

Methodologies for Sustainable Development of TEN-T/RFC Corridors and Core Ports: The Role of Governance in the Export Time Optimization

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Abstract. Ports are a key element of the economic development of a country but have to face with many problems of different nature, above all, linked to the governance process. In particular, some ports, due to a slow and complex bureaucracy, find difficult to become competitive on a European and international level.

The paper investigates the critical issues related to port nodes and proposes a model that allows to understand which variables at governance level, can be modified to intervene in order to improve the competitiveness of a port and therefore encourage the economic development of his country. A European comparison is presented in which the individual components of the costs are analyzed.

Keywords: Sustainable port · Smart port · Core port · Export time port optimization · Port governance · Special Economic Zones · TEN-T network · RFC

1 Introduction

Ports are a key element of the economic development of a country; for many years they represented the main point of access to territories and cities and were *the gateway for the exchange of freight among cities* due to the lack of land connections [1].

In recent years, ports have been a key component of the supply chain. The port is a resource that allows his country to compete on an international level with decisive impacts on productivity and therefore on the economy.

Ports have been the topic of many classifications. It is possible to refer to a classification proposed by UNCTAD [2] according to which ports are divided into first, second and third generation [3–5].

First generation ports gave birth to cities; they not only represent a symbol of the city but are also its development engine. Second generation ports developed thanks to the industries of the 20th century. The port was built to serve the industrial system and for this reason the structure was organized in relation to industrial needs. Third-generation ports were created for the containers transport and therefore have well-defined characteristics

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and functions in relation to the type of cargo unit transported. Unlike previous generation ports, these ports represent a crucial and strategic node of the supply chain capable of generating added value [6–13]. UNCTAD [14] proposed the definition of fourth and fifth generation ports on which the debate is still open [15–17].

To be competitive, today, a port has to produce added value; it has to be a third-generation port and certain conditions have to be met. The first condition in EU concerns the connection with the TEN-T and RFC networks. The TEN-T networks are a set of linear (railway, road and river) and nodal (urban nodes, ports, freight villages and airports) infrastructures considered relevant at a Community level; these networks constitute the priority of Community strategies and policies and have the objective of ensuring the continuity of the Corridors, creating the missing connections, ensuring connections among the different modes of transport, eliminating the existing bottlenecks [18, 19]. The Rail Freight Corridors (RFC) are oriented to the international market services in EU, established to strengthen cooperation among infrastructure managers on key aspects such as the assignment of paths, the diffusion of interoperable systems and the development infrastructure; find the right balance between freight and passenger traffic along the rail freight corridors, allocating adequate capacities and priorities for freight transport in line with market needs and ensuring the achievement of the common punctuality objectives for freight trains; promote intermodality among rail and other modes of transport by integrating terminals in the management and development of corridors [20].

Furthermore, a port has to be smart [21, 22], in terms of integration of ICT, transport ed energy factors to pursuit sustainable development goals of Agenda 2030 [23] considering the three pillars related to society, economy and environment [24–29]. Emerging information and communication technologies (ICT), involved in horizontal interactions among different decision makers could reduce the generalized costs of port operations (for example, times) [1]. ICT modify horizontal interactions through a more advanced level of communication and have to be integrated and interconnected with transport and the energy sector for a port to be smart [21].

The observance of these conditions increases the competitiveness of a port which can become of third generation if it produces added value thanks to the presence of industrial areas.

In recent years, many Special Economic Zones (SEZs) have been established, especially in underdeveloped EU regions, with the aim of generating added value in the ports, attracting investments and increasing exports [30–34]. The main purpose of the SEZ is financial and fiscal support and bureaucratic simplification.

A study proposed by the World Bank [35] shows how export times in some European ports, such as Italy and Greece, are almost double those of Holland, Germany and Belgium.

