Available online at www.jlls.org

JOURNAL OF LANGUAGE AND LINGUISTIC STUDIES

ISSN: 1305-578X

Journal of Language and Linguistic Studies, 18(4), 1284-1293; 2022

Intersection Traffic Analysis Using The Ptv Vissim Tool

Cárdenas-Gutiérrez Javier Alfonso [a] [1], NJ Cely-Calixto[b], C.H. Acevedo-Peñaloza[c]

[a] *Master in Business Administration with emphasis on project management, Director of Civil Engineering and of the Department of Civil Construction, Roads and Hydraulic and Fluids Transportation, Director of the Transportation and Civil Works Research Group (GITOC)., Orcid: https.//orcid.org/0000-00029894-0177, Email: javieralfonsocg@ufps.edu.co, Universidad Francisco de Paula Santander, Cúcuta, Colombia*

[b] *Master in Hydraulic Works, Specialist in Water and Environmental Sanitation, Research Group in Hydrology and Water Resources - HYDROS, Orcid: https://orcid.org/0000-0002-2083-6978, Email: nelsonjaviercc@ufps.edu.co, Universidad Francisco de Paula Santander.*

[c] *PhD in Mechanical Engineering, Orcid: 0000-0002-5049-8754, Research Group in Engineering and Development Partner (INDES) Universidad Francisco de Paula Santander, Cúcuta, Colombia, carloshumbertoap@ufps.edu.co*

APA Citation:

Alfonso, C.G.J., Cely-Calixto, NJ., Acevedo-Peñaloza, C.H., (2022). Intersection Traffic Analysis Using The Ptv Vissim Tool, *Journal of Language and Linguistic Studies, 18*(4), 1284-1293.

Submission Date: 07/11/2022

Acceptance Date: 28/12/2022

Abstract

Within the framework of the traffic analysis of the intersection under consideration, micro simulation is performed with the PTV Vissim tool under various scenarios to provide solutions to the problems identified through the aforementioned tool. In this sense, there are different calculation procedures for the analysis of the capacity of a road intersection. The regulations require the verification of the distance depending on the vehicle inside the traffic circle. This verification is performed by showing the distance in terms of the vehicle that is entering through the entrance branch prior to the analysis. Thus, the circulation analysis determined the conflict zones after the micro simulation, detecting these in the vehicular crossings at the entrance and exit of the traffic circle, according to the model determined after the feeding through the information collected in the field work. According to the analysis of the impact matrix, it is observed that scenario 1 presents the highest score, making it the most feasible solution in terms of costs, reduction of critical areas, regulatory compliance and execution time among the alternatives proposed in this research study.

Keywords: analysis; intersection; tool; conflict; scenarios.

1. Introduction

Vissim is a simulation tool used for the design of traffic control systems developed by PTV Vision Traffic Suite (Kučera, T., & Chocholáč, J. 2021), which integrates macroscopic simulation information processing. The same, employs a method focused on the analysis of each vehicle as a particular entity (Ramadhan, S. A., Joelianto, E., & Sutarto, H. Y. (2019), which, makes possible its application for different traffic analysis projects such as intersections, traffic circles, among others (Samuel, L., Shibil, M., Nasser, M., Shabir, N., & Davis, N. (2021, May). In addition, this program is capable of working with a wide variety of vehicles such as cars, vans, motorcycles, bicycles, trucks, and other types of vehicles (Suarez, 2007).

[1] Cárdenas - Gutiérrez J.A.
E-mail address: javieralfonsocg@ufps.edu.co

Low speeds in a traffic circle facilitate this acceptance process (NCHRP 672, 2010). The operational efficiency of traffic circles is higher when traffic speeds are lower (Rodegerdts, LA 2010). This phenomenon is due to the fact that, if the circulating traffic is faster, the intervals will be smaller so that the entering traffic can accept them comfortably, i.e., they can accelerate and enter it (Rodrigo Chayña, E. P., & Rivas Vilcas, J. B. (2019). In this way there will be a smaller number of acceptable intervals with a greater number of vehicles accumulated at the entrance, which translates into delay to enter the traffic circle (Illacanchi Guerra, P. K).

