Available online at www.jlls.org

JOURNAL OF LANGUAGE AND LINGUISTIC STUDIES

ISSN: 1305-578X

Journal of Language and Linguistic Studies, *18*(3), 626-634; 2022

Analysis Of A Sustainable Public Mass Transit System In The City Of San José De Cúcuta

Cárdenas-Gutiérrez Javier Alfonso [a 1], Rodríguez – Lizcano Adriana [b], Gallardo – Amaya Romel Jesús [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] PhD in Education, member of the Road Infrastructure Research Group GIVIAL, Orcid: https://orcid.org/0000-0002-9764-5993, Email: adrianarodriguez@ufps.edu.co, Universidad Francisco de Paula Santander, Cúcuta, Colombia

[c] Master in Geotechnical Engineering, Director of Construction, Geotechnical and Environmental Research Group – GIGMA, Orcid: https://orcid.org/0000-0002-4740-4841, Email: rjgallardoa@ufpso.edu.co, Universidad Francisco de Paula Santander Seccional Ocaña, Ocaña, Colombia

APA Citation:

Alfonso, C.G.J., Adriana, R-L., Jesús, G.M.R., (2022). Analysis Of A Sustainable Public Mass Transit System In The City Of San José De Cúcuta, *Journal of Language and Linguistic Studies*, *18*(3), 626-634.

Submission Date: 31/10/2021

Acceptance Date: 05/02/2022

Abstract

Due to the inefficiency of the public transportation system in the city of San José de Cúcuta, the high emission of greenhouse gases, the disorder and lack of security, an efficient, safe and environmentally sustainable public transportation system is proposed within this research. For the development of this research, the population density was initially taken into account, as well as the main routes and passenger loading and unloading sites. Subsequently, 3 subway lines were established to replace the main public transportation routes, covering the main passenger loading and unloading sites in the city. Finally, the criteria for the optimal development of the project are established, as well as the possible social, economic and environmental impacts. As a conclusion, it is established that the development of a mega project of this magnitude can bring multiple types of benefits, the main ones being the development of the city, the tourist attraction, as well as some consequences mainly focused on the purchase of private real estate and the unemployed generated by the construction of this project.

Keywords: Subway, Cúcuta, Sustainable construction, Innovation, public mass transit system.

1. Introduction

The need for transportation is the result of the rapid urbanization that has given rise to large cities around the world, such that this need establishes the urgency of developing new strategies to ensure the mobility of citizens while addressing traffic problems such as congestion, collisions, poor quality transportation services, inaccessibility to those services, and encroachment on public spaces, as well as the effects on the environment(Cárdenas Gutiérrez et al., 2022).

[1] Corresponding author.
E-mail address: javieralfonsocg@ufps.edu.co

While research on different modes of transport and vehicular traffic behavior has advanced recently, it initially focused mainly on analyzing travel demand, assessing quality of service, determining levels of service of streets and roads, and studying some externalities, such as tariffs, a trend that is still evident in developing countries, some of which are in Latin America(Torres Prada, 2006a).

Traditional solutions such as expanding the vehicle fleet to meet demand, replacing some public service vehicles with fewer, higher capacity vehicles, which in some cases take up more space or emit more pollution, extensive studies of origins and destinations, and transportation externalities such as fare design have been the main focus, rather than developing solutions that actually solve a city's internal transportation problem(González & González, 2015; Velásquez, 2015a).

Municipal operations in large cities and intermediate cities have encouraged the development of new urban mobility projects based on the implementation of alternative and sustainable transportation methods as a response to the numerous problems generated by the transportation activity, for which we operate worldwide. land use, environmental protection, demand management and public health(Chuquén et al., 2009a).

The implementation of improved infrastructure for the growth of non-motorized modes of transport, but more importantly, the thorough examination of the real needs of users, not in the context of an efficiency scheme, but in the context of sustainable and efficient urban transport and mobility far removed from conventional sketches(Aparicio, 2010a). Based on the above, a preliminary analysis was carried out to identify the public transportation needs in the city of San José de Cúcuta, whose findings allow to establish in the first instance which are the main access routes used in the city to transport people, likewise, the population density of the city was identified, to finally be able to propose an efficient and environmentally sustainable mass public transportation system.

