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Trends in the share of railways in transportation

This issue of the *FAL Bulletin* analyses the history of railways in modal distribution in Latin America, and puts forward recommendations for improving their functioning and making them a real, competitive and sustainable transport option.

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Introduction

Railways flourished in the nineteenth century, becoming a key element in the transport of goods and passengers For a number of reasons, however, their prominence has gradually diminished and they now have only a limited role, mostly in the transportation of certain bulk products. This document looks at the how the use of the railways for freight has changed over the years, and puts forward a series of recommendations to increase their use in present-day Latin America.

I. The rise of railways

Railways rose to prominence in the nineteenth century, leading to a radical change in the surface transport of freight and passengers, and they rapidly became essential to economic activity. The move from animal power to steam power resulted in better linkages between centres for the production and consumption of goods, improving the quality of life of the population, territorial connectivity and access to goods produced outside the immediate periphery of urban areas. At the same time, the development of the steel industry and of a new traction system saw the introduction of the first horse-drawn trains and trams, which helped to resolve growing problems of mobility in cities at the time, caused mainly by the increase in the urban population and the impossibility of using steam-powered transport in city centres.

The introduction of motor vehicles did not initially restrict the development of the railway, thanks to the imposition of road speed limits of 5 kph in the United Kingdom and 30 kph in the United States of America. In addition, the lack of proper roads meant that there

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was little demand for this new mode of transport. This situation changed radically when road transport was developed and promoted, although at varying rates, following the second world war. In North America, where the transport infrastructure had not been destroyed during the war, factories that had been built to produce military equipment were redeployed to manufacture road vehicles and aircraft, causing a relative fall in the role of railways. In Japan and Western Europe, infrastructure had been devastated, making it necessary to rebuild in order to reconnect the existing centres of production and consumption. The opportunity was taken to modernize the European rail infrastructure, maintaining or even in some cases increasing the share of railways in the overall modal distribution.

Despite this, particularly from the 1970s onwards, the popularity of rail transport began to wane, mainly because it was quite inflexible in terms of adapting to trends in economic growth and to new realities and social dynamics.

The railway experienced another rebirth with the first oil crisis and the publication of The Limits to Growth (1972) by the Club of Rome, which began to consider issues of environmental sustainability. This led to the revaluation of the railway as a mode of transport, mainly because it is energy efficient, less polluting and safe. In the 1980s, high-speed trains were introduced in France and Japan to relieve congestion problems in certain corridors, making modern railways into a real option for passenger transport. While this was taking place in developed countries, Latin America entered upon a process of dismantling the rail network, and railways almost completely disappeared as a competitive mode of transport, as will be seen in the next section.

II. Recent history of railways in Latin America

A wave of railway privatizations which began in the 1990s, in Latin America and the rest of the world, sought to open up State-owned railways to competition from other transport companies. This was in accordance with the theoretical model which predominated at the time, proclaiming that effectiveness was more likely to be achieved with private-sector companies, and that if public funds were no longer tied up in maintaining State-owned corporations, that money could be invested in health care, education or other social programmes. Although there would be exceptions, it was clear that State-owned businesses in almost all countries had been economically ineffective, representing heavy financial burdens. The governments, regardless of their ideologies, had become aware of this. An initial account of the process and its results in Latin America can be found in "Rieles con futuro. Desafíos para los ferrocarriles de América del Sur" (Andean Development Corporation (CAF), 2004). Together with a detailed analysis of the situation in the railway sector, that document offers a series of recommendations for its modernization and strengthening as a modal option.

Many authors agree that it was essential to cut down on railway costs and personnel, and this in turn called for a profound restructuring of the sector. Excess staffing levels had resulted from technical factors and the types of service provided; the operation of steam locomotives had originally required large staffing levels, and freight services allowed the addition at each station of wagons with local goods, requiring large numbers of staff at each station to avoid excessive delays to trains.

