PROMOTING AN IMPROVEMENT OF THE PORT-RAIL INTERMODALITY IN SPAIN

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ABSTRACT

In Spain, the railway modal share in freight transport is very slight: in 2007 railways achieved a ratio of 3.9% of the whole freight transport market, a poor value compared with most of the European Union countries. Despite the willingness of national and regional governments to increase this fraction, there is still not a clearly significant trend towards a growth of freight railway modal share. On the other hand, more than a half of the whole railway freight transport is based on sea shipping goods in Spain but, in spite of this fact, only 5.1% of whole sea shipping freight uses the railway for the inland section of the logistic chain (2007). The causes of this behaviour must be identified with the aim of proposing a full set of general advices, standards and practical methodologies intended to improve this modal share. This has been the challenge of the research project “Moving forward to better port-rail integration: Advices, methodologies and case studies”, whose reached conclusions are the source of this paper. Furthermore, this study is one of the bases for the development of the Public Works Ministry’s Strategic Plan to promote the freight railway transport in Spain, whose third strategic line deals with the improvement of railway facilities, including the port-rail intermodality. However, it must not be ignored that the successful development of the port-rail freight transport, as intermodal linkage, requires a suitable combination, integration and coordination of all the involved modes, stakeholders and, in general, any implied agent. This is the reason why the general challenge has been approached from different points of view: physical facilities level, operational level and information management level. Thus, the performed tasks have been, among others: analysis of the current state regarding maritime and rail traffics and freight railway facilities, with detection of bottleneck elements; analysis of the main features taken into account for modal choice by customers and shippers; study of procedures developed at the port-rail interchange; compilation of standards and technical advices for the sizing and design of rail terminals in port areas, which have been applied to particular cases of several Spanish ports (Valencia and A Coruña New Port); etc. In the frame of all these studies, different measures have been identified as necessary to encourage significantly the competitiveness of the rail system regarding the sea-inland freight transport. An outline of these measures, which are intended to attract traffics mainly from the road mode, will be also presented in this paper.

1. INTRODUCTION

According to 2007 data, the rail mode carried 3.9% of the total amount of goods that were moved in the Spanish domestic inland transport (assessed this value as a fraction of the whole ton-km performed). This quantity is the more recent one of a time series whose main feature is the gradual decrease of the railway share within the field of domestic freight transport market. Thus, railway moved 7.8% of total carried ton-km in 1993; this share had fallen to 4.6% in 2005, reaching only 3.9% two years later. Certainly, this very poor ratio must be considered as a challenge to be improved, mainly by taking into account the quantities achieved in other European Union countries.

As well known, the expansion of the rail freight transport depends on its suitable and efficient combination with the rest of transport modes. Therefore, it is necessary to promote the intermodal...
transport development, which is identified by the PEIT (Spanish Strategic Plan for Transport Infrastructures) as a key factor for the improvement and rationalization of the whole freight transport performance.

In this field, ports are a critical key for intermodality development. Nowadays, according to Renfe Cargo statistical data, sea shipping-based goods are a very relevant fraction (more than a half) of the whole freight railway traffic in Spain. In contrast, only 5.1% of port-inland traffic (and vice versa, excluding the pipeline transport) are routed by rail; meanwhile the remaining 94.9% use the road mode (2007). This reflects a very strongly unbalanced status towards road transport.

Thus, the main target of the "Moving forward to better port-rail integration: Advices, methodologies and case studies" research project has been to progress in developing intermodality between sea shipping goods and railway mode. For this goal to be achieved, the knowledge about the current state and its causes must be the first step to improve in order to set an accurate diagnosis that enables, in later stages, to propose standards, recommend actions and develop suitable methodologies for practical application.

The referred project, which this paper is based on, has been carried out by several research teams from University of A Coruña, University of Cantabria, Valenciaport Foundation, A Coruña Port Authority, Santander Port Authority, PORTEL, Spanish Railways Foundation and Renfe.

