www.cepal.org/transporte

Issue No. 310 - Number 7 / 2012

BULLETIN FAL

FACILITATION OF TRANSPORT AND TRADE IN LATIN AMERICA AND THE CARIBBEAN

Port-rail integration: challenges and opportunities for Latin America

Introduction

At a time when connectivity to the hinterland is becoming ever more important, many Latin American ports are upgrading their rail connections to turn them into a competitive differentiator. This issue reviews the cases of North America, Asia-Pacific and Europe, identifying the main issues that have driven port-rail integration as a source of port competitiveness. It goes on to examine the case of Latin America in order to pinpoint the main challenges facing its industry and the potential benefits of greater modal integration for the competitiveness of ports and the entire regional economy.

Port-rail connectivity is a strategic element of port development, both in economic and competitive terms and to reduce negative externalities on people and the environment. Not only does proper rail connectivity expand the port hinterland —and so increase the capture of new value added freight and services for the port— it also promotes growth in capacity without affecting the port-city relationship, by linking "spatially" fragmented processes without congesting the urban environment surrounding the port.

Even though railways represent a tremendous opportunity to improve port competitiveness, their effectiveness varies according to the particular characteristics of each industry. Geographical and economic aspects, industry structure, type of foreign trade and institutional structure are some of the factors influencing successful implementation. For example, concentration and geographical location have a major influence on potential transport volumes and thus on the competitiveness of rail, especially in the case of raw materials such as bulk minerals or agricultural products. Similarly, in cases where competition is mainly between port ranges, the railway has proved useful in competing effectively for discretionary cargo.

This issue analyses port-rail integration as a factor of competitiveness in Latin America's port industry. Section 1 makes a brief conceptual review of the importance of rail as a factor of port competitiveness. Section 2 discusses

This issue of *FAL Bulletin* analyses the role of good modal integration between port facilities and the rail network to ensure port competitiveness.
It is one of the activities carried out by the ECLAC Infrastructure Services Unit under a project on sustainable transport in Ibero-America, funded by Puertos del Estado de España.

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UNITED NATIONS

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GOBIERNO DE ESPAÑA MINISTERIO DE FOMENTO Puertos del Estado

the role played by rail in (intra-) port competition in the light of international experience in North America, Asia-Pacific and Europe. Section 3 examines port-rail integration in Latin America, its main characteristics and remaining challenges. Section 4 puts forward a set of recommendations for enhancing modal integration and extending its benefits to society as a whole.

I. Port and rail competitiveness

The importance of rail in port competitiveness dates back to the early models of port development postulated by Taaffe and others (1963) and Bird (1980), who focused their analysis on the geographic expansion of transport networks through more and better integration of ports with railways, to meet the demand for accessibility and greater competitiveness by production sectors involved in exploiting raw materials in underdeveloped countries. Later Hayuth (1981 and 1988) incorporated into the analysis containers and intermodality as new factors enhancing a port's competitive position. Slack (1990) and Kuby and Reid (1992) focused on exploring the spatial dynamics of transport networks, pointing to the growing importance of inland terminals and the spatial characteristics of integrated inter- and multimodal services, where rail services play a key role not only in competitiveness *per se* but also in inter-port competition. Robinson (2002) and Carbone and De Martino (2003) stressed the importance of a new paradigm: ports must be understood as a link in the value chain (supply) whose degree of functional and organizational integration extends beyond ship-port relationships to encompass the port-hinterland relationship as being of equal or greater importance. Notteboom and Rodrigue (2005) conceptualized these new relationships by incorporating the regionalization phase into port development models, where access to a "discontinuous hinterland" relies primarily on railway development or on inland waterways, which together with road transport lead to the development of "networks of regional load centres" that are integrated functionally and organizationally with logistics zones, dry ports and inland distribution centres. Complementing the above, Cullinane and Wilmsmeier (2011) returned to the port development concept, arguing that dry ports and inland load centres play an important role in the "structural transformation" of port development. According to this concept, it is crucial to integrate hinterland infrastructure with the sea transport leg in order to extend the port development life cycle, where rail is seen as a key element for resolving problems of economies of scale, congestion and lack of space typical of the mature stage in a port's development life cycle.

Accordingly, the railway is crucial to port competitiveness, either by increasing accessibility, providing more efficient and reliable services, or promoting the spatial growth of ports with less impact on people. Despite these advantages, the rail share in the modal split of freight transport differs quite markedly across the various regions of the world. Such differences could be explained by a number of conditions required for railways to become a source of port competitiveness, as discussed in the next section.

