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Determination Of Vehicular Flow Of Traffic Roundabout In The City Of Cúcuta

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Abstract

Within the framework of this study, techniques and tools were used to achieve the objective of obtaining the observed vehicular demand at the traffic circle in the city of Cucuta. To this end, the location of the roundabout was started with google maps. Then, using a vehicle counter, we proceeded to determine the vehicular capacity of the traffic circle, with the help of other instruments such as; clock, checklists, scissors, cameras; these, to observe the routes that each driver takes in the course of the observed hours, also, to achieve greater coverage with less margin of error by obtaining information quickly and economically, a GPS - Global Positioning System was used. The specific purpose is to obtain field information to comply with the methodology used. Therefore, the instruments used are the direct means by which it is possible to collect information for the analysis and subsequent execution of a traffic study. The results allow determining very important aspects for the control of accidents in the city, such as obtaining the demand of the vehicular flow of the traffic circle, thus contributing to the Municipal Transit to apply intervention measures to considerably reduce the high levels of traffic congestion in the traffic circle.

Keywords: flow; traffic; capacity; demand; vehicles.

1. Introduction

Due to the vehicular growth in the city of Cucuta, represented by 16.5% compared to 2017, according to the (Diario El Tiempo 2018) it is logical that congestion and problems related to circulation are present, especially at peak hours. The traffic circle, located in the eponymous neighborhood of the city of Cucuta, is characterized by being of circular type where vehicles move clockwise. The fundamental characteristic is that vehicles within the ring road have priority over vehicles at the different entrances, considerably reducing speed while also reducing the points of conflict at the intersection (Daniels, Brijs, Nuyts & Wets, 2010).

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In terms of mobility, it produces greater capacity than signalized intersections and even equals or exceeds the capacity of traffic signalized intersections (Mendoza Molina, E. R., & De La Cruz Alvarado, E. S). Therefore, it is essential to determine the vehicular flow, capacity and level of service of the traffic circle in the city of San José Cucuta, Norte de Santander.

It is expected with the present research, to make a contribution to the Municipal Policies for road safety in the city of Cucuta, including the implementation of measures for comprehensive intervention at critical points, (Ministry of Transportation, 2014). Which, as mentioned in the above figures, there is an urgency to propose preventive measures to curb current trends, as it has also become a factor of economic impact.

A traffic circle or traffic circle when compared to other types of intersections (Arévalo Tristancho, T. J. 2018). generates greater safety, because it reduces accidents by 42% compared to a signalized intersection and by 32% when previously there was a traffic light intersection; being this reduction stronger when a traffic circle or traffic circle exists on high traffic roads, between 90 and 50 km/h (Brabander & Vereeck, 2007).

Traffic circles or traffic circles function in such a way (Hernández, N. M. P.) that when drivers approach the entrance to a traffic circle, they must make two basic decisions: first, to select the appropriate lane for their destination, and second, to "yield" to those who have priority, those who are traveling through the traffic circle (Vázquez Meléndez, K. K. (2020). The decision-making process within traffic circles is generally more complex than for other types of intersections (Cutipa Luque, J. P., & Lozano Laffore, E. 2020), especially because the driver cannot always see the exit. In addition, because the intersection is curved, it forces drivers to slowly change their direction, which could disorient other drivers about their destination (Pérez Vargas, D. M., & Yauyo Baltazar, J. E). The decision to "yield the right of way" produces a negotiation at several points of the traffic circle, despite the fact that priority is normally regulated. Drivers must choose an acceptable interval at which they can enter within the conflicting flow of the traffic circle. Many procedures to perform capacity analysis at traffic circles are based on stochastic models (Condori Aguilar, W. N. (2018).

According to this, the capacity depends on the availability of intervals and the acceptance of these by drivers entering the circulating traffic (Ticona Colque, S., & Seleme Gandolfo, A. M. T.). According to (Raff 1950) the mainstream (in this case the conflicting flow) can be interpreted as a continuous offer of intervals that the driver must accept or reject according to his personal criteria.

2. Method

2.1. Obtain the Vehicular Flow Demand (Quantity and Composition) of the Roundabout

- Procedure for the beginning of the physical characterization:

The first measure performed; in the traffic circle the road inventory was recorded (Mayor's Office of San José de Cúcuta. 2015), the location of google maps determining the geometric characteristics present, such as, for example: the number of lanes that the road intersection to be studied has, followed by identification of the entrances and exits, width of each one of them, number of lanes in the ring and their width. In addition, the diameter of the central island is identified.