When the conflicting volume approaches zero, the maximum entry volume is given by 3,600 seconds per hour divided by the following interval (Molina Martínez, C. J., & Ortega Cabascango, A. P. (2022), which is analogous to the saturation flow for a movement receiving green at a signalized intersection (NCHRP 572, 2007). In summary, the operational performance of traffic circles depends, on the one hand, on the behavior of drivers when arranging intervals in the conflicting flow (Castro Barrientos, L. F., & Mendoza Mendoza, B. E. (2021). On the other hand, as with other intersections, its operation is influenced by its geometry (number of lanes, width of entrances, diameter, etc.) (Arce Rodriguez, L. E. V., & Canales Macarlupu, J. I.

Thus, the capacity of a traffic circle is determined according to (Ortega H. 2017) by the number of vehicles that reasonably traverse a uniform point or section within a lane of the traffic circle during an accepted time interval, using only as fundamentals, infrastructure (size) traffic laws and control devices (Frisancho Camero, F. L. (2021).

2. Method

The following study is carried out through the following steps:

- Perform traffic analysis procedure
- Identification of the traffic circle or traffic circle
- Setting the scale in the program
- Creation of the road network
- Conflict analysis
- Area speeds
- Revision scenarios

3. Results and discussion

3.1. Traffic analysis procedure

Within the framework of the traffic analysis procedure for the traffic circle, the first step is to identify the traffic circle. To do this, the physical space for the modeling is generated in global terms. This is achieved through the online GPS location, using the TOGGLE BACKGROUND/GRID option, selecting the geographic point where the traffic circle is located, which is the product of the study.

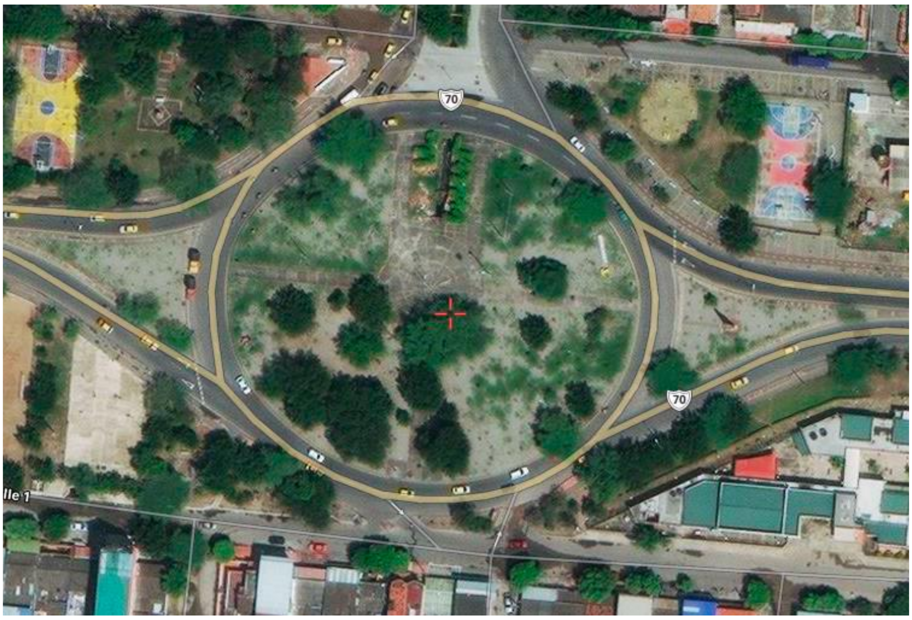
3.2. Scale adjustment.

Afterwards, the map scale is adjusted in order to perform the measurements correctly. In this case, a reference line is drawn in AutoCAD, which in this particular case has a distance of 50m. This allows to draw on the reference segment a line of equal magnitude, to assign the distance of 50m in the window that appears at the end of the drawing, thus leaving the scaled plane.

3.3. Creation of the road network

Continuing with the procedure, the creation of the road sections necessary for the transit of vehicles in the modeling is carried out within the program, through the commands and guidelines. To do this, we start from the information provided by the online GPS, where, through the Network Objects option, the modeling of lanes, divisions, traffic circles, directions are established from the beginning of the road to the end.

Figure 1. Geographical location



Source: Own elaboration

Figure 2. Scaled design of the network

Source: Own elaboration

Next, the routes, directions, road width and direction to which the vehicles will run are designed. Specifically, the program is fed through the information collected during the observation. The purpose of this is to identify through the program the conflict points of the road. The model is made respecting the characteristics, numbers and names of the road.

