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INTERMODAL COMPETITION OF MINING FREIGHT TRANSPORTATION: THE CASE OF PERU

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Abstract

The research shows a comparative analysis of land transportation infrastructure where there is an intermodal competition in Peru, specifically between the Road and the Rail in the Central Region. Based on this analysis, it is established which means of freight transportation are used to carry goods such as solid bulks, by? incorporating producers and consumers who compete for mining logistics to the Callao Port. The results show that transferring the mining freight from the road to the rail reduces traffic congestion from heavy truck use.

Keywords: Transport infrastructure, intermodal competition, transport mode, freight transport means, solid bulk, mining logistics.

1. INTRODUCTION

1.1. Problematic situation

The Central Road has collapsed because of an increase in traffic that makes it unsafe, due in large part to being saturated with heavy trucks, which leads to the carriers decreasing their speed, and consequently to assuming a greater economic cost of vehicular congestion, considering the lost time in traffic. However, the alternative solution to this problem of roadway expansion and improvement of geometry is virtually unthinkable from the geodetic and economic point of view, so it is necessary to introduce an alternative modal in the land transportation of goods such as minerals, that can reduce their commercialization costs.

1.2. Background

In Peru, since the appearance of automotive transport by road, this one faced competitively with the railroad, the same one that already had a previous development of 50 years, nevertheless, this railway transport system of the central and south of the country has been witnessing a slow decline, even though in other countries a balance has been currently reached in terms of cargo volumes that are transported.

In the modal distribution of freight transportation in different economies of the world - including 28 countries of the European Union, USA, Japan, China, and Russia- the maritime and highway modes carry the highest percentage with 33%, while the rail is approaching with 22% of the total load in billions of Ton-Kilometers, according to the European Commission (2018) [1]. However, this intermodal competition is far away from our reality, where in the studies of the Intermodal Transport Plan PIT 2004-2023 of the Ministry of Transport and Communications - MTC establishes an "interurban cargo" transport by 74% on the road, 13% by the rail mode, 12% by sea, and 1% between river and airway (MTC, 2005) [2].

The productivity of Peru is strengthened in the mining exploitation, so there has been an expansion of the road network with the primacy of this transport system over the rail, this is how the Central Rail competes directly with the Central Road, however, this last route has exceeded adequate traffic for which it has been designed, increasing costs in the product commercialization on the Central Region, so it is propitious to pay more attention to the rail ? certain mining centers move their goods to complete their mineral commercialization chains.

Casapia (2014) [3] notes these both modes of competitive transport are the "Central Bimodal", which integrates the regions of Pasco, Junín, and Lima with Callao Port, deducting a road load with Origin-Destination Lima in a proportion 3,5 times higher than in rail, which leads to its saturation (see Figure 1).

The high level of road congestion not only occurs when you arrive in Lima and Callao city but also comes from La Oroya city, due to the increased volume of traffic and the little capacity of the road, that is narrow cross-sections with a higher count than six thousand vehicles per day, and of which one-third of the flow is made up of heavy trucks.

The Central Road is currently under concession by Deviandes S.A.C. since 2010 with a length of 377 Km, and their job is to perform routine and periodic maintenance, postponing rehabilitation. Their income comes from the collection of tolls in Corcona, Casaracra, and Quiulla, to which an additional toll would be added, covered by the minimum guaranteed income granted by the Government.