How can SEZ produce added value in a port that has to face challenges of a different type and, above all, of a bureaucratic nature? How can the competitiveness of a port be expressed and what are the main components on which it is possible to intervene? Sect. 2 of the paper investigates the critical issues related to ports and proposes a model that allows to understand which variables to intervene in order to improve the competitiveness of a port and therefore encourage the economic development of a country. A European comparison is recalled in which the components of the costs are analysed. The case of

Italy, located in the centre of Mediterranean area, is introduced; Italy is crossed by four of the nine TEN-T corridors (Mediterranean, Rhine Alps, Baltic Adriatic, Scandinavian-Mediterranean); it has many core ports that risk compromising competitiveness due to slow and complex bureaucracy.

How can a port be competitive if export times are long? How can a port be third generation if it has long export times? What is the advantage for companies of remaining within a SEZ area connected to a port that has longer export times than in other European contexts? The paper proposes an application in which the case of Italy is presented where, as stated by the World Bank [35], the average export times are around 19 days, almost double that of other European countries such as Germany and Belgium (9 days) and Holland (7 days).

2 General Model

A third-generation port is a port in which added value is created with consequent optimization of costs and benefits. The cost optimization problem can be expressed as:

$$min(C) \tag{1}$$

where C represents the generalized cost of transportation that can be minimized by increasing port efficiency.

The benefit optimization problem can be expressed as:

$$max(U) \tag{2}$$

where U represents the utility that can be maximized by introducing the added value in the products into the port.

To make a port strongly competitive it is therefore necessary that the utility linked to the added value of the goods in a port is greater, in absolute value, than the costs:

$$|U| > |C| \tag{3}$$

Assuming that the utility is equal, with zero value for all ports, the main goal is to minimize the generalized cost of transportation, C_E, which, in the case of ports, can be expressed in relation to export costs given by:

$$C_E = \beta_1 \cdot C_m + \beta_2 \cdot T \tag{4}$$

where:

C_m: is the monetary cost of export which represents the ticket to be paid in order to carry out the shipment, expressed in dollars;

T: is the time necessary to complete the export operations, expressed in days;

β_1, β_2: are parameters of homogenization or parameters of mutual substitution.

Assuming that the monetary cost is constant in each country.

The export time is defined by the World Bank as the time, recorded in calendar days, necessary to comply with all procedures required to export goods [35] considering all the

waiting times between the start of the procedure (packing of the goods in the container) until its completion (departure of the container from the port).

The export time is the sum of three main components: documental time, time for customs activities and handling time in port. Each time will be analysed below.

The export involves a procedure that requires the compilation of many documents that must be verified and approved in order to finalize the shipment. These activities also provide for the interface with several entities located in different places in the area. The documentary phase is therefore divided into a lot of processes which, in most cases, cannot be developed simultaneously since the approval of the documents envisaged in the previous step is required to start the next step with a different decision-maker.

The procedural process relating to export also includes customs operations. In particular, this phase begins with the electronic presentation of the customs declaration and if this is accepted, the risk analysis for tax and security purposes follows. Once these obligations have been fulfilled, the freight are subjected to checks before they can be completely released.

Before leaving the port, the goods to be exported undergo a series of handling and transfers within the node; the cargo that arrives at the port on trucks or on trains is moved to a collection area where it is checked and validated. The freight is then stored waiting to be combined with any loads with the same destination and subsequently, when the ship is ready in the port, the containers are loaded.

The export time can therefore be divided into three components linked to the: document procedure T_D, customs operations T_C and handling in port T_H:

$$T = T_D + T_C + T_H \tag{5}$$

It is possible to represent the trend of the cost function C and of the utility function U (Fig. 1). Neglecting the component linked to the monetary cost, the cost for each country is a function of the export time T.

Assuming that the utility has a constant value of reference for all the EU countries, for which its trend is similar to a straight line parallel to the x axis and there is an average cost (identical to U in absolute value) for the whole EU continent T^*.