The model is designed by feeding the system with the information concerning each road, indicating where each road leads to, with all the geographical characteristics of the area and with the number and composition of cars on average that travel on the road (Moscoso Ttito, P. D., & Zambrano Masco, M. N. R. (2020).

Table 1. Information tables for the program feed

Capacity during business hours 11:30 am - 13:30 pm						
Entrance	Vehicles					
	Cars	Motorcycles	Buses	C2P	C2G	≥ C3
Entrance 1	1692	930	296	61	91	6
Entrance 2	1435	805	185	190	75	5
Entrance 3	1007	710	118	23	12	0
Entrance 4	426	492	0	31	0	0

Note: When modeling in VISSIM, it is observed that the analysis is done over 1 hour, so it was decided to divide the average capacity in each hour.

Capacity during business hours 11:30 am - 13:30 pm						
Entrance	Vehicles					
	Cars	Motorcycles	Buses	C2P	C2G	≥ C3
Entrance 1	846	465	148	31	46	3
Entrance 2	718	403	93	95	38	3
Entrance 3	504	355	59	12	6	0
Entrance 4	213	246	0	16	0	0

Note: The imapres values when divided result in an exact number, for example: 1435/2=717.5, so it is decided to add (+1) to obtain an exat number, for example (1435+1)/2=718.

Source: Own elaboration

3.4. Conflict analysis

Once the program has been fed with the required information, having defined the routes and their corresponding percentages, the program is run to observe the behavior of the vehicles. In view of the above, at the moment of running the program, errors are detected where priorities are given and even some vehicles overlap, taking the model very far from the reality of the intersection. For this, the priorities are established in the design, going to the Conflict Areas option.

The design offers signaling (yellow marks) where through simulation (Bautista Ñaupari, J. C., & Guevara Martel, M. M), the program detects the conflict areas. For this purpose, by means of the following formulation, the program detects the conflict zones.

Figure 3. Equation for traffic circle capacity calculation.

$$Qp = \frac{160 * W * (1 + \frac{e}{W})}{1 + \frac{W}{L}}$$

$$e = \frac{e1 + e2}{2}$$

Source: Jerez & Morales, 2015.

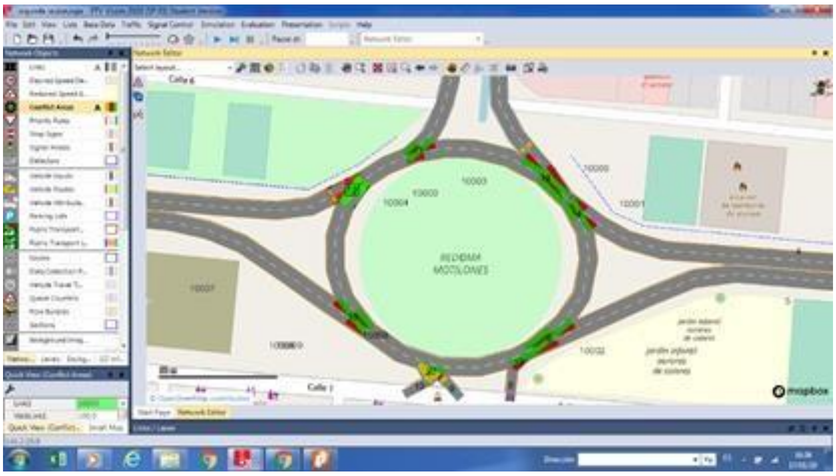
Where:
Qp: Crossing section capacity, as mixed traffic, in vehicles/hour. W: Crossing section width, in meters. e: Average width of the entrances to the crossing section, in meters. e1, e2: Width of each entrance to the cross-link section, in meters.
L: Length of the cross-linking section, in meters (Laserna, L. D. D., Borja, B. L. G., López, A. V. M., & Espinal, C. I).

Through the calculation of the capacity of the traffic circle, following the criteria of the Colombian technical standard NTC 900-975 with reference to demarcations, lighting and signaling on public roads (2006-2013), which takes into account the relevant considerations and presents the methodology adapted to the nation's road systems. In this sense, an intersection length must be proposed that is compatible with the geometry of the intersection. Subsequently, the capacity of the intersection section is calculated using the equation presented above. However, this formula only serves to determine the conflict zones at the system level. In practice, in traffic circles, the rule of priority in the traffic ring applies. Where, the vehicle that is inside; has the lane, while the one that is going to enter must wait for the vehicle that is inside; to exit.

