

ANALYSIS OF THE TECHNICAL AND OPERATIONAL CAPACITY OF A COMBINED SEMI-TRAILER RAIL TRANSPORT SERVICE BETWEEN THE PORT OF ALGECIRAS AND ZARAGOZA.

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ABSTRACT

The aim of this study is to evaluate the feasibility to run an Autopista Ferroviaria with Iberian width from a technical and operational point of view in order to analyse the business model in the short term.

A.F. (Autopista Ferroviaria) is defined by the Spanish Public Works Department as a combined transport in which semitrailers are transported by train in a shuttle service using specific wagons and terminals conditioning for this service according with the chosen operational typology. According to this definition, Spain, for the moment, still has not a service that could be called A.F. in Iberian width.

This study is based on the current Iberian railway line between the Port of Algeciras and Plaza (Logistic Platform of Zaragoza) and its focus is to determine whether from a technical and operational point of view, this rail line provides enough features to be used as A.F. To reach this goal, a European Ten-T corridor, the Atlantic one, and two important connections which are included in the Core Networks: Algeciras and Zaragoza are considered.

1. COMBINED FREIGHT RAIL TRANSPORT IN SPAIN

How is it possible that a country with an incredible technologic railway level, a good GDP level and a large railway net in three different gauge has one of the worst Europe figures in terms of freight rail? And the last but not the least question: Why Spain still has not an Iberian track rail motorway with the target of increasing rail freight transportation? Is it a technical issue due to the current infrastructure? Operational or Economic trouble? Or perhaps, could it be due to the past and present of the public policies in matters of rail freight transportation?

Nowadays, in Spain, the freight transport by rail compared to the total freight in all the transportation modes, inside the country, is around 1,4%.

The percentage of the freight transportation between the two terrestrial modes (road versus rail) indicates that the 95% of the terrestrial frights are moved on the roads. Only 5% are transported by train. The percentage of Spain in comparison with the European average and with several countries with similar characteristics is pretty small. The graphic bellow describes the curve of the historical evolution of the freight via road versus rail in Spain.

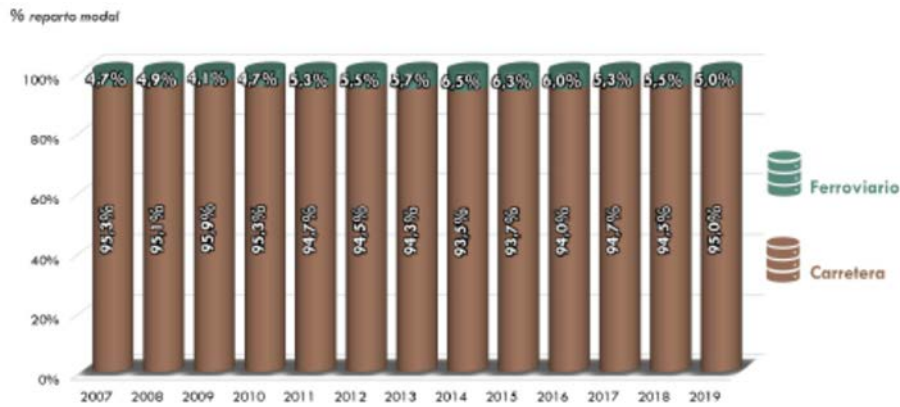


Fig. 1 – Percentage of modal split Spanish terrestrial transport. Source: Informe OTLE 2020

The question is easy: What makes these numbers possible? The answer is not so easy to respond. In the past, the freight operations were running by a state company in a monopoly market that oriented the Spanish railway sector just on passengers, not freights. The strategy was based always on passenger transport because the returns in economics and in politics terms are higher. Also, Spain has a very good highway net with large public inversions year to year. The result of the combination of these two public strategies through time is already mentioned percentage between road and train freight transportation.

In the year 2005 (Ministerio de transportes, movilidad y ayuda urbana), the market was opened for private capital, as a result, other companies entered to play the game. However, although the theory says that the market should be more competitive, and the cake should be distributed, the reality is completely different.

In Spain, freight railway transport can be competitive comparing to road transport when a minimum distance is overcome and the supply chain is fed with the necessary load. Also, the goods to be transported must meet certain characteristics. Otherwise, there will not exist an opportunity for railway transportation.

Consequently, to be sustainable in terms of the supply chain of the companies, freight railway transport has to adapt to the rules of the current logistic markets. Nowadays, the freight rail sector is not flexible enough to compete with the road one with the “market rules” of the logistic supply chain.

Definitively, the challenge to succeed is that the freight rail transportation would be competitive in order to reliability, cost and supply chain adaptation.

