

Environmental Incidence of the Western Regiotram Project and its Contribution to the Objectives of Sustainable Development in Colombia

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ABSTRACT

The Regiotram de Occidente It has been one of the largest innovations and development projects for the department of Cundinamarca in Colombia, since over the years and due to the great growth of the population in the area of influence of this sector of the country, transport of the inhabitants has caused great conflict, that is why this book chapter will demonstrate how the environmental impact assessment is related and its direct relationship with the sustainable development objectives (SDG) in the execution and construction of high impact for the environment in this sector of the country (Colombia), planting the relationship that this has with Latin American trains [1].

Keywords: Area of influence; area of intervention; concession; development; growth; evaluation and environmental impact.

1. INTRODUCTION

At present, the fact that the development of a country is measured among other aspects, by its road development and its transport systems, Colombia, comes in a process of growth in which large infrastructure projects have been implemented, highlighting the Regiotram Occidente commuter train [2-4].

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Proposing solutions to the mobility problem that afflicts the metropolitan area of Bogotá and neighboring municipalities of the western savannah, since the implementation and execution of this national project generates new economic, political and social alternatives of great benefit to the community of the area of influence that will intervene this project [5-8]. However, although the Regiotram Occidente commuter rail project generates positive effects on its surroundings, it also generates negative impacts, which must be evaluated in order to mitigate and compensate for environmental damage in order to preserve the environment [9].

In this chapter, in an initial phase, the comparative framework of the Western Regiotram with other transport systems in the Latin American region is proposed, and then, a holistic description of the project is made, evaluating the environmental impact through the Leopold matrix methodology which will allow determining the harmony that an environmental management plan of this mood has and its contribution to the contribution of the Sustainable Development Goals in projects of high impact, bearing in mind that Colombia advances in more than 72% of compliance with the SDGs [10].

2. COMMUTER TRAIN SYSTEM IN LATIN AMERICA

As a result of the positive impact, it has offered throughout its history, the railway is getting back on track as the most important and relevant land transport option in the modern world; being, furthermore, the only means of large-scale passenger transport, which, in a practical, safe, comfortable, efficient and less polluting way, facilitates transport for a series of people in Latin America [11].

To international literature, a suburban or commuter train is a rail transport system that has the ability to move large crowds of people daily, which is why they become a fundamental instrument in the daily mobility of a city, in the face of large urban population densities with a clear growth trend in the coming decades [12].

Among the 30 countries with the largest rail network in the world, we only find 4 Latin American countries, in the following order: Argentina (8), Brazil (10), Mexico (11), Chile (30).

2.1 Metropolitan Railways of Buenos Aires

In the development of the Metropolitan Area of Buenos Aires (AMBA), the railway has fulfilled the main role of central circulation, defining according to its organization, since it only serves the popular sectors in a system of localities following the regulation of centers and sub-centers regional [13-16].

The railway system implemented it is high-end development and fully privatized as, has of a series of branches classified in seven suburban train lines, six subway lines and a light rail line that serve the Metropolitan Area of Buenos Aires (AMBA). The total length of the system used for the provision of passenger

service reaches approximately 945 km, of which 332.6 km operate by way of and the others provide diesel traction engine service [17], made up of 230 stations in the AMBA, of which 49 are located in the City of Buenos Aires and 181 in the suburbs, with a distance average of 3 kilometers between stations [18].

The railway network of Buenos Aires and its metropolitan area can be considered as the largest network of metropolitan trains in the world, these depart from the Autonomous City of Buenos Aires to the conurbation of Greater Buenos Aires.

2.2 São Paulo Metropolitan Trains

The Paulista Metropolitan Train Company (CPTM) is made up of 36 commuter trains. Each unit is composed of 8 cars, offering a large capacity currently being are in operation 94 stations on seven lines, with a total route of 273 kilometers in its railway network. Its lines connect 23 cities of Greater São Paulo transporting daily about 2.9 million passengers [19].

2.3 Valley of Mexico Suburban Railroad (FSVM)

According to the impact generated by the growth of the area Metropolitan of Mexico City in the Northwest sector was implemented line one of the suburban train surroundings, from Huehuetoca, State of Mexico, to Tepeji del Río, State of Hidalgo and San Juan del Río, State of Querétaro, distant populations that are not yet part of the Mexico City Metropolitan Area.

Line one transports approximately 21 million passengers per year, about 200 thousand passengers a day. Travel time is 25 minutes. It has an extension of 25.5 km. in which they are 7 stations of which During its layout, a series of these connect with the STC Metro and Metrobus network, none of these underground and they are located on the old network railway used for cargo transportation.

2.4 Metrotren Nos Chile

As a consequence of the dominant and constant growth of the urban area of the Santiago Metropolitan System (SUMS) arises the metro train Alameda-Nos with 20.8 km of extension, which connect the communes of Central Station and San Bernardo; In addition, with its Alameda and Lo Valledor stations, it connects with Lines 1 and 6 of the Santiago de Chile Metro, respectively, and has a 30-minute reduction in travel time for users of these districts [20].

Suburban trains, the Transport Master Plan 2025 [21] I know described as a low-pollution mass passenger transport system, in seasons travels at distances between 10 to 80 km/h and during the journey to speeds ranging from 50 to 150 km/h, raises a coverage since the city center with sectors fence either [22]. East operates efficiently, since their stations are at a certain distance from each other (between 2 and 5 km).