In almost all the Latin American countries, this organizational and personnel restructuring began with the privatization process, with considerable results in terms of the systems' productivity. The process was not simple, however, requiring appropriate planning and consideration of the numerous variables. This is clear from the case of British Railways (BR) in the United Kingdom. BR was an excellent rail service offering comprehensive, punctual and high-quality services, with operations which included not only train transport but even hotels within or close to stations. Its excessive staffing levels, however, led to the introduction into its operations of private companies, which cut human resources, maintained existing levels of service and reduced the cost to the State. Nonetheless, between 1997 and 2002 there were five serious rail accidents involving many deaths, forcing a review of the business model. The causes of the accidents were found to have included the following:

(a) Laxity in compliance with safety standards in railway traffic, resulting from the retirement of large numbers of experienced staff.

(b) Cost-cutting in the maintenance of the railway lines and rolling stock, motivated by the operating companies' desire to strengthen their balance sheets.

(c) Lack of investment in new safety systems for the operational exploitation and extension of equipment left over from the period of public ownership.

This analysis led to a change in the business model, with increased State supervision and the requirement for companies to invest in new safety systems. Compared with the case of the United Kingdom, where much of the railway superstructure had been updated, with careful maintenance of metal railway bridges (many of which were national monuments), the situation in Latin America was diametrically opposed.

With few exceptions, most of the fixed installations of Latin American railways had degraded to such an extent that, for example, rails were 30-40 years old compared to the usual standard of 20-25 years, and in most cases they were the original rails that had been laid when the railway was constructed. The same was true of sleepers, mostly wooden, many of which were broken, and non-elastic equipment such as coach screws and nails did not hold the track firmly enough to meet minimum standards. Safety equipment was antiquated and ineffective. In short, the condition of the fixed installations at the time of privatization was close to disintegration.

Rolling stock had also been neglected, maintenance work was slowing, and as a result the services provided lacked quality and safety standards were very low; all this reflected the lack of investment in the Latin American rail system. Consequently, privatizations were followed by sharp rises in productivity, services were improved through modest investments and an image of effectiveness was achieved initially. Such improvements were, however, short-lived because the tracks and rolling stock handed over to the private sector were in very poor condition, and deteriorated rapidly despite the efforts of the private railway companies.

The early twenty-first century saw a system in difficulties, providing services to only a small fraction of the market it should have been serving. When economic growth accelerated in Latin America thanks to the opening up of new markets, the railways did not have the capacity to rise to the challenge. Only a few railway services —those involved in transporting mining products— have been renovated, either as a result of a government decision (Colombia) or where mining companies saw the railway as the only choice for transporting their output (Brazil). There is a simple reason for the lack of investment in superstructures: major sums would be needed and would take about 30 years to be amortized. The private rail companies cannot make such investments, for profitability reasons, and governments have more urgent issues to deal with.

III. Consideration of externalities and associated social costs for sustainable modal choices

Externalities are always present when a consumer's decisions are directly affected by those of others. Social cost refers to the cost to a whole society of choosing an option, and is the sum of individual costs. While externalities are hard to quantify, costs can be measured. Although transport is necessary, it affects the quality of life of the population, which is why the lowest possible "global cost" should be sought. The costs of the different modes of transport have been studied and defined, focusing on those which can be in direct competition: rail and road transport. The following factors were taken into account:

- Accident rates
- Fiscal distortion
- Environmental impacts (pollution, climate change, noise)
- Congestion
- Land-use requirements
- Energy consumption

The analysis of these factors and their economic and social valuation clearly show that railways have a positive impact on savings in the economy as a whole, surpassing road transport in both passenger-miles and ton-miles of freight, as set out in "Manual de valoración de las externalidades en el transporte terrestre. Comparación de costos entre la carretera y el ferrocarril" (Latin American Railway Association (ALAF), June 2003). This manual allows for simple calculations of value in the aforementioned areas.