By virtue of the above, conflict zones are identified at the entry and exit points of the traffic circle. It should be noted that these are logical points, since this is where the crossing between entering and exiting vehicles originates. It should be noted that this model takes into account all types of classified vehicles, such as cars, motorcycles, trucks with two or three axles and more.

Finally, to determine the total capacity of a traffic circle, the capacity of each of the entrances must first be determined. This capacity is the maximum value of the traffic flow of a secondary flow, vehicle at the entrance, which can be continuously inserted into a main flow or ring road, over a certain period of time. By means of this principle, the formation of a continuous waiting queue on the approach to that entrance is guaranteed, the same that has to determine its entrance with a certain level of priority traffic; the total capacity of the traffic circle being the sum of the capacities of each of the entrances. Thus, by means of the following Ct= CE1 +CE2+CE3...CEn the total capacity of the traffic circle is determined. In this way, the points where conflict zones will be generated are detected.

Figure 4. Track identification



Source: Own elaboration

The graph presented by the Vissim 20.0 program shows in green the vehicles that are in the traffic circle at the points of conflict and in red the vehicles that must yield the right-of-way. From here, projections can be made for possible solutions.

3.5. Speeds per area

Since the behavior of vehicles after the priority rules and conflict zones does not reflect the real behavior of the point under study, the program can be used to generate a model to calibrate the model by means of this tool, allowing the input of specific speeds by areas that resemble the behavior of the model to reality. From there, these velocities are obtained by means of field gauging. In this case, this tool was used to enter the specific speeds at which the different types of vehicles crossed the traffic circle, using a calculated speed of 20 km/h as a base.

The graph generated by the VISSIM 20.0 tool shows the entry of the different types of vehicles, with the corresponding entries and directions. However, it is important to highlight, at the moment of determining the automobile traffic, the different types of vehicles, since there is a different driving culture between automobiles and motorcycles. Therefore, in the program, adjustments must be made to the behavior for motorcycle driving, which is different from the default behavior of the program. Within this framework, this variable is calibrated by adjusting the behavior of motorcycles allowing lane changes, overtaking vehicles and the traffic of several motorcycles in the same lane, as it happens in reality.

3.6. Review scenarios.

Three revision scenarios were simulated in the Vissim 20.0 program, as explained below:

3.6.1. Scenario 1:

Stop signaling, by means of the micro-simulation tool Vissim 20.0 a revision scenario can be generated seeking to correct the faults detected by means of the simulation within the program. In this sense, the stop location point is selected, identified by means of an orange line and the corresponding signals. Therefore, the program generates a window where you can add the different types of vehicles that you want to meet the stop, specifying the stopping time of each one.

A simulation was carried out where stop signs were placed prior to the entry of vehicles to the traffic circle. It should be considered that the signs are placed at the four main entrances of the traffic circle, this option is linked to the Stop Signs tool of the program, where each of the points where the different types of vehicles can be added, specifying the time, should be selected.

Stop signs, are used to reduce the speed of vehicles before entering the traffic circle, being a measure to reduce congestion in critical areas internally (Sosa & Dueñas, 2018). According to the results of the program, a reduction in the speed levels of entering the traffic circle and therefore decongestion in the critical zones identified "before" types of vehicles specifying the time are noticed.

3.6.2. Scenario 2:

Creation of crosswalks. Another revision measure allowed by the Vissim 20.0 program is the placement of crosswalks. The same, allow the use of the traffic circle by pedestrians without prejudice to pedestrians and that avoids waiting time at the entrance of traffic circles or unnecessary vehicular deviations that generate unusual traffic within the traffic circle and minimization of conflict areas (Alvarez, 2017).

The creation of crosswalks, is done using the Left (Links) tool, the road section where pedestrians will transit is created and then the location point is selected, the road section where pedestrians will transit (yellow lines) is created. In this particular case, simulations were made with crosswalks at the two entrances considered the most important for vehicles, according to the data provided by the information collected, selecting two points where, by means of the trial and error method, it was determined that these were the points where the critical zones previously identified in the traffic circle were most effectively minimized.

In the design, the crosswalk is placed at the height of entrance 1, transversal 17 East-West orientation. This has the highest percentage of vehicle entry with about 36.59%, as estimated in the first objective of the project.