The intersection between the average time function and the time function in each country determines an equilibrium point u^* for which the utility is equal to the cost ($T^* = T$).

Countries on the right u^* are characterized by higher costs than utility; are non-competitive countries, while the countries on the left are the competitive ones with higher utilities than costs.

The problem is understanding how countries can become competitive, what actions need to be taken to make countries move to the left of u^*. It is possible to intervene in two ways: increase of the utility (increase of straight-line $y = T^*$), or reduction of the export time. Utility is linked to the added value of the freight. To reduce export costs, it is necessary to analyse their cost components and identify the critical issues that produce slowdowns in export procedures.

Assuming the trends of the time components as shown in Fig. 2. To reduce the total time, it is necessary to intervene on the components that significantly affect the total value. While the time related to customs operations T_C is negligible, the time related to

the handling of goods T_H and the time for documentation T_D play a significant role. T_H can be reduced by optimizing node activities. How is it possible to intervene to reduce T_D and therefore move the countries to the left of u^* by increasing their competitiveness of ports?

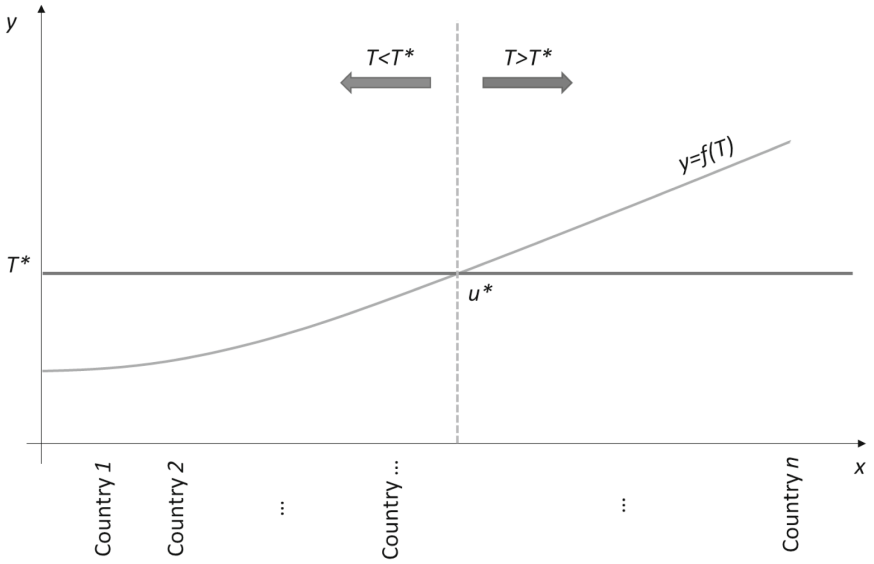

Fig. 1. Trend of cost and utility functions

From a disaggregated point of view, the solution is to organize operations in ports in the best possible way. From the aggregate point of view, it is possible to intervene on the management of the SEZ area where the companies that have to create added value are located. The SEZs were born with the goal of procedural simplification that cannot be pursued due to delays produced by the sequence of the activities and by the fragmentation of the decision-making activities.

If the cost function is expressed in terms of time, in the present case (a):

$$Ta = \sum_{i=1}^{N} (t_i + R_i) \tag{6}$$

where:

t_i is the time necessary to complete the i-th procedure;

R_i is the delay related to the i-th procedure;

N is the number of decision makers involved.

Referring to the graph of administrative procedures in Fig. 3 [32], where the nodes represent the decision-makers involved in the process, the links represent the relationships among them. Each company to have an authorization, from the origin to the final node, is forced to cross a multiplicity of nodes (a) which translates into losses in terms of time and costs.

To simplify the procedures, one could intervene by eliminating some nodes (solution b) but this could lead to problems of a different nature.

A first result can be given by the grouping of some nodes in a single interface which allows the performance of several operations (solution c).

In the latter case the total time can be expressed as (6) but the total value decreases because the number of authorities involved N decreases.

