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ANALYSIS OF DEVELOPER-CONCESSIONAIRE RATES FOR A PROPOSED NEW
PRIVATE COMMERCIAL PORT MODEL

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To my wife, Mary, for her patience and dedication and for always being there.

To my daughter Martina, an inspiration in the most difficult moments. So that you do better than your father, because that's what it's all about.

To my parents, wherever you may be. For all the support you gave me and for all you fought for to give me the opportunity that you never had. DEP

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ABSTRACT:

This investigation presents a study of the rates that generate economic flows between developers and concessionaires in the port sector based on the hypothesis that a private developer purchases the land on the waterfront and, with the approval of the state, creates a multi-activity port and concessions spaces to private operators. This thesis presents, therefore, the construction of a port and its business model through a private initiative.

For the model to be successful, certain contextual conditions must arise that characterise demand, prices and legal conditions, among other aspects. Having established the regulatory parameters of these contextual conditions, the economic flows generated by the various rates are studied and their importance relative to the developer and concessionaire are assessed through the construction of a mathematical model that allows the determinants to fluctuate and to study, on the basis of these fluctuations, the profitability of each one.

Moreover, within the model, a module has been created that enables the researcher to determine whether the concessionaire may be awarded discounts on their rates based on the performance in certain operational aspects. Both the mathematical model and rate correcting module are validated through their application in a practical case and, in this way, the importance of each rate and how the bonuses affect the performances of the developer and concessionaire are assessed.

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1

Motivation and organization

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1. MOTIVATION

Throughout my professional career, I have always maintained close contact with the port sector. In the early days, this was as Head of Production in a construction company that carried out its main activities in the Logistics Activities Zone (LAZ) in the Port of Barcelona and later, as Planning and Projects Manager in the Intermodal Logistics Centre, which manages LAZ, and currently, as Director of Projects and Training at ILI Logística Internacional, a company founded by the Port of Barcelona and LAZ and whose main area of activity is as an internationally operating logistics consultancy firm.

My training as an engineer is not specialised in port management and I have had to adapt myself and learn much about this sector. For this, obtaining a Master's degree and my more than 10 years work experience in this area have been fundamental. This same experience enabled me to detect a need to study in depth an area of business unexplored up until that moment or in which, at least, no specific initiatives had materialised: the design of a port from a private perspective.

Further on, I will explain the enormous difference that exists between private ports —of which there are many examples throughout the world and which are incorrectly termed 'private'— and the private business model used to study the developer-concessionaire rates presented in this thesis.

2. THESIS ORGANIZATION

This thesis is divided into a total of 13 chapters that follow a very similar structure in terms of their internal organization, including the aims, organization, introduction, methods, the main body of the chapter and finally a bibliography specific to each one.

Conceptually, there are four blocks:

The first block consists of chapters 1 and 2, which detail the aims and organization of this thesis (chapter 1) and the methods sections, which includes an introduction, aims, bibliometric analysis, theoretical framework, scope, working hypothesis, contributions to the investigation, etc. (chapter 2).

The second block presents the study of what exists in the port sector at the international level and what is being done at the moment. This block includes a study of ports worldwide, which was carried out with the aim of determining the most common size and type of port and to be able to use this characterisation to determine the size of our port (chapter 3). An additional study has also been carried out that demonstrates the enormous heterogeneity that exists in port management systems, including in regions governed by community regulations, such as the Eurozone (chapter 4). Chapter 5 presents a more ambitious study that defines how certain countries located in the most important global maritime traffic zones act vis-à-vis key aspects for the development of the proposed business model. This latter study demonstrates that some countries are more susceptible than others to implementing the business structure presented here.

The considerable heterogeneity observed both in the port management among various countries or between regions of the same country and in the proactive nature of governments in terms of the participation of foreign capital has meant that it was necessary to finish off this block with a chapter aimed at orienting the developer in the process of negotiation with the government and with the concessionaires of its port terminals (chapter 6).

The third blocks starts with the characterisation of a container terminal, used as an example of a concession to define the volumes of investment in infrastructure and superstructure necessary and, consequently, to determine how these investments are divided between the developer

and concessionaire (chapter 7). Since the mathematical model may be applied to any type of terminal, this study focused on a container terminal as a practical example. Additionally, the import/export processes are defined (chapter 8) with the aim of determining whether the presence of a public entity is strictly necessary for these processes to be carried out.