II. Key prerequisites for rail to become a source of port competitiveness: international experience

A review of international experiences is very useful for identifying patterns of development based on evidence and actual experience, which are extremely helpful to decision-making in the region. Such a review is a valuable way to explore the challenges facing Latin America. A case review of Asia-Pacific, Europe and North America reveals at least four important prerequisites for effectiveness: (i) geographical and economic aspects, whose main impact is on cargo demand; (ii) return and risk aspects of the industry's competitive structure; (iii) structure of foreign trade, which influences not only aspects of demand but also the types of service that can be offered; and (iv) institutional aspects and public-sector technical regulations concerning business development.

Geographical and economic aspects

The ***geographic distribution*** of production or consumer markets is one of the main drivers for port development based on rail connectivity. A combination of high-concentration, high-volume production or consumption creates the conditions for achieving the minimum efficient scale of railway operation. When such activities or population centres are located in the hinterland, distance promotes not only the minimum efficient scale but also integration with a port, creating a transport network.

In the case of North America, particularly the United States, railways have been used to link the Atlantic and Pacific coasts with other major high-volume, high-concentration urban and production centres, such as Kansas City and Chicago. Port-rail links are essential not only for trade integration between hinterland cities and the rest of the world (including the North American Free Trade Agreement (NAFTA)) but also to support domestic trade flows between hinterland cities and coastal areas. As a result, in 2007 rail's modal share of domestic freight transport was 43%, exceeding road transport's share of only 32.8%. Rail's modal share of NAFTA imports into the United States totalled 20% in 2007, very close to the

road transport share of 21%, which was second only to maritime transport's 39% share.

Europe's major conurbations and clusters of economic activity are concentrated in the hinterland, which gives railways the opportunity to integrate the hinterland with "gateway" ports or load centres (Notteboom, 2010, 2002 and 1997). Inland waterways also provide access to the hinterland but the two modal options are not mutually exclusive; indeed, they are complementary, accounting for a combined total of a little over 22% (16.5% rail) of Europe's modal share of hinterland traffic in 2009, still a long way behind road transport's 75.5% share.

The fact that most Asia-Pacific economies are export-oriented encouraged production centres to be sited near the coast to lower the cost of access to international transport networks. In contrast to North America and Europe, which expressly sought to develop hinterland access, in Asia-Pacific sharp political differences and the region's geography have severely constrained the development of hinterland connectivity. This has fostered coastal urban growth with railway development confined to highly specific forms of transport, mainly to do with the exploitation of raw materials in the continent's interior.

The ***relative location of the port*** is another important factor added to the aspects discussed earlier. Ports equidistant from, or located in an intermediate position in relation to, the world's main consumption and production centres tend to follow a pattern of development consistent with the shipping network configuration. This leads them to integrate themselves competitively with other feeder ports, prioritizing the coast over hinterland development, with the result that rail links are less important. Prime examples are the ports of Hong Kong, Busan and Kaohsiung, which initially acted as hub ports (Yim Yap and others, 2006), neglecting their internal development with the hinterland. In contrast, ports like Shanghai (Singapore), Shenzen (China) and, more recently, Qingdao (China) and Tanjung Pelepas (Malaysia) challenged that position during the first decade of this century and have gone on to become the main peripheral ports rivalling the competitive status of the traditional hubs (Slack and Wang, 2002; Low and others, 2009; Rimmer and Comtois, 2009; Ducruet and others, 2009).

Of necessity, ports located in central areas, that is to say those adjacent to consumption or production centres as in North America, require higher levels of overland access, particularly by rail, when their main markets are located in the hinterland and represent high production or consumption volumes. A special case is where the two positions are complementary, as in Western Europe, where most ports are sited both centrally to the continent's major markets and in an intermediate position in relation to the world's main shipping lanes (Ducruet, 2006). The importance of rail in this case is twofold: first, rail is vital in decongesting the port node, especially as transshipment totals as much as 75%; second, rail can be used to link together and exploit economies of scale between the port node and dry ports carrying out value added or other public service-related activities, which have been relegated to the hinterland to address congestion problems stemming from increased freight.