2. Method

The methodology used in this article consists of:

1. Identify the population density of the city of San José de Cúcuta, in order to establish in which sectors of the city are the largest number of people to be mobilized.
2. Identify all public transportation routes, the companies that offer them, the mobility rates and the time interval.
3. Establish the areas with the highest demand for transportation
4. Develop an efficient and environmentally sustainable mass public transportation proposal.

2.1. Public transportation system

Having a public transport system is a decisive factor for a city's income-generating capacity and the social integration of its inhabitants, since a good transport system provides good mobility and accessibility. It is a powerful tool that is available to all city residents, promotes development, combats poverty, and maintains political and social harmony.

It improves the performance of product and factor markets, particularly the labor market, and expands the opportunities available to city residents. Similar objectives are pursued with the implementation of mass transit systems (MTS), which aim to improve safety conditions, restore public space, and foster a greater sense of civic pride.

Thus, a mass transit system, especially in developing countries, improved transportation services result in lower product costs, more employment opportunities, the creation of new industrial zones, the promotion of agricultural production, and the expansion of urban areas(Vuchic, 2002).

2.2. Public mass transit system

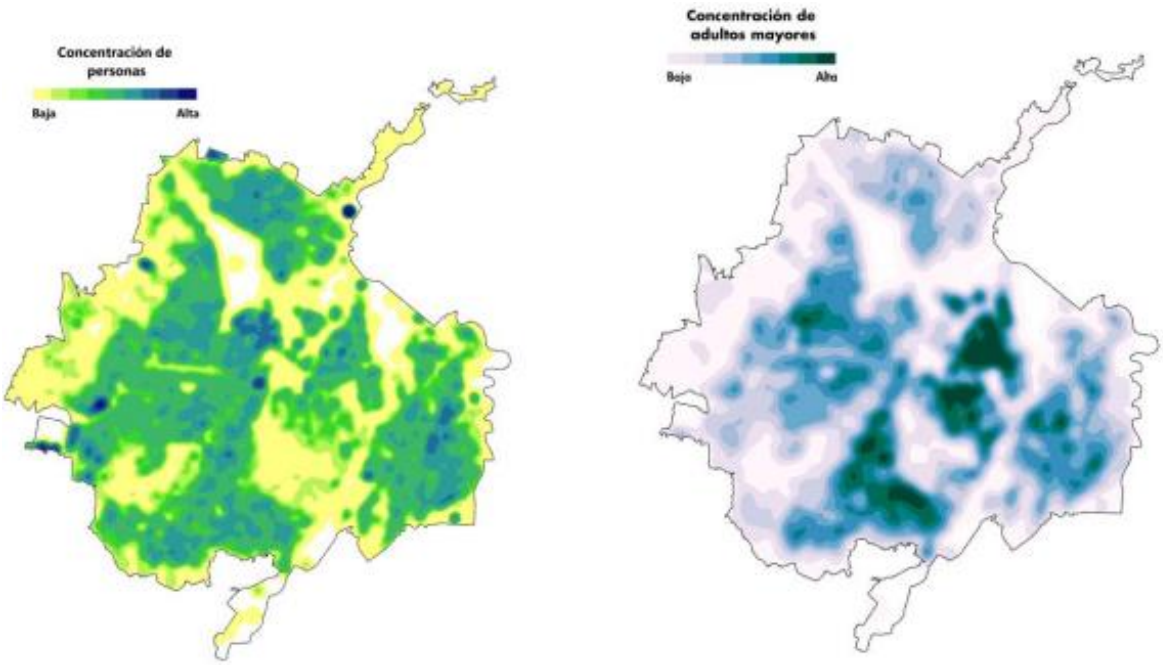
A public mass transit system is defined as the service offered through a planned combination of infrastructure and equipment, in a system that accommodates a large number of passengers and serves an important part of the mobilization needs. This system consists of the set of buildings, machinery, equipment, systems, signals, stops, stations and road infrastructure used to effectively and continuously meet the demand for transportation in a given area of influence (Zeng et al., 2014). The competent transportation authority established for this purpose by the corresponding territorial or administrative entity will exercise planning, organization, control and surveillance functions under the institutional coordination of the Ministry of Transportation. This authority will then issue the authorization to provide the public mass transportation service.