3. GENERAL DESCRIPTION OF THE WESTERN REGIOTRAM PROJECT

The Regiotram de Occidente project will be the first 100% electric commuter train for passenger transport at a regional level, connecting the municipalities of Funza, Mosquera, Madrid and Facatativá with Bogotá, its operation will be carried out in suburban and urban areas, most of the route will be developed in the existing railway corridor [9].

This project has an approximate length of 40 km, distributed in 25 km in the municipalities of the Savannah of the West, and 15 km in the Capital District. The Regiotram de Occidente starts at Carrera 17 with Avenida Calle 6 in the city of Bogotá, connecting the first metro line of Bogotá, to achieve this connection, it is planned to build a one kilometer section, called "Ramal Metro", which It takes place on the urban roads corresponding to Calle 22 and Carrera 17 in the town of Los Mártires. After the Metro Branch, take the axis of the existing corridor and begin its development towards the west, crossing Av. NQS, Av. Américas, Av. Carrera 50, Av. Carrera 68, Av. Boyacá, the Canal San Francisco and Av. Ciudad de Cali, to Fontibón Station.

The system will have 17 stations, of which 9 nine will be located within Bogotá and 8 distributed along the western savannah layout, using the current train track [22].

Likewise, the new urban stations of this mass electric transport system will require an energy consumption of more than 42 GW/h per year, that is, the equivalent of the annual energy demand of 71,000 inhabitants of Bogotá (Jan, 2021) [23].

3.1 Location

The Western Regiotram project understands the Cundinamarca department in Colombia. A route that goes from its capital Bogotá DC to the western municipalities of Cundinamarca, for this project several scales of location are included from the field of regionalization as they are:

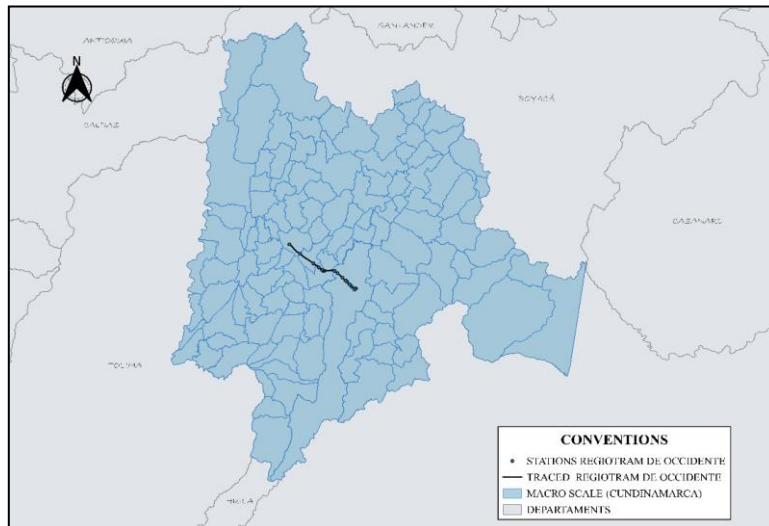
3.1.1 Macro scale

This scale directly includes the delimitation of the department of Cundinamarca, since they are the municipalities and cities that are in an area where their affectation is mostly economic, where the project promotes the department as an area of progress compared to the rest of the country [24-28].

3.1.2 Mesoscale

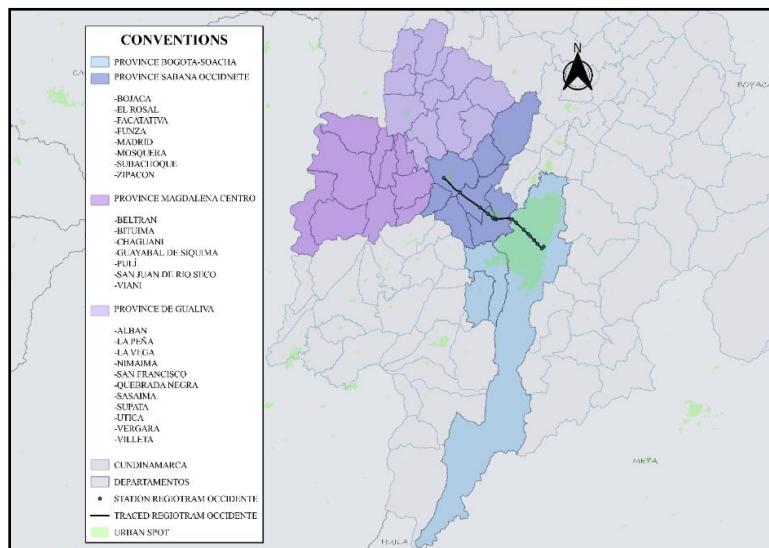
This scale includes different provinces of the western center of Cundinamarca and the capital Bogotá DC where the influence of the project is indirect, due to the fact that this area benefits from the project thanks to its layout, in terms of

mobility, promoting in the same way the which is agricultural and manufacturing trade.