2. STAGES OF THE RESEARCH

The procedure for the performed research has been approached through the following outline:

- Study on the Spanish current state regarding port-rail intermodality.
- Analysis of the factors influencing on the competitiveness of port-rail intermodality.
- Development of a practical implementation methodology concerning the needs assessment, general sizing, technical design and appraisal of port-rail facilities projects.
- Practical application of the achieved results to the cases of several ports in the Mediterranean and Atlantic Coasts.

In the following sections, the main items of the developed working-plan will be presented.

3. STUDY ON THE SPANISH CURRENT STATE CONCERNING PORT-RAIL INTERMODALITY

3.1. Railway infrastructure in transport key nodes

Port terminals are strategic points for freight railway transport, since they play the role of main key nodes for the rail routing of transport flows that are generated or attracted by port activity. In this sense, the greatest potential for increasing the railway transport share arises from gaining traffics which currently are being routed to/from ports hinterland by road mode. Related to this issue, it must be highlighted the fact that, in some of these ports, the rail use for inland routing of certain categories of goods implies necessarily pre- or post-haulage by road from/to a railway terminal located more or less close to the port facilities, although outside the port service area (this is the case of Morrot for Barcelona Port, Silla for Valencia Port, Alicante-Benalúfa for Alicante Port, etc.). Despite this circumstance may lead, in certain cases, to some helpful aspects (increased ability for bundling goods intended for both sea shipping and inland transport), it usually implies a lack of competitiveness for port-rail routing, because of higher costs arising from the need for truck carrying to/from the outer terminal, the largest amount of handling or transhipment operations, etc.

Regarding sidetracks and private industrial rail-sidings at the origin/destination traffic sources, their availability in inland areas provide solutions to railway for more suitable pick-up and delivery processes (door to door), skipping the dependence on other transport modes and lowering in this way the negative impact of haulage needs, wasteful handling and transhipment of goods, etc. Nevertheless, the density of these sidetracks or sidings is comparatively low in Spain, and they usually provide inefficient operating conditions. So, as a result, in many cases it is necessary to use supporting shunting yards for coupling/uncoupling wagon groups.

Concerning other kinds of terminal nodes which play a rail-related role, dry ports and intermodal logistic centres should be mentioned. Regarding these nodes, different general models for such
facilities have been developed and implemented in recent decades with varying success and with higher or lower use ratios. However, these typologies of facilities show, in many cases, a highly road-oriented operational pattern, even when an adequate rail link is available. Moreover, the needs for a better nodal hierarchy and a more suitable territorial structuring are additional deficiencies.

3.2. Sea shipping

The freight trade traffics in Spanish ports are the starting point for supply chains which port-rail intermodality is intended to be improved in. Therefore, the study and analysis on this topic have to be one of the early stages of the project in order to provide a set of criteria that lead to identify and quantify those port traffics that could potentially be caught by railway mode in the inland routing of sea shipping goods.

In overall terms, total traffic of Spanish State-Owned Ports amounted to more than 425 million tons in 2005, detailed by the following fractions: 34% of liquid bulk cargo, 27% of dry bulk cargo, 27% of containerized general cargo and 12% of non-containerized general cargo.

General cargo is the typology of goods that has experienced a fastest growth in recent years. It must be spotlighted that 70% of general cargo traffics are performed by container. The main ports concerning containerized cargo are Algeciras (specialized hub for transit and transhipment of containers), Valencia, Barcelona and Las Palmas. On the other hand, if total traffics are considered, most important ports are anew Algeciras, Valencia and Barcelona, with high containerized general cargo percentages, followed by Bilbao, Tarragona and Cartagena, which are more specialized in other cargo typologies.

In order to enable later analyses about the potential ability of rail mode to catch certain traffics from other transport modes, the study on the sea shipping-based traffics by specific sort of goods and their inland origin/destination area is particularly interesting. In this field, as conclusion for this section, it should be mentioned that the available statistics supplied by State Ports Entity and by Spanish port authorities are insufficient when they are required to know the inland routing of sea shipping traffics, as they do not provide information either about the hinterland extent (inland origins and destinations) or about the inland transport mode used. Therefore, it has been developed specific works intended to analyze the main inland transport flows that are performed as routing for imported/exported sea shipping goods. Thus, it has been identified for each one of these flows: sort of goods, carried tons, origin/destination inland area and entry/exit port. As previously pointed out, for this purpose it is not enough to use the State Ports Entity’s statistical data about sea shipping, but it is necessary to supplement this information by employing the TradeTrans (Spanish Trade and Transport Flows) database, which had been previously developed by Valenciaport Foundation.