It is therefore possible to provide examples of various rail corridors and their respective savings. For example, using data from 2003, it is estimated that a suburban line with 16.5 million passenger-kilometres per month can potentially generate annual savings of US$ 121 million. A freight line with 200 million ton-kilometres per month will generate savings of US$ 70 million. In addition, the following factors should be taken into account:

Energy efficiency: The low levels of rolling resistance of a train allows for optimum use of the traction energy. Rolling resistance varies between r = 2.5 + 0.0005 v2 and 1.5 + 0.00022 v2 in the case of the railway, compared with r = 17 + 0.0048 v2 for road traffic, or five to ten times less energy per unit of traffic. This energy saving means a major cut in carbon emissions per quantity of freight or number of passengers transported, making railways more environmentally sustainable. In addition, the use of electrical traction for suburban trains helps to reduce atmospheric pollution in urban areas.

Rational land use: In urban areas, the smaller land area needed for the transport corridor for a given number of users favours railways and frees up land areas for other urban uses. As for areas protected as environmental reserves, studies conducted in the Amazon region show that railways do not produce the spider's-web pattern of deforestation which results from road construction.

Lower accident rates: Railways show significantly lower accident rates than road traffic, thereby reducing the financial repercussions of accidents and their social impacts.

IV. The role of railways in modal shifts

Any mode of transport must meet the demands of the market it serves. This section will analyse certain key factors which can enable Latin American railways to increase their modal share and provide competitive and viable responses to the region's logistical and mobility needs.

First, both freight users and passengers expect certain things from a transport service. For the former, the decisive variables are cost and the successful completion of the planned journeys, whereas for passengers, comfort, journey time and a suitable price are the key issues. Only if it meets these demands can a railway provide the service expected by society. This means striking a balance between capacity, speed and level of service, and in the case of passenger transport, security and comfort.

The element of cost is present in both segments of the market. Calculation of the final price is influenced by operating costs, amortization of investments and, if the railway is in private hands, profit. It is known that in the case of railways the price offered to the passenger takes the full operating cost into account, whereas in road transport there are cross-subsidies from private vehicles to lorries and buses. Other factors to be taken into account are spending on road safety (infrastructure, equipment and traffic policing) which are not funded directly by road transport, and in the case of railways, the cost of management staff and infrastructure such as stations, communication equipment, signals and control. To compensate for this imbalance, mechanisms must be found to support railways financially, mainly for the benefits they provide to society in comparison with other modal options.

V. Capacity

Capacity is defined as the maximum quantity of freight or number of passengers which can be transported on a line in a given time period. Overall capacity is the sum of the capacities of all the elements which make it up, depending on the real capacity of its smallest component.

The system's capacity depends on rolling stock, the railway line in its broadest sense, and the system of operation.

Capacity of the rolling-stock fleet: This is defined as the maximum freight tonnage or passenger numbers that the fleet can handle in ideal operating conditions. Determining this capacity requires assessing what proportion of the rolling stock is available to provide the service, and what proportion is being repaired or is unusable. Traction and hauling subsystems must be analysed; generally, only part of the rolling stock is appropriate for a given cargo or type of passenger traffic. As for traction units, the envelope of their number and power has to be considered in fixing the freight tonnage and the number of journeys. The problem of lack of capacity can be resolved relatively easily by purchasing the appropriate equipment available on the market, seeking to achieve maximum effectiveness in the ratio of procurement to requirements.

Line capacity: This takes into account, and is defined by, the various elements making up the railway line in its broadest sense, infrastructure, superstructure and route. In the particular case of infrastructure, the consolidated lines in Latin America generally do not have roadbed problems unless nearby works have changed conditions in the area. In the case of tunnels, problems may arise from infiltrations of water which may affect the tunnel walls. There can also be traffic problems owing to the reduced clearance for modern equipment; this is because, when the line was constructed, excavation methods were primitive and unsafe, so the tunnel diameters were held down to the bare minimum.