Table 2. Circulation by entrance

Entrance	%
Entrance 1	36,59%
Entrance 2	31,70%
Entrance 3	20,24%
Entrance 4	11,48%

Source: Own elaboration

The next entrance, which according to the Vissim 20.0 simulation is the one that generates the greatest decrease in critical zones, according to the model, is entrance 2 or avenue 24 North-South orientation, which has the second highest entrance capacity to the traffic circle with 31.7%.

3.6.3. Scenario 3:

Road demarcation, in a design, which interprets the road directions, crosswalks, and specific information (Pulido & Gómez, 2018). For which, the Pavement Markings option is selected, which opens a window where the appropriate option is typed and selected for each case to be demarcated.

In attention to the above, the vertical signs are drawn in the Vissim 20.0 tool, which are those that are presented in a fixed way on the road or on the sides, such as stop signs, direction, direction, etc (Pulido & Gómez, 2018). The following should be pointed out in this regard, to draw vertical traffic signs and traffic lights in 3D the tool, 3D Traffic Signals is used, by right clicking the location of the sign is pointed out and a window opens, where the structure of the sign can be created and the dimensions of the sign can be modified, allowing to add arms and choose whether to add a traffic light or traffic signal.

The Vissim 20.0 program, by calculating the reduction of critical zones and the trial and error method, was able to determine the points where the critical zones identified within the analyzed traffic circle are most effectively reduced. In this sense, it is evident that all four points should have this type of signaling;

however, the intersection located at entrance 4 (South-North) 23rd Avenue is where the critical zones present in the model are most successfully reduced.

3.7. Double impact matrix

This double impact matrix is a qualitative risk analysis tool that allows prioritizing the possible operational risks of a project according to both the probability of their occurrence and the repercussions they could have on the project if the expected phenomena were to occur (Serna, 2008).

This type of measure is given a rating of 1 to 5 according to the degree of difficulty encountered in the model for the fulfillment of the aspects taken into account. Thus, if an aspect shows greater feasibility, it will have a high weighting otherwise a low one.

Criteria:

High degree of difficulty = 1

Medium degree of difficulty = 3

Low degree of difficulty = 5

Table 3. Double impact matrix

Solutions	Cost	Reduction of critical areas	Regulatory compliance	Time of execution	Total
Scenario 1 "Stop" signage	5	3	5	5	18
Scenario 2: Creation of crosswalks	1	1	5	1	8
Scenario 3: Road Demarcation	3	3	5	3	14

Source: Own elaboration

According to the analysis of the impact matrix, scenario 1 presents the highest score, making it the most feasible solution in terms of costs (Cárdenas-Gutiérrez, J., Molina-Salazar, L., & Medrano Lindarte, C. T. (2020), reduction of critical areas (Cely-Calixto, N. J., Bonilla-Granados, C. A., & Soto, G. C. (2021, July), regulatory compliance and execution time among the proposed alternatives.

5. Conclusions

After the traffic analysis at the intersection considered, using the PTV Vissim tool, under 3 different review scenarios yielded the following results. The traffic analysis determined the conflict zones after the micro simulation, detecting them in the vehicular crossings at the entrance and exit of the traffic circle, according to the model determined after the feeding through the information collected in the field work.

Through the technological tool used, Vissim 20. It is possible to perform simulation models that allow observing the impact that a road proposal would have in practice on a significant road artery. In this sense, the first recommendation is: the use of the Vissim 20. tool to obtain reliable information that provides a higher percentage of reliability and grants a higher performance in the field for the implementation of road improvements.

References

Kučera, T., & Chocholáč, J. (2021). Design of the city logistics simulation model using PTV VISSIM software. *Transportation Research Procedia*, *53*, 258-265.

Ramadhan, S. A., Joelianto, E., & Sutarto, H. Y. (2019). Simulation of traffic control using Vissim-COM interface. *Internetworking Indonesia Journal, 11 (1)*, 55-61.

Samuel, L., Shibil, M., Nasser, M., Shabir, N., & Davis, N. (2021, May). Sustainable Planning of Urban Transportation Using PTV VISSIM. In *International Conference on Structural Engineering and Construction Management* (pp. 889-904). Springer, Cham.

Suárez, A. (2007). Análisis y evaluación operacional de intersecciones urbanas mediante la micro-simulación. Universidad Nacional de Colombia, Medellín, Colombia.

