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Determination Of The Maximum Hourly Traffic Volume Of A Traffic Circle

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Abstract

Traffic circles are the maximum number of vehicles that can reasonably be expected to pass through a uniform point or section of a lane or roadway during a given time interval, under prevailing conditions of road infrastructure, traffic and control devices. This study initially analyzes the average traffic flowing through the traffic circle. In this aspect, through the analysis, it was determined the average number of vehicles that circulate through the traffic circle during the hours considered to have the highest vehicular flow according to what was observed, being the hours from 11:30 am to 1:30 pm the one with the highest traffic flow with about 39% of the total number of vehicles circulating through the traffic circle, followed closely by the hours from 5:30 pm to 7:30 pm with 36%, while the hours from 6:00 to 8:00 am is the peak hour with the lowest demand or vehicular flow with 25%. Subsequently, the maximum hourly volume is determined, where an observation is made between 6:00 am and 6:00 pm, which gives a total of 3,125 vehicles in one hour, circulating through the traffic circle, this being the hour with the highest hourly volume during the day.

Keywords: hour; demand; vehicles; traffic; maximum.

1. Introduction

Capacity determines the performance of a traffic circle or traffic circle, as stated in the book Traffic Engineering: Fundamentals and Applications, (Bastos, Santos, Vasconcelos, Seco, & Silva, 2014) is:

The maximum number of vehicles (Verdezoto, T. Z. A., Montes, F. F. C., & Medina, O. B. R. 2020) that can reasonably pass through a uniform point or section of a lane or roadway during a given time

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interval, under prevailing conditions of road infrastructure, traffic and control devices (Basurto Velásquez, J. C. (2022).

From the analysis of capacity, it is possible to measure the quality of operation, which is done through the level of service, this is a qualitative measure that reflects the quality of operation based on the perception of drivers (Sánchez Caicedo, J. L., Gaona Santamaria, C. A., & Parra Ortiz, C. A. (2021).

In order to evaluate the evolution in terms of the methodology used for the calculation of the capacity of this type of intersections in Colombia (Bocanegra Hernández, E. H., & Parra León, M. S. (2021)., goes back to the 2003 NDGC standard (Marcial, G. C. (2021), it was identified that, for capacity analysis, the criss-crossing length principle is used (Echevarría Ramírez, C. A., & Silva Ruiz, M. E. (2020). This standard does not present any guidelines for calculation, but mentions in terms of traffic that:

A traffic circle does not operate satisfactorily (Barrios Villanes, R. (2022) when traffic volumes on one or more branches of the intersection reach their simultaneous capacity (Basurto Velásquez, J. C. (2022). They estimate that a total value of 3,000 v.p.h (vehicles per hour) arriving on all access branches is the maximum practical capacity for overhead type traffic circles (Muentes Lucas, C. A. (2019).

1.1. Maximum hourly volume

This is defined according to (Calderón Valera, C. D. (2019) as the total capacity of a lane point or cross section of a road during 60 consecutive minutes (Misari Salazar, L. O. (2021). It represents the period of maximum demand recorded during a day at a road intersection (Gomez Miraval, F. W. (2022).

The hour of maximum demand is called the Hour of Maximum Demand Factor (HHMD) (Huatay Mosqueira, A., & Llanos Calderon, S. W. (2022). o Peak hour factor. In which calculations are determined following this pattern:

$$FHMD = VHMD/N * (Qmax)$$

Where:

N: Number of periods during the hour of maximum demand (HMD).
Qmax: Maximum flow (number of vehicles)
FHMD= VHMD/4 *(qmax) For 15 minute periods
FHMD= VHMD/12 *(qmax) For 5-minute periods
The FHMD: It is also known as the hourly peak factor
(PHF) expresses the Ratio of the peak hour volume demand to the volume-maximum rate within the peak hour.

1.2. Traffic Density

It is the number of vehicles (Villalobos-Barquero, V., & Meza-Montoya, A. (2019) occupying a unit of travel length at a given instant. It is usually expressed in vehicles per kilometers (Cusi Ortiz De Orue, V. A., & Tantalean Ccahua, Y. R. (2018).