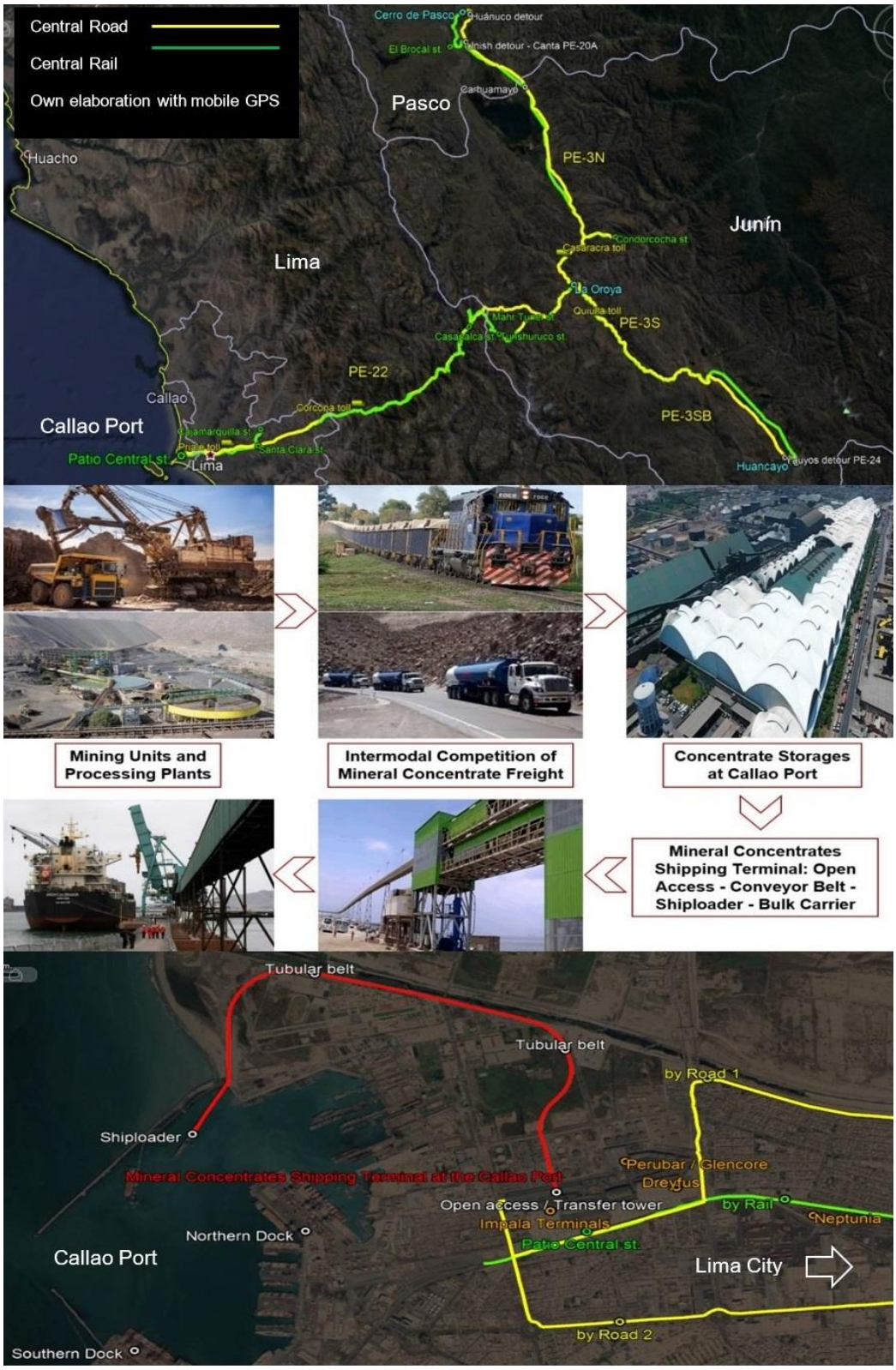

Figure 1. Intermodal competition of the Central Bimodal and concentrate shipping in Callao Port

In 1999 the Central Rail was concessioned to Ferrovias Central Andina S.A. - FVCA, their infrastructure and tractive material (locomotives) and rolling stock (wagons and cars) came from the National Company of Railways - Enafer. The railway with a standard gauge of 1,44 m and an extension of 477 Km has been rehabilitated and its railway park has been renovated. Their rates come from charging for railroad use per Km traveled but paying a percentage of their income to the Government.

The importance of the storage and shipment coming from the Central Region falls in the Callao Port, it is about the logistics chain of the minerals exported between the mine or the concentrator plant and the ships that are loaded in the port, although the bad choice significantly increases the total cost of transport and hinders the fluidity and efficiency of freight transport along the chain.

