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Factorial analysis of road infrastructure related to traffic accidents occurred in Neiva in the years 2017-2018

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Abstract
The transportation sector has been fundamental in Colombia and faces serious consequences in terms of traffic accidents. This paper examines the relationship between accidentability and most outstanding road infrastructure factors in ten urban stretches of Neiva in the period 2017-2018, following the inclusion and exclusion criteria of the International Road Assessment Program (IRAP) for developing countries in order to characterize the state of road infrastructure of the selected points. The results showed that the central sections of the city tend to be related to the day, time, type of vehicle and victim, attribute and direction of the road. The motorcyclist was the road actor most vulnerable to injuries and fatalities, Saturday and 8:00 am was where more crashes occurred. The road infrastructure factors contributing to accidents highlight the relevance of the environment in the city.

Keywords: road infrastructure; traffic accidents; factorial analysis.

Análisis factorial de la infraestructura vial relacionada con los accidentes de tránsito ocurridos en Neiva en los años 2017-2018

Resumen
El sector transporte ha sido fundamental en Colombia y se enfrenta a serias consecuencias en materia de accidentes de tráfico. Este trabajo examina la relación entre accidentabilidad y factores de infraestructura vial más sobresalientes en diez tramos urbanos de Neiva en el periodo 2017-2018, siguiendo los criterios de inclusión y exclusión del Programa Internacional de Evaluación de Carreteras (IRAP) para países en vías de desarrollo con el fin de caracterizar el estado de las infraestructuras viarias de los puntos seleccionados. Los resultados mostraron que los tramos centrales de la ciudad tienden a estar relacionados con el día, hora, tipo de vehículo y víctima, atributo y sentido de la vía. El motociclista fue el actor vial más vulnerable a lesiones y muertes, el sábado y 8:00 am fue donde más siniestros ocurrieron. Los factores de la infraestructura vial que contribuyen a los accidentes destacan la relevancia del entorno en la ciudad.

Palabras clave: infraestructura vial; accidentes de tránsito; análisis factorial.

1 Introduction

More than 1.25 million human lives are lost annually due to traffic accidents (TA) and public health problems that have mainly affected people between 15 and 29 years of age [1]. For Campos et al. [2], land transport has come to be considered one of the most dangerous means of transportation, where many pedestrians, cyclists and motorcyclists have been killed. It has been found that this major problem causes about 50 million serious damages on citizens, where by the year 2020, in developing countries, it has come to be even within the top three of the major causes of disability; with a share of about 87% of the total events occurred [3,4], and it is predicted that by the year 2030 road accidents will be the fifth leading cause of death worldwide [5]. In addition to physical injuries, TAs cause psychological and social effects on families, impacting emotionally and economically between 1 and 3% of the Gross Domestic Product (GDP) of each nation [6].

For the year 2016, there were about 154,997 deaths

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caused by traffic in the Americas region, which came to represent about 11% of deaths worldwide due to this cause [7]. Similarly, Dávila et al. [8] pointed out that road safety in this region claims more than 154,000 lives per year, with an increasing trend, accounting for 12% of deaths worldwide due to this factor, where it has been estimated that TA are the ninth cause of death and by 2030 it is predicted to be the seventh worldwide, about half of these deaths correspond, as mentioned; to pedestrians, cyclists and motorcyclists. Motorcyclist deaths have increased from 15% in 2010 to 20% in 2013, reflecting great vulnerability and the need to further protect the lives of these road users [9].

In the country, for 2016, it was estimated that there were about 9.7 deaths per 100,000 inhabitants, which places it as the second country in South America with the second highest accident rate [10]. TAs cause approximately more than 7,000 deaths per year, for 2017, in Bogota about 32% of the TAs triggered in deaths to motorcyclists on the roads [11]. For the same year, to the National Institute of Legal Medicine and Forensic Sciences (INMLCF) [12] about 48,669 events entered by TA were reported; within this figure 15% corresponded to deaths, and, the remaining percentage to serious injuries. According to the National Road Safety Agency (ANSV) [13], in the country about 8,264 people died from road traffic in 2022, which represents a 13.67% increase over the previous year.