An economic-financial model necessary for the exploitation of the terminal is then described, in addition to the relationships and the economic flows that may exist between the business participants —essentially the developer and the concessionaire (chapter 9). These economic flows are the rates that should be established in the economic-financial model of the exploitation and management of the terminal. However, it is assumed that the developer should be able to reward the performance of its concessionaire(s) in specific aspects it considers relevant. Therefore, an algorithm has been designed to calculate the bonuses applied to the environmental performance and to correct the value of one of the rates (chapter 10).

This third block finishes with the validation of both the mathematical model and the bonus calculation algorithm through the practical application of an actual case (chapter 11). This validation defines all the economic flows and the contextual conditions and enables a sensitivity analysis to be carried out that determines the fundamental variables of the models.

Lastly the fourth block includes the conclusions, recommendations and future lines of investigation (chapter 12) and sets out the academic curriculum of the author (chapter 13).

2

Aims and thesis summary

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1. INTRODUCTION

Since the beginning of mankind, commerce has been strongly linked to the sea and sea transport. The Phoenicians and the Greeks believed ports had a strategic importance that made the sites in which they were located hubs of business generation and with it, the resulting economy for the territory.

Maritime commerce has always been linked to technological advances. From the first ships to transport goods, which were made of wood, of limited capacity and a certain fragility, there have been many technological advances that have allowed the development of means of sea transport. These advances have occurred in steps throughout history. Nevertheless, there is an evolution considered disruptive in the maritime commerce of goods unrelated to the way in which ships are built but to the way the cargo is managed. This evolution was the invention of the goods transport container, invented by Malcolm McLean, of the USA. From the building of the first container carrier ship, the "Ideal-X", which set sail from the port of Newark with 58 20 foot high containers on April 26 1956, to the present day, the size of container carriers has increased exponentially, currently reaching capacities of 18,000 TEU per ship.

The change in the sizes and types of ships has had an impact on ports, since the constant need to develop and improve the ships themselves has meant that, independently of the types of cargos they specialise in, the changes have resulted in new needs in the terminal that service them.

Nowadays, according to the figures provided by multilateral organisations, the sector overall is growing and, it seems, will continue to do so for the coming years. Current large shipping routes use the Panama Canal and the Suez Canal and connect China, the largest production hub in the world, to the countries it supplies, not only with containerised goods but also other types of cargo. At the same time, experts forecast a promising future for some African nations and there are even those who predict that these countries will, in the not-so-distant future, be the world's new production hub.

Within the containerised goods sector alone, it is believed that 80% of world trade uses this means of transport. These contextual conditions means that ports, understood as installations adapted to handle any of these market segments, will continue to be significant hubs of business generation and economic activity in which there is an increasing need for efficient operators capable of optimising the volumes of investment in relation to their cargo handling capacity.

Of the installations required for managing the supply chain, ports are, through their very nature, the most capital intensive. To ensure the ships can operate, not only is it necessary to protect the inner waters of a port, but also to also invest in platforms that often sit on land reclaimed from the sea and in extremely specialised and expensive machinery.

This volume of investment means that traditionally it is the public sector that takes on the burden of investing in infrastructure. However, the traditional lack of public sector efficiency, defended by many authors, has meant that over the last few years, privatization, or its intermediate stages, has taken place. There are many port installations that have been privatized in the search for improvements in efficiency or simply to relieve the public sector of the burden of some of the activities that take place in a port. Nevertheless, privatization is an extremely particular management model that usually arises from a public need and which implies that the investments in infrastructures by the public sector are considered with the importance due them.

The global economic situation and the creation of large corporations with financial muscle has lead many countries to open their doors to a greater or lesser degree to foreign private investment as a means of developing capital intensive projects such as those related to ports. In

this context, and given the sector forecasts, a need has arisen to study business models in which the initiative may arise from the private sector and in which the participation of the public sector is not required.

2. AIMS

The aims of this investigation are divided into two groups:

Main aims:

- To analyse developer-concessionaire rates that generate the economic flows between the two parties.
- To determine, based on the contextual conditions established and the variables that govern the economic-financial model, how the variability in the rates affects the expected profits of the developer and concessionaire.