Plan 1. Western regiotram regionalization macro scale

Source: Elaboration of the Authors

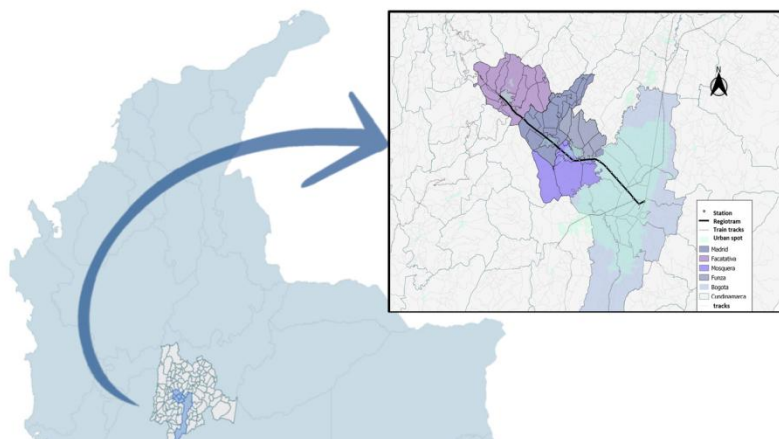


Plan 2. Western regiotram regionalization scale meso

Source: Elaboration of the Authors

3.2 Intervention Area

The intervention area of the Regiotram de Occidente project includes the municipalities directly affected, and it also corresponds to the area where the project layout is located. These municipalities are immersed, since thanks to the passage of the Regiotram increases the economy in a direct way, benefiting the community in its mobility to the capital and vice versa as well as in others important areas. These municipalities are presented in the following map.



Plan 3. Regiotram Regionalization of the West Area of Intervention
Source: Elaboration of the Authors

3.3 Stages

The Western Regiotram is divided into three major stages, the first of which is the pre-operational stage, subdivided in turn into three phases, preliminary, construction, and testing and start-up phase. The second stage or operation and maintenance stage and finally the reversal stage. The table below shows all the phases with their duration and specification:

3.4 Estimated Costs

For this project, construction costs of 5.3 billion pesos are estimated, which were subdivided into the following items:

- Civil Works Construction.
- Property acquisition.
- Audit.
- Financing.

Table 1. Stages and phases of the western regiotram

Stages	Phases	Duration	Activities
Pre-contractual	Previous Phase	18 months	As of the date of the signing of the initiation act, June 24, 2020. In this phase, the Férreo de Occidente concessionaire must carry out studies and designs, in addition to carrying out the environmental impact study and all the activities necessary for the environmental licensing of the project necessary to continue with the construction phase.
	Construction Phase	30 months	The Férrea de Occidente concessionaire must carry out all the necessary activities for the construction of the Regiotram de Occidente project. For example, construction of new infrastructure, removal of unnecessary infrastructure, etc.
	Testing and Commissioning Phase (without passengers)	6 months	During this stage, the trains must run through the entire Regiotram structure, but without passengers, in order to test the safety of the system, the operation of the trains and the stations, and to be able to guarantee that when put the Western Regiotram into operation this will be totally safe for all users.
Operation and maintenance		258 months	The Férrea de Occidente concessionaire must oversee carrying out the operation and maintenance of the project in order to have the service in operation all the time.
Reversal stage		6 months	The entire inventory of the infrastructure associated with the Regiotram must be developed, in charge of the Western Railway concessionaire, to later make the reversion or delivery of the same to the Regional Railway Company attached to the government of Cundinamarca.

Source: Elaboration of the Author

The means of obtaining money will be from three sources, The Nation, the department and the expected income from the rate, it is expected that with the resources of the nation 1.36 Billion pesos will be obtained, with the help of the department there will be 615 thousand million pesos, and lastly, 3.32 billion pesos are foreseen with the rate income.

For this megaproject, two previous values are planned to be analyzed, the value with the Chinese concessionaire which will be in charge of the Férrea de Occidente concession, this has a value of 3.6 billion pesos. In addition, there is a construction inspector made up of different companies, such as Ayesa Ingeniería Y Arquitectura Sau Sucursal Colombia; consultancy in Integral Engineering SAS, and C&m Consultores SA, for the inspection, 71,402,000,000 pesos were allocated (Lozano, 2020).

3.4.1 CAPEX Distribution (Capital Investment)

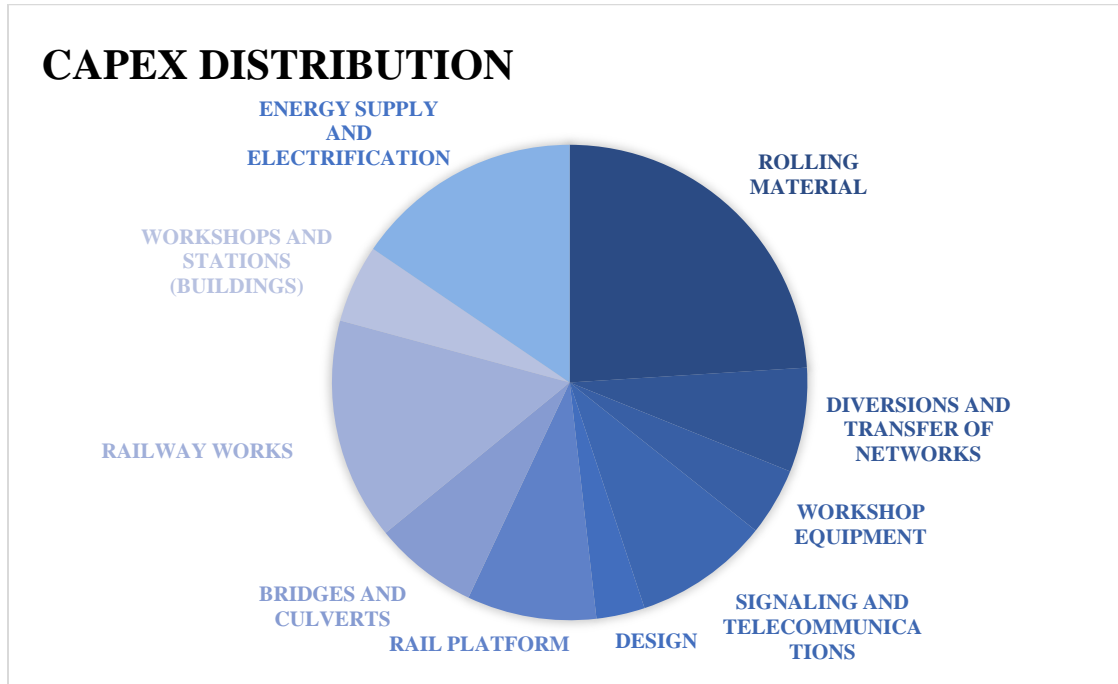
For the Western Regiotram, the capital investment that will be made by the different means already mentioned is taken into account, according to the estimate provided by the Western railway concessionaire, the distribution of this capital investment will be as follows:

Capex distribution	
Description	Percentage
Rolling material	24.0%
Diversions and transfer of networks	7.1%
Workshop equipment	4.6%
Signaling and telecommunications	9.2%
Design	3.3%
Rail platform	8.8%
Bridges and culverts	7.1%
Railway works	15.1%
Workshops and stations (buildings)	5.3%
Energy supply and electrification	15.5%

For the execution of the project there are different stages, such as pre-construction, construction, testing and commissioning, and finally the Regiotram operation process is entered, in which the Operation and maintenance stage is constantly evident. for 22 years (Lozano, 2020).

As indicated in the schedule, each one of the steps is evaluated from June 2020 until the end of the concession of the estimated regiotram in August 2046, in addition, the activities to be carried out are indicated both in the pre-construction area of the project and the activities of construction.

The different phases of the project and their respective duration are evidenced, likewise, some activities of both pre-construction and construction of the work, later the testing and start-up stage without passengers and finally the operation and maintenance stage is presented, which approximately will begin operation in December 2024 and its reversal time in order to end the concession. It is 6 months from February 2046 to August of this year.



Graph 1. Western Regiotram CAPEX distribution

Source: Prepared by the authors based on the CFRO. EFR Booklet regiotram occidental Execution schedule

PRE-CONSTRUCTION ACTIVITIES	CONSTRUCTION ACTIVITIES
Adaptation Workshop K5	Construction Civil works railway
Elaboration of Studies and Designs Eng. Detail	station construction
Environmental License for the Project	Construction of patios and workshop
CODENSA Environmental License	Workshop Construction
Transfer of Networks	Control centroid construction
property management	Construction of electrical substations
Concessionaire Financial Closing	Comprehensive system test

Image 1. Western regiotram schedule

Source: Prepared by the authors based on the CFRO. EFR Booklet regiotram occidental

3.5 Waste

For the Western Regiotram project, two types of waste are handled, hazardous and non-hazardous waste. Hazardous waste is considered as construction and demolition waste, that is, in the construction phase, for the driving This type of waste will be carried out through the provisions of Law 1252 of 2008 and decree 1076 of 2015 [29].

On the other hand, non-hazardous waste is handled, which can be domestic or industrial, within domestic waste there are those that can be classified as recyclable, usable, organic, and non-usable waste. One of the phases with the highest waste production is the construction phase, since solid waste may be generated in the areas of camps, offices, work fronts, and other activities associated with the construction of the Western Regiotram.

It is estimated that the production of non-hazardous waste will be 624.9kg/day, with a production of this waste per capita of 0.3kg/inhabitant/day. As estimated in the following table (Taken from: CFRO. Environmental Impact Assessment):

Table 2. Estimated waste production

Description	Unit	Worth
Solid waste production rate	g/inhab/day	0.3
Number of workers	Person	2083
waste production	kg/day	624.9

Source: Prepared by the authors based on the CFRO. EFR Booklet regiotram occidental

Table 3. Types of regiotram west waste

Type of waste	Composition (%)	Estimated production (kg/day)
Recyclable		
Paper and paperboard	7.5	46.87
Glass	2.2	13.75
Plastic, rubber and leather	11.5	71.86
metals and wood	1.3	8.12
Total	22.5	140.6
Non-Recyclable		
food waste	64.2	401.19
Others: Contaminated without the possibility of recycling	13.3	83.11
Total	77.5	484.3
Total production	100	624.9

Source: Prepared by the authors based on the CFRO. EFR Booklet regiotram occidental

Therefore, a projection is also made of the types of non-hazardous waste that will be generated during the work, as estimated in the following table (Taken from: CFRO. Environmental Impact Assessment):

Table 4. Types of risks in the West Regiotram

Guy	Risks
Natural Hazards	<ul style="list-style-type: none"> • Flooding of the rivers: Bogotá, Botello, Bojacá and Subachoque. • Ceramic events (electrical discharges, caused by electrical storms). • Earthquakes • Mass movements • Rapid loss of strength in saturated soils.
Anthropic Risks	<ul style="list-style-type: none"> • Malicious acts by third parties. • Blockades on railway tracks, riots and riots. • Hostile actions against the execution of the project. • Theft, vandalism, dismantling and/or damage to equipment. • Potential interference with other development initiatives. • Invasions of the corridor by pedestrians, livestock and vehicles.
Socio-Natural Risks	<ul style="list-style-type: none"> • Forest fires.
Operational Risks	<ul style="list-style-type: none"> • Flooding due to overflow of the Ramada. • Damage to public service networks. • Failure in the emission control system (concrete plants). • Differential settlement of the ground. • Collisions. • Failures in the activities of maintenance and operation of the railway system. • Minor spill of oil, fuel and other substances. • Contingencies due to electrical failures.

Source: Elaboration of the authors

3.6 Risks

Risks are events of a natural, anthropic, social or operational nature that may occur during the construction or operation phase of the project, which may have an impact on the components of the environment, on the communities and on the equipment and assets of the project (CFRO. EFR Western Regiotram Primer, 2021).