Structure of the industry

The ***maturity of the port industry*** usually leads to problems of diseconomies of scale, that is to say, severe congestion, high private and external costs, and lower financial returns and service output. Dry ports are one means of addressing such problems, and railways are essential in linking spatial development processes that become fragmented at a certain point in a port's maturity. Coupled with high hinterland concentration, this creates the necessary conditions of volume and distance to achieve the abovementioned minimum efficient scale. For instance, during the pre-sub-prime crisis period (2009) ports such as Los Angeles/Long Beach (LA/LB) suffered capacity and congestion problems, which could have been much worse without rail connectivity. In the case of Europe, the network of logistics centres spanning much of Western Europe, known as the 'Blue Banana' belt, have been based mainly on rail links, which, as mentioned earlier, are also integrated competitively with inland waterway and road transport.

Similarly, certain ***competitive industry structures*** are more dependent on port-rail integration. Where the dominant structure is competition between port ranges, greater market coverage incurs higher costs in the land transport leg, making the integration of ports with railways crucial in competing for discretionary cargo (discontinuous markets). For example, the aforementioned congestion problems in LA/LB prior to the crisis have raised high expectations for the position of Mexico's largest seaport, Lázaro Cárdenas, and its direct access to the NAFTA market by full integration of the railway through Laredo, which would be less competitively served by road. Furthermore, in industries dominated by competition between ports in the same range, as in Europe, volume rather than distance is the overriding factor for port-rail integration. Similarly, the evolution of the European Union is one of the biggest challenges for the port industry, especially for railway development, as the integration of Eastern European countries opens up windows of opportunity to both the port ranges that predominate at present and those that have been little involved in the European context up to

now, such as ranges on the Baltic Sea, Adriatic Sea or Black Sea, as improvements in their hinterland connectivity would allow them to exploit competitively their proximity to trans-oceanic routes (Ferrari and others, 2006).

Structure of foreign trade

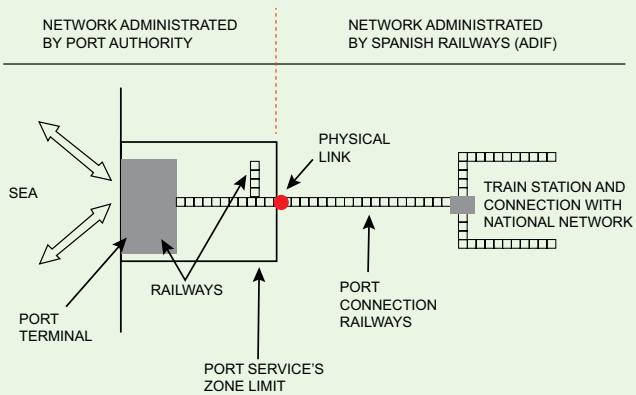
The concentration of high volumes of raw material extraction/production in a specific location encourages railway implementation through economies of scale. When distance from ports is factored in, the costs of road transport can make the activity unsustainable from a private or social perspective. In the case of general freight, the activity is usually fragmented and scattered throughout the port hinterland, with the result that railway implementation will depend more on how concentrated local economic activity is, the volumes involved and distance from the coast. In this instance, the main competitive advantage for railways, in addition to volume and distance, is the logistics service, where route reliability and safety of the chain are key factors. Intraregional cross-border trade can become a major driver of railway development, which the port sector is able to capture competitively. For example, the high percentage of intraregional trade in the European Union, totalling as much as 65%, has facilitated the implementation of international rail infrastructure, a development that some ports have used to capture discretionary cargo, adding international trade volume to their freight transport matrix. Thus, rail has become an important factor of competitiveness and driver of competition between port ranges, as has occurred in NAFTA, where increased north-south traffic to and from Mexico and Canada has led to the development of integrated rail infrastructure from the port of Lázaro Cárdenas through Laredo.

Institutional framework and technical regulations

The institutional framework has a significant impact on railway development in a number of ways, combining regulatory aspects, the degree of fragmentation/concentration of authority and the coordination and influence of the various levels (local, national and regional). For example, cabotage restrictions in the United States have favoured railway development by limiting the degree of substitution between the two modes of transport (Brooks, 2009). Similarly, where regional cabotage is permitted, there is a possibility of complementing modes of transport and fostering multimodality, as in the case of the European Union's trans-European transport network (TEN-T) programme, which seeks to harmonize the transport system by building complementary land corridors that link by rail all 22 major ports in or close to one of the corridors.