In the department of Huila, as described by the National Road Safety Observatory (ONSV), between the first and twelfth month of 2017, about 986 injuries were recorded with a total of 230 deaths [12]. Of these deaths, 114 and 116 occurred due to TA in urban and rural areas, respectively. It was found that Neiva was the city in the department that accounted for the highest percentage of fatalities for the year 2017 (26%) [14].

According to studies conducted by the Department of Transportation of the National Highway Traffic Safety Administration (NHTSA), they agree that the human factor is responsible for between 70 and 90% of accidents; road infrastructure, between 15 and 30%, and vehicle failure, between 5 and 12% [15].

On many occasions, the conditions and characteristics of the road infrastructure have been considered irrelevant to TA; however, it has been found that road conditions are actually significant on the occurrence of accidents, material losses and fatalities [16,17].

The municipality of Neiva remains as the seventh city in the country with the highest road accident rate, reflecting great weaknesses in the road safety system of the municipality, so it is clear that pedestrians and motorcyclists have been the most vulnerable road actors. It is important to recognize the role played by all road actors without underestimating the economic and social contribution that the city receives daily in terms of public and cargo transportation through the responsible use of road infrastructure; and although large investments have been made in the city, their condition has not been adequate.

In this research, we intend to factorially analyze the road infrastructure with respect to traffic accidents occurred in the city of Neiva during the years 2017 and 2018. The selection of the 2017-2018 period is based on the need to perform a retrospective analysis covering recent years. This approach allows us to examine trends and patterns over two consecutive years, providing a more comprehensive view of accident rates in Neiva. This city was selected for this study not only because of its specific challenges in terms of traffic density, geographic characteristics and mobility patterns, but also because of its representativeness and relevance in terms of accident rates in the Colombian context, as it has been ranked as one of the top 10 cities with the highest road accident rates in our country.

2 State of the art

At the international level, B. Lin [18] developed an accident study in New York City on two-lane rural roads, concluding that "it is evident that curvature is an important determinant of accident rates when curvature exceeds 9°, the probability of a curve being dangerous is approximately 50% or greater (at a 95% confidence level) than straight sections of road. These characteristics suggest that curve flattening is considered a logical approach to improve road traffic safety. Speed reduction, when the vehicle moves from a straight section to a curve, has a significant impact on traffic safety. Á. Briz-Redón et al. [19] showed an analysis about TA in Valencia (Spain) during the years 2005 to 2017. The authors used binomial count models and specifically studied road crossings. The results showed that overdispersion of accident counts and disparate effects lie on road sections near intersections, generating high accident rates.

M. Pljakic and collaborators [20], analyzed the impact on infrastructure and road traffic on pedestrians, therefore, they used a geographically weighted regression to obtain and identify the significant factors on accidentability. The authors obtained about ten strong factors on pedestrian accidents: length of street networks, vehicle-kilometers traveled, length of roads, total population, number of bus stops, among others.

M. Tanishita and his team [21] investigated the impact of traffic control and road infrastructure on bystander severity in Japan. The authors applied logistic linear regression and determined that medians over intersections increased crash severity, on the other hand, they analyzed the intermittency of traffic lights (when the time to cross is about to end for the red light to turn on), and found an increase in severity over flashing traffic lights versus stop lights (stop sign).

D. Harwood et al. [22], who investigated the operational and safety effects of road geometry, found that geometric factors play an important role in defining the operational efficiency of any road and are key because they influence traffic operations and road safety. Among the most relevant elements are: the number and width of lanes, the presence and width of berms, the horizontal and vertical alignment of the road, and the signage".

Later, G. Karlaftis and Ioannis Golias [23], conducted their work on the effects of geometry and traffic volumes on road accident levels, finding that the results differed between two-lane and multi-lane (multi-lane) roads, and it was inferred that generally factors such as pavement type and condition are the most relevant variables affecting TA rates.