3.7 Technology to Use

This project has as an initiative the implementation of an electric train, it will be built with infrastructure of the old western train route, the old rails will rise and give way to the new rails, one going and one returning, which will see trains running that will move 130,000 passengers between 4 am and 11 pm They will be wagons manufactured and assembled directly in China, who will travel from the other end of the World they will be Assembled in Colombia.

4. COMPARATIVE FRAMEWORK OF TRAIN SYSTEMS IN COLOMBIA AND LATIN AMERICA.

In the following comparative table, evidence different commuter rail systems in some cities of Latin America, therefore, it evidence the aspects so much technical and operating of each of the trains. Likewise, the demographics to be treated for each city are reflected. It is taken into account that for cities such as São Paulo, which has one of the largest populations plus high in America, the effects of this transport system on society are evident, due to this, it is understood that the larger the city, the more population will benefit from the train.

It should be noted that in the case of the Western Regiotram, this has been a controversial front, the strong delays in its construction due to political and social issues, which have given rise to talk about the adaptation of an effective mobility system, such as the from other Latin American countries. This is why the positive impact that this suburban train could have is high, due to the fact that there are a number of people who carry out their daily operations in the capital city and live in the municipalities near Bogotá, in addition to this, It is expected to benefit the population that lives in Bogotá, because thanks to the route that will be built, from the town of Los Mártires, which is one of the towns most traveled daily, likewise, the towns of Teusaquillo and Fontibón.

5. ENVIRONMENTAL DESCRIPTION OF THE WESTERN REGIOTRAM

The main ecological structure was determined by analyzing the impacts manifested in the different components of the environment, giving emphasis to the analysis of the potential for change induced by the project, in relation to the current situation, considering the transcendence at a spatial level, the importance

Table 5. Comparative chart commuter trains regiotram de occidente

	Colombia	Argentina	Brazil	Mexico	Chile
	Regiotram occidente	Metropolitan Railways of Buenos Aires	São Paulo Metropolitan Trains	Valley of Mexico Suburban Railroad (FSVM)	Metrotren Nos Chile
kilometers of network	40	945	273	25.5	20.8
Electrified Kilometers	40	332.7	273	25.5	20.8
Speed (km/h)	Suburban: 70 Km/h Urban: 28 Km/h	Suburban: 80 Km/h Urban: 48 Km/h	90km/h	65km/h	90km/h
Passengers per year (millions)	40	430	700	21	23
Seasons	17	230	94	7	10
Lines	1	24	7	1	1

Source: Elaboration of the Authors

and persistence of each of them. All from the impact areas determined in the Western Regiotram Environmental Impact Study, the main coverage present in the area of biotic influence are: road network, railway and associated territories (33%), clean pastures (16%) and industrial or commercial zones (15%) and other zones (36%).

According to the analysis of habitat fragmentation and landscape connectivity, it was found that the study area is completely fragmented and with very low connectivity. In terms of flora, 4 species of closed trees were recorded: Oak (*Quercus humboldtii*), Walnut (*Juglans neotropica*) and Romerón Pine (*Retrophyllum rospigiosii*) and 41 species of non-vascular closed season (liverworts, mosses and lichens) of epiphytic, rupicolous and terrestrial, no vascular individuals were recorded in the closed season (bromeliads, orchids, tree ferns).

Likewise, the characterization of the fauna registers the avifauna as the most representative group. The most common bird species are the Swallow (*Orochelidon murina*) and the Dove (*Zenaida auriculata*). Among the other recorded fauna groups are the Savannah Snake (*Atractus crassicaudatus*), the Savannah Frog (*Dendropsophus molitor*), the Fara (*Didelphis pernigra*) and the common mouse (*Mus musculus*), the latter an introduced species.



Image 2. Sabanera Frog (*Dendropsophus molitor*)
Source: Bogotá Wetlands Foundation

From the environmental zoning, it is possible to establish different levels of sensitivity in the project area, according to this, it is part of the planning of management measures in the construction and operation stages.

These are defined as follows:

- **High sensitivity areas:** Areas of economic production and areas of goods of cultural interest, community facilities, areas of economic importance; bodies of water, areas with high risk of flooding and areas in conflict of land use; areas of ecosystem importance: wetlands.

- **Medium sensitivity areas:** Industrial zones, hydraulic system for environmental management and flood control of the La Ramada irrigation district (given its importance in the region's hydraulics).
- **Low sensitivity areas:** Corresponds to the rest of the territory.

6. EVALUATION OF THE ENVIRONMENTAL IMPACT OF THE PROJECT

According to the analyzes carried out using the Delphi methodology, which was contrasted through citizen participation, it was determined the environmental impact of all the activities of the Regiotram de Occidente thanks to the Leopold Matrix, which consists of evaluating each of the project activities in the biotic, abiotic and social components, this impact can be both positive and negative, although according to In this study, it was found that the biotic and abiotic components are the most negatively affected, due to the fact that the previous and construction phase, the latter of which includes the activities for the total elaboration of the work, which are the ones that generate the greatest impact both society as well as the environment.

In the same way, the use of geographical information on the distribution of the railway network generates a view of which and how the environmental effects are generated at the regional level, thus looking at different socioeconomic and environmental factors, among others.