- Procedure for vehicle counting:

The determination of vehicular traffic was done with the participation and collaboration of the members of the research work and other collaborators, as follows: First, a total reconnaissance tour of the road was made, identifying different factors such as: slopes, lanes, types of lanes, horizontal and vertical signage, collector roads, vegetation and possible points that serve for the counting station. Next, the vehicles circulating on the road are counted according to the established forms, where the type of vehicle, time and entrance are attached for each direction. It should be noted that the counting must be done 7 consecutive days of the week, 24 hours a day, but for educational purposes it was done on Mondays, Wednesdays and Saturdays at the previously defined times.

3. Results and discussion

Table 1. Characteristics of the traffic circle lanes

Entrance	Track gauge	Number of lanes	Lane width
Entrance 1 Transversal 17 (East West)	6 meters	2	3 meters
Entrance 2 Avenue 24 (north-south)	6 meters	2	3 meters
Entrance 3 Cúcuta- Zulia (West- East)	6 meters	2	3 meters
Entrance 4 23rd Avenue (South-North)	3 meters	1	3 meters

Source: Own elaboration

Table 2. Dimensions of the traffic circle

Location	Diameter	Circumference	Mts2
Central island the Roundabout	99.97 meters	320 meters	31.400 square meters

Source: Own elaboration

3.1. Determination of vehicular flow demand.

To continue with the analysis of the indicated intersection, it is necessary to carry out the collection of the corresponding data, following three main criteria, namely; types of vehicles and time of entry and days of circulation in the traffic circle (Hernández Rodríguez, L. A., & León Vallejo, O. A. 2021).

The study of the intersection in each of the lanes is carried out by means of a relatively simple process. For this, the geometry of the intersection and the distribution of traffic movements are considered. Therefore, demand volumes are taken into account, where each period of analysis is indicated, such as an hourly volume, in this case, vehicular traffic is recorded at times corresponding to peak hours, namely; from 6 am to 8 am and from 11: 30 am to 1: 30 pm; from 5: 30 to 7:30 pm. In this order of ideas, data were taken on Mondays, Wednesdays and Saturdays. It is necessary to convert the hourly volumes to flow rates during 15 minutes through the peak hour factor, in this way:

Figure 1. Entrances to the network

Source: Own elaboration

Table 3. Traffic flow on Monday

Roundabout						
Monday capacity of 06:00 - 08:00						
Entrance	Vehicles					
	Cars	Motorcycles	Buses	C2p	C2g	≥ C3
Entrance 1	918	603	154	197	202	7
Entrance 2	840	698	160	220	180	8
Entrance 3	516	242	102	97	13	2
Entrance 4	306	414	0	31	2	0
Monday capacity of 11:30 - 13:30						
Entrance	Vehicles					
	Cars	Motorcycles	Buses	C2p	C2g	≥ C3
Entrance 1	1595	863	290	65	95	10
Entrance 2	1295	708	165	208	85	8
Entrance 3	1017	813	132	32	13	0
Entrance 4	534	599	0	35	0	0
Monday capacity of 17:30 - 19:30						
Entrance	Vehicles					
	Cars	Motorcycles	Buses	C2p	C2g	≥ C3
Entrance 1	1432	903	282	47	84	11
Entrance 2	1252	752	159	152	31	12
Entrance 3	917	813	115	23	8	0
Entrance 4	452	602	0	13	0	0

Source: Own elaboration

Table 4. Traffic flow on Wednesday

Roundabout						
Wednesday capacity of 06:00 - 08:00						
Entrance	Vehicles					
	Cars	Motorcycles	Buses	C2p	C2g	≥ C3
Entrance 1	709	803	200	210	176	10
Entrance 2	730	562	172	240	210	8
Entrance 3	712	159	99	125	21	1
Entrance 4	158	230	0	25	0	0
Wednesday capacity of 11:30 - 13:30						
Entrance	Vehicles					
	Cars	Motorcycles	Buses	C2p	C2g	≥ C3
Entrance 1	1670	915	295	55	85	2
Entrance 2	1110	802	173	209	71	4
Entrance 3	1005	709	122	20	14	0
Entrance 4	428	482	0	31	0	0
Wednesday capacity of 17:30 - 19:30						
Entrance	Vehicles					
	Cars	Motorcycles	Buses	C2p	C2g	≥ C3
Entrance 1	1602	1004	305	38	55	4
Entrance 2	1309	846	162	209	53	2
Entrance 3	820	630	115	24	10	0
Entrance 4	398	570	0	20	0	0