To achieve these main aims, a calculation system must be built and certain hypotheses must be made, which leads us to the secondary objectives:

Secondary aims:

- To create a modular mathematical model that allows the economic flows of the participants in the port business to be studied.
- To construct a tool that allows port terminal concessionaires to be penalised or awarded bonuses as a function of their performance in various aspects and that can be included as modules within the main mathematical model.
- To design a new port business model whose initiative is strictly private and in which the public sector is not necessary.

3. BIBLIOMETRIC ANALYSIS

To carry out this investigation, it is necessary to address various disciplines, as technical aspects related to port installations need to be studied in addition to financial, organisational, environmental and management aspects.

Therefore, the transport sector is the most important in terms of information requirements. Moreover, it could be said that by studying this sector, sufficient information will be obtained, as there are many publications that address aspects related to other previously mentioned knowledge areas.

However, these knowledge areas should also be explored. Therefore, a search of the specialised publications related to the port sector and transport has been carried out. However, the possibilities have been extended to allow for greater crosscutting scope in which areas such as management, environmental studies, operations research, etc., can be studied.

Regardless, this preliminary approximation of the analysis of the current state of affairs in crosscutting knowledge areas also includes a focus in specialised journals, since we are aiming to obtain information about these aspects but from the perspective of a port business. Table 1 shows an extract of the list of most important journals by sector and country, ordered according to their SJR index¹.

¹ SCImago Journal Rank. A measure of the journal's influence both in terms of the number of times it is cited and the prestige of the journals that cite it. This index is a variant of the eigenvector centrality measure used to measure network theory.

Table 1. The most important journals

Journal	Quartile in Category	5-Year impact factor	SJR	Knowledge field	Country
Transportation Science	Q1	3.753	3.001	Transportation	U.S.A.
Transportation Research Part B: Methodological	Q1	4.116	2.819	Transportation	U.K.
International Journal of Production Economics	Q1	3.069	2.768	Operations research and management science	Netherlands
European Journal of Operational Research	Q1	2.911	2.368	Operations research and management science	Netherlands
Transportation Research Part E: Logistics and Transportation Review	Q1	3.513	2.293	Transportation	U.K.
International Journal of Sustainable Transportation	Q2	2.548	2.261	Transportation	U.K.
Transportation Research Part A: Policy and Practice	Q1	3.563	2.256	Transportation	U.K.
Transport Reviews: A transnational transdisciplinary journal	Q1	3.188	2.118	Transportation	U.K.
International Journal of Physical Distribution and Logistics Management	Q1	1.802	1.934	Transportation	U.K.
Journal of Transport Geography	Q1	3.215	1.891	Transportation	Netherlands
Transportation	Q2	2.358	1.713	Transportation	Netherlands
International Journal of Project Management	Q1	2.758	1.508	Management	Netherlands
Transport Policy	Q1	2.182	1.49	Transportation	U.K.
Marine Policy	Q1	2.768	1.295	Environmental studies	U.K.
Maritime Policy and Management: The flagship journal of international shipping and port research	Q3	1.309	1.294	Transportation	U.K.
Environment and Planning A	Q2	1.604	1.205	Environmental studies	U.K.
International Journal of Logistics Management	Q3	0.946	1.066	Management	U.K.
Maritime Economics and Logistics	Q3	1.229	1.019	Transportation	U.K.
Economics of Transportation	Q2	N.A.	0.898	Transportation	U.K.
International Journal of Shipping and Transport Logistics	Q3	1.840	0.847	Management	U.K.
Research in Transportation Economics	Q2	N.A.	0.799	Transportation	U.S.A.
Journal of Transport Economics and Policy	Q3	0.950	0.772	Transportation	U.K.
Ocean and Coastal Management	Q1	2.000	0.745	Environmental studies	Netherlands
Journal of Transport and Land Use	Q2	N.A.	0.683	Transportation	U.S.A.
Journal of Transportation Engineering	Q3	0.797	0.621	Transportation Science & Technology	U.S.A.
Research in Transportation Business and Management	Q2	N.A.	0.614	Transportation	Netherlands
European Journal of Transport and Infrastructure Research	Q4	0.670	0.604	Transportation	Netherlands
European Transport Research Review	Q3	N.A.	0.447	Transportation	Germany
International Journal of Transport Economics	Q3	0.548	0.365	Transportation	Italy
Transportation Journal	Q3	N.A.	0.275	Transportation	U.S.A.