Spain is an interesting example of an institutional framework where rail has lost market share to road transport and now represents only 6% of all freight moved through Spanish ports (Góngora, 2011), compared with an average 10% in northern European ports. To remedy this situation, in 2011 Spain's Ministry of Development, Railway Infrastructure Administrator (ADIF) and Puertos del Estado set out to improve the rail network's integration and coordination with Puertos del Estado to promote rail freight and the competitiveness of Spanish ports. A set of institutional arrangements was made setting out and coordinating operational aspects of the network, as well as each entity's rights and obligations regarding the physical link and management of rail operations within ports. Special attention was paid to demarcating the connection points between the infrastructure managed by ADIF and the intra-port infrastructure managed by the respective port authorities, as shown in figure 1 below.

Figure 1
RAIL NETWORK MANAGEMENT IN SPANISH PORT AND RAILWAY COMPLEXES



Source: Antonio Góngora, *Estrategia Ferroviaria en Puertos del Estado*, May 2012.

Also, some Spanish ports, like Barcelona and Tarragona, have already incorporated internal rail developments into their port planning via a rail master plan, which considers the various port infrastructure investments and interventions needed to reorganize the internal rail network and gears their criteria and geometry to meeting the new logistical requirements (Rodríguez Dapena, 2009).

National or regional technical regulations also have an influence. For example, while the diversity of rules on the maximum allowable weight for road vehicles between different States in the United States limits the competitiveness of road transport, the nationwide system of railway concessions facilitates railway operation throughout the United States and the rest of NAFTA. In the case of Europe, lack of a standard gauge, particularly on the Iberian Peninsula, as well as other aspects relating to the maximum length or electrification of train sets act as major barriers to the development of regional business and integration (Barreiro, 2011).

China's recent hinterland development, driven by rising production and distribution costs in coastal areas, has prompted the authorities to boost the development of dry ports in both coastal areas and the hinterland, where rail is used to connect dry ports with sea ports (Beresford and others, 2012). As mentioned earlier, the traffic structure in the ports of Shenzhen and Shanghai appears to be shifting from transshipment to local traffic, increasing the need to connect the hinterland and hence step up investment in railways, especially in view of traffic volumes in these ports.

So, while railways represent a tremendous opportunity to improve competitiveness, a number of factors will determine their successful implementation. The following section considers these factors in the case of Latin America, identifying the particular conditions of its leading industries.

III. Latin America: current situation and future challenges

The current situation in Latin America differs from the international cases studied, mainly because patterns of local economic development are highly diverse and, when Latin American ports were modernized, rail connections were not considered as an integral part of port infrastructure; their use was discouraged and, in extreme cases, existing networks were removed.

During the reforms of the 1990s, State railway companies, which tended to be large and difficult to manage, were split up to allow private operators to enter the railway business, mainly in freight services. The results were mixed. Even though profits were used to rehabilitate routes and rolling stock, in many cases it signalled the end of the rail service as it was formerly known, which was relegated to a few transport legs carrying specific loads. This led many ports to dispense with their rail connections and focus solely on road transport to link them to their hinterland.

This is evident from analysing the tonnage of freight carried by kilometre (km) of rail, where 62% of the 626 million tonnes-km carried in the region consists of mineral products, followed by other bulk products, such as grains and building material. Of the region's total tonnes-km, 85% are transported by only 10 railways: 6 in Brazil, 3 in Mexico and 1 in Colombia (IDB, 2010), which goes to show the industry's degree of concentration and rail's lack of competitiveness as a modal option in other countries.

In Latin America, economic activity tends to be geographically concentrated in coastal areas, with the result that most of its major markets have developed around port cities. Thus the competitive position of much of the port industry is characterized by centrality, dominated by freight flows to/from a geographically continuous hinterland where the respective governments have favoured road-development policies to the detriment of other modal options. Added to the fairly insignificant freight traffic for intraregional trade and the fact that competition is confined chiefly to ports within a given range, there has been very little opportunity for railway development in Latin America in general and it has been limited to industries with a strong commodities component (particularly bulk mineral or agricultural products), or where population size and density allow for passenger-oriented railway development.