3.3. Port-rail routing

Once the sea shipping traffics in Spanish ports have been analysed, the next step relies on the study of the fraction of the whole inland transport generated by these nodes that is actually routed by rail. This study has been split in three main points:

- Current situation of the rail freight traffics and their main features (see Section 3.4).
- Current situation of the port-rail routing in the Spanish State-Owned Ports.
- Forecasting of future development of port-rail routing in such ports.

Concerning the modal split in the field of the inland traffics whose origin or destination is some of the Spanish State-Owned Ports, it should be highlighted that the relative share of rail routing is, overall, not highly significant, but there are some exceptions. This is the case of Santander Port, where the port-rail traffics share achieved 23.3% of total traffics to/from hinterland in 2005; also, Málaga Port routed by rail 11.6% of the hinterland traffics. In this sense, other remarkable ports are Gijón, Pasajes, Tarragona, A Coruña and Marín. However, the four main Spanish ports by their total amount of sea shipping traffics (Algeciras, Barcelona, Valencia and Bilbao) do not reach a port-rail share of 5%.

Furthermore, the following subjects should be remarked in relation to the use of rail mode in the Spanish State-Owned Ports system:

- There are some ports where rail routing is not feasible because they are located in a region without railway network. This is the case of the insular ports (Baleares, Las Palmas and Santa Cruz de Tenerife), and Ceuta and Melilla (which are located in Northern Africa).
Other ports, such as Almería and Motril, show a lack of rail traffics either because they have no physical or operational rail connection to the railway network, or because it is not used.

Ports that route a largest amount of goods by rail are, following this order: Santander, Tarragona and Bilbao, all of them with more than one million tons. On the contrary, there is a considerable quantity of ports where rail traffics amount zero or near zero.

Finally, a future evolution forecast on port-rail routing has been performed. For total port-rail traffics, these forecasts show that 18.3 million tons would be carried by 2020 (growth rate of 32% with respect to the 2010 estimated data). Particularly, the ports of A Coruña, Santander, Bilbao, Barcelona, Tarragona and Valencia have been chosen for a more in depth study. It has been found that the increasing trend in rail routing will be common to all these ports, with estimated growth rates between 25% (Bilbao Port) and 81% (Valencia).

3.4. Rail traffics and their relation to sea shipping goods

The aim of this task has been to identify and quantify those freight rail traffics that are based on goods coming from or intended to sea shipping, as well as to compare them with the corresponding road share in a same typology of traffics.

Concerning single wagonload traffics, Renfe Cargo moved, in 2005, 16,219,574 tons by single wagonload in domestic traffics. On the 38 origin-destination links that have carried more than 100,000 tons/year there are a total amount of 43 different freight traffics performed by single wagonload trains. These links represent almost a half (47.8%) of the whole volume shipped by Renfe Cargo by means of single wagonload. However, among these 38 links, somewhat less than a half (17) has their origin or destination point in a port, totaling about 4.7 million tons, i.e., 29%.

The typologies of goods more commonly carried by single wagonload are bulks, both dry and liquid, as well as steel materials. Thus, a very revealing fact is that the two more important links, which moved 12.7% of total amount carried by single wagonload, correspond to imported coal traffics for thermal power plants, whose origins are respectively the ports of Tarragona and A Coruña.

On the other hand, regarding containers transport by intermodal trains, the Renfe Cargo domestic traffics amount to more than 2.5 million TEUs between 2001 and 2005. Through the analysis of collected data the following conclusions have been achieved:

- About 80% of the carried sea shipping-based TEUs were issued through one of the top 10 origins, led by Madrid-Abroñigal railway terminal.
- Traffic links between Madrid and the ports of Valencia, Bilbao and Barcelona along with their supporting terminals (Coslada dry port, Silla, Morrot, etc.) generated four-fifths of sea shipping-based intermodal traffics in 2005.
- In 2005 a decrease of the relative weight of these origins took place with respect to the whole set of ports. This might be understood as a consequence of a slight dissemination of origin ports.
- Madrid keeps on leading the ranking as the largest receiver of sea shipping-based traffics by number of TEUs.