1.3. Directional distribution

It is the volume during a particular hour in the predominant direction expressed as a percentage of the volume in both (Rodriguez Bonilla, D. A. (2021).

2. Method

- Determine the Average Daily Traffic in Peak Hours
- Vehicular traffic per hour.
- Determine the maximum hourly volume

3. Results and discussion

3.1. Determine Average Daily Traffic at Peak Demand Hours

We proceeded to analyze the average traffic (Cal, R., & Cárdenas, J. 2018) circulating through the traffic circle. In this regard, through the analysis, the average amount of traffic (Coicaposa Salcedo, G. M., & Salazar Becerra, E. I. (2021) through the referred traffic circle at the times considered the highest vehicular flow as observed (Picoy Alvarado, S. J. (2021) was determined.

Thus, a total of 36 hours were counted in 6 days, that is, 6 hours per day at each entrance of the traffic circle, taking into account that at the time of obtaining the data, the gauging stations must be correlated with each other. Within this same aspect, it will be taken into account that for measurements in urban areas, the volume measurement should generally be performed in the middle or inner lanes in the direction of flow.

For this purpose, the average daily traffic per week (TPDS) formula is used to determine the average traffic of the traffic circle during the hours of highest demand of vehicular flow:

Weekly Average Daily Traffic Formula (TPDS)

$$TPDS = \frac{TS}{7}$$

Source: Flores, Andachi, Morales, Quispe, 2012.

Where:

The TPDS value is the number of vehicles totaled among the days of the daily average to be calculated. In this case we want to calculate the weekly traffic, therefore, the denominator is 7.

The vehicle count was performed from 6:00 am to 8:00 am and from 11:30 am to 1:30 pm and from 5:30 pm to 7:30 pm, for 6 hours, over a period of 6 days. For didactic purposes, the count was carried out during 2 weeks, specifically Monday, Wednesday and Saturday. It should be emphasized that the analysis is carried out with a minimum of 6 hours of traffic per day in 3-day periods.

For each day, the peak hour factor was studied, which is the ratio between the fourth part of the hourly volume of maximum demand (VHMD) and the maximum flow (qmax), which occurs in a given period within that hour.

$$PHF=VHMD/(qmax*4)$$

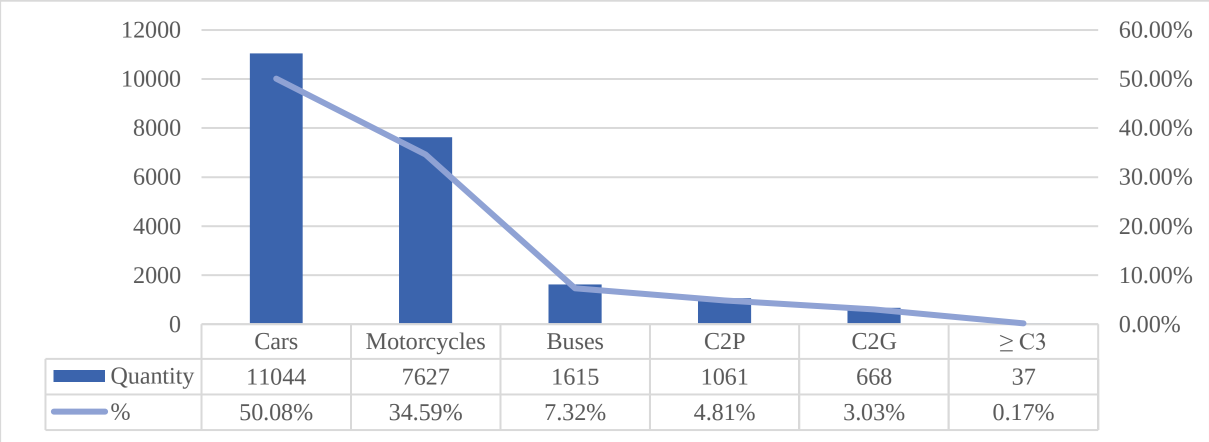
The peak hour factor is an indicator of traffic flow characteristics at peak periods. If this value is equal to 1, it means uniformity, while very small values indicate peak flow concentrations. Taking this calculation into consideration, the peak hours or hours with the highest traffic at the traffic circle were determined from 6am to 8am, from 11:30am to 1:30pm and from 5:30am to 7:30pm.