3. Results and discussion

3.1. Population density

In the city of San José de Cúcuta there is a population of 787,891 inhabitants, where the following figures show the concentration of people in the municipal capital and the concentration of older adults.

Figure. 1 Populatión density of Cúcuta



Source: (DANE, 2022)

From these figures, it can be clearly observed that the population of Cúcuta is uniformly densified, since the spaces that appear with little densification are the areas of the airport, found in the upper left part, and the center, found in the central part, where thousands of people of the city go daily to develop their economic activities.

3.2. Public transportation routes in the metropolitan area of San José de Cúcuta

The following table summarizes the total number of public transportation lines in the metropolitan area of San José de Cúcuta, specifying the number of transportation companies, route length, travel time, bus frequency and total travel time.

Table 1. Public transportation routes in the city of San José de Cúcuta

Company name	No. of routes	Average travel length (km))	Average route time (min))	Average frequency (min)	Average travel time (min)
Cooperativa de microbuses (coomicro)	9	35.22	101.11	13.33	139.44
Corta distancia ltda	5	35.60	107.00	13.80	145.60
Cooperativa de transportadores de la frontera nororiental (cootransfronorte)	4	35.00	77.50	10.00	122.50
Transporte guasimales (trans - guasimales s.a.)	10	37.30	94.20	8.90	124.30
Transportes petrolea s.a (trans-petrolea s.a.)	3	46.33	128.33	16.67	160.33
Transporte puerto santander s.a. (trasan s.a.)	10	40.70	109.00	14.00	136.70
Transportes tonchala (trans - tonchala s.a.)	7	39.14	100.00	8.86	138.86
Transportes ontiveros s.a.	5	28.00	73.00	9.20	97.20
Transportes oriental s.a. (trans-oriental s.a.)	6	44.67	126.67	8.33	143.17
Total	59	38.00	101.87	11.45	134.23

Source:(Acevedo Patiño & Hernandez Sanabria, 2022)

Most of these routes cross from one end of the city to the other, being the main sites of interest, the courtyards, the terminal, the stop, the citadel of juan atalaya, freedom and bellavista. It is also possible to observe an average route of 38 kilometers, in a city that has from end to end a distance of approximately 10km, therefore, these routes are not directed in a direct and efficient manner, but rather cross mostly through multiple neighborhoods and surrounding commercial areas, medical centers and universities.

It can also be observed that the average travel time is around 100 minutes, which means that finding an efficient way to transport a significant number of people in less than that route time would already be a huge benefit for the inhabitants of the city of Cúcuta.

