivers. In this sense, it can be pointed out that the induces of vehicular traffic are the ones who assume the consequences of delays in mobilization times and increased operating expenses. Although there is a portion of society that is affected as a collateral effect and corresponds to the users of public transport, a situation that reflects a problem of social inequality [23].

Discussion
To study the level of road service in the urban sector of the Pelileo canton of the province of Tungurahua, the equivalent light vehicle (ELV) factor was analyzed, facilitating the impact analysis of different types of vehicles due to the mixed nature of the vehicular flow in the area. In the present study, the Headway time methodology was used to calculate the ELV factor, finding that in the three intersections analyzed, the average times calculated by vehicle type were in a range between 1.79 and 14.41 seconds, with the lowest and longest time attributed to bicycles and buses, respectively. On the other hand, the equivalent light vehicle factor calculated according to the type of vehicle was between 0.27 and 1.91, with the bus having twice the impact on the level of road service compared to the light vehicle.
For its part, [24] found that the Headway times by vehicle type at the relevant intersections in the city of Cuenca-Ecuador ranged between 1.75 and 4.76 seconds, being the longest time for the light truck; In this case, buses had the penultimate place in ascending order. In this case, the range of the calculated ELV factor was in a similar range between 0.72 and 1.98, thus the medium truck being the means of transport that has the greatest impact on the city's road capacity, and twice as much with respect to light vehicles.
In the same context of the city of Cuenca, [25] identified that Headway times in the urban road system were between 2.68 and 4.36 seconds. On the other hand, the ELV factor was in a range between 0.85 and 1.38. Like the present study, in the urban area of the city, the highest Headway time and ELV factor was for the bus, although quantitatively it was slightly significantly lower in the city of Cuenca, since the impact on road capacity was only 38% higher than for light vehicles 2019. The area of the expressways of the City of Cuenca identified that the Headway times by type of vehicle are between 4.89 and 21.90 seconds, it can be highlighted that the maximum time is higher for bicycles and higher than the other situations, including the maximum value of this study [26]. On the other hand, the ELV factor was in a range between 1 and 4.71, being significantly higher than all previous cases. It is highlighted that in this case, contrary to other studies, a small vehicle such as a bicycle has a four times greater impact compared to a light vehicle.
[27], in the context of the rural road system of the city of Cuenca, determined that the Headway time according to the vehicle type was in a range of 2.22-10.16 seconds and a ELV factor between 0.71 and 3.08. Quantitatively, the results were similar to the present study, although due to the rural nature of the roads, the heavy truck was the means of transport with three times greater impact on road capacity compared to light vehicles.
On the other hand, through the triangulation of research methodologies using bibliographic search in secondary information sources, it was possible to determine the economic relationship with the equivalent light vehicle factor. In this regard, [20] mention that the economic impacts of the urban road system have consequences at the individual

and collective level. Thus, at a private level, the use of vehicles implies operating expenses for repairs, maintenance and fuel costs. While, at a collective level, they have an impact on the investment of public entities in the design, maintenance and repair of urban roads.
For its part, [23] points out that the effects of traffic congestion as an aspect of travel can have an impact on a personal level in loss of time and decreased productivity, which indirectly influences the economic development of society. In this sense, [28] mention that, in the case of Sao Paulo, one of the most populous cities, the common citizen spends 173 minutes when traveling in their own car and 166 minutes when traveling by public transport. In this way, when they travel five days a week for studies or work, they invest 14.42 and 13.83 hours of their lives in this activity alone.
With respect to the influence of vehicle use and vehicular traffic status on drivers' operating expenses. [29] note that vehicle-related spending at home is compared to owners' income. Among these expenses, two amounts are broken down, corresponding to use and maintenance. The usage amount includes fuel, parking fee, and toll, while the maintenance cost addresses the registration fee, insurance cost, and maintenance; Thus, operating expenses represent approximately 85% of total expenses.

Conclusion

It was determined that the average Headway times by vehicle type at the three selected intersections had a minimum and maximum time of 1.79 and 14.41 seconds, respectively. The lowest and longest average time was for bicycles and buses correspondingly, so that the bus is the vehicle that takes the longest time to travel in the urban road system of the province of Tungurahua.
It was identified that the equivalent light vehicle factor by type of vehicle for the canton of Pelileo was in a range between 0.24 and 1.91 for bicycles and buses, respectively. Thus, the means of public transport registered a greater impact on road capacity compared to other vehicles. By its average Headway time, it is the vehicle that contributes the most to traffic congestion in the areas studied.
It was determined that the economic relationship with the equivalent light vehicle factor in the province of Tungurahua, through the triangulation of information, is based on the individual and collective consequences of the drivers. Individually, drivers pay the costs of operation and maintenance according to the intensity of use of a means of transport. While, at the collective level, construction, maintenance and repair influences the management of public expenditures.

Conflicts of interest
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