Table 1. Average number of vehicles

Cars	Motorcycle	Buses	C2p	C2g	≥ C3	Total
11.044	7.627	1.615	1.061	668	37	22.052

Source: Own elaboration

Figure 1. Average number of vehicles



Source: Own elaboration

Through the analysis it was identified that an average of 22,052 vehicles of all types and models described above transited on all days of observation; Monday, Wednesday and Saturday during the peak hours.

The above data transformed into percentage terms yield very similar results to those observed in vehicle traffic per day. In addition, the following graphs show the times of the day with the highest average vehicle traffic.

3.2. Vehicle traffic by schedule.

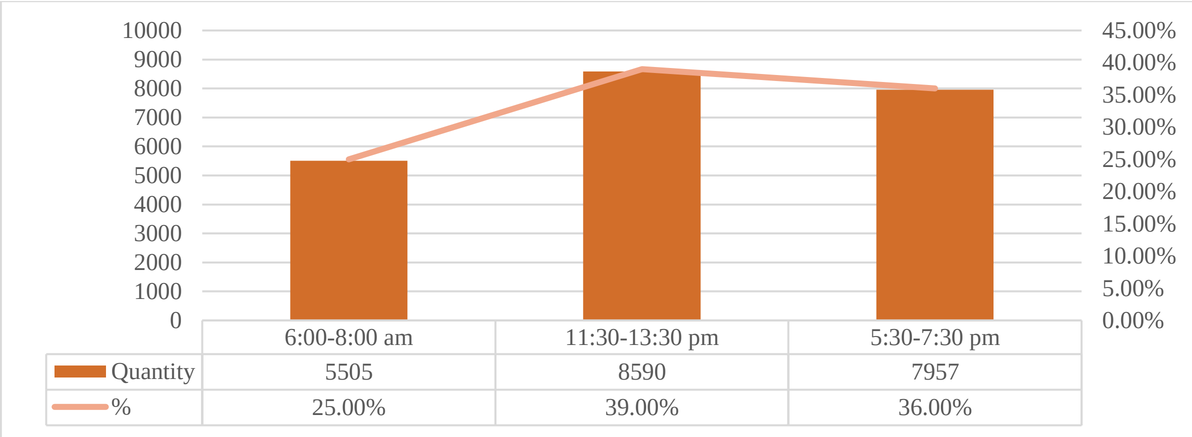
In order to determine the hours of greatest convergence and vehicular flow, the formula described above was used to determine the average weekly number of vehicles using the traffic circle. For this purpose, the observations made during the previously defined schedules were taken into account. The results are shown below:

Table 2. Vehicle traffic by schedule

Schedule	6:00-8:00 am	11:30-13:30 pm	5:30-7:30 pm
Quantity	5505	8590	7957
%	25,00%	39,00%	36,00%

Source: Own elaboration

Figure 2. Percentage of vehicle traffic per schedule



Source: Own elaboration

The graph shows that between 11:30 a.m. and 1:30 p.m. is the time when there is the highest average vehicular flow or demand, with 39% of the total number of vehicles circulating through the traffic circle. This, according to the analysis of the information collected. Additionally, it is observed that the second schedule with the highest vehicular flow is 5:30 pm 7:30 pm; and finally, the schedule with the lowest vehicular demand is the morning from 6:00 am to 8:00 am with 25%.