6.1 Leopold's Matrix

In order to know the environmental cause and effect relationship of the western regiotram project, the execution of Leopold Matrix, having take into account the component so biotic, abiotic and socioeconomic environment contemplating the phases of pre-construction, construction and operation of the western regiotram, in which through this to arise I gave them versa activities that are developing the different phases in which will be involved Project. In each of these activities was evaluated using the Delphi methodology, structured communication technique, developed as a systematic and interactive method of prediction, which is based on a group of experts the impact generated by each of these in the three media already mentioned, in addition, in each of the media different environmental factors are obtained that depend on the component to be studied, likewise, each of this component was evaluated according to the activity of each of the phases. In order to analyze the final result and generate greater fullness to the study.

Thanks to the interpretation of data from the Leopold matrix, which gives us a final affectation value of -55, it is noted that the Regiotram de Occidente project is projected negatively with respect to environmental factors, since the construction will bring with it the risk of affectations to the soil, water, flora and fauna, but it is also highlighted that this affectation is not very excessive, since the social factors in which it will intervene, drive it as a high-impact project, which will help develop economic activities that drive the region's economy.

Table 6. Aspects Used in the Elaboration of the Leopold Matrix

Components		Activities		Construction phase														
				Railway civil works construction	Earth movement on the trace	Demand for new surfaces	Deposit of materials	Construction of drainage works	station construction	patio construction	workshop construction	Construction of control center	Construction of electrical substations	positive averages	negative averages	Arithmetic averages	Impact by subcomponent	Impact by component
abiotic medium	Physical	Water	Superficial water	-1	-3	0	-3	-1	-1	-1	-1	-1	-1	1	21	-131	-422	-1194
			surface water	9	3	0	5	9	9	9	9	9	9	0	18	-85		
			flow	-1	-2	0	-1	-1	-1	-1	-1	-1	-1	0	18	-85		
		I usually	groundwater	7	1	0	5	7	7	7	7	7	7	0	4	-22		
			water quality	0	0	0	-1	0	-5	0	0	0	0	0	4	-22		
				0	0	0	5	0	3	0	0	0	0	0	14	-184		
	Atmosphere	Air quality	Changes in morphology	9	3	0	6	9	9	9	9	9	9	0	14	-140	-457	
			soil quality	-1	-2	0	-1	-1	-1	-1	-1	-1	-1	0	14	-140	-457	
			vibrations	9	2	0	6	9	9	9	9	9	9	0	14	-140	-457	
		Air quality		-1	-3	0	-1	-1	-1	-1	-1	-1	-1	0	14	-136		
				7	3	0	6	7	7	7	7	7	7	0	18	-181		
				-1	-5	0	-1	-1	-1	-1	-1	-1	-1	0	18	-181		

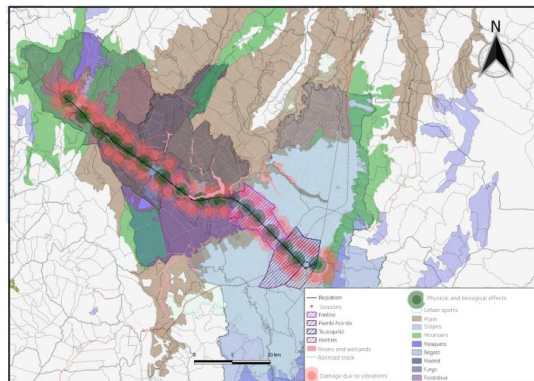
Components	Activities	Construction phase														
		Railway civil works construction	Earth movement on the trace	Demand for new surfaces	Deposit of materials	Construction of drainage works	station construction	patio construction	workshop construction	Construction of control center	Construction of electrical substations	positive averages	negative averages	Arithmetic averages	Impact by subcomponent	Impact by component
	Environmental factors															
	Noise	-1	-8	0	-1	-1	-1	-1	-1	-1	-1	2	23	-173		
	landscaping	7	4	0	4	7	7	7	7	7	7	0	5	-74	-74	
	landscape perception	0	-1	0	0	0	0	0	0	0	0	0	5	-74	-74	
		0	4	0	0	0	0	0	0	0	0	0	5	-74	-74	

Source: Elaboration of the Authors

6.2 Spatial Distribution of Impact through Geographic Information Systems

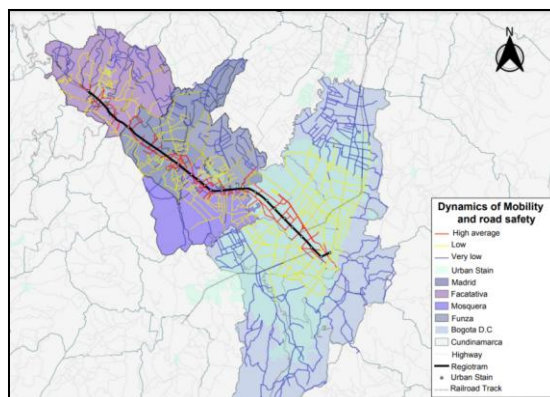
With respect to the spatial distribution of the impacts at the regional level, with the help of geographic information it is evident how the layout of the western regiotram affects the different ecosystems, fauna, the soil at an ecological level and at a social level, characteristics such as electrical networks, networks roads among others.

6.2.1 Soil affectation



Plan 4. Affectation of the Western Regiotram soil in the intervention area
Source: Elaboration of the Authors

6.2.2 Affectation of mobility dynamics



Plan 5. Alteration in the road network, construction of Western Regiotram in the intervention area
Source: Elaboration of the Authors

According to this we can denote how the different characteristics are affected, where the type of magnitude is highlighted, looking like this from the lowest where almost no interference is seen and medium-high or high where the magnitude of affectively increases, an issue that makes us see in which areas the municipalities and the city are immersed in both temporary cuts of public services as the possible environmental impact of the different areas.