3.3. Proposed mass transit system

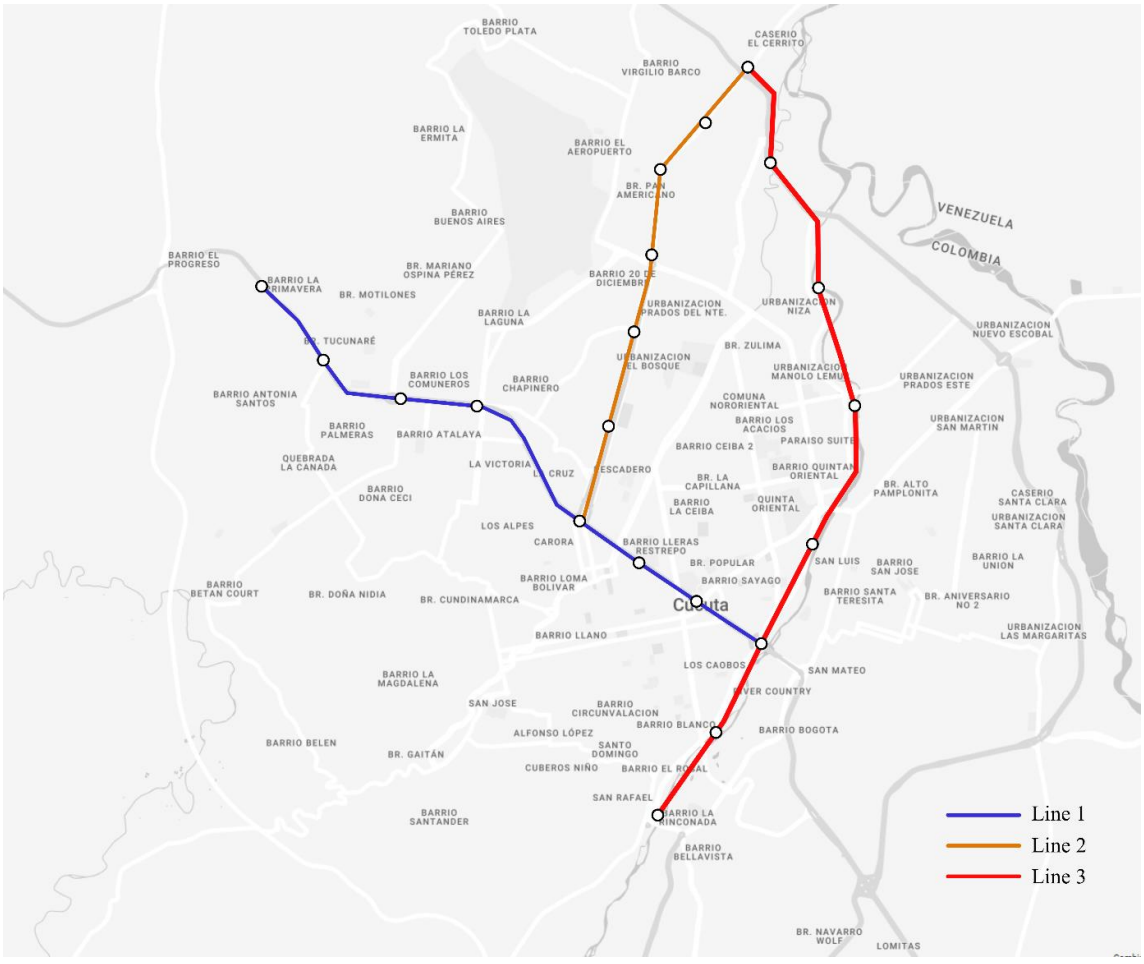
The initial mass transportation system proposed for the city of San José de Cúcuta consists of three subway lines, which will be located at a distance of about 750 meters, for a total of 20 stations, 3 of which are bimodal. As can be seen in the following figure.

In the first instance, there would be a line 1, and it would have an approximate length of 7 kilometers, crossing the city in the middle by the Santander diagonal, allowing the flow from one end to another, this line would have two bimodal stations that would allow the change to line 2 and line 3.

This avenue is one of the most spacious in the city and its construction would be relatively simple with minimal intervention in private spaces, likewise, this line would also have two bimodal stations at each end and would communicate the center of the city with the north, reaching the El Salado neighborhood.

Finally, line 3 would move along the Pamplona River, which is currently being channeled and has a high demographic prospect, therefore, this line would connect to two other lines, thus allowing the flow interchange.

Figure. 2. Proposed subway routes



Source: own elaboration based on google maps

Lines 1, 2 and 3, in blue, orange and red respectively, are shown in the figure above. Now, If a route speed of 50 km/h is estimated, and a maximum travel distance of 10 km, the transport system would go from one side of the city to the other in approximately 20 minutes, without taking into account stop times, which last less than a minute, and with an average of 8 stations per line, this transport system would have a maximum route time of 30 minutes, being extremely conservative.