Bridges are special structures which require maintenance, but they have been neglected as railways have declined. The resistance of old metal bridges has deteriorated through corrosion of the metal structures, sometimes worsened by water run-off which has damaged the foundations. In the latter case, the solution tends to be sought by lowering the speed with which trains cross the bridge or reducing the axle weight; this, extended throughout the line, lowers the capacity the railway can offer to the market. Problems with infrastructure, the basis of any railway, are difficult to resolve and the amortization of investments takes over 100 years. If the infrastructure is not in good condition, the cost of its rehabilitation prevents the operation of the railway service, aside from exceptional cases.

Superstructure: This is the railway track itself, consisting of rails, sleepers, fastenings and ballast. In Latin America, these items tend to be close to the end of their useful lives. This weakness leads to breaks and accidents, with major impacts on the reliability of the transport service. Reducing train speed is a temporary solution; as

more trains pass, the probability of structural collapse increases. The answer to the problem is to renovate the railway lines.

Route: The route has a fundamental effect on train capacities, and is a factor which is practically impossible to modify, even through major investments. In hilly terrain, speed limits and gradients can reduce the hauling capacity of locomotives, and this often makes this mode of transport uncompetitive. The need to divide the freight load of train compositions to overcome those problems has a decisive impact on the time period and the means to be used, with increased costs which are acceptable only if road transport cannot act as a complementary mode in the transport chain.

VI. Exploitation systems

Railway operations are based on the concept of the track segment, a length of track in which only one train may be present at one time. In the case of suburban railways, where there are generally two tracks, there can be timetables which will satisfy demand provided that there are safety systems which can cope with higher frequencies and that level crossings are not an insoluble problem. In this regard it should be noted that the number of level crossings tends to be higher than the frequency of traffic through them. Together with safety installations, capacity problems can be resolved through increases in train length (which will require corresponding changes in the length of station platforms), with the only limitation being the time it takes for passengers to enter and alight from the train.

In the case of long-distance trains, whether freight or passenger, the number of trains which can cross a critical track segment (the one taking the longest time to pass through) during a given time period determines the capacity of the line as a whole. That critical segment can be reduced, thereby increasing capacity; other options are to open stations where overtaking and crossovers are possible.

VII. Speed

Speed determines the duration of the journey, and should be treated as a unitary value from the beginning to the end of the journey. In the case of cargo, a minimal number of stops is the crucial factor. On a rail track which is accident-free and allows appropriate axle weight, speeds can exceed 60 kph, which is sufficient for a non-stop journey.

The problem lies with inter-city passenger train services, which are in competition with other transport modes: private vehicles, buses and air travel. The competitive battle with private vehicles is usually lost because of the comfort, flexibility and variability in time which characterize motor-vehicle travel, which is also the most economical mode if more than two people travel together. Rail travel can capture users who travel alone, if it offers competitive speeds and services.

In the case of buses, although the time taken to reach the terminal is the same as for rail travel, bus services are favoured by their ability to vary frequencies in response to demand. The commercial speed of buses while complying with traffic rules can be within the parameters that rail travel can offer. With air travel, the time spent at the airport before boarding and in the baggage reclaim hall, together with the time taken to travel to and from airports (which are generally located outside urban areas) provide a margin enabling rail travel to be competitive if the journey is less than 400 km.

VIII. Incidents and reliability

Reliability in transport relates to the absence of incidents, which relates to the risk factor. The latter is caused by technical failures and the physical environment, in which the human factor is decisive. Technical problems can occur in the track, rolling stock or safety installations. Problems with the track can be due to excessive speed or the failure of one or more of its components; those with rolling stock are caused by deterioration, with missing wheel flanges and suspension failure being the most frequent causes of derailment. Other incidents can relate to engines, which can cause the train to stop, or faults with couplings, whose failure can cause it to break apart. As for safety installations, their absence or defective operation can cause accidents.

The physical environment can affect trains in various ways, such as the slippage of a cutting or embankment, torrential rain or earthquakes, and little can be done about them. Only railway construction on land where such events cannot occur can prevent such accidents or lessen their impact on train services.