7. ENVIRONMENTAL MANAGEMENT PLAN, MONITORING AND CONTINGENCY.

7.1 Environmental Management Plan

According to the environmental factors intervened negatively in the Leopold matrix due to the action of the Regiotram de Occidente project, it is desired to implement environmental management plans, where alternatives are proposed to mitigate the environmental impact that is caused, the actions that will be implemented are also highlighted. to prevent, control, mitigate, correct or compensate the negative environmental impacts and effects that are caused.

7.2 Monitoring Plan

It is estimated that for the Western Regiotram project, the monitoring plan with which measures will be adopted to adequately follow the progress in each of the stages, will be as follows; Different parameters will be handled, whose purpose is to generate knowledge of the execution of the activities to be indicated, this monitoring plan will have the following items, according to the CFRO, 2021.

7.3 Contingency Plan

The contingency plan for the activities that are going to be developed both in the different phases of the project, as well as, within the environmental management plans, the contingency plan of the National Planning Department is evaluated and adapted, said plan identifies , analyzes and evaluates all types of natural and social threats, among others, in order to establish an immediate response to any type of risk.

The contingency plan consists of identifying each one of the risks that may arise, in addition, estimating a probability of occurrence of these threats, establishing preparation and response measures, likewise, defining responsibilities during the contingency and, finally, setting response levels. and specific procedures depending on the threat.

7.3.1 Threat identification

According to the activity, which will be generated by the Western Regiotram project, there are three types of phenomena which can become threats, among these are:

Table 7. Management plan in the biotic component (Fauna)

Component: biotic (fauna)	
<i>Impact:</i> mammals	<i>Cause:</i> Demolition associated with property purchase and acquisition, Construction of the camp, Transfer of networks, Construction of railway civil works, Movement of earth in the trace, Construction of drainage works, Construction of stations, Construction of patios Workshop construction, Control center construction, Electrical substation construction, Railway system operation, Station operation, Train operation, Station operation.
<i>Kind of WFP Activity:</i>	<i>Objective:</i> Carry out preventive constructions identifying the sectors with the existence of mammalian species in the sector.
<i>Management measure:</i>	
<ul style="list-style-type: none"> • At the time of landslides in the sector, keep in mind the places of migration of the species so as not to affect their surroundings, avoiding the location of debris. • Clear rural sectors of rubble as quickly as possible, so as not to impede the passage of species through this sector. • At the time of the operation of the trains, place a sound signal that is not affective for the species, so that when they pass through the railway network, they notify the species of its passage. • In the operation of the Western Regiotram stations, keep transport users informed of the existence of these species in the sector, to prevent damage and injury to them. 	
<i>Implementation time:</i> This will be carried out before and during the execution and construction of the Regiotram de Occidente project, since the existence of species in the area of influence must be controlled.	
<i>Monitoring and control indicator:</i> Number of mammals studied before construction versus Number of mammals studied after construction	

Source: Elaboration of the Authors

Table 8. Management plan in the biotic component (Fauna)

	Description
1. Objective	It specifically and precisely establishes the intended result of the follow-up and monitoring strategy.
2. Associated management plan	The code and associated management plans are indicated.
3. Actions to be developed	Specific measures to be adopted to follow up and monitor the proposed management plans.
4. Monitoring and evaluation indicators	<p>Goal: They are the proposals in the management plan</p> <p>Indicator Description: Parameter to measure through tracking and monitoring</p> <p>Indicator: Indicators corresponding to the goal</p> <p>Criterion: They are used for the planning of each indicator (why these variables were defined as an indicator)</p> <p>Justification: The purpose of the indicator and its representativeness (based on the information used for its calculation) are established.</p> <p>Reference value: Set the efficiency ranges</p> <p>Measurement frequency: Indicates the execution time of the proposed verifications and/or monitoring</p> <p>Actions - information: Actions to obtain the information and/or data that allow calculating the indicators proposed in the PMA</p>
5. Actions in case of low effectiveness	Action implementation scenario in case of finding a low effectiveness of the management program reflected in the indicators.
6. Location of the monitoring or monitoring site	Site, area or route where the follow-up and monitoring measures will be applied.
7. Execution schedule	Indicates the time of application of the monitoring program.
8. Responsible for execution	It establishes the persons (individuals or legal entities) in charge of executing, controlling, evaluating and/or carrying out the proposed follow-up and monitoring and coordination mechanisms between the actors involved in the calculation of the indicator.
9. Quantification and costs	Set the total cost

Source: EFR Western Regiotram PrimerExecution schedule.

- Technological risks.
- Environmental risks.
- Unintentional anthropic risks.

It is estimated that these are the main risks that the Western Regiotram project will have, this is due to the fact that the conditions in which the project will be will be according to the aforementioned criteria.

7.3.2 Probability estimation

The evaluation criteria to assess the probabilities of the threat are estimated as follows:

- If the event is Possible, it is understood that it has never happened and therefore its level of probability of its happening is minimal.
- If the event is Probable, that is, it has already occurred and therefore there are reasons to believe that it could happen again, for this reason, its level of probability is between the intermediate range.
- If the event is Imminent, therefore, it is an evident and detectable event, due to this this phenomenon has a high probability of occurring.

7.3.3 Vulnerability scan

In addition to the estimation of probabilities, the vulnerability of the elements that could be affected in the event of an emergency must be taken into account, for this reason, the severity of the consequences on the damaged elements is established. For this case, three categories are taken into account.