Solution c could be further improved by considering parallel activities within a single authority (solution d, Fig. 4).

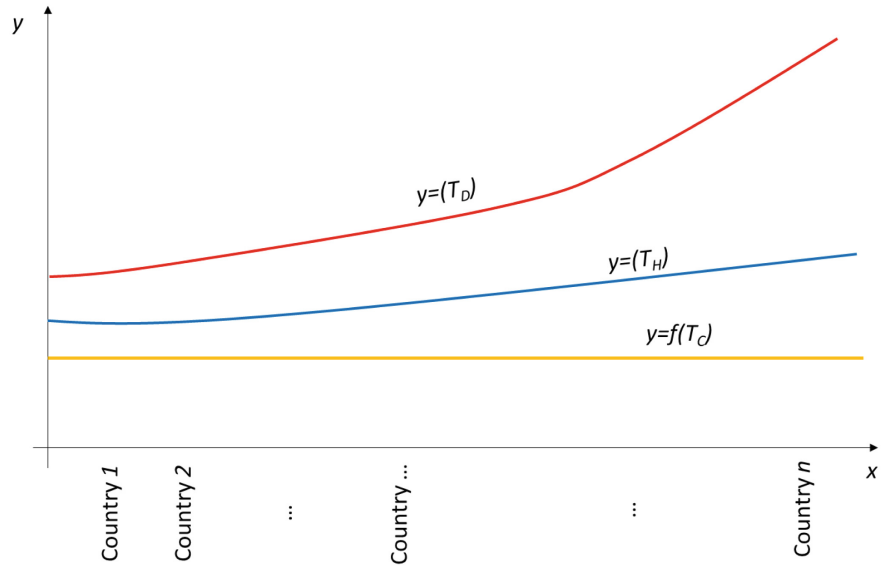

Fig. 2. Export time components trend

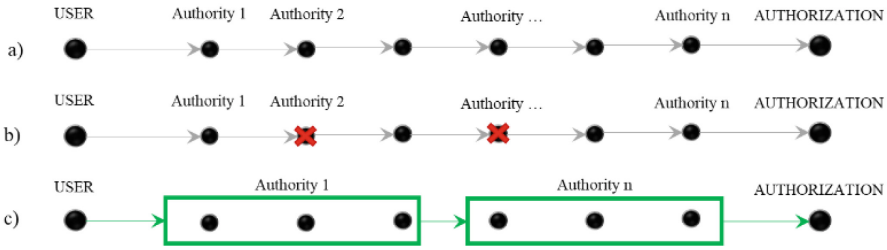

Fig. 3. Graph of administrative procedures (elaborated from [32])

The optimal solution would be to have a single governance of the SEZ and the activities were in parallel and not in series; in this way, the times linked to the documentary procedures would be reduced and consequently the export time would be reduced with the possibility for the State to be competitive (solution e, Fig. 4).

In case d) the time function would become:

$$T_d = \sum_{i=1}^{N} t_d^i \tag{7}$$

where:

$$t_d^i = \max_i (t_i + R_i) \tag{8}$$

where i refers to the single generic authority.