2. OPERATIONAL FEATURES

Freight railway transport needs a minimum distance to be competitive versus road transport. Moreover, the efficiency of the AF will depend on a daily minimum quantity of freight to be transported. Hence, in order to ensure the sustainability of the AF, a minimum distance, a big quantity of goods and a perfect adaption to the current supply chain are important and necessary features.

The selection of nodes of Algeciras and Zaragoza, as a part of the AF, is born out of these necessities. The distance is optimal for rail transportation and the freight to move via semi-trailers is daily and large enough. Furthermore, Algeciras and Zaragoza belong to the Ten-T Core Network and Atlantic and Mediterranean corridors are involved between both cores.



Fig. 2 – Ten-T core network corridors. Source: European Commission’s Ten-T portal

Therefore, for the complete analysis of the technical and operational capacity of the AF between the nodes of Port of Algeciras and the Intermodal terminal of Plaza-Zaragoza) several critical issues have to be analysed.

The infrastructure of the railway (slopes, electricity, ...), the infrastructure nodes (terminals), the technical system for loading semi-trailers, typology of wagons, selection of the railway traction, characteristics of the supply chain of the goods to be transported, etc.

2.1 Infrastructure

2.1.1 Railway Infrastructure

The railway infrastructure that joins Algeciras with Zaragoza consist of 1.074 km with Iberian width. Currently, all the line has got energy (catenary) except the path between Algeciras and Bobadilla which is planned to be ready in the short term (this issue is in ADIF's planning department).

One of the singularities of the infrastructure is that the maximum slope of the line is 24''.

This fact is very relevant in terms of traction or maximum load to be transported and it will have a significant importance in terms of operational profitability. Besides, the maximum length of the composition (traction and wagons) is, for the moment, 550 meters. It is because of the maximum length of the railway sidings.

The table below reflects the characteristics of the railway infrastructure.

Length	1.074 km
Width	1.668 mm
Catenary	3 Kv (except Algeciras – Bobadilla. It will be 25 Kv)
Maximum length	550 m (railway sidings)
Maximum slope	24'' Bobadilla - Algeciras
Rail gauge	Analysing by Technical department of ADIF

Table 1 – Main characteristics of the railway infrastructure. Source: Compilation based on the public information from ADIF

The main problem to make available the infrastructure for the combination of wagon and semi-trailer (P400 or more) is the tunnel gauge for the rolling stock. The nature of this problem is because of two aspects. The first one is that, currently, there does not exist regulation for this type of rail gauge in terms of safety. The responsible for this regulation is the State Agency for Railway Safety (Department of Transport, Mobility and Urban

Agenda of the Spain Government). And the second aspect is the need to analyse whether physically the current tunnels permit or not the traffic of the combinations of wagons and semi-trailer. If not, it will be necessary to study the investments needed for improving the infrastructure (tunnels, platforms, etc) in order to permit the pass of the “new” railway set (extra low wagons and semi-trailers P-400 or more).

2.1.2 Terminals Infrastructure

The multimodal (road-train) terminals based on Zaragoza (Plaza) and Algeciras (Port of Algeciras) are already in service. The maximum length of the railway is 750 m in both cases, and these have all the characteristics to house the rail service system for providing “trailer on flatcar”.

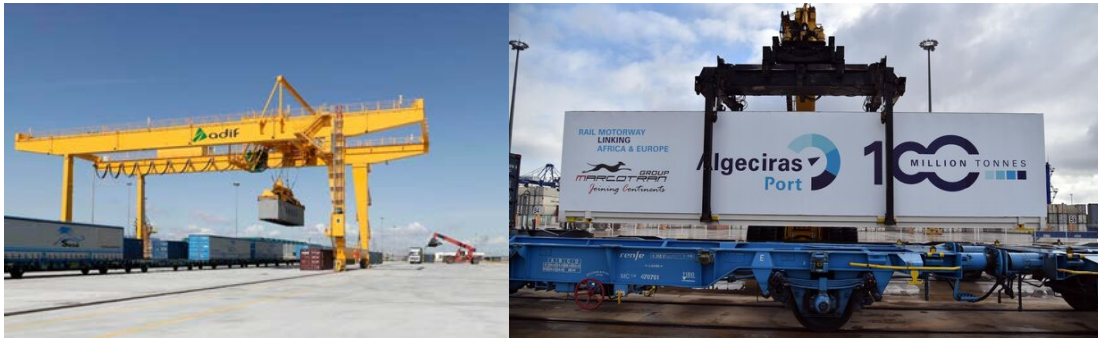


Fig. 3 - Left: Rail terminal of Plaza. Right: Rail terminal of Port of Algeciras

On the other hand, it will be necessary to adequate the terminals for the singularities of the operations of the AF. For instance, access to a big number of semitrailers, new digital systems, space for the “trailer on flatcar” system, etc.