At the national level, in the research conducted by F. Flórez et al. [24], the authors made a multicausal analysis of TA for the cities of Ibagué and Valledupar, using the method of reliability analysis and driving errors (DREAM) to categorize the causes associated with road incidents, for the first city, For the first city, up to 20 causes were found, 9 of which were recurrent, while for the second city, 18 causes were found, 12 of which were recurrent for accidents, where human factors (such as fatigue, vehicle failure, road geometry, among others) favor the constant frequency of accidents. N. Lopez et al. [25] analyzed the road conditions in terms of safety and road infrastructure for the city of Santa Marta, for this purpose, they conducted an exploratory and descriptive research under a survey of a sample of the population of the city, where they determined that the origin of accidents is due to factors such as speeding, lack of signaling and poor pavement condition.

P. Salcedo et al. [26] in their research, by means of network science studied the road accident rate in Bogotá, the authors spatially divided the city under Transportation Analysis Zones (TAZ) in 922 polygons. As materials, they used databases with information related to road accidents in the capital since 2011 and analyzed them using the free software GNU PSPP. It was found that the time, day, peak and plate, are significant on the pattern of accidents in the city.

In the research published by V. Cantillo et al. [17] and carried out for the city of Cartagena, the authors conducted an exploratory analysis on severe factors in TA in urban areas of the city. For the study the authors used seven factors (road infrastructure, traffic and control, victim, day and time, vehicle, and environmental factors) and three levels of crash severity (injury, fatal and only with property damage), in the study a discrete model was used to study the factors under the three levels mentioned, within the results obtained it was found that in streets with speed limit higher than 40 km/h, bridges or crosswalks, and at ages over sixty years; there is a high probability of an accident with fatal outcome.

H. Ospina et al. [10], analyzed a series of data about TA in motorcyclists in the city of Bogotá, the data were processed with information about weather and infrastructure and categorized into: weather conditions and schedule, road actors, road conditions, motorcyclists and people involved, and, location and characteristics of the accident. These five categories were found to be significant in terms of road safety in the city, which could recreate new scenarios for study and further research.

3 Materials and methods

The most distinctive feature of traffic bottlenecks is the tendency to create congestion. In this study, bottleneck road is caused by the reduction of adjacent lanes. School road is caused by a strong traffic attraction source. This section focuses on the difference in traffic characteristics between the two types of scenarios.

3.1 Type of study

In this research, a quantitative descriptive observational cross-sectional descriptive approach was used, as used by authors such as [27–29], under this approach, objective, quantifiable and analyzable data were collected about TA occurred in the city of Neiva for the years 2017-2018.

3.2 Geographical location

The study was conducted in the city of Neiva, capital of the department of Huila (Colombia). It was found that this city remains as the eighth in the nation with the highest accident rate exceeding even more than 20 fatalities per 100,000 inhabitants, managing to surpass capital cities such as Cali, Bogota and Medellin [13]. The city has 348,964 inhabitants according to the national population and housing census conducted in 2018 [30]. As of 2017, 27,439 vehicles, 20,411 motorcycles, 710 buses and 2,196 cabs were registered in the municipality.

According to data obtained from the city's Secretariat of Mobility, during 2017 and 2018 about 2,702 accidents occurred, of which 57% were reported in 2017 evidencing a decrease in the total number of accidents of 25%, compared to the previous year; although it is evident that the number of deaths increased by 150%.

3.3 Population

The study population contemplates the road sections of the city of Neiva with the highest occurrence of accidents during 2017 and 2018. In this sense, some criteria were taken into account: i) inclusion criteria, it relates the TA reported in the urban area of Neiva between January 01, 2017 and December 31, 2018, ii) exclusion criteria, it discards the report of accidents with missing information.

3.4 Sample

In this research, a non-representative sample was used, so the identification of the ten points with the highest occurrence of accidents in the period 2017-2018 was determined. Table 1 corresponds to the sample studied in this research, which, considers streets, races and avenues on which the events occurred.

Table 1.
Critical points with the highest occurrence of accidents.

Importance	Section of track	Accident	Injured	Deaths	Total
1	7 Street 55	11	10	0	21
2	Race 5 Street 48	16	2	0	18
3	Race 1 Street 48	8	7	1	16
4	Race7 Avenue Toma	11	4	0	15
5	Race 2 Street 21	9	5	0	14
6	Race 2 Street 4	5	8	0	13
7	Race 7 Street 21	7	4	0	11
8	Race 7 Street 10	9	2	0	11
9	Race 9 Street 4	3	8	0	11
10	Circunvalar avenueStreet 7	9	2	0	11

Source: Own elaboration.