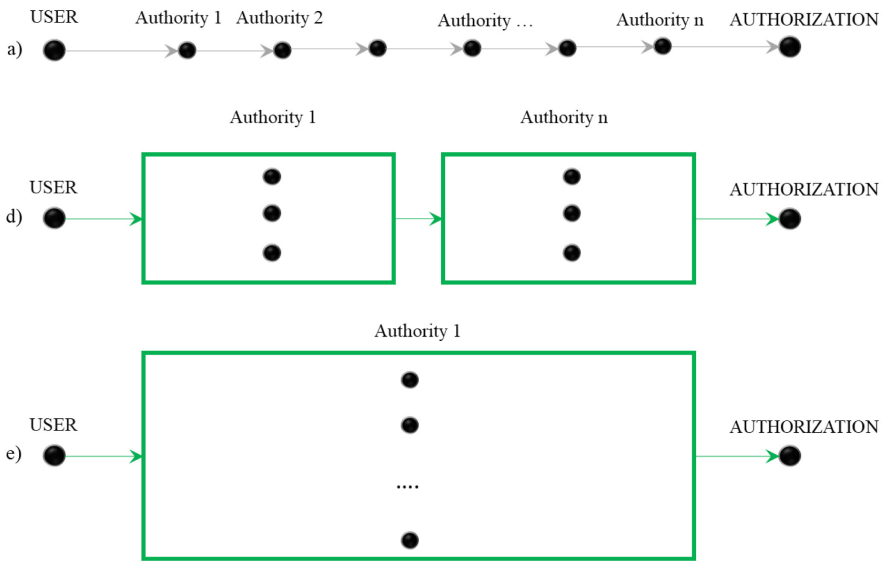

Fig. 4. Graph of administrative procedures

In case e), the time is minimal because it is not given by a sum of times as the operations take place simultaneously, at a single authority, and the delays do not accumulate:

$$T_e = t_e \tag{9}$$

where:

$$t_e = \max_i (t_i + R_i) \tag{10}$$

The reduction of the number of authorities allows to pass from Eq. (6) to (7) and in the optimal case, with single authority, to have a time expressed by (9).

3 Application

3.1 The Dataset

Starting from the data provided by the World Bank [35] it is possible to draw the experimental trend of the cost by reporting the export time for each country, as shown in Fig. 5.

The values of the export time are considered, elaborated at a national level [36], according to an increasing scale starting from the Netherlands for which T is 6 days up to Italy with T equal to 19 days.

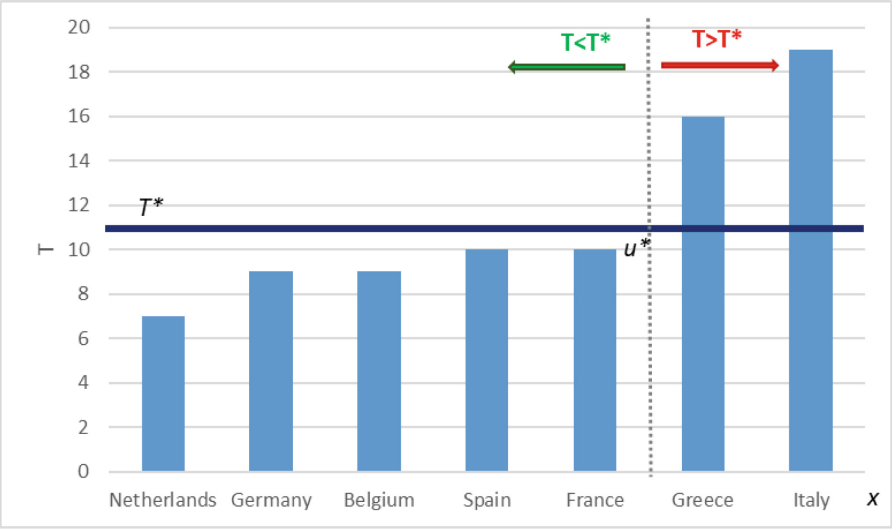

Fig. 5. Trend of cost and utility functions in European countries

It is possible to compare the three components of export time for each port of origin. In particular, from Fig. 6, it can be seen that the time T_D for customs operations is almost constant and assumes a value of 1 day for all the countries considered except for Italy which is 2. The weight of T_D on the time export is minimal. The handling time T_H is relevant for some countries such as Belgium and France for which it covers over 50% of the total time; for Germany it has the same value of the documental time T_D equal to 3 and 4 days respectively. For the Netherlands, Spain, Greece and Italy, $T_H < T_D$ occurs.

Documentary time plays an important role for all countries except Belgium for which it is 3 days (33.3% TE). In particular, it covers more than 50% of T for the Netherlands (57.1%), Spain (50.0%), Greece (68.8%), Italy (57.9%).