2.2 “Trailer on flatcar” system

In Europe, there exist several systems operating combined transport, which objective is to load semi-trailers on wagons. The most common systems are: Modalohr, CargoSpeed System, Load-unload semi-trailer systems through cranes, bimodal bogies, ... All of them have benefits and disadvantages in comparison with the others.

For the present study, the system which has been chosen is Load-unload semi-trailer system through cranes because of its flexibility, initial investment (the lowest), space necessary in terms of demanded surface and reutilization in case of other possible projects.

2.2.1 Wagon

Wagon must be special in terms of height in order to fulfil the requirements of tunnel gauge. For this reason, wagon must be low-floor. Currently, there are no Iberian gauge low-floor wagons. They must be designed, produced, and certificated for Spanish rail-tracks. Besides, it is important that these wagons could be compatible with different uses. Although, the AF has been thought for loading P-400 (or more) semi-trailers, it is important that other types of load could be carried (maritime containers, etc).

2.2.2 Platform to load semi-trailers

Generally, road transport companies do not use crane trailers. This fact make necessary a special platform in order to load the semi-trailer on the wagons. This piece will travel with each semi-trailer from terminal to terminal.

This platform must fit with the wagon. There are different alternatives in the market.

2.3 Composition of the train

The maximum slope of the railway track (24''), the maximum length permitted (around 550 m) and the maximum load (TBR; gross tons towed) are the technical variables that have an influence in the decision of the selection of the rail traction. The following table shows the information of the different alternatives.

RAIL TRACTION	SLOPE & TONS		
	16''	17''	24''
253	1.180	1.130	860
253 DT (high resistance hooks)	2.130	2.040	1.550
EURO 4000 (335) Diesel	1.490	1.410	1.060
EURO 4000 (335) Diesel (DT)	2.680	2.540	1.910

Table 2 – Different rail traction alternatives. Source: Compilation based on the public information from ADIF, Bombardier and Vossloh

In addition, in order to select the rail traction and respecting the maximum length that is permitted on the rail infrastructure (550 m) the factors to be analysed are: mix of container (semitrailer vs maritime container) and average load of each container. There are many different combinations as a result and all of these have different consequences in the economic part of the analysis. (The hypothesis considered for the analysis are 22 tons of average load for semi-trailers, the low-floor wagon is the standard gauge T-3000 and the platform is the Krona).

COMPOSITION	NUMBER OF WAGONS	LENGTH (m)	WEIGHT (Tons)
Simple traction + 8 wagons (SR) + 4 wagons (UTI)	12	430	1.230
Simple traction + 10 wagons (SR) + 3 wagons (UTI)	13	467	1.448
Double traction + 10 wagons (SR) + 3 wagons (UTI)	13	491	1.571
Simple traction + 11 wagons (SR) + 3 wagons (UTI)	14	502	1.550
Double traction + 11 wagons (SR) + 3 wagons (UTI)	14	525	1.673

Table 3 – Examples of different possible combinations of train compositions. Source: Compilation based on the public information

2.4 Availability of Traffic (Railway Capacity of the infrastructure)

To fulfil parameters defined for being an AF, certain capacity (railway operation of trains) on the infrastructure is needed. This capacity must permit to enhance the needs of the current supply chain. Otherwise, the success of the AFAZ will fail. One relevant aspect of the supply chain between these points are schedules agreed of the freights.

3. TRADE FLOWS

The AF makes economic sense if the trade between Africa; through Tanger Med Port of Morocco; and Spain and Europe; via Zaragoza; is economically sustainable, enhance the current supply chain and can be transported via rail.

3.1 Trade Flows

With the flows studied in the point 3.1, it will be considered that the trade flows are optimal in terms of this project.

Besides, the main flows that could be captured will be coming from RO-RO. The table below describe the forecasting for these flows.

