Statistical analysis of vehicular accidents and alternatives for critical points

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Abstract. There are different factors that can cause a vehicular accident, starting with the carelessness of the driver or pedestrian, putting in risk his life and the life of third parties; by roads in bad conditions and lack of signaling, without warning him of the adversities that continue in the road, for this reason, the research work was developed on the causes of road accidents in four sectors, compiling information on the roads corresponding to the proposed streets and avenues, followed by defining the possible causes of the problems in the critical sites and thus defining the potential factors of an accident. Finally, solutions are proposed to reduce the percentages of vehicle accidents at the critical points found, decreasing the indicators of accident and mortality in this vehicle sector, giving people peace of mind when leaving their homes.

1. Introduction
Traffic accidents can involve several factors, such as driver/human errors, vehicle failures, poor road infrastructure, and uncertainty in environmental conditions, such as torrential rains, rock falls, and downpours [1]. In 2016, the number of traffic accidents in China reached almost 300,000 and the number of victims was around 40,824, an increase of 4,646 compared to 2015 [2]. Each year, while the number of vehicles on the streets increases, the number of road traffic accidents fluctuates from one year to the next, with a growth trend of around 10% per year [3]. The fatal type is caused by a secondary crushing of the vehicle in pedestrian and vehicle collision accidents. The second crushing is that the driver of a motor vehicle suffers a new crushing through backing the car or turning the steering after colliding to suffer so that he is injured but not killed [4].

Despite a small number of heavy vehicles in traffic volume, accidents involving these vehicles cause more than 1,000 deaths per year in Malaysia, causing more than 80% of the deaths of second vehicles [5], sometimes due to driver distraction. The fatality analysis reporting system (FARS) in 2008, distraction was identified as the shock factor in approximately 16% of all fatal crashes. Driver distraction has also been estimated at about 80% as the factors of traffic accidents that are directly or indirectly contributed by the driver [6]. Even so, there are other factors such as the use of some drugs may reduce drivers’ reaction to acoustic and graphic stimuli; insomnia, fatigue, reduced alertness, and vertigo are the result of medical drug use and physical illness [7]. The number of traffic accidents in China decreased from 567.75 thousand in 2004 to 212.85 thousand in 2016, a decrease of 62.51%, and the number of victims decreased from 587.94 thousand in 2004 to 289.52 thousand in 2016, a decrease of 50.76%, highlighting that the implementation of existing prevention and traffic management policies have helped reduce the accident rate [8]. Simultaneously, the World Health Organization’s 2013 report on road safety indicates that road traffic death rates in Iran are much higher than the global average (34.1
This research article investigated the causes, factors, vehicles that cause more accidents, and the frequency of these accidents on the roads, proposing alternatives to improve road safety for drivers and pedestrians who risk their lives every day.

2. Methodology
It began with a previous investigation of the current situation of these most traveled roads and registration of traffic accidents in the city of San José de Cúcuta, Colombia [10], through the Secretariat of Traffic of San José de Cúcuta, Colombia; followed by a survey for drivers and pedestrians, the distribution of response, in terms of an accurate foundation by respondents is raised under a margin of 50%, to obtain results according to the issue and problem of the study raised. Subsequently, a quantitative and qualitative analysis of all the factors that influence the problem, the vehicles that cause more accidents, was carried out, among them: In this way, a methodology with diverse alternatives of low price that support the processes of the solution of accidents and of mortality of pedestrians and drivers is conceptualized.

3. Results
3.1. Statistics on accidents in road corridors
Traffic accidents are mainly caused by direct causes, which are responsible for the immediate occurrence of the accident and the inability of the driver of the vehicle to react effectively to prevent it. These causes can generally be observed, deductible, and quickly evidenced according to the type of action executed by the driver, seconds before the accident. These actions, as mentioned above, correspond to different factors such as speed, direction, distance, among others.

It is usual to find traffic accidents that have been unleashed by more than one direct cause, and that also makes possible a greater probability of occurrence of the same. In San José de Cúcuta, Colombia, during 2017, has presented the records of injuries that are shown in Figure 1, and general deaths recorded are shown in Figure 2. According to the National Observatory of Road Safety in San José de Cúcuta, Colombia, 818 accidents were recorded, of which 84 deaths and 734 injuries were recorded.

![Figure 1. Record of road traffic injuries.](image1)

![Figure 2. Registry of deaths due to traffic accidents in San José de Cúcuta, Colombia during the last year.](image2)

Figure 3 shows the behavior of 63 traffic accidents occurred in the study areas, with the sector with the highest accident rate corresponding to avenue 5 between 25th and 31st streets with 46% of accidents; the terminal bus registered 24% of accidents; avenue 3 with 12th, 13th and 14th streets in the San Luis neighborhood accounted for 13%; the remaining 17% was registered in the roundabout Escobal between 7th street east and Demetrio Mendoza avenue, San José de Cúcuta, Colombia.
In Figure 4, most accidents were caused by 37% drunkenness; followed by 14% speed access; they did not make a 21% stop; there is no stop sign at the scene of the accident 11%; lack of traffic lights at the scene of the accident 10% and there is no horizontal and vertical signage 8%.