Source: Own elaboration

Table 5. Vehicle flow on Saturday

Roundabout						
Saturday capacity of 17:30 - 19:30						
Entrance	Vehicles					
	Cars	Motorcycles	Buses	C2p	C2g	≥ c3
Entrance 1	1602	1004	305	38	55	4
Entrance 2	1309	846	162	209	53	2
Entrance 3	820	630	115	24	10	0
Entrance 4	398	570	0	20	0	0
Saturday capacity of 11:30 - 13:30						
Entrance	Vehicles					
	Cars	Motorcycles	Buses	C2p	C2g	≥ c3
Entrance 1	1809	1010	301	62	91	2
Entrance 2	1900	903	215	151	64	3
Entrance 3	999	610	99	15	8	0

Entrance 4	318	397	0	29	0	0
Saturday capacity of 15:30 - 17:30						
Entrance	Vehicles					
	Cars	Motorcycles	Buses	C2p	C2g	≥ c3
Entrance 1	1630	1009	297	28	47	0
Entrance 2	1208	709	151	100	43	1
Entrance 3	710	599	111	19	2	0
Entrance 4	355	530	0	4	0	0

Source: Own elaboration

3.2. Determination of the type of vehicle traveling through the traffic circle.

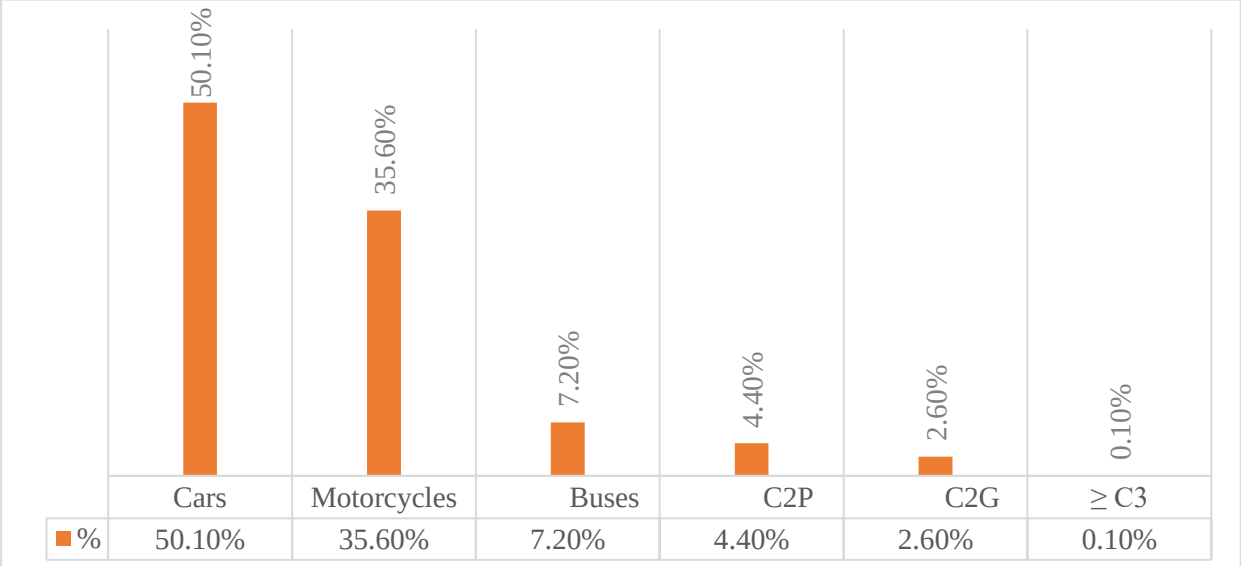
In the framework of the study design of the traffic circle (Sosa Martínez, P. A., & Dueñas Bohorquez, I. D. 2018), a recognition of the type of vehicle transiting through the referred intersection was made (Leon Vallejo, O. A. (2020), identifying; cars, motorcycles, buses and cargo trucks of between 2 and more axles, obtaining the following results:

Table 6. Vehicular flow

Type	Cars	Motorcycles	Buses	C2P	C2G	≥ C3
Total	34614	24624	4978	3016	1798	101
%	50,1%	35,6%	7,2%	4,4%	2,6%	0,1%

Source: Own elaboration

Figure 2. Composition of vehicular traffic flow



Source: Own elaboration

The graph shows that 50.1% of the vehicles identified during the observation days are classified as automobiles; another 35.6% of the vehicles transiting the El Claret traffic circle are motorcycles; 7.2%

are buses; 4.4% are two-axle cargo trucks; 2.6% are three-axle cargo trucks; and finally, 0.1% are heavy cargo trucks with more than three axles.

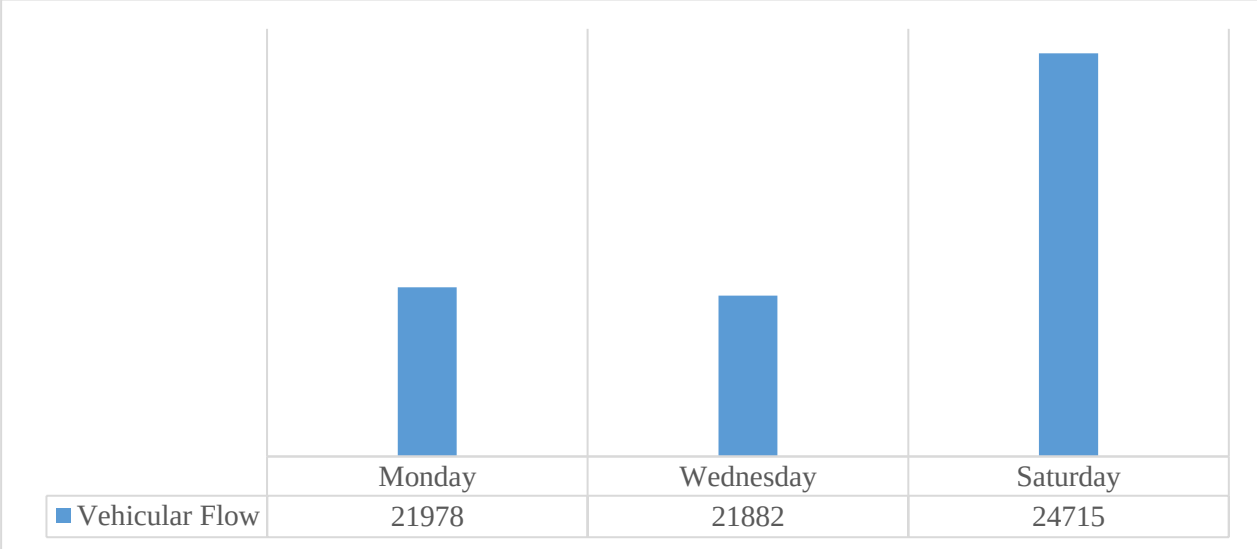
Regarding the number of vehicles transiting through the traffic circle (Echevarría Ramírez, C. A., & Silva Ruiz, M. E. (2020), it was possible to determine through vehicle counting, on the days of observation, the average number of vehicles transiting on the days of observation on Monday, Wednesday and Saturday.

Table 7. Number of vehicles per day

Days	Vehicular Flow
Monday	21978
Wednesday	21882
Saturday	24715
Total	68575

Source: Own elaboration

Figure 3. Number of vehicles per day



Source: Own elaboration

Observation showed that between Monday, Wednesday and Saturday, 68,575 vehicles transited within the defined schedules. On Monday, 21,978 vehicles of all predefined types transited; on Wednesday, 21,882 vehicles transited; and on Saturday, 24,715 vehicles of all types transited.

5. Conclusions

After collecting field information for the traffic estimates, the demand for vehicular flow was obtained, the data allowed determining the number of vehicles per entrance, in order to determine the one with the highest vehicular flow. In this regard, it was determined by observing Figure 2 that 50.1% of the vehicles identified during the days of observation are classified as automobiles and have a higher vehicular flow and that the lowest vehicular flow

with 0.1% are heavy trucks with more than 3 axles. In addition, Figure 3 shows that Saturday with a total of 24,715 vehicles is the day with the highest vehicle flow and Wednesday with a total of 21,882 vehicles transited is the day with the lowest vehicle flow.

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