3.2 Results

The average values of the time components have been calculated. The average time for document procedure T_D is 6 days; the average time for customs operations T_C is about

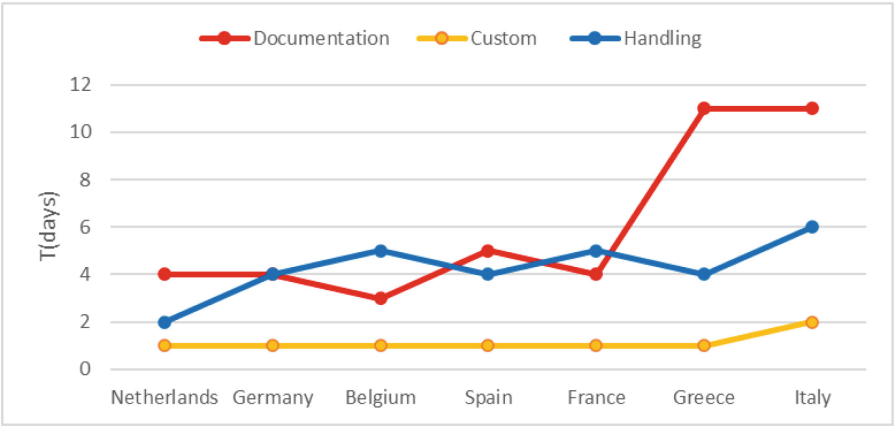

Fig. 6. Export time components for some European countries

1 day; the average time for handling in port T_H is about 4 days. If the utility assumes a value equal to the average of the times of the countries considered, equal to 11 days, it is possible to identify two areas of the graph in which the competitive countries are found with $T < T^*$ (Netherlands, Germany, Belgium, Spain, France) and non-competitive countries with $T > T^*$ (Greece and Italy).From the data presented, it emerges that Italy is not very competitive ($T > T^*$) compared to other European countries. From the analyses carried out, a criticality emerges linked to the export time which stands at around 19 days for Italy, more than double compared to the Netherlands (7 days), Germany (9 days) and Belgium (9 days). Such long export times compromise the possibility of having latest generation ports and are not compatible with the SEZs which were established precisely with the aim of attracting investments and increasing exports.

The SEZs in Italy were introduced with the aim of simplifying bureaucracy and reducing the number of entities involved; in fact, initially the port authority was the only entity identified with the power of initiative and decision-making. The unique and central role of the Port Authority would have improved the country's competitiveness, affecting the times associated with documentary activities and therefore the export time.

Subsequently, loans managed by Entities other than the Port Authorities are made available to the Italian SEZs. Thus, the number of nodes in the bureaucratic graph is not reduced but is increased; the process becomes complex.

Another entity in the governance of the SEZ (Government Commissioner) is also identified, eliminating the unification of the decision-making responsibilities of the process times within the SEZs, and therefore also of the times of exports.

To ensure Italy's competitiveness, it is necessary to move the country to the region with $T < T^*$; it is necessary to reduce the export times which are affected by the component linked to document activities. To reduce T_D it is necessary to centralize governance under a single entity and carry out all activities simultaneously so that the delays of each phase are not reflected in the entire process.

4 Conclusions

The port is a resource that allows countries to compete on an international level with decisive impacts on productivity and therefore on the economy. For this reason, there are specific strategies aimed at optimizing port processes with the main goal of improving the efficiency of the port and making it as competitive as possible, well integrated with the other components of the global distribution network. The paper has investigated the critical issues related to port nodes and proposed a model that allows to understand which variables at governance level, can be modified to intervene in order to improve the competitiveness of a port and therefore encourage the economic development of a country. A European comparison has been presented in which the costs in the individual components are analyzed.

The paper has proposed an application that analyzes the components of the export time for Italy.

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