4. COMPETITIVENESS OF PORT-RAIL INTERMODALITY

4.1. Rail versus road as transport mode for inland routing of sea shipping traffics

In this kind of study, a key task is to define the importance level of different freight transport features (cost, travel time, frequency, reliability, etc.) since they act as factors influencing on the modal choice process. Due to this reason, it has been performed a survey that aims to identify the key factors that guide the modal choice of container inland transport as routing for sea shipments. This survey has been intended for several choice-making agents in the field of the supply chain (shipping agents and freight forwarders). The priorities of these agents have been quantified regarding the inland transport services, either if these are performed by rail or if they are developed by its alternative, the road.

In order to develop this study, Valencia-Madrid and Bilbao-Madrid corridors have been selected as the most relevant inland routing links for sea shipments in Spain. This choice relies on the importance and representativeness of these corridors.
Challenge C: Increasing freight capacity and services

Thus, in the framework of this survey, the most of sample agents (90%) manage inland transport in shipments from or to ports, but it has been found that only a part of them use the rail mode (63%). On the other hand, 81% of the sample agents have ever used railways, so a relevant fraction (18%) of decision-makers have ever used the rail mode in the past but do not use it currently.

Regarding 19% who have never used railways, most of them (78%) have never considered using it because they have a negative opinion about it, due to lack of adaptability or, simply, because they do not know it enough. The remaining ones have considered using it but finally they have rejected it adducing unfavourable features related to time, as well as certain complexities in booking procedures.

Results show that railways use is unbalanced in favour of shipping agents; meanwhile, very lower booking rates are achieved among freight forwarders. Moreover, shipping agents are almost the only ones who book block train services.

Among those who have ever used the railway transport, reasons for choosing this mode are depicted in Figure 1.

![Figure 1. Reasons for choosing the rail mode among those who have used it.](image)

The importance-rating of all those variables related to generic inland transport ranks the priorities and needs of decision-makers. For identifying them the Linkert scale has been used, with five grades (‘1’ is equivalent to a ‘very low’ grade, ‘2’ to ‘low’, ‘3’ to ‘mid’, ‘4’ to ‘high’ and ‘5’ to ‘very high’). It must be highlighted that most of the time-related variables (reliability in delivery deadline, transit time and frequency), along with cost and reliability in delivery conditions, fill the top five positions in importance (Figure 2). Therefore, it could be derived that the critical subject for inland transport is the combination between time-related variables and cost.

![Figure 2. Mean values of importance-rating for inland transport variables.](image)

Figure 3 shows the evaluation of the same variables as in the previous one, but now they are rated exclusively for road transport.
Challenge C: Increasing freight capacity and services

By performing the same kind of analysis for the case of railways (see Figure 4), a remarkable issue is the high degree of ignorance about rail transport supply found in a significant part of the sample, since 37% of them were not able to answer to the formulated questions because of their lack of knowledge about this field. This percentage drops to 12% among shipping agents; on the contrary, it increases to 47% among freight forwarders. On the other hand, taking into account that cost is considered as the main reason for using railways (cf. Figure 1), a revealing and worrying fact is that this one is not the best rated variable; indeed, cost fills the third position and, moreover, with downward trend (according to collected qualitative assessments).

If individual ratings for road and rail are compared with each other, differences between them are remarkable for most of the analysed variables or concepts. Thus, the opinions of the interviewed agents are highly unfavourable for railway compared with road. Rail transport is ahead only in one category: cost (Figure 5). This is an adverse state, especially if it is also considered the downward trend for the railway cost perception. In fact, this comparison reflects and explains the actual situation: one mode (railway) suffers a marginal position with respect to the other (road).

Figure 3. Mean ratings for road transport variables.

Figure 4. Mean ratings for railway transport variables.