Since the end of 2014, the export is developed through the concession of the Mineral Concentrates Shipping Terminal to Transportadora Callao S.A. - TC, the same one looks for the efficiency in the export port activities of concentrates, and includes a hermetic conveyor belt system from a public access point (open access), a transfer tower, and the dock (ship loader) intended to serve 2 thousand tons/hour and ships of up to 60 thousand deadweight tons (DWT).

The benefits of the shipping system are 5 times faster than the previous system, which reduces waiting time at bay by 8 days, reduces 3 days at the dock, and has replaced approximately 369 thousand truck trips between storages and the port.

1.3. Objective

Analyze the adequate intermodal competition in the transport of mining freight, which reduces traffic congestion in the Central Region.

1.4. Justification

The traditional mining sector is the main exporter of our country, ? 2017 had around 61% of the total value of FOB exports, it means US$ 26.809 million, growing 27.4% concerning the previous year due to the increase in copper exports (36%), iron (27%), zinc (32%), and the rest (42%) (SUNAT, 2018) [4], which has been driving GDP growth, this indicator measuring the generation capacity of wealth in the economy.

In the absence of refineries in Peru, more than 95% of mining production is sent to the foreign market, including mineral concentrates (copper, lead, silver,

gold, zinc, and molybdenum), which have been commercialized internationally through the private channel, constituted by national and foreign producers and traders who are in charge of mobilizing the total exportable production of these concentrates, making use of the logistics and their means of transportation.

Due to the extensive use of freight trucks with the premise that it is the one means to meet the marketing schedules, year after year the traffic congestion on the Central Road increases in rates for which its transport infrastructure was not designed.

According to Thomson and Bull (2002) [5], congestion is the condition that prevails if the introduction of a vehicle in a traffic flow increases the circulation time of the others. In that sense, Ortúzar and Willumsen (2011) [6] defines that congestion arises in conditions in which the demand approaches the capacity of the traffic infrastructure and the transit time increases to a much higher value than the one that prevails in conditions of low demand.

The Central Region has another means of transport, the Central Rail, which is much more efficient for large volumes of cargo and long distances, however, it does not have the same conditions of equity, even though the National Rail Development Plan (MTC, 2016) [7] indicates its purpose that contributes to the competitiveness of exports.

The transport infrastructure for public use must comply with the fact that it reaches more places faster, that it is cheaper, safer, more comfortable, and mainly that it reduces the infrastructure gap and increases the country's competitiveness; so, this research analyzes the relationship between the problem of truck congestion with mining cargo on the Central Road and the solution according to the relative theory in which rail transport is more efficient and more economical.

2. METHODOLOGY

This non-experimental research work is carried out based on a descriptive-comparative methodological approach, trying to study the relationships of influence established in a technical and economic comparative analysis of the transport of land mineral cargo, both on the Central Road and the Central Rail in service, to know the modal alternative to traffic in the vehicular infrastructure.

Both the population and the sample under study include the two land infrastructures for public use in the Central Region, such as the Central Rail and the IIRSA Highway, Section 2 Center (Amazonas Centro Multimodal Axis).

The mining logistics chain is evaluated from the plants in the mining units up to the Callao Port, which comprises the intermodal competition of the freight analyzing both the Annual Average Daily Index - IMDA of the vehicles passing

through counting stations of the Central Road and its alternate routes, and the demand for trains from the Central Rail's shipping reports, thus totaling the units that arrive at storage in the port, which then proceed to dispatch the mining cargo by maritime means through the traffic movement of the Mineral Concentrates Shipping Terminal in the Callao Port.

3. RESULTS

3.1. Mining productivity in the Central Region

The research area covers the Central Region of the country, in which for many years it has been producing metallic mining activity, particularly in the Andean orography of the Regions of Lima, Junin, and Pasco, consequently the research is directly circumscribed in 20 mining units, including 15 with underground mining exploitation method, 04 surface mining, and 01 refinery that is Cajamarquilla, which are taken from the Map of Main Mining Units in Production of the Ministry of Energy and Mines - MINEM (2018) [8].