3.5 *Sampling*

According to the sample referred to, a non-probabilistic and convenience sampling was carried out, authors such as Medina, Hincapié et al. and Gonzales et al. [31–33]; have used this type of sampling for the development of their research.

3.6 *Collection of information*

Based on data consulted from: i) Ministry of Transportation and Public Works (MTOP), ii) ONSV, iii) INMLCF, and iv) the Neiva Mobility Secretariat; information necessary to describe how TAs behave in the city during the indicated period was obtained as input. All the information consigned in tables and figures were constructed from ITTH and INMLCF 2017-2018 data [12,34].

In this research, the methodology of the International Road Assessment Program (IRAP) for developing nations was used to characterize the state of the road infrastructure of the selected points. For this purpose, the most important factors of study on the safety and road infrastructure of Neiva's road users were determined in this research, as shown in Table 1. IRAP seeks to improve road safety by inspecting high-risk roads to encourage the prevention of TA fatalities; authors such as Lauragrazia Daidone et al. [35] have conducted similar studies.

For the collection of the information, a visual inspection was carried out by traveling in both directions of the determined roads, verifying the conditions of the infrastructure elements. The observations were recorded in the questionnaire designed for this purpose, which inquired about the characteristics, geometry, condition, flows and severity of the roads. Table 2 shows the structure of the instrument used for the questionnaire applied to the sample.

Table 2.
Structure of the questionnaire.

Road infrastructure	Variable
Track characteristics	Paved berm Unpaved berm Direction of traffic Number of lanes Auxiliary lanes Speed limit Lane width Pedestrian sidewalk Land use (lateral conflicts) Ciclovía Median Traffic calming
Track geometry	Track Surface Pavement condition Horizontal signage Vertical signaling Traffic light condition
Track condition	Public lighting Intersection control Other conditions present
Severity	Obstacle on the track Slopes Ditches
Flows	Ditches Pedestrian Cyclist

Source: Own elaboration.

3.7 *Information processing*

The data were tabulated and analyzed using Microsoft Excel. In this research, statistical analysis was performed by observing the behavior of the factors independently. Frequency distribution and measures of central tendency were used for qualitative and quantitative data, respectively.

4 Results and discussion

Fig. 1 corresponds to the frequency distribution of TA occurring between 00:00 and 24:00 hours per day for the study period. As can be seen, there were 3,178 TA, of which 2,807 met the defined exclusion and inclusion criteria. In relation to the time of occurrence of the accident, this figure shows that 60% of the TA occurred between 8:00 and 9:00 a.m. (1,688 accidents), 3.7% at noon (103 accidents) and less than 3.5% in the other hours. Records have shown that in countries such as Chile, the time at which the most accidents occurred during the period 2000-2009 was between 7 and 8 a.m., and that of the seven days of the week, Fridays and Saturdays had the highest incidence [36].

Table 3 corresponds to the total number of accidents that occurred during the study period according to the two aforementioned criteria. As can be seen, about 371 TA did not comply with detailed information or occurrence within the urban perimeter of the city.

Table 4 corresponds to the data obtained from the distribution of frequencies according to the type of outcome triggered by TA.

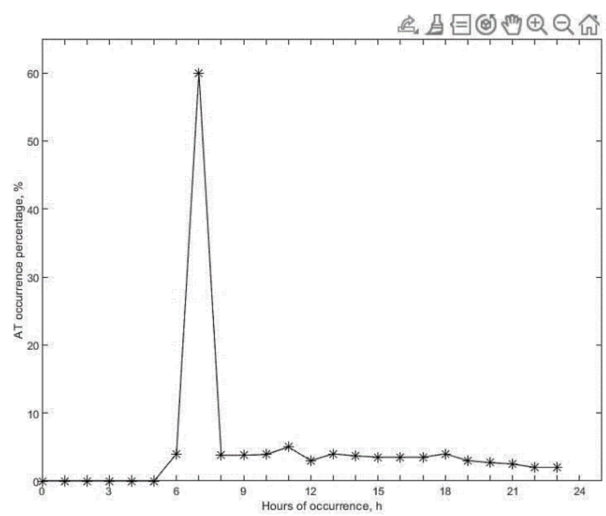

Figure 1. Hours of occurrence of TA.
Source: Own elaboration.