Lastly, problems with the environment can include the human factor. Many incidents are caused by railway staff, through incorrect action or failure to take the necessary action.

IX. Equipment parameters

Analyses have been made of the qualities that railway services must have in order to meet the demands of the society in which they operate; the degree to which demand is satisfied relates to a series of factors. In that regard, the concept of railway equipment is defined as all

the components of a railway which enable it to provide transport with a given level of service.

There are varying levels of equipment, depending on the level of quality of the service to be provided, but in the twenty-first century it comprises two indispensable components: the continuous welded rail and —for suburban services and for inter-city passenger railways which strive for a certain level of speed and frequency— safety installations to avert human error or minimize its impact.

Continuous welded rail was introduced into railway construction around 1970, and involves welding rails together between stations. This cuts the need for maintenance work by 30%, reducing dependency on the human factor, and rolling stock needs less maintenance work by a similar percentage because it is now subjected to much less bumping over rail joints. In order to obtain the greatest benefit from this technique, rails have to be replaced and new sleepers and resilient fastenings installed.

The second essential element of railway equipment is safety installations which avert or minimize human error; they were revolutionized with the arrival in the 1980s of electronics. The purpose is to ensure that the train will stop when signalling equipment reports that there is another train in the track segment it is about to enter. The type of safety installation varies, depending on the equipment already present. Systems are becoming increasingly sophisticated, even allowing for driverless trains. Without reaching this ultimate extreme, there must be safety systems for frequent passenger services in order to avert human error and thereby prevent accidents and their consequences.

X. The future of railways in Latin America

Future plans for railways must begin by eliminating myths and the nostalgia factor. Trains are involved in memories of an idealized world of the past, and some people wish for a return to irrational, technology-free trains, as if merely opting for railway transport would suffice to make everything work perfectly. Railway rehabilitation projects must provide for investments which will ensure a certain level of quality, otherwise nothing will be achieved except a waste of money. Starting with a factual picture, those involved must plan the role of the railway in each corridor, assessing its potential and avoiding fantasy, studying the problems which can arise and matching the project to the socio-economic environment.

In most of the region, years of disinvestment have destroyed much of the supporting infrastructure of the railways. There are no businesses dedicated to supplying the material needed or construction firms with the necessary equipment to ensure the continuance of railways in the twenty-first century. Once the usefulness of rehabilitating a railway in a corridor has been assessed and the decision to implement it has been taken, the railway has to be updated technologically with the items described above. The rehabilitation could if necessary be phased in, thereby achieving acceptable results quickly. Techniques have to be found which are appropriate for the physical environment and which can reduce costs, in accordance with the quality level of the operation to be set up. In the case of railway sleepers, for example, the desirability of using bi-block sleepers has to be analysed; to do so would make it possible to manufacture the sleepers in areas close to the construction site, unlike concrete monoblock sleepers, whose manufacture require more complex technology and which will therefore not be available throughout the country.

Safety is another critical factor, especially on suburban passenger routes, where it is essential to invest in training and safety installations to prevent incidents caused by human error or minimize their impacts.

All these issues lead to a real problem, in that the private firms which are awarded railway concessions do not have the financial capacity to make those investments, the scale of which is greater than most enterprises can cope with. Large-scale borrowing would be required and would entail long-term amortization. This brings us to the role that can be played by the State. In most cases, only the State can make the necessary investments, and from a realistic viewpoint, free from fantasy, it is for public administration to undertake such projects.

An additional problem is that, in much of the region, railway know-how has been lost or become obsolete in the face of recent technological progress; this makes the modal shift to railway transport more difficult.

The countries therefore need not only to rebuild port infrastructure, but also to restore a social fabric of experts and enterprises which will back railway development. Reliability in transport policies and the security of plans and investments which will last for more than one parliamentary term are vital factors for the achievement of suitable railway systems which will meet present-day requirements and ensure sustainable transport.