Source: Author, from data obtained from the Web of Science² and the SCImago Journal & Country Rank³

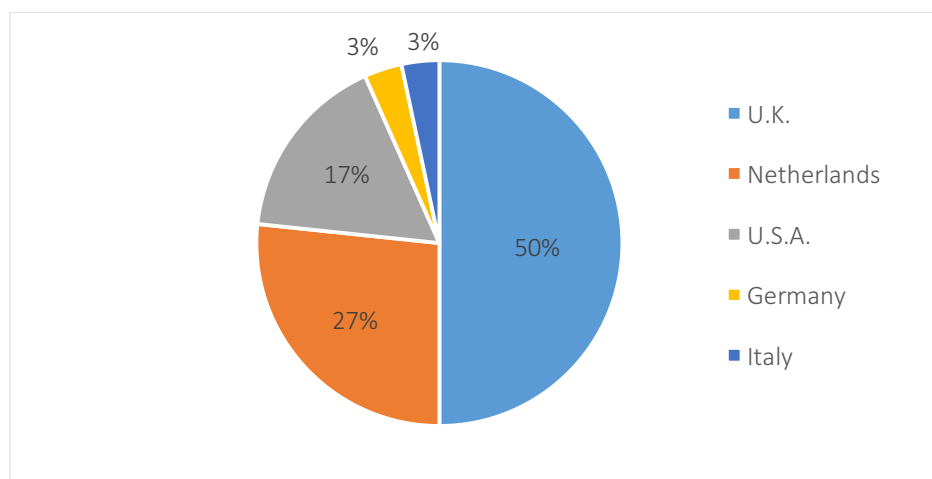
As can be seen, the majority of the journals belong to quartile 1. However, the interdisciplinary nature of the knowledge field necessary to carry out the present investigation means that there are journals that are references in the port sector (for example, the European Journal of Transport and Infrastructure Research), but which, in the speciality of transport, fall in quartile

² (Reuters 2016)

³ (SCImago 2016)

4. Figure 1 shows the country of origin of the journals. As can be seen, the most productive country is the United Kingdom, followed by Holland, the United States, Germany and Italy.

Figure 1. Countries of origin of the sector's most important journals



Source: Author, from data obtained from the Web of Science and SCImago Journal & Country Rank

Of all the publications in the sector considered the most important and influential, several have been used as the basis for this investigation's basic bibliography. This basic bibliography has been completed throughout the writing of this thesis with additional publications, generating a total of more than 250 references.

For the use of a publication for the basis of the referencing of this investigation, a rigorous quality assurance process has been followed with the aim of obtaining only reliable and truthful information. Therefore, the basic sources include:

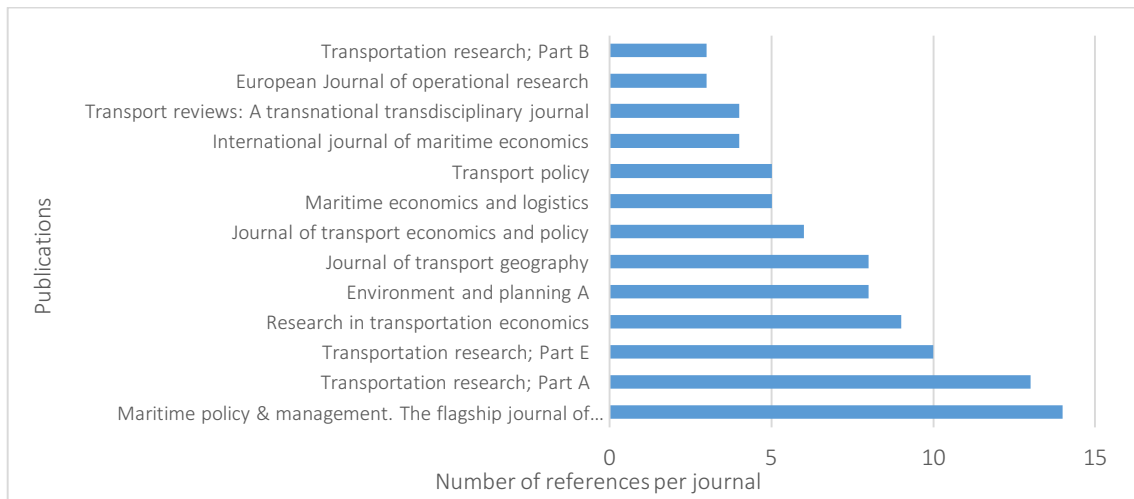
- Indexed publications (JCR or Scopus)
- Reports and publications from multilateral (Worldbank, UNCTAD, etc.) or public entities (State Ports, the Port Authority of Barcelona, etc.).