Table 3.
Total accidents according to inclusion and exclusion criteria

Year	Yes	No	Total
2017	1,634	214	1,848
2018	1,173	157	1,330
Total	2,807	371	3,178

Source: Own elaboration.

Table 4.
Frequency distribution by type of outcome in TA.

Unraveling	Number of accidents	Frequency (%)
Material damage	1,519	54.11
Wounded	1,232	43.89
Death	56.00	2.00
Total	2,807	100

Source: Own elaboration.

Table 5.
Frequency distribution of TA occurrence.

Day	Number ofaccidents	Frequency (%)
Monday	390	13.89
Tuesday	415	14.78
Wednesday	379	13.50
Thursday	401	14.29
Friday	447	15.92
Saturday	466	16.60
Sunday	309	11.01
Total	2,807	100.00

Source: Own elaboration.

Of the number of accidents that meet the above criteria, 54.11%, 43.89% and 2% correspond to TA that resulted in property damage, injuries and fatalities, respectively. As can be seen, in the 10 points of the city analyzed, propertydamage accounted for more than half of the TA.

Table 5 corresponds to the occurrence of accidents according to the day on which they happened. As can be seen, during January 01, 2017 and December 31, 2018, Saturday was the day of the week where the highest number of TA occurred (466), contrasting with what was obtained in [36], this great top 3 is complemented by, Friday and Tuesday which triggered a total of 447 and 415 of accidents, respectively, representing about 15.92 and 14.78% of the total accidents occurred during the period in the sections studied. It is evident that the percentage variation with respect to the day with the highest accident rate on Tuesday (Δ%=1.82) and Friday (Δ%=0.68) is lower compared to Sunday (Δ%=5.59), a day on which the occurrence of TA was 11.01%. Although Sunday was the day with the lowest accident rate (considered a day of rest and not a working day in many places and companies), it has been found that it can never exempt citizens from the possible risks or hazards that can result in TA [37].

Table 6 corresponds to the distribution of TA frequencies according to the four daily shifts tabulated and classified as follows: i) early morning, between 00:00 and 06:00, ii) morning, between 06:00 and 12:00, iii) afternoon, between 12:00 and 18:00, iv) night, between 18:00 and 24:00. From the above table, it can be inferred that 70.12% of the accidents occurred in the morning. Also, it was found that the time range and day with the highest accident rate was Saturday morning, with about 11.62% of the total number of TA.

Table 7 corresponds to the percentage of accidents according to the type of vehicle and the outcome triggered. According to the type of vehicle involved in TA occurring in the city during the study period, it was found that the first place went to the private motorcycle (41.38%), the second to the private vehicle (23.98%) and the third to the cab with 14.79%. In relation to the type of outcome, it was found that the private motorcycle was the type of vehicle that caused the most damage, injuries and deaths in TA, with 19.70%, 67.05% and 64.29%, respectively.

Table 8 shows the type of victim involved in TA occurring in the city during the period analyzed. Of the total number of accidents reported, about 581, i.e., almost 21% involved victims (injured and deceased). Of this figure, 54.78% were vehicle occupants, 37.04% pedestrians and 8.17% cyclists. In terms of fatalities, pedestrians were the greatest fatalities (71.43%), followed by cyclists (17.14%) and vehicle occupants (11.43%). As for the injured, it was found that most of the victims were vehicle occupants (57.9%), followed by pedestrians (34.81%) and cyclists (7.59%).

Table 6.
Frequency distribution Daily days of TA occurrence.