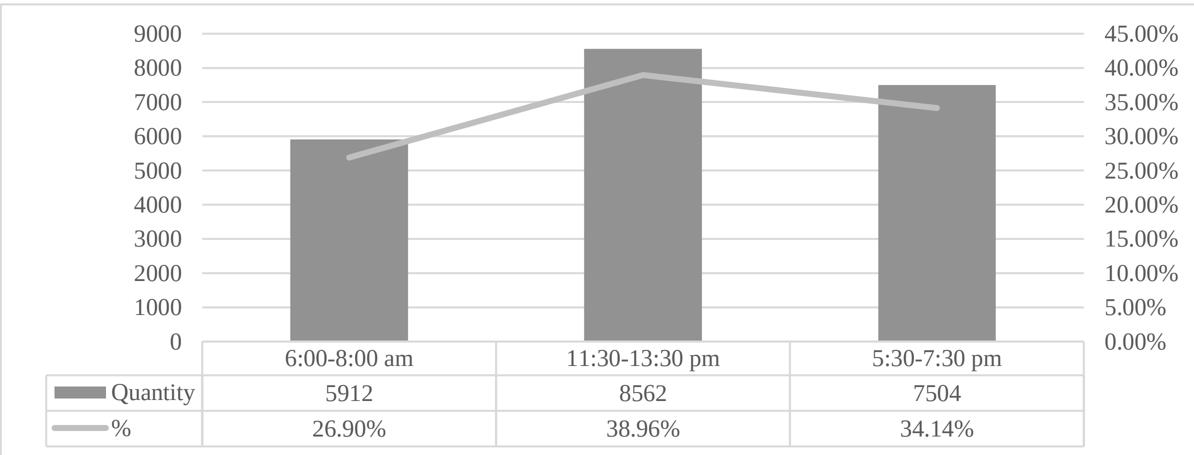
Average daily traffic. As part of the search to identify the average number of vehicles per day analyzed, information was collected at the traffic circle between 6:00am to 8:00am; between 11:30am to 1:30pm and from 5:30pm to 7:30pm. The results are shown in the following table.

Table 3. Average traffic on Mondays by timetable

Schedule	6:00-8:00 am	11:30-13:30 pm	5:30-7:30 pm
Quantity	5912	8562	7504
%	26,90%	38,96%	34,14%

Source: Own elaboration

Figure 3. Average traffic on Mondays by timetable



Source: Own elaboration

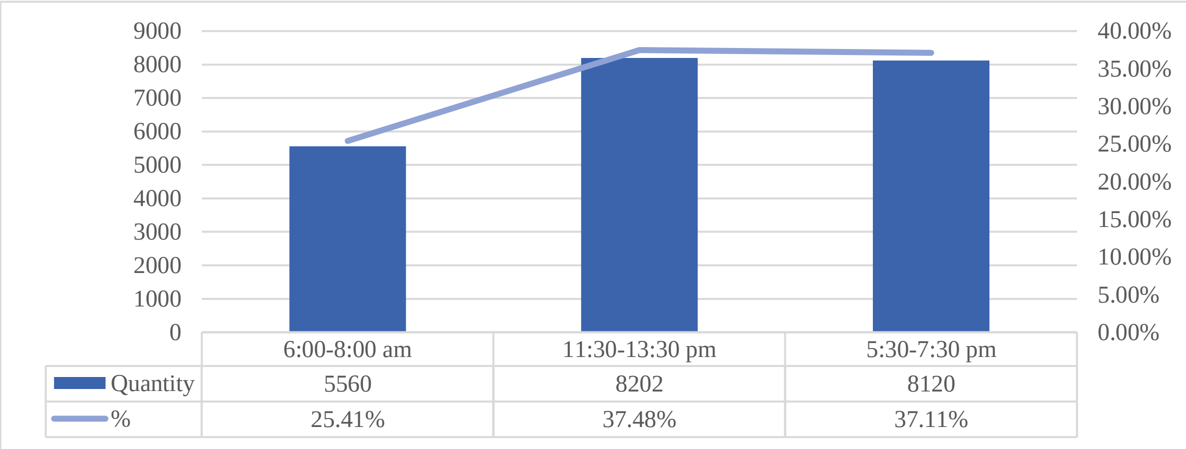
The graph shows that between 11:30 a.m. and 1:30 p.m. is the time with the highest average vehicular flow or demand, with 38.96% of the total number of vehicles circulating through the traffic circle. This, according to the analysis of the information collected. Additionally, it is observed that the second schedule with the highest vehicular flow is from 5:30 pm to 7:30 pm with 34.14% and finally the schedule with the lowest vehicular demand is in the morning from 6:00 am to 8:00 am with 26.9%.