Rodegerdts, LA (2010). *Rotondas: una guía informativa* (Vol. 672). Junta de Investigación de Transporte.

Rodrigo Chayña, E. P., & Rivas Vilcas, J. B. (2019). Análisis de la capacidad, congestión y flujo vehicular para la optimización del nivel de servicio del Óvalo Pachacutec de la ciudad del Cusco. Illacanchi Guerra, P. K. Análisis de la circulación y propuestas de mejora del óvalo Pedro Ruiz Gallo en el límite de Breña y Pueblo Libre.

Molina Martínez, C. J., & Ortega Cabascango, A. P. (2022). Análisis y evaluación del tráfico vehicular, y propuesta de rediseño geométrico del redondel Atahualpa, ubicado en el sur del Distrito Metropolitano de Quito, provincia de Pichincha (Bachelor's thesis, Quito: UCE).

Castro Barrientos, L. F., & Mendoza Mendoza, B. E. (2021). Evaluación y propuesta de un nuevo diseño de las rotondas de la variante internacional lado Perú del eje vial N° 1 carretera Panamericana Piura–Guayaquil en la provincia de Zarumilla.

Arce Rodriguez, L. E. V., & Canales Macarlupu, J. I. Propuesta de rediseño geométrico de la intersección no convencional ubicada en el cruce de las avenidas José Granda y Universitaria, distrito de San Martín de Porres, Lima; para mejorar las condiciones operacionales del tránsito vehicular y peatonal.

Ortega, H. (2017). Evaluación de la capacidad en rotondas, en función de la optimización de su diseño geométrico basado en un aumento de la seguridad. Caso de estudio Cuenca. Instituto Politécnico de Leiria, Oporto, Portugal.

Frisancho Camero, F. L. (2021). Evaluación del nivel de servicio en flujos vehiculares del óvalo Cuzco-Tacna 2019 y simulación de paso a desnivel sentido NS utilizando Synchro V. 8.

Norma Técnica Colombia NTC 900-975

Moscoso Ttito, P. D., & Zambrano Masco, M. N. R. (2020). Propuesta de mejora del nivel de servicio vehicular mediante el uso de carril reversible en Av. Jose Carlos Mariategui entre Av. Las Magnolias-Av. 1ro de Mayo.

Bautista Ñaupari, J. C., & Guevara Martel, M. M. Propuesta de mejora del nivel de servicio mediante la reversibilidad del sentido de tránsito en hora pico en la Panamericana Norte entre la Avenida Tomas valle y el puente peatonal control Zarumilla.

Jerez, A. & Morales, O. (2015). Análisis del nivel de servicio y capacidad vehicular de las Intersecciones con mayor demanda en la ciudad de azogues. Universidad Politécnica Salesiana, Quito, Ecuador.

Laserna, L. D. D., Borja, B. L. G., López, A. V. M., & Espinal, C. I. Análisis De Los Criterios De Diseño Y Movilidad De Glorietas En La Zona Urbana De Ibagué-Tolima.

Sosa, P. & Dueñas, I. (2018). Estudio comparativo entre una glorieta target y una glorieta convencional por medio de su diseño geométrico y microsimulación de tráfico como alternativa de intersección vial en Bogotá. Universidad Santo Tomas de Aquino, Bogotá, Colombia.

Álvarez, J. (2017). Micro-simulación intermodal en la ciudad del Cusco empleando los software Vissim 8 y Viswalk 8. Pontificia Universidad Católica del Perú, Lima, Perú.

Pulido, P. & Gómez, M. (2018). Evaluación de la capacidad y nivel de servicio de la glorieta ubicada en la calle 63 con carrera 50 en Bogotá D.C. – Colombia por medio de métodos no convencionales, Bogotá, Colombia.

Serna, H. (2008). Gerencia estratégica. Bogota: 3R ediciones.

Cárdenas-Gutiérrez, J., Molina-Salazar, L., & Medrano Lindarte, C. T. (2020). Costos y Presupuetos en la Industria de la Construcción. *Eco Ediciones*.

Cely-Calixto, N. J., Bonilla-Granados, C. A., & Soto, G. C. (2021, July). A mathematical model for the simulation of the Magdalena River in the city of Barrancabermeja, Colombia. In *Journal of Physics: Conference Series* (Vol. 1981, No. 1, p. 012016). IOP Publishing.