Time range	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Total
00:00-06:00	0.86	0.32	0.14	0.11	0.25	0.46	0.46	2.6
06:01-11:59	7.31	10.19	10.76	9.52	10.12	10.69	11.62	70.21
12:00-17:59	1.78	2.42	2.53	2.96	2.46	3.21	2.42	17.78
18:00-23:59	1.07	0.96	1.35	0.93	1.46	1.57	2.07	9.41
Total	11.01	13.90	14.79	13.51	14.29	15.93	16.57	100

Source: Own elaboration.

Table 7.
Type of vehicle and TA-related outcome.

Vehicle	Damage	Wounded	Dead	Total
Bicycle	0.07	0.08	1.79	0.11
C/tractor-trailer*	0.00	0.00	1.79	0.04
Public truck	8.04	2.60	5.36	5.60
Micro bus	14.43	5.28	7.14	10.26
Private motorcycle	19.77	67.21	64.29	41.60
Cab	17.52	11.93	3.57	14.79
Official vehicle	0.07	0.00	0.00	0.04
Private vehicle	39.33	5.76	8.93	23.98
Grand total	100	100	100	100

* Indicates a person who has suffered a TA while either as a driver or as a passenger.
Source: Own elaboration.

Table 8.
Type of victim involved in traffic accidents.

Víctims	Injured (%)	Deaths (%)	Total (%)
C/occupant*	57.59	11.43	54.78
Cyclist	7.59	17.14	8.17
Pedestrian	34.81	71.43	37.04
Total	100	100	100

* Indicates a person who has suffered a TA while either as a driver or as a passenger.
Source: Own elaboration.

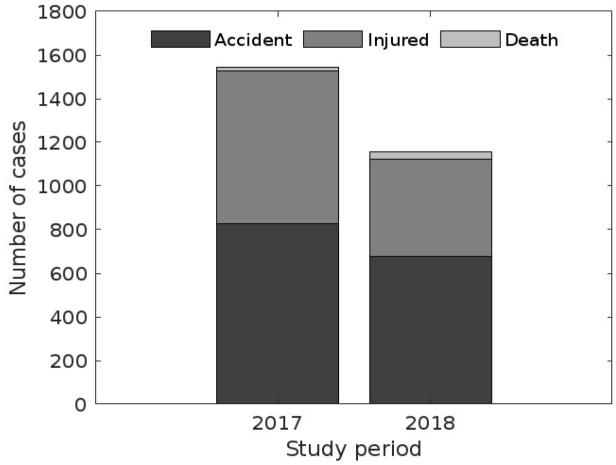

Figure 2. Number of cases reported by accident, injured and death during 2017 and 2018.
Source: Own elaboration.

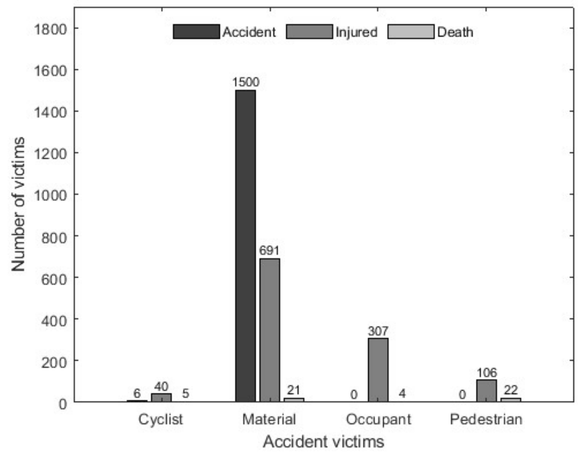

Figure 4. Cases for accident victims.
Source: Own elaboration.

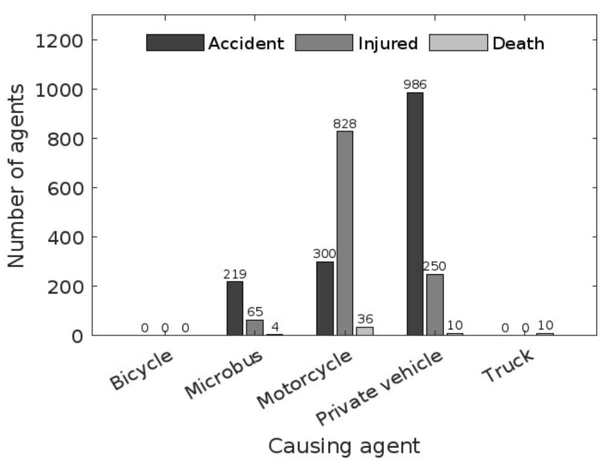

Figure 3. Cases by causative agent and type of event.
Source: Own elaboration.