3.2. Intermodal competition of mining freight transportation of the Central Bimodal

A century ago, the mining transfer between Andean mountains from the units of the company Cerro de Pasco Copper Corporation to La Oroya and El Callao was carried out through the rail, but the later appearance of the heavy freight vehicles and the completion of the Central Road in 1936 showed that its logistics could be reduced, even more so when it would not exist at that time and would last until today, a fair price between the toll payment per axle and the equivalent axis deterioration that causes overloading the road.

Due to the difficulty in obtaining information on the transport of minerals through the country's roads, many of the land transport units crossing control points or stations are counted, therefore, the MTC obtains the IMDA by type of vehicle according to road sections, which for the Central Region between the data MTC (2013) [9] and MTC (2016) [10] -the last year with the information is counted in that ministry- Table 1 and Figure 2 are analyzed.

The table shows the number of vehicles that use the Central Road (PE-22, PE-3N, and PE-3S) and alternate routes in both directions. According to the demand classification of the Road Manual (MTC, 2018) [11], if there was a road with "IMDA greater than 6.000 vehicles/day ... it would be a First-Class Highway ... with two or more lanes of 3,60 m minimum width ... and central separator of

6,00 m ... ", that is to say, a typical section would measure a minimum width of 20,40 m, however, it still has a road of 6,60 m, which is why still has drawbacks with its geometric design and therefore problems of vehicular congestion.

It is convenient to observe the means of heavy transport of 6 axles like the trucks T3S3 (tractor of 3 axes and semitrailer of 3 axes), that include to the encapsulated miner trucks with that move the concentrates towards the port. These increase in flow at a rate of 1 to 5% per year on average, although in Carhuamayo (between Cerro de Pasco and La Oroya) this movement was extended up to 20%.

Table 1. IMDA 2013 - 2016 in the Central Region

Control Station	Route	2013					2016				
		L.V.	**P.T.**	**F.T.**	**IMDA**	**T3S3**	**L.V.**	**P.T.**	**F.T.**	**IMDA**	**T3S3**
Corcona	PE-22	2.150	1.034	2.376	**5.560**	1.061	2.570	1.090	2.539	**6.199**	1.077
		39%	19%	43%		45%	41%	18%	41%		42%
Tambo de Viso	PE-22	2.121	750	2.558	**5.429**	1.081	2.370	876	2.764	**6.010**	1.182
		39%	14%	47%		42%	39%	15%	46%		43%
Casaracra	PE-3N	1.272	446	1.730	**3.448**	688	1.776	654	2.112	**4.542**	795
		37%	13%	50%		40%	39%	14%	46%		38%
Carhuamayo	PE-3N	1.054	302	1.017	**2.373**	490	1.223	407	1.717	**3.347**	788
		44%	13%	43%		48%	37%	12%	51%		46%
Quiulla	PE-3S	1.520	517	884	**2.921**	464	2.723	617	984	**4.324**	352
		52%	18%	30%		52%	63%	14%	23%		36%

Both directions
L.V.: Light Vehicle — cars and trucks
P.T.: Public Transportation — rural truck and buses
F.T.: Freight Transportation — 2 and 3 axles trucks and articulated trucks