Figure 5. Ratings comparison: road vs. rail.
The fact that road has a large amount of very highly rated variables reveals that this is a mode that adapts quickly to market conditions, to the different sorts of decision-makers and to the transport users’ needs. Thus, almost all of the possible variables combinations are favourable to road, meanwhile only a few are favourable to railway. The choice process for these ones would be as follows:

**Rail decision \(\rightarrow\) preference of ‘cost’ variable rather than \((x, y, z, \ldots)\) variables**

On the other hand, by analyzing the general transport variables as well as the rating of these variables for road and, particularly, for rail mode, it has been observed that there is always a correlation between the time-related variables. In other words, if the importance of a certain time-related variable for a decision-maker increases, the importance of the remaining correlated time-related variables also will grow most probably. Therefore, when it is intended to implement a decisive improvement for railways (the same could also be said for road), upgrades that do not entail parallel enhancement for time-related variables would lead to limited and non-proportional effects due to the linked behaviour of such variables.

Because of this particular property of time-related variables and also due to their relation to cost, the best way to encourage rail use might be the simultaneous improvement of these time-related variables as a whole along with the enhancement of their features, as these actions would induce a modal shift from road to rail. This modal shift will facilitate, ideally, the setting-up of economies of scale and thus the drop of costs and prices.

Hence, the simultaneous improvement of these time-related variables constitutes a critical mass of actions that is considered as the main barrier hindering the rail transport expansion. Consequently, the removal of such obstacle is a necessary goal to achieve a decisive increase of the railway share in the field of containers transport.

Furthermore, in the frame of the carried out studies it has been noticed, additionally, a high degree of ignorance about the rail mode features, especially among freight forwarders. Therefore, this ignorance makes advisable the development of suitable promotional tasks as a desirable complement that supports the implementation of the necessary improvements in rail transport supply.

### 4.2. Identification and analysis of processes influencing directly on modal choice

In order to identify those physical and functional processes that, as a critical factor, have direct influence on modal choice, an analysis has been carried out about the different operational patterns developed in the port-rail intermodality course for each traffic typology: dry and liquid bulks, containers, ro-ro cargo and non-containerized general cargo. Within these processes, the elements to focus on have been the involved infrastructure, equipments, resources and concerned agents or stakeholders, as well as the role played by each one of them in such operational procedures.

Although some relevant differences have been observed depending on the cargo typologies, the main general factors that facilitate the enhancement of rail transport competitiveness in the field of port areas, according to these analyses, are: the availability of particularly suited inland rail terminals at the destination/origin points; double track availability; suitable location of sidetracks or rail-sidings; as well as the bundling of a demand volume enough to make trains formation economically feasible.

In short, the critical strongest efforts intended to reach a higher market share for railways in the field of sea-inland traffics should be focused on improving the rail transport features from the point of view of both infrastructure and freight services offered by rail operators.

### 4.3. Setting-up of standards and general advices for infrastructural and functional design of port-rail services

On the basis of the current state of the rail mode supply in the field of port areas, the statement of a set of advices about physical and functional design of port-rail services has been considered necessary in order to enable the development of a higher ability for traffics attraction. But, on the other hand, the troubles concerning territorial integration of maritime and inland transports and their involved infrastructures should not be ignored, as port areas are usually located in metropolitan environments. Currently, this fact gives rise to a number of difficulties in port-city interrelationships.

Therefore, several studies have been carried out about some representative cases of good practice and successful experiences in the field of port-rail integration, both from an urban-planning approach...
and chiefly from the point of view of planning infrastructures and services for rail connection between ports and their hinterland.

Among the recommended actions, the following ones should be highlighted:

- Implementation and development of rail corridors dedicated to freight traffics.
- Enlargement of loading gauge.
- Upgrading of rolling stock, both locos and wagons.
- Lengthening of train compositions in order to reduce unit costs.
- Construction of new rail-sidings or sidetracks and enlargement of the existing ones in order to allow larger train lengths (750 m), as usual maximum length in Spain is about 400-450 m.
- Development of specific aid programs for rail operators.
- Development of marketing campaigns in order to spread knowledge and promote railway freight transport.
- Improvement of load and unload operational processes in port areas, taking into account the possibilities for development of new and more efficient systems.
- Rehabilitation and upgrading of the railway network in port service areas, with renewal or adjustment of the infrastructure to current operational criteria.
- Construction and development of specific rail connections to/from ports, especially designed for freight trains traffic.
- Building of specialized port-rail terminals wherever the expected demand volume makes it feasible.
- Discounts in port taxes for those goods that are intended to be routed by rail.
- Setting-up of taxes of infrastructure use for freights transported by road mode.