3.4. Project development guidelines

Since the proposed public transportation system consists of an elevated subway, in order to avoid vehicular congestion, real estate purchases and more complex construction processes, it is proposed to use prefabricated elements that implement waste from construction and other industries in order to reduce the environmental impact and carbon footprint.

The procedure for the construction of this mega project consists of:

1. Identification of the land adjacent to the location of the stations of the public transportation system.
2. Determination of the necessary area for the construction of the public transportation system stations.
3. Identification of the land needed for the purchase of the land.
4. Development of a budget for the purchase of real estate.
5. Development of construction budget for railway stations and networks.
6. Budget analysis using construction waste
7. Budget development for the purchase of trains and station equipment.
8. Development of a budget for supplies, maintenance and human resources necessary for the correct operation of the public transportation system.
9. Determination of energy consumption, transportation demand and establishment of the break-even point for the establishment of the tariff.

3.5. Social impact

The city of San José de Cúcuta has never had an efficient transportation system controlled by the municipality, so the establishment of a mass transportation system, such as the metro, would classify the city as the second in having a functional metro, which would draw national attention and give an added value, thus allowing the attraction of business and tourism, thus increasing the development of the city(Camelo Escobar & Restrepo Serna, 2015).

However, this proposal puts in check the 9 private public transportation companies, which have the current control of the mass movement of people within the city, therefore, measures should be implemented to allow the migration of the current system gradually to the proposed system(Aparicio, 2010b).

Likewise, this proposal does not consider the municipalities of Los Patios and Villa del Rosario, which may require a main line that runs through these municipalities; however, it would be difficult to build a line in Los Patios, unless it is built next to the river, since its main street is narrow and surrounded by multiple commercial establishments. On the other hand, for the municipality of Villa del Rosario, there are large highways that could be used for the construction of an additional line.

3.6. Economic Impact

The economic impact of this proposal initially lies in determining the profitability of this system using construction and demolition waste, as well as waste from other industrial processes (such as coal ash produced at the tasajero thermoelectric power plant)(Chuquén et al., 2009b).

The purchase of real estate may also become a substantial problem, since this could make the project unviable. However, with a correct distribution of the stations, and the correct design of the same, these purchase costs can be substantially reduced(Torres Prada, 2006b).

Finally, the entire population would benefit, since a transportation system such as the one proposed would allow the exponential development of the city, speed up mobility in the streets and influence more effective logistics(Velásquez, 2015b).

3.7. Environmental impact

This proposal is intended to reduce costs and exploitation of natural raw materials, since there are currently final disposal sites for construction waste, in addition, the city is in an exponential growth of housing, which in turn generates the generation of waste that can be used(Hurtado Figueroa, Cárdenas Gutiérrez, & Prada Botia, 2018; Hurtado Figueroa, Cárdenas Gutiérrez, & Rojas Suarez, 2018; Hurtado-Figueroa et al., 2019).

Currently, there is very little control by the environmental authorities in the control of vehicles that massively transport people, being this, a huge damage to the environment due to the excessive emission of greenhouse gases in our city, which directly influences the quality of air breathed by the cucuteño and soil contamination.

Therefore, by proposing a 100% electric mass transportation system, C02 emissions to the atmosphere are substantially reduced, by restricting the flow of highly polluting public transportation vehicles in a conditioned manner.

4. Conclusions

The population density of the city of San José de Cúcuta made it possible to identify the spatial distribution of the people living in the city, thus, it was possible to observe that there was no exact preference in such distribution, facilitating the process of selecting routes for the proposed transportation system.

The identification of the routes and transportation companies made it possible to know the route times, the frequency of the system, as well as the main areas for loading and unloading passengers, thus, it was possible to develop a proposal that would cover these main areas, except for those that began or ended in the municipalities of Los Patios and Villa del Rosario.

The shared proposal should be complemented with feeders to take passengers to the subway stations, mainly in the western central zone, since a line was not proposed for this zone, since space and relief did not allow it, in addition to the fact that this zone is the one with the greatest economic activity and therefore, one of the most expensive in terms of real estate purchases.