![Figure 3. Traffic accidents recorded in different areas of San José de Cúcuta, Colombia.](image1)

![Figure 4. Causes of accidents in the study areas for San José de Cúcuta, Colombia.](image2)

In countries like the United States of America, there is an increasing trend in the percentage of property damage due to speeding and a reduction in injury (Figure 5). The opposite occurs with driver inattention, where there is an injury percentage of 86%, which is consistent with the study by Ayazi et al. [11]. If the behavior of Figures 4 and Figure 5 is compared, it is observed that in the case of San José de Cúcuta, Colombia, the influence of speeding on the accident rate is lower compared to other countries, due to speed controls within the city.

Another interesting behavior can be observed in the accident behavior in Medan City (Indonesian province of North Sumatra), which has urbanism similar to San José de Cúcuta, Colombia. For the year 2018, 5688 accidents were observed (Figure 6), where 26% of the cases refer to drivers who use their cell phones being in the category of "driver's inattention"[12], while accidents due to drunkenness are low, due to the strict legislation on the subject in that country. In the case of San José de Cúcuta, Colombia, drunkenness is the major cause of accidents (Figure 4), which indicates that it is necessary to reinforce the pedagogical and regulatory component in the city to reduce accidents in San José de Cúcuta, Colombia, due to this cause.
3.2. Impact of road users on accidents on these roads

To study the impact of road users on accidents, the vehicles where the accidents occurred in San José de Cúcuta, Colombia, were studied. The highest percentage of accidents occur because of motorcycles, 35% of the causes are those of public transport, and 20% are private vehicles, recorded in Figure 7.
Figure 8 presents the Medan city case study, exposing the types of factors and vehicles that cause accidents. Comparing Medan city and San José de Cúcuta, Colombia, it is observed that in both cases, motorcyclists have a large impact. The acquisition capacity is low for the population of both cities, being easier to buy motorcycles than cars, therefore they will be mostly involved in accidents and with a high mortality rate. Something similar happens in other countries like Iran, showing that motorcycles were involved in most accidents, representing 25% of them, followed by pedestrians involved in 20% [13]. In all the cities studied, it is necessary to improve road safety and pedagogy in driving.

3.3. Proposal to solve the vehicle accident at critical points
This proposal is part of the analysis of the current situation of each of the sectors where the critical points are located, especially the roundabout of the transport terminal: Demarcation and signaling. Begin with a road inventory of existing horizontal and vertical road signs on the roads. This area requires intervention and permanent maintenance of sectors, with signage and demarcation consistent with new vehicle technologies, safety, and vision in urban traffic planning is judicious and adaptable to the constant dynamics of urban centers.

Rethinking speed-limited areas for the city center: Finally, the revision of municipal regulations should be carried out in order to give it a new citizen perspective that allows it to make free use of the road and the public space, in order to be consistent with the designed city model. Traffic light intersections. Suggested measures to improve the circulation of intersections such as the Terminal roundabout that requires traffic lights making them safer for pedestrians are: Once the traffic light is installed on this road, programming of traffic light times adjusting to the times necessary for pedestrians.

Critical sections. In general, the sections observed correspond to variants and corridors of the transport terminal and Buenos Aires neighborhood, especially in avenue 5 between 25th and 27th streets. Therefore, measures such as reducing traffic speed is not an easy task. It is indispensable to develop in the city’s campaigns of safe users of pedestrian bridges and to cross over zebras, especially over the roundabout of the transport terminal. This is considered the main low-cost strategy that can be to reduce the potential risk.

4. Conclusions
The study of the data collected shows the volume of vehicles at various points, noting that motorcycles are the largest flow of traffic, followed by light vehicles between individuals and cabs, as well as public service buses. There is an appreciable volume of motorcycles circulating in these sectors, drivers show a tendency to violate traffic rules and regulations, mainly related to overtaking other motorcyclists, vehicles, giving way, among others. The highest percentage of accidents is caused by motorcycles with a 45% incidence.
According to the causes of accidents, the main reason is drunkenness, with 37%, followed by failure to make a stop, speeding and lack of signaling, mainly; also presents: overtaking by invading a lane, crossing without observing, not respecting traffic signs. In other countries the main cause of the accident is the distraction and recklessness of the driver, even more so in countries where the motorcycle is a means of transport used in a high percentage, which also increases the likelihood of death by being more exposed in this mode of transport; a global problem lies in the distraction generated by the development of technology, the acceleration of driving style and lack of road awareness.

Research also shows the recklessness of bus drivers who perform dangerous maneuvers such as turning without warning on the same road. There is also evidence of recklessness by drivers of both private and public service vehicles who do not respect the signs of yield or those who a...