4.4. Setting-up of standards and general advices on implementation and use of information technologies, administrative procedures and documentation flow

As known, the traffics of goods have to be accompanied, in parallel, by flows of a significant amount of information. The complexities, rigidity and lack of systematization in these flows can sometimes imply an additional barrier for the port-rail routing processes. For this reason, it was considered as interesting the detailed analysis of the whole set of procedures and informational, documentary and administrative flows that take place during the development of port-rail transport activities.

On the basis of these analyses the efficiency of the information and data flow-chains should be improved in such a way that they tend to be more precise and less complex. In this sense, a further development and more extensive implementation of ICT-based procedures would make the rail routing of sea shipping-based goods quicker and simpler.

Concerning the administrative and documentary exchanges, the following current deficiencies must be pointed out:

- After analyzing the whole procedure of filling in the Unloading Summary Statement, it has been found that this document does include a reference to the preceding and later transport modes, but they are not mandatory items, in such a way that they are not considered as relevant either by Port Authorities or by Customs Authorities.
- Port Authorities adopt as main documents to comply with their tasks the Unloading Summary Statement, the Bill of Lading (BL) and the Transport Order. All of them are used with the aim to permit entry/exit of goods, but Port Authorities are not interested in the transport mode to be used, but only for the purpose of authorizing land vehicles to access into their areas.
- Port Authorities do not send or receive data about transport modes to/from other entities as Customs Authorities and rail operators (mainly Renfe Cargo in this case).
- Customs Authorities use the documentation that is required by them, such as ‘DUA’ (Single Administrative Document), ‘T1’ and ‘Transits’, in order to check data referred exclusively to goods.
• Rail operator transfers all the shipment liabilities to shippers. Furthermore, rail operator does not exchange documentation with other entities either.

On account of all these reasons, the rail transport share in the field of port traffics cannot be quantified with the desirable accuracy. This important lack, which needs to be overcome to develop more in-depth studies on this topic, clearly suggests the need for including the mandatory announcement of the preceding and later transport modes in the documents to be filled in.

5. METHODOLOGIES FOR NEEDS IDENTIFICATION, SIZING, DESIGN AND ECONOMIC EVALUATION OF PORT-RAIL INFRASTRUCTURE PROJECTS

5.1. Demand estimation and detection of infrastructural needs

Demand estimation is an essential task in transport planning whose function is to provide a reliable tool in order to forecast the flows that a certain transport network is intended to meet. Such information is a decisive support to decision-making in the field of needs detection and network sizing.

Thus, on the basis of the different models studied, the following conclusions should be remarked:

• Network models include a detailed physical depiction of the transport network, but they are hardly applicable to develop mid-long term forecasts. On the other hand, econometric models provide a better handling of these issues, and this is why models to be used in the estimation of port-rail connections should point to this second option.

• In aggregated models, information is relatively easy to obtain, their technical-mathematical requirements are moderate and aggregation and results calculation are also easier. On the contrary, their results are less accurate and they do not include socioeconomic characteristics of decision-makers.

• Disaggregated models lead to more accurate estimations and provide a larger amount of information about the decision-maker’s behaviour. As unfavourable features, these models imply greater technical complexity, a more expensive data collection and certain practical restrictions due to the large amount of data required. These disadvantages can be minimized by using stated preferences instead of revealed ones, but then reliability decreases since these are hypothetical choices.

• In those contexts where analysis is limited to specific lines (such as the case of railway infrastructures connecting a specific port) disaggregated models provide more suitable results and supply more thorough information on the decision-maker’s behaviour. Thus, for such cases the development and application of disaggregated models is recommended.