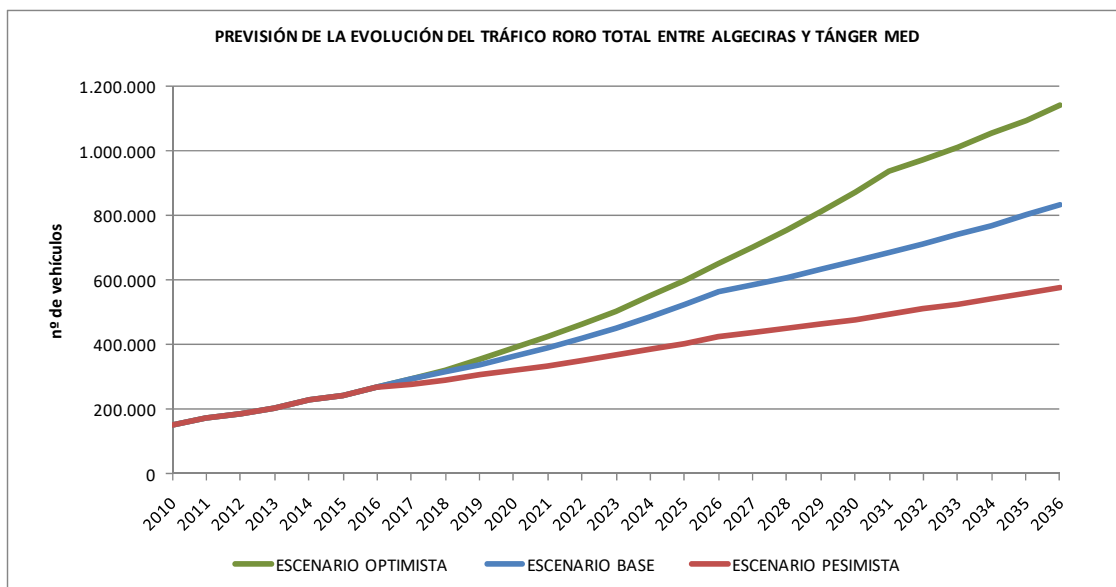


Fig. 4 – Evolution forecast of RO-RO traffic between Algeciras and Tanger Med.
Source: Autoridad Portuaria Bahía Algeciras

With this scenario it is logical establish that the freight to be transported is big enough. It will be necessary an exhaustive analysis in order to know which kind of loads (sectors) are more interesting to be carried by train.

3.2 Supply Chain

After several meetings with important road transportation companies that operate currently between Algeciras and Zaragoza (both directions), there is one variable that is repeated constantly:

The most important feature of the supply chain is the concerted time for the freight, principally in the area of Zaragoza, in the direction Algeciras-Zaragoza. Therefore, Adif has to offer the possibility to use the infrastructure with these requirements.

4. COST EFFECTIVINESS

4.1. Economics

Although a precise model is being realized in this moment as a part of a PhD in the Mechanical Engineering (Transports) of the University of Zaragoza, an example of a Profit and Loss forecast results is expressed in the next table. The main inputs, for the moment, are simple. The combination of the rail traction and wagons are the same in all path. So the mix of the freight is formed by traction, 17 wagons and Nikrasa platforms. The averaged for the load is 24 ton. It is a non-stop in Madrid or other place in order to load or unload goods. The considered occupation is a 70%,80%,100% of the total wagons in the first, second and third year respectively. The costs are based in the cost publications and consultants and the sales are based on the different scenarios.

	ECONOMIC RESULTS (millions of euro)								
TRACCION	Euro 4000 DT -> Euro 4000 (524.84/501.82 m)			253 DT -> 4000 (550.8/536.02 m)			253DT->253DT (550.8 m)		
YEARS	Y1	Y2	Y3	Y1	Y2	Y3	Y1	Y2	Y3
SALES	10,6	11,3	12,0	11,4	12,2	12,9	11,4	12,2	12,9
COSTS	11,5	11,6	11,7	12,1	12,3	12,4	12,7	12,8	13,0
INCOMES B.T.	-0,9	-0,3	0,3	-0,7	-0,1	0,5	-1,3	-0,6	-0,1

Table 4 – Forecast P&L (years 1 to 3)

With these inputs, it is possible to find combinations that permit an economic sustainability operations model.

4.2 External cost

Nowadays, it is very important for different reasons, such as environmental, safety, etc., to keep in mind that rail transport is more ecological than road transportation. With a unique frequency (Algeciras-Zaragoza and Zaragoza-Algeciras) and considering the short train of the analysis (8 wagons for semitrailers and 4 wagons for maritime containers) the train

transport will absorb 48 trucks per day. The number of annual kilometers (just for this composition) would be 14.396.429.

5. CONCLUSIONS

On one hand, considering all technical aspects, AF (with Iberian gauge) in Spain between Algeciras and Plaza is possible. The limitations in the infrastructural aspects such as slopes, static, cinematic and dynamic gauges, catenary and terminals do not limit the possibility to run the AF services between Algeciras and Zaragoza.

At the same time, the main operational features (wagons, traction, and systems to load and unload semitrailers) are running in the European market. Therefore, from the perspective of the operations, the AF between Algeciras and Zaragoza is feasible.

On the other hand, currently, there is a big amount of semitrailers in both directions and it will be increased in the short time. And make sense, if the supply chain of the principal players is not altered, that the logistic market accepts a new channel with attractive attributes.

Finally, it has to be mentioned that AF between Algeciras and Zaragoza is a sustainable economic model for private equity with the previous compromise of the public sector.

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