Regional experiences of port-rail integration

Even though rail accounts for only around 6% of Argentina's freight movement, it has adopted a marked port-rail integration approach in its extensive network spanning nearly 30,000 kilometres. Most of the railway branch lines serve Argentina's inland waterway ports on the rivers Paraná and Plate, including Formosa, Barranqueras, Santa Fe, Paraná, Diamante, Rosario (and its hinterland), Villa Constitución, Ibicuy, Campana, Buenos Aires and La Plata. Most of the maritime ports are also connected by rail, including Mar del Plata, Quequén, Bahía Blanca, Viedma, San Antonio Oeste, Puerto Madryn, Rawson, Comodoro Rivadavia, Puerto Deseado and Río Gallegos, which in one way or another were all ports created by the railways, or vice versa (Martorelli, 2011).

The Nuevo Central Argentino (NCA) railway company carries mainly grain, pellets and flour from the provinces of Tucumán, Santiago del Estero, Córdoba and Santa Fe to the port of Buenos Aires. Second in importance is the Ferrosur Roca (FR) concession, which transports mainly minerals and rock from the provinces of Neuquén, Rio Negro and La Pampa, principally to the ports of Rosario, Buenos Aires and Bahía Blanca. The company Buenos Aires al Pacífico San Martín S.A. (now ALL CENTRAL

S.A.) moves chiefly cereals from Mendoza, San Juan and Córdoba to the ports of Rosario and Buenos Aires. Lastly, the Ferroexpreso Pampeano freight operator carries mainly soybeans to Bahía Blanca and Rosario. As table 1 shows, Argentina's rail network carried a total of around 24 million tonnes in 2011.

Table 1
ARGENTINE RAILWAY CONCESSIONS

Concession	Tonnage
FERROEXPRESO PAMPEANO S.A.	3 990 130
FERROSUR ROCA S.A. (FR)	5 579 970
MALLA MESOPOTAMICA (ALL MESOPOTAMICA)	586 962
NUEVO CENTRAL ARGENTINO S.A. (NCA)	8 616 030
CENTRAL PACÍFICO (ALL CENTRAL)	4 269 280
BELGRANO CARGAS S.A.	1 151 885

Source: Prepared by the authors on the basis of publicly available information.

Just as has happened in other ports in the region, Argentine ports have gradually been losing their railway links, owing to illegal land occupancy, technological obsolescence or simply a deliberate policy to favour road transport. For example, there is no longer a direct rail link to the port of Buenos Aires. To access the port, ALL, NCA and FR railway operators have to travel to the Empalme Norte junction where they unload their freight onto the locomotive of Argentina's ports authority (Administración General de Puertos (AGP)), which then traces a tortuous route to the port terminals. In the end, both ALL and NCA decided to stop taking their freight to the port by rail and instead to transfer it onto container trucks routed through the Retiro district, which has aggravated the city's traffic. In the case of ALL, the problem has been compounded by the fact that the tracks leading to its outer harbour rail yard have been invaded by informal settlements (Martorelli, 2011).

There is now interest in gradually re-establishing rail access to ports with a view to reducing transportation costs, managing traffic flows around ports, or for environmental reasons. Work is under way to reconnect the freight rail network with the port of Buenos Aires, in order to optimize container freight transport and ease traffic congestion in the Puerto Madero port area. After a 20-year absence, rail access to the south of the port has now been reinstated. However, works to recover access to the northern part have been paralysed by informal settlements (Martorelli, 2011). Since rail access to the south was re-established, around 40,000 containers from Bahía Blanca now travel to the port area along 700 kilometres of rail, which starts in Bahía Blanca, traverses the southern Buenos Aires province through the towns of Ingeniero White, Olavarría, Las Flores and Avellaneda, and ends at Buenos Aires city (*Enfasis*, 2011). Port operator Terminales Río de la Plata S.A. (TRP) also runs a container train with 30 double-stack rail cars for Ferrosur Roca to transport feedstock for the plastics industry from Blanca to San Francisco Do Sul in the Brazilian State of Santa Catarina (TELAM, 2011).

In Brazil, rail's share of the modal split is roughly 21%, with a target of 32% by 2025. Currently it has 29,000 kilometres of railways whose private operation was phased in gradually as from 1992 and was consolidated in the late 1990s by three major freight rail operators: Vale, ALL and MRS Logística. In the port transport leg, the port of Santos moved 2.7 million twenty-foot equivalent units (TEU), capturing 27.9% of container traffic along this coast, whose immediate hinterland is served by MRS and ALL rail networks; the latter has the potential to access discretionary cargo (Argentina and northern Brazil) via a 21,000-kilometre rail network that includes a set of dry terminals for the consolidation and deconsolidation of shipments and another set of logistics services for project cargo, containers, petrochemicals, building products and other items.