The consultation carried out on webpages have been restricted to the official websites of multilateral entities and governments and its use has been limited as we consider these are sources highly subject to change.

As a substitute for these, and whenever possible, analogous publications of the same entities were referred to. In the bibliometric analysis, it is worth pointing out that less than 20 references belong to webpages (8% of references).

The most cited journals in this thesis are shown in Figure 2, which shows that the most cited journal is *"Maritime policy & management. The flagship journal of international shipping and port research"*, followed by series "A" and "E" of the journal *"Transportation research"* and *"Research in transportation economics"* (which are listed in Figure 1). With the aim of providing an overall view of the bibliometric analysis, Figure 2 only shows those journals that have been cited three or more times.

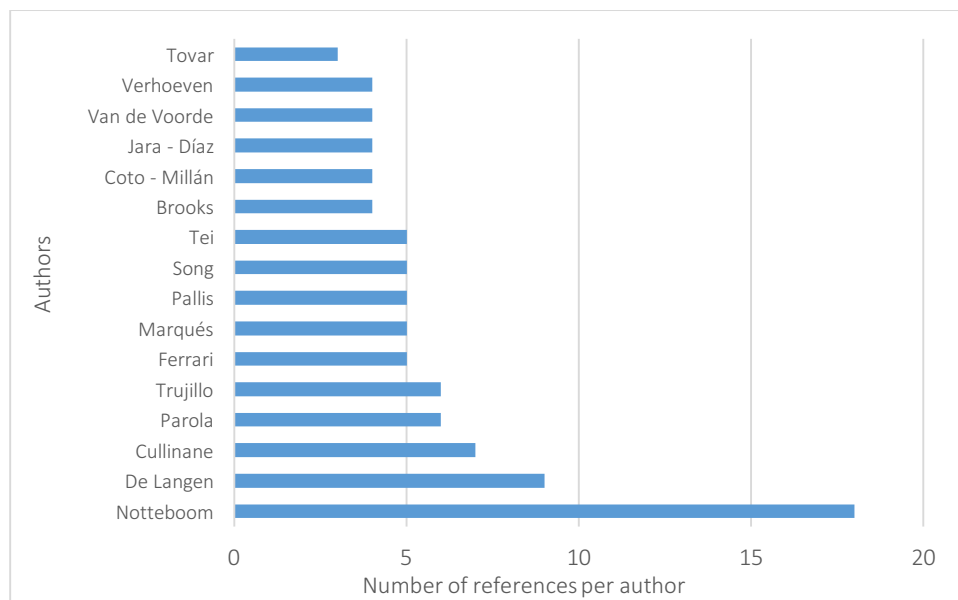
Figure 2. The most cited journals



Source: Author

A criteria similar to that previously described was followed for the authors and, with the aim of focusing the bibliometric study on the most important authors, Figure 3 only shows those who have received more than four citations. It is important to point out that these citations are not always by different works.