- Damage to people, where there will be different criteria and interpretation of each of these criteria, from the minor that does not generate any injury to the individual, to the presentation of one or more deaths, between this interval of criteria, criteria are generated that are of mild affectation, and rises gradually, in order to evaluate each of the possibilities that could occur.
- Effects on the environment, as is also handled in the previous category, this same is divided, according to its interpretation of the criterion to be evaluated, since it can have this same one, with slight, minor effects and/or even localized contamination, greater. and irreparable, the latter, with a higher assessment when analyzing vulnerability [30-32].
- Economic consequence, likewise, the consequences that the activities could generate must be taken into account, according to the interest of the threat, since it can be from an impact where it can be of internal knowledge without public interest, as well as, a generate affectation of the entity at the national level, generating disgust for the threat [33-37].

7.3.4 Procedures

According to what is established in the analysis of threats and vulnerability, some of the scenarios that could be generated as a result of each of the risks are

presented, the presentation of these is based on a sequence of steps, which must be followed carefully. in order to avoid the greatest vulnerability in the possible affected elements.

8. REGIOTRAM DE OCCIDENTE'S CONTRIBUTIONS TO THE SUSTAINABLE DEVELOPMENT GOALS

The main policy of the Western Regiotram project is to guarantee communication on mobility issues between the region to consolidate a mobility system between the city of Bogotá and the municipalities of the western savannah such as Funza, Madrid, Mosquera and Facatativá. Thus, giving a response from the department towards the modernity and innovation of the comprehensive development of sustainable regional transport mobility, thus contributing to the objectives of sustainable development such as:



- ***SDG 7 Affordable and clean energy***

The 7 SDG emphasizes global access to energy as a development challenge for communities that are in evolution, for which Colombia is one of the Latin American countries with projection and execution of various high-impact projects at the national level such as What is Regiotram de Occidente proposes a non-polluting energy strategy, such as the implementation of 100% electric trains, reducing local atmospheric emissions, reducing noise in its environment, and lower CO2 emissions. Which makes this commuter train propose great maintenance and conservation strategies for the ecosystem of the western savannah of Cundinamarca.

- ***SDG 8 Decent Work and Economic Growth***

Promoting inclusive, sustainable economic growth, full and productive employment, as well as decent work for all, has been a boom for Regiotram de Occidente to be immersed in SDG number 8. Contributing and helping municipalities, development of employment and the economy, thanks to its interconnection as a city-region.

- ***SDG 9 Industry, Innovation and Infrastructure.***

The Regiotram de Occidente is also betting on objective number 9 of the SDGs, with the proposal to build resilient infrastructures, promote inclusive and

sustainable industrialization and encourage innovation, thus creating a new order of mobility operation, with the interconnection of the city and the municipalities of savannah, with a high-efficiency train, which is developed in such a way that it is innovative compared to other forms of transportation in Latin America, creating an infrastructure capable of moving thousands of people a day [38-41].

8.1 SWOT Analysis

As an initiative to the objectives of sustainable development, what can the Regiotram of the West contribute, it was decided to make an analysis between the SWOT analysis methodology, in order to analyze the internal and external factors of the project's performance.

Table 9. SWOT Regiotram West

Weaknesses	Opportunities
<ul style="list-style-type: none"> · Delays due to changes in government policies every 4 years. · Large initial investment to carry out the project. · Environmental effects on the project. 	<ul style="list-style-type: none"> · Implementation of new routes to other western municipalities. · Possible union with Transmilenio and Bogotá metro stations. · Expansion of the cargo network as an alternative for cargo transport.
Strengths	Threats
<ul style="list-style-type: none"> · Improvement of the quality of life of the citizens surrounding the layout area. · Innovation with the implementation of electric trains. · Use of existing routes of the old railway. · Development as a new alternative for mobility between Bogotá and the municipalities of the western savannah. 	<ul style="list-style-type: none"> · Delays due to changes and allocation in budgets. · Delays due to environmental permits. · Delays for land acquisition. · Valuation poorly estimated by public demand.

Source: Elaboration of the Authors

9. CONCLUSIONS

Thanks to the research that was carried out, we can denote that the advancement of technology and the development of communities around the world have been an emphasis for the development of Latin American countries, which have decided to implement new alternatives for transporting users, as it is in the case of Colombia and especially the department of Cundinamarca, which proposes the implementation of its first commuter train Regiotram de Occidente, which brings about great development for the communities of this sector without knowing the positive or negative impact that can be produced in this sector of the country due to the implementation of these projects, therefore, when carrying out the various environmental analyses, social and influential in the conditions of comparison with the other Latin American countries, it is evident that Colombia is one of the countries with the greatest delay in mass transport systems for users, since many countries have implemented this commuter train system at the beginning of the 20th century. 21st century and Colombia executes this project as one of the most influential and innovative according to the Sustainable

Development Goals (SDG) highlighting the new technologies that will optimally improve the mobility of this sector of the country with electric trains that provide excellent efficiency of route and food to the users of the system.

It is also highlighted, with the development of various environmental research methodologies, such as the Leopold Matrix, the environmental contingency plans, among others, we can notice how the project despite the fact that it will impose a great advance in mobility issues between the city and the region, this is immersed in environmental conflicts with different ecosystems, it is where it is denoted if the Western Regiotram will adopt special care with the environmental media in its different phases of construction, in order to meet both the development objectives of the country and its interaction with the world.

10. QR ADDITIONAL INFORMATION



In the following QR code you will find information of great importance for the development of knowledge such as plans of various environmental impact assessments, the complete Leopold matrix, and environmental management plans with highly relevant information according to the effects of the Leopold's matrix.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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