Table 2
BRAZIL'S MAIN RAILWAY CONCESSIONS LINKED TO THE PORT OF SANTOS

Port connection	Volume (tonnes)	Percentage	Kilometres
Santos (2010)	85 401 154	11.41	
Maha Paulista (2008)	5 228 700	1.2	1 989
MRS (2008)	119 796 000	28.1	1 674
Maha Oeste (2008)	3 235 400	0.8	1 945
Maha Sul (2008)	26 762 600	6.3	73 04

Source: Prepared by the authors on the basis of publicly available information.

At present, all soybeans arriving in the port of Santos are carried by rail, and sugar is gradually following the same trend (13 million tonnes in 2008). To this end, COSAN, the State-owned conglomerate producing bioethanol, sugar and energy in the State of Sao Paulo, established a logistics subsidiary that contracted its rail freight to ALL, which is currently working to incorporate fuel and lubricants into rail traffic. In addition, Brazil's metals and mining corporation, Companhia Vale do Rio Doce (Vale S.A.), set up LOG IN, a company dedicated to logistics and to promoting intermodal business for the railways Vale S.A. controls, complementing its rail operations with road transport legs and storage.

In the bulk segment, the ports of Tubarão and Ponta de Madeira carry the largest volume of agricultural bulks, minerals (iron) and other bulk cargoes, with 107.7 million tonnes and 96.4 million tonnes respectively. The two ports accounted for around one-third of all freight moved through the east coast in 2010. They are both operated by subsidiaries of Vale S.A., which also controls the concessions of the railways Estrada de Ferro Vitória a Minas (EFVM) in Tubarão and Estrada de Ferro Carajás (EFC) in Ponta de Madeira, each connected with their respective production centres.

Table 3
RAIL CONNECTIONS TO THE PORTS OF TUBARÃO AND PONTA DE MADEIRA

Port connection	Volume (tonnes)	Percentage	Kilometres
Tubarão (2010)	107 760 287	14.40	
Estrada de Ferro Vitória a Minas (2008)	133 207 000	31.20	905
Ponta de Madeira (2010)	96 364 127	12.90	
Estrada de Ferro Carajás (2008)	103 670 000	24.30	892

Source: Prepared by the authors on the basis of publicly available information.

Even though Colombia's main markets for import container traffic are located in the hinterland, specifically the cities of Bogotá and Medellín, the competitive position of ports has been based primarily on developing the coast and achieving competitive efficiency by incorporating the private sector into the operation of container terminals, while the hinterland has been served mainly by road transport. The situation is the complete reverse in the bulk segment, with Colombia moving 131.5 million tonnes, consisting almost entirely of coal exports, where the railway takes on special significance, not only because would make it possible to integrate the various modes of transport (road, inland waterway, rail and sea), improving the competitiveness of the adjacent producing districts and increasing port traffic on Colombia's Caribbean coast.

Mexico's rail network spans 27,000 kilometres. While the network mainly serves the local market, the proximity of Mexican ports to the world's major shipping routes and the advantages of rail for intraregional trade within NAFTA have led to strong growth in port-rail integration. The International Intermodal Corridor of Kansas City Southern de México (KCSM) links the port of Lázaro Cárdenas with 15 Mexican States, including the industrial and consumption areas of Morelia, Querétaro, Mexico City, San Luis Potosí, Saltillo, Monterrey and Nuevo Laredo. This rail network is also connected with the border city of Laredo in Texas, which, apart from concentrating the largest foreign trade traffic to and from the rest of North America, connects the city with major production and consumption centres like Houston, Dallas and Kansas City and any other point in the United States or Canada within the North American Super Corridor Coalition (NASCO). Even though the potential of this corridor has been exploited primarily for intra-NAFTA traffic, a number of factors position it as an alternative to traditional gateway ports into the North American market, such as LA/LB. The concentration of economic activity both on the coast and in the hinterland stimulate demand for high-volume freight transport, in which the railway becomes a key element of port competitiveness for extending economies of scale from the port transport leg to the hinterland.

The fact that Kansas City Southern operates the rail corridor in both Mexico and the United States provides additional facilities for the transit of goods within NASCO, as well as logistics, with more than 2 million tonnes of beer exported via this route, as well as finished vehicles in high added-value logistics processes. The competitiveness of the rail corridor is shortly to be enhanced with the new