Table 4. Average traffic on Wednesdays by timetable

6: 00am a 8:00am	5560	25,41%
11:30am a 13:30pm	8202	37,48%
5: 30pm a 7:30pm	8120	37,11%

Source: Own elaboration

Figure 4. Average traffic on Wednesdays by timetable



Source: Own elaboration

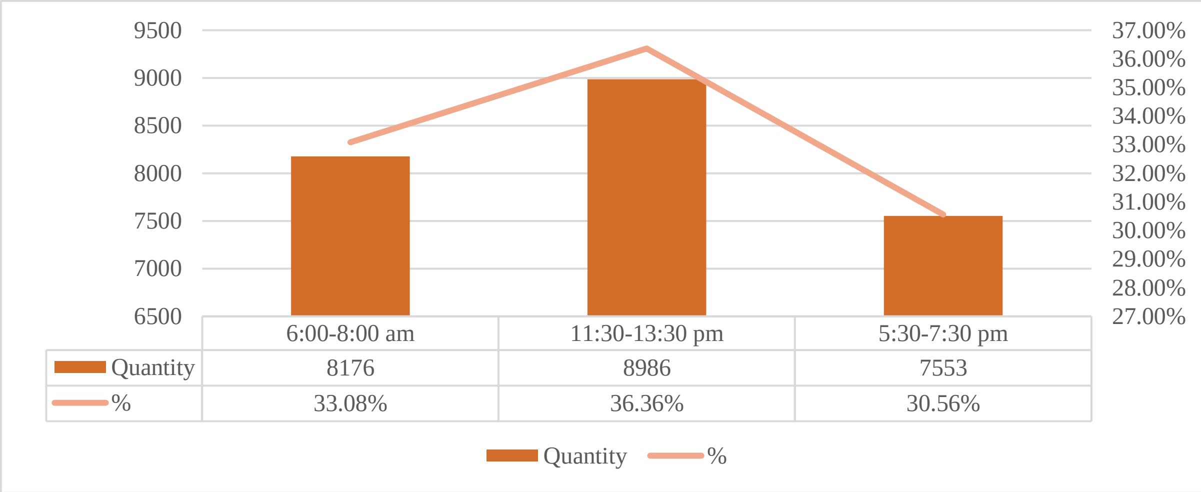
The graph shows that between 11:30 a.m. and 1:30 p.m. is the time when there is the highest average vehicular flow or demand, with 37.48% of the total number of vehicles circulating through the traffic circle. This, according to the analysis of the information collected. Additionally, it is observed that the second schedule with the highest vehicular flow is from 5:30 pm to 7:30 pm with 37.11% and finally the schedule with the lowest vehicular demand is in the morning from 6:00 am to 8:00 am with 25.41%.

Table 5. Average traffic on Saturdays by timetable

Schedule	6:00-8:00 am	11:30-13:30 pm	5:30-7:30 pm
Quantity	8176	8986	7553
%	33,08%	36,36%	30,56%