• Since the environment influencing on transport choices is dynamic and quickly changing, information collected for demand estimations has limited time validity. Therefore, with a view to later further studies, it would be interesting to use tools or techniques that automate or systematize data collection in order to save costs in future demand estimation processes.

5.2. Methodologies for technical sizing and design of port-rail connection infrastructures

Port-railway terminals stand as the key nodes for performing the intermodal exchange between sea shipping traffic and the railway network, so the carried out task has been focused particularly on the plan and design of these nodes. Therefore, in order to comply with the proposed goal, a comprehensive handbook concerning “Design and sizing of port-railway terminals: Technical advices, methodologies and standards” has been prepared. It is remarkable that, up to now, a full handbook gathering all this kind of knowledge had not ever been published in Spain, so this one may be of undoubted interest to those technicians who are faced with the design of rail terminals in port areas.

This handbook consists on five main thematic units. The first unit stands as a general introduction where three key factors involved in the physical development of rail transport as inland routing for sea shipping traffic are studied in detail: the nodal facilities within rail networks, the rolling stock (wagons) and the load units and/or intermodal transport units (chiefly the container). The second thematic unit aims to set the basis for the general plan design of a container port-railway terminal, through the introduction and explanation of the functional sectors and the constituent infrastructure and equipments of such terminals, the setting-up of the main alternatives that may be taken into consideration in the design process and, at last, the outlining of general layouts for the respective
alternatives. The third unit includes standards and specific guidelines for technical sizing and design of container rail terminals, such as, among many others, length and number of transhipment tracks as well as their geometric requirements, design of traffic areas for rubber tired heavy equipment and/or trucks, temporary storage area for non-direct transhipment of load units, full cross-sectional layout of transhipment modules, etc. On the other hand, the fourth unit focuses on the design, sizing and main general features of bulk port-railway terminals. Finally, the fifth unit includes the development of two practical cases of Spanish ports where the contents above could be applied. These cases concern the port of Valencia and the new port facilities of A Coruña.

5.3. Methodology for economic and social analysis of port-rail terminal projects

The decision to set up a port-railway terminal is an issue which should be assessed in economic and social terms. To this end, conditions under which the activity of port-rail facilities would be performed must be known from an economic approach, since the implementation of new infrastructure or railway services promoting rail routing of sea shipping traffics entails funding of the involved costs.

Concerning such costs, the carried out study and the developed methodology aim to provide the planners with an analysis tool that assists them in decision-making within a field so specific that otherwise would usually force them to develop their own fieldwork and documents. As a summary of the more relevant conclusions, the following figures (6 and 7) have been included, as they are useful for the budgetary pre-dimensioning of port-railway terminals. In these figures the total investment costs in the terminal are depicted as a function of the traffic capacity per year (note that this one is drawn in logarithmic scale).

![Budgetary pre-dimensioning abacus for container port-railway terminals](image)
On the basis of the proposed figures, the facilities to build may be pre-dimensioned from a budgetary approach. Furthermore, the graphics included in the full report of the project provide the expected operating costs in order to set the pricing to be applied in new port-rail terminals. On the other hand, a comparative analysis of results obtained in actual facilities versus the foreseen ones (benchmarking) is presented too.

Derived from the results analysis, the following conclusions can be reached:

1. Usually, small-sized port-railway terminals are hardly viable in economic terms without protective measures and subsidies which would not be easily legally covered and would require a strong strategic justification.

2. Bulk port-railway terminals can be viable for a wide range of sizes; meanwhile, container port-rail terminals present strong profitability variances in favour of larger facilities given the important role of economies of scale.

3. Changes in costs scheme that would be induced by a likely rise in power costs could be easily handled within the framework of the proposed parameters.

4. In general, the noticed profitability appears bounded (for the comparison cases used in the study); on the other hand, the sensitivity analysis shows that the considered mid-sized terminals would need very favourable conjunctures in regard to prices or strong public funding to reach viability.

5. The management and costs optimization abilities in case of container terminals are critical to award a contract, since large profits can be achieved by means of small savings in unit costs.
6. The adaptability as well as the operational and competition conditions concerning actors involved in the port system are critical for feasibility of the facilities.

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