Fig. 2 corresponds to the information discriminated by accident, injury, death and year of the event. As can be seen, in 2017 and 2018 there were 1,544 and 1,158 reported cases, respectively. It is highlighted that for 2018 there was a lower number of TA and injured, however, there were about 37 deaths, a higher figure than the immediately previous year (15 deaths), which allows inferring that of the fatalities does not necessarily depend on the number of accidents, but also, on the lethality and period of occurrence of the TA.

Fig. 3 shows the number of cases by causal agent and type of event. According to the agent causing the event, it was found that 46% of the cases were caused by vehicles, followed by motorcycles (43%) and minibuses (11%). In addition, it was found that private vehicles caused the greatest number of material damages with about 65% of the total number of events, while motorcycles accounted for the greatest number of injuries (72%) and deaths (75%), reflecting the great vulnerability of this means of transportation.

Fig. 4 corresponds to the number of cases per accident victim during the period studied. In terms of accident victims by TA, injury and death, it was found that property damage also dominated the first place with 82%, followed by vehicle occupants (11%) and pedestrians (5%). Similarly, it was observed that vehicle occupants had the lowest probability of death compared to cyclists and pedestrians.

Once the visual inspections were carried out and the road attribute registration forms were filled out, based on the IRAP, the following information was obtained:

Table 9 (which, because of its size, is at the end of the section of the document) represents the matrix of attributes of the sections indicated in Table 1 according to IRAP.

In this sense, according to the evaluation criteria used by IRAP to carry out the star rating of road safety by levels to the elements inspected in the road sections, and once the matrix analysis of the sections in Table 9 was performed, it was obtained as a result, that these sections maintain a level of 3 and 4 stars, this because the roads (at a general level) inspected have a sidewalk for pedestrians, wide lane, road in good condition, adequate signaling and dividing islands between lanes.

Table 10 represents the attributes associated with the accident rate during the period investigated. According to the information collected, a relationship was observed between the level of accident occurrence and attributes such as: speed, land use, berm width, intersection control, etc.

Table 9.
Matrix of attribute results according to IRAP of the sections in the ten sections studied.

			Accident hotspots in the city of Neiva (2017 - 2018)									
Categories	**Track attributes**	**Criteria evaluated**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Characteristic of the track	Number of lanes	One			X						X	
		Two	X	X		X	X	X	X	X		X
		Three										
	Direction of transit	Unidirectional			X							
		Bidirectional	X	X		X	X	X	X	X	X	X
	Lanes	Does not exist										
		One way		X	X							
		In both directions	X			X	X	X	X	X	X	X
	Speed limit	Value	80	80	80	80	80	80	80	80	80	80
	Lane width	> 3.25 m										
		<3.25		X	X							
		2.75-3.25	X			X	X	X	X	X	X	X
	Width of paved berms	No existe	X	X	X	X	X	X	X	X	X	X
		>=2.4										
		1-2.4										
		<1,0										
	Width of unpaved berms	Does not exist										
		>=2.4										
		1-2.4										
		<1.0										
	Pedestrian sidewalk	Does not exist										
		Right	X	X			X	X	X	X	X	X
		Left			X	X					X	X
	Land use (lateral conflicts)	Commercial		X		X	X	X	X	X	X	X
		Industrial										
		Housing	X		X						X	
		Worship										
		Education										
	Ciclovía	Segregated barrier-free										
		On the road										
		Does not exist	X	X	X	X	X	X	X	X	X	X
	Median	Without median		X	X							
		With median	X			X	X	X	X	X	X	X
	Quieting	Speed reducers velocidad										
		None	X	X	X	X	X	X	X	X	X	X
Track geometry	Horizontal curves	Very closed										
		Closed										
		Moderate										X
	Vertical curves	Concave										X
		Convex										
		Flat	X	X	X	X	X	X	X	X	X	X
	Track inclination	Wavy										
		Mountain										
Track condition	Horizontal signage	Good										
		Fair	X	X		X	X		X		X	
		Poor										
	Vertical signage	Good										
		Fair	X	X	X	X	X	X			X	X
		Poor										
	Pavement condition	Good	X	X		X	X	X	X	X	X	X
		Fair			X							
		Poor										
Intersection characteristics	Intersection control	Signaled by fiscal						X				
		Traffic light				X	X		X	X	X	
		Stop										
		No signage	X	X	X							X
		Not applicable										
		Detour				X			X			