Source: Own elaboration

Figure 5. Average traffic on Saturdays by schedule



Source: Own elaboration

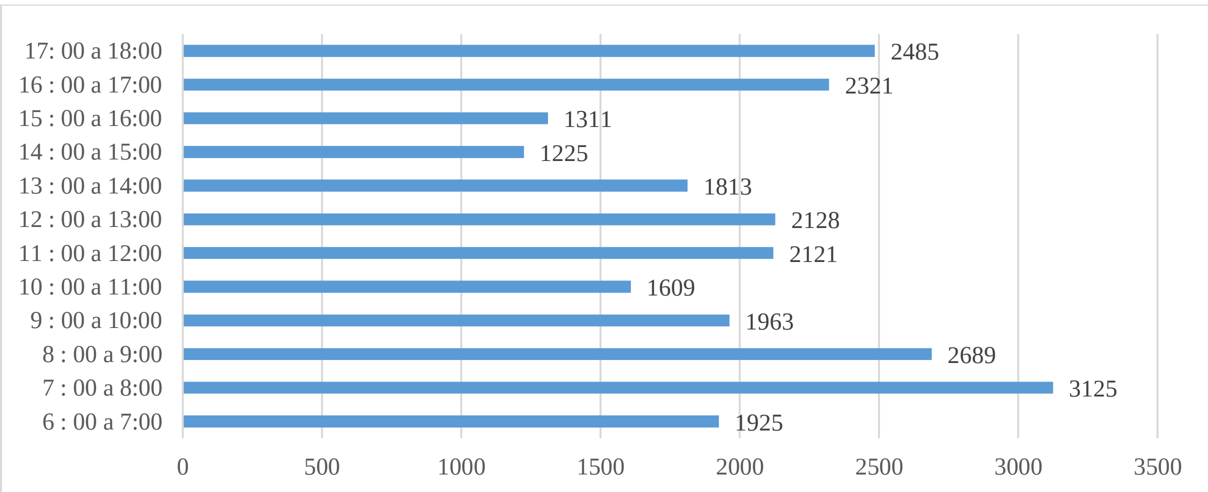
The graph shows that between 11:30 a.m. and 1:30 p.m. is the time when there is the highest average vehicular flow or demand, with 36.36% of the total number of vehicles circulating through the traffic circle. This, according to the analysis of the information collected. Additionally, it is observed that the second schedule with the highest vehicular flow is from 5:30 pm to 7:30 pm with 30.56% and finally the schedule with the lowest vehicular demand is in the morning from 6:00 am to 8:00 am with 33.08%.

In all cases it is observed that the time corresponding to the hours between 11:00 am and 1:30 pm is the average time and per day that the traffic circle has the highest vehicular demand, and the time with the lowest demand is from 6:00 am to 8:00 am. It is important to note that on Saturdays, the three schedules show a constant flow of vehicles at all three times.

3.3. Maximum Hourly Volume at the Roundabout

In order to determine the Maximum Hourly Volume of the Roundabout, measurements were taken every 5 minutes on the sample days, and the standard error of the sample observation was determined for the selected days, thus, the vehicular flow, after applying the formula, was fixed as follows:

Figure 6. Maximum Hourly Traffic Flow



Source: Own elaboration

FHMD= VHMD/N *(Qmax)

Where:

N: 12

Qmax: 171.63

FHMD For periods of 5 minutes

FHMD= 3125/12* (24715)

FHMD= 18.21 vehicles, at Maximum Hourly Volume

5. Conclusions

Following this line, it was determined that, on average, the hours with the highest vehicular traffic are between 6am and 8am; from 11:30am to 1:30pm and from 5:30pm to 7:30pm. In this sense, the time from 11:30am to 1:30pm is the peak hour or highest traffic flow with about 39% of the total number of vehicles circulating through the traffic circle at that time, followed closely by the time from 5:30pm to 7:30pm with 36%, while the time from 6:00 to 8:00am is the peak hour with the lowest demand or vehicle flow with 25%. It should be noted that, according to the analyses made in the background of this study, these are the times that conventionally, at the national level, are those with the highest average vehicle traffic.

References

Bastos, A., Santos, S., Vasconcelos, L., Seco, Á. & Silva, J. (2014). Driver behavior characterization in roundabout crossings. Transportation Research Procedia, 1(3), 80-89.

Verdezoto, T. Z. A., Montes, F. F. C., & Medina, O. B. R. (2020). Análisis del congestionamiento vehicular para el mejoramiento de vía principal en Guayaquil-Ecuador. *Gaceta Técnica*, *21*(2), 4-23.

Basurto Velásquez, J. C. (2022). *Determinación del nivel de servicio y capacidad Vehicular de la intersección entre la avenida Dr. Fortunato Safadi Emen y calle 9* (Bachelor's thesis, Universidad de Guayaquil-Facultad de Ciencias Matemáticas y Físicas-Carrera de Ingeniería Civil).