The possible social, economic and environmental impacts are sufficient to consider developing a more detailed study to determine whether the development of this project is economically viable and sustainable in the long term.

References

Acevedo Patiño, M. A., & Hernandez Sanabria, B. F. (2022). *Modelo informativo tecnológico de transporte* . https://issuu.com/mittcucuta/docs/catalogo_rtp_mitt_cucuta

Aparicio, L. S. (2010a). El impacto del transporte en el ordenamiento de la ciudad: el caso de Transmilenio en Bogotá. *Territorios*, *22*, 33–64.

Aparicio, L. S. (2010b). El impacto del transporte en el ordenamiento de la ciudad: el caso de Transmilenio en Bogotá. *Territorios*, *22*, 33–64.

Camelo Escobar, C. A., & Restrepo Serna, L. E. (2015). *Desarrollo urbano de Medellín alrededor del sistema de transporte masivo METRO*.

Cárdenas Gutiérrez, J. A., García Torres, N. E., & Panizo Cardona, C. A. (2022). *Introducción a los sistemas de tránsito y transporte* (ECOediciones, Ed.).

Chuquén, R. M., Mesías, M. A. R., López, G. A. R., & Restrepo, E. Q. (2009a). Sistemas de alimentación eléctrica a sistemas e transporte masivo tipo metro. *Ingeniería y Universidad*, *13*(2), 11.

Chuquén, R. M., Mesías, M. A. R., López, G. A. R., & Restrepo, E. Q. (2009b). Sistemas de alimentación eléctrica a sistemas e transporte masivo tipo metro. *Ingeniería y Universidad*, *13*(2), 11.

DANE. (2022). *Demografía y población*. https://www.dane.gov.co/index.php/estadisticas-por-tema/demografia-y-poblacion

González, J. R. Q., & González, L. E. Q. (2015). El transporte sostenible y su papel en el desarrollo del medio ambiente urbano. *Ingeniería y Región*, *14*, 87–97.

Hurtado Figueroa, O., Cárdenas Gutiérrez, J. A., & Prada Botia, G. (2018). Verification of compression resistance between a conventional concrete and its addition of 5, 10 and 15% in volume of fly ash replacing fine aggregate. *Journal of Physics: Conference Series*, *1126*(1). https://doi.org/10.1088/1742-6596/1126/1/012037

Hurtado Figueroa, O., Cárdenas Gutiérrez, J. A., & Rojas Suarez, J. P. (2018). Determination of the quality of coarse aggregates for the elaboration of concrete mixes from 3 water sources in the City of Cucuta-Colombia. *Journal of Physics Conference Series*, *1126*(1), 12041.

Hurtado-Figueroa, O., Colmenares-Bernal, C. E., & Cárdenas-Gutiérrez, J. A. (2019). Quality of aggregates for the preparation of asphalt mixtures from 4 processing companies in San José de Cúcuta, Colombia. *Journal of Physics: Conference Series*, *1388*(1), 12024.

Torres Prada, A. C. (2006a). Fundamentos científicos del desarrollo del sistema metro como vía de solución al problema del transporte masivo de grandes ciudades. *Épsilon*, *1*(7), 23–29.

Torres Prada, A. C. (2006b). Fundamentos científicos del desarrollo del sistema metro como vía de solución al problema del transporte masivo de grandes ciudades. *Épsilon*, *1*(7), 23–29.

Velásquez, C. v. (2015a). *Espacio público y movilidad urbana. Sistemas Integrados de Transporte Masivo (SITM)*.

Velásquez, C. v. (2015b). *Espacio público y movilidad urbana. Sistemas Integrados de Transporte Masivo (SITM)*.

Vuchic, V. R. (2002). Urban public transportation systems. *University of Pennsylvania, Philadelphia, PA, USA*, *5*, 2532–2558.

Zeng, W., Fu, C.-W., Arisona, S. M., Erath, A., & Qu, H. (2014). Visualizing mobility of public transportation system. *IEEE Transactions on Visualization and Computer Graphics*, *20*(12), 1833–1842.