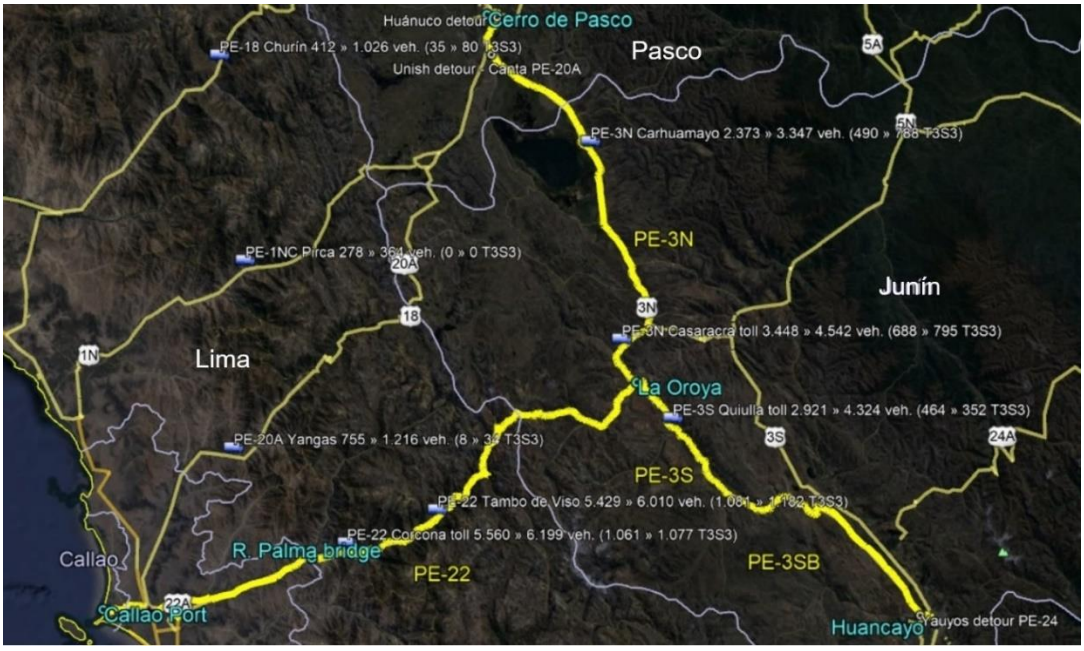

Figure 2. IMDA 2013 - 2016 in the Central Region

As the transfer by heavy vehicles has been analyzed, it can also compare the movement of trains - locomotives and wagons - and their respective freights through the Central Rail, whose information comes from the FVCA concessionaire, this is the Table 2 of the Accumulated Customer Report for Loading Mineral Concentrates (FVCA, 2017) [12].

Table 2. Freight transportation in Central Rail, destination Callao 2017

Cu Concentrate from mining unit/plant to Callao Port:

Company	Origin	Destination	WMT	%
Minera Chinalco Perú S.A.	Tunshuruco	Patio Central	1.169.924	99%
Sociedad Minera El Brocal S.A.A.	El Brocal	Patio Central	11.374	1%
Milpo Andina Perú S.A.C.	Unish	Patio Central	1.264	0%
Compañía Minera Atacocha S.A.A.	Unish	Patio Central	158	0%
			1.182.719	

Pb Concentrate from mining unit/plant to Callao Port:

Company	Origin	Destination	WMT	%
Milpo Andina Perú S.A.C.	Unish	Patio Central	15.443	51%
Compañía Minera Atacocha S.A.A.	Unish	Patio Central	14.108	46%
Volcan Compañía Minera S.A.A.	Mahr Túnel	Patio Central	835	3%
			30.385	

Zn Concentrate from mining unit/plant to Callao Port:

Company	Origin	Destination	WMT	%
Volcan Compañía Minera S.A.A.	Carahuacra / Mahr Túnel	Patio Central	173.562	92%
Milpo Andina Perú S.A.C.	Unish	Patio Central	9.115	5%
Sociedad Minera El Brocal S.A.A.	El Brocal	Patio Central	4.131	2%
Empresa Administradora Cerro S.A.C.	Cerro de Pasco	Patio Central	1.607	1%
Empresa Minera Los Quenuales S.A.	Casapalca	Patio Central	161	0%
			188.577	

WMT = Wet Metric Tons

The origin of the transport of copper, lead and zinc concentrate in 2017 through the railway line to the Callao Port (Patio Central) comes from the beneficiation plants and/or mining units in production, being the main customer of the railway the Minera Chinalco with 99% in the case of copper, Volcan with 92% with zinc, and the distribution of the lead concentrate between Milpo with 51% and Atacocha with 46%, however, both have come to conform currently the company Nexa Resources, which consequently would take 97%.

3.3. Mining logistics in Callao Port

Regardless of the supply chain to the mines, the logistics chain organizes transport to deliver the products from the processing plants to the final customer. Whether using the Central Bimodal or other alternative routes, the purpose of the

Mining Companies is to complete said chain towards a refinery or Callao Port, according to the commercialization contract that has subscribed.