Sánchez Caicedo, J. L., Gaona Santamaria, C. A., & Parra Ortiz, C. A. (2021). Afectación de la capacidad vial por estacionamiento en vía, caso de estudio: Avenida Carrera 7ma con Avenida Calle 72, Bogotá DC.

Bocanegra Hernández, E. H., & Parra León, M. S. (2021). Evaluación de cruces a desnivel como alternativa de solución al tráfico de la avenida ciudad de Cali con calle 6d.

Marcial, G. C. (2021). Divulgação de fatores de risco: estudo das companhias do subsetor de transporte listadas na B3, no período de 2017 a 2019.

Echevarría Ramírez, C. A., & Silva Ruiz, M. E. (2020). Diseño de intercambio vial tipo glorieta en la intersección vial entre las av Cáceres y la calle San Ramón–Piura–región Piura.

Barrios Villanes, R. (2022). Influencia de la geometría vial en el nivel de servicio de una intersección, distrito de La Molina, Lima–2022.

Basurto Velásquez, J. C. (2022). *Determinación del nivel de servicio y capacidad Vehicular de la intersección entre la avenida Dr. Fortunato Safadi Emen y calle 9* (Bachelor's thesis, Universidad de Guayaquil-Facultad de Ciencias Matemáticas y Físicas-Carrera de Ingeniería Civil).

Muentes Lucas, C. A. (2019). *Diseño geométrico de un intercambiador de tránsito en el ingreso nortede la ciudad de Jipijapa* (Bachelor's thesis, JIPIJAPA-UNESUM).

Calderón Valera, C. D. (2019). Ampliación y mejoramiento del servicio de agua potable e instalación del saneamiento básico de la localidad de Monte Grande, Distrito de Sapillica–Ayabaca-Piura.

Misari Salazar, L. O. (2021). Capacidad Vial y Flujo Vehicular en la Carretera PE. 3SB.

Gomez Miraval, F. W. (2022). Diseño de propuesta de solución al desorden de tránsito vehicular-peatonal en la intersección vial del km 8 de la carretera pe-18a de la esperanza, 2021.

Huatay Mosqueira, A., & Llanos Calderon, S. W. (2022). Nivel de serviciabilidad de la Av. Hoyos Rubio, comprendida entre las intersecciones del cruce del aeropuerto Armando Revoredo Iglesias y el Jr. Manuel Seoane, Cajamarca, 2021.

Villalobos-Barquero, V., & Meza-Montoya, A. (2019). Impacto en la densidad aparente del suelo provocado por el tránsito de búfalos (Bubalus bubalis) en arrastre de madera. *Revista de Ciencias Ambientales*, *53*(2), 147-155.

Cusi Ortiz De Orue, V. A., & Tantalean Ccahua, Y. R. (2018). Análisis del sistema de tránsito y propuesta de mejoramiento mediante el modelo de redes en la Av. Sucre con la prolongación Av. Cusco, Av. La Cultura, Vía Expresa y sus ocho intercesiones, en el distrito de San Sebastián–Cusco 2017.

Rodríguez Bonilla, D. A. (2021). *Análisis de congestión vehicular generada por establecimientos educativos en el hipercentro de la ciudad de Ibarra* (Bachelor's thesis).

Cal, R., & Cárdenas, J. (2018). *Ingeniería de tránsito: fundamentos y aplicaciones*. Alpha Editorial.

Coicaposa Salcedo, G. M., & Salazar Becerra, E. I. (2021). Estudio técnico para el mejoramiento del camino vecinal del tramo Pacahuara–Punta carretera en el distrito de Iberia–Tahuamanu, 2020.

Picoy Alvarado, S. J. (2021). Análisis del flujo vehicular y el nivel de servicio en el jirón dos de mayo aledaño al centro de la Ciudad de Huánuco, 2021.

Flores, M., Andachi, O., morales, J. & Quishpe, W. (2012). Estudio Del Tránsito de la Avenida BENÍTEZ – HUAMBALM. Universidad Técnica de Ambato. Tungurahua, Ecuador.