	Other conditions present	Work on the road Speed reducer Channelizer vehicle Other	X	X	X		X	X		X	X	
Flows	Pedestrians	None Density B,M,A	M	B	B	A	A	A	A	A	B	B
	Cyclist	None Density B,M,A	M	X	M	M	B	B	M	B	B	X
	Motorcyclist	None Density B,M,A	A	A	A	A	A	A	A	A	A	A
	Vehicle	None Density B,M,A	A	A	M	A	A	A	A	A	A	A
Visual inspection rating with stars for each section			4	3	3	4	4	4	4	4	3	4

Source: Own elaboration.

Table 10.
Attributes with observable relationship to accidentability.

Track attributes	Result	Percentage
Speed	80	-
Land use (lateral conflicts)	8	80
Width of paved berm	9	90
Ciclovía	10	100
Unpaved berm width	10	100
Quieting	10	100
Track inclination	10	100
Horizontal signage	6	60
Vertical signage	8	80
Pavement condition	9	90
Intersection control	4	40
Motorcyclist	High	-
Vehicle	High	-

Source: Own elaboration.

As can be seen in Table 10, although there is evidence that the roads are acceptable, have a wide lane, a flat profile and a high-speed limit, this causes drivers to travel at high speed, creating complications and threats to pedestrians and road actors in the face of sudden events that could lead to threats and critical or catastrophic events in the face of relatively short response times. It has been found that speeding has been the main cause of TA involving fatalities on urban roads, and the second cause of fatalities on rural roads [36]. In addition, it is evident that the high mobility of motorcycles and vehicles overloads the roads, generating a large increase in the accident rate.

From this table, it can be inferred that the road signaling is not adequate in the studiedsections, according to the road level, and that intersection control is less than 50%, which induces great vehicular congestion, increased accident rate, difficulty and threats to cyclists and pedestrians.

In view of this situation, authors such as Y. Asprilla et al. [5] have involved the concept of sustainable mobility through mass transportation where the use of motorcycles and vehicles with few passengers is minimized, and therefore, high road traffic is minimized leading to the reduction of AT. Likewise, as pointed out by the same author, but by means of [38], The inclusion of mass public transportation systems guarantees not only a safer transportation, but also a more complete one, according to the complementarity and organization of schedules established for the common transportation of citizens.

5 Conclusions

Road accidents involve all actors, pedestrians, cyclists, motorcyclists, passengers and vehicle drivers. In the urban context of the city of Neiva, through this research it could be determined that in 2017 there were more TA compared to 2018 (1,544 vs 1,158), however, for the latter there were more lethal deaths (about 37). Likewise, at a general level there were cases in which there are factors that have really been significant on the TAs, such as: the environment and type of soil, time of occurrence, type of transport and victim, road section and speed. The latter has become a worrying factor for society, considering its high level of threat and weakness in terms of compliance with the regulatory system by the authorities and road actors. The results showed that, for the study period in question, the highest number of TA occurred around 8 a.m., and that the day with the highest accident rate was Saturday. Likewise, it was found that out of the ten stretches analyzed, the one comprising Carrera 7 between 54th and 55th Streets had the greatest number of occurrences; these results are truly representative for the identification of critical stretches in terms of TA. It was found that motorcyclists are the most vulnerable road actors in the city for the time range studied, highlighting also that, until now, as transportation, this means of transport has been a tool for informal work as a growing phenomenon. As pointed out by Y. Lara et al. [39], motorized urban mobility has always been the most vulnerable, where the implementation of AT mitigation policies will be essential.

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