Due to the demands of mineral deliveries, the majority of mining companies subcontract the organization of transport to logistics operators or traders, which offer the service of mining logistics consultancies, such as hiring transport companies, collecting and moving the merchandise, hiring storage, transact in customs and maritime shipments. Among them strategically are Trafigura Perú S.A.C. (ex Cormin) and Glencore Perú S.A.C.

The Business Plan of the Concentrates Shipping Terminal (TC, 2018) [13] details the 2017 traffic of the feed stores used in port, such as Impala Terminals with 45%, Perubar with 33%, Chinalco with 15%, and Dreyfus with 7%; which is complemented with the information from the General Summary of Ships and Freight Traffic at the Mineral Concentrates Shipping Terminal (OSITRAN, 2018) [14], from Table 3.

Table 3. Export of concentrates, Transportadora Callao 2017

Total bulk carriers	Solid bulk – Zn Mineral MT	Solid bulk – Cu Mineral MT	Solid bulk – Pb Mineral MT	Total Exports MT
182	1.175.862	1.506.644	290.584	2.973.090
	40%	51%	10%	100%
Total WMT exported by Transportadora Callao			2.973.090	77%
Total WMT exported by big bags in containers			880.385	23%
Total WMT exported by Callao Port			3.853.475	

In 2017, some 182 ships or bulk carriers were attended with an average of 16.450 MT and totaling 2.973.090 tons of cargo, representing 77% of the total export of mineral concentrates in Callao Port and 26% of the total exported in Peru.

Among the main problems that can see in the Callao Port is because they still export concentrates in big bags inside containers with 23% of the total exported, that show the concessionaire has been recording losses in its income statements associated with the fact that the load served by the Terminal is substantially less than projected.

With the previous information, it can be compared to the mining units and their concentrating plants of the mining production in the Central Region, the number of heavy truck movements, the number of mineral concentrate transport wagons, and the exportation that makes use of the conveyor belt from the Mineral Concentrates Shipping Terminal at the Callao Port.

4. DISCUSSION

Transportadora Callao mobilized a total of 2.973.090 WMT between copper, zinc and lead concentrate in 2017, and if the Central Rail transported 1 391.644 WMT in the same year with the same characteristics, the difference informs us of the tons that were sent in trucks to Callao, in other words, 1.581.446 WMT, which corresponds to 47% and 53% respectively, depending on the transportation mode.

Following an analysis based on the factthat an encapsulated mining concentrate truck has an average payload of 30 WMT, it results that the number of trucks per year that arrived at the port was 52.715 with a frequency of 144 trucks/day.

Studying the Corcona control point and transferring the freight from the road to the rail, the IMDA would be reduced by 5%, with only an average of 288 trucks in both directions. When including in the change of freight to the transport trucks of big bags, around 450 units would be replaced per day between their concentrator plants and the port, that is to say, 42% of trucks with 6 axles, which would result in the decongestion of vehicles heavy not only on the road but particularly in the access to Lima and the maritime port of Callao.

5. CONCLUSIONS

The development of infrastructure about the land transportation means has been consolidated according to the technological prominence of their means of transport so that the average operating costs of a truck are significantly lower than the rolling and tractive material used by a train. While the infrastructure of transport on roads with a flexible pavement has a lower cost in investment than the rail, nevertheless the first receives a greater subsidy although the railway has higher stranded costs with an average period of use of 80 years in operation before being rehabilitated, depending on the pound/yard of their rails and their freight capacity per axle they support.

The rail must guarantee the socio-economic benefit of the country, reducing vehicular congestion, saving the travel time and the vehicular operation cost, the reduction of traffic accidents, and especially to lower the costs derived from the intensive use of trucks, in other words giving priority to safety policy, environmental health and social responsibility.

As indicated by OECD (2014) [15], the development of transport infrastructure is necessary to reduce logistics costs and increase sustainable

growth in the region, closing the infrastructure gap; Latin American economies could increase the GDP growth rate by 2 percentage points each year and should invest around 5.2% of the regional GDP, being a good option to achieve the strength of the country's competitiveness.

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