Figure 3. The most cited authors

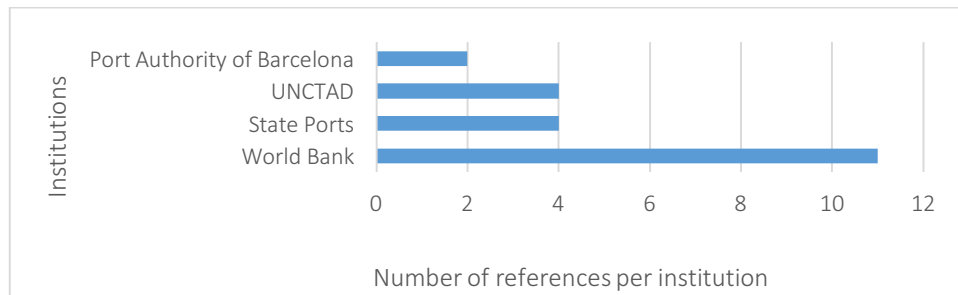


Source: Author

Among the authors shown in Figure 3, the most cited is Theo Notteboom, with almost 25% of the citations. 50% of the citations are made up jointly by authors Peter De Langen, Kevin Cullinane, Francesco Parola and Lourdes Trujillo. These five authors can be considered the most influential in the writing of this thesis.

As has been mentioned previously, the basic bibliography has been completed with reports and documents from multilateral entities, official bodies and other institutes of varying prestige. Figure 4 shows those entities that have been cited more than twice.

Figure 4. The most cited entities



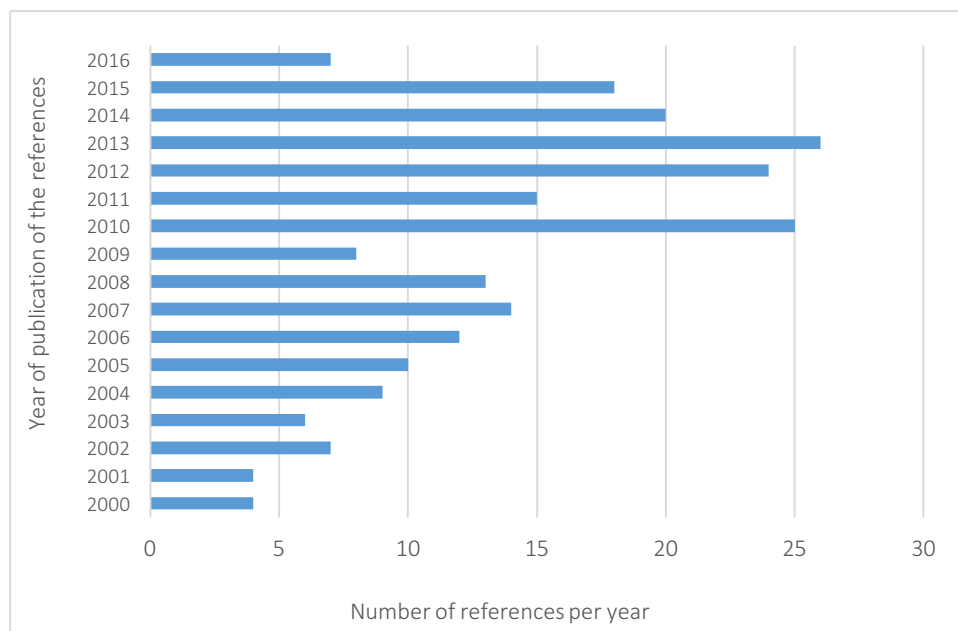
Source: Author

In the case of entities and institutions, the World Bank alone makes up practically 50% of the references of this sector. This is understandable, as it is the institute of reference for obtaining economic indicators, management and accurate information about developing countries.

With regards to the year of publication of the references used, including both indexed journals and the previously mentioned entities, we have tried to use only recently published references.

As shown in Figure 5, more than 50% of the references were published during the period 2010-2015. The most cited years are, in order: 2013, 2010, 2012, 2014 and 2015. As can be seen, there has been an increase in interest in the subject of ports, as in recent years there has been an increase in the number of authors working in this area.

Figure 5. Year of publication of the references



Source: Author

4. THEORETICAL FRAMEWORK

This thesis addresses a sector affected by various concurrent fields of research. It is therefore necessary to open several lines of investigation and to combine the results obtained after studying each one separately. These lines of investigation include:

1. The definition of port components and logistical concepts.
2. Concession models and the relationships between the participants in port businesses.
3. A study of port processes.
4. Trends that point to the privatization of port infrastructures.

These are research fields that converge in the port sector but that group the technical concepts of the definition of legal and business processes. Therefore, an approximation for each line of investigation has been carried out.

4.1. The definition of port components and logistical concepts

There are numerous studies and projects that have addressed the definition of the components of a port and the activities carried out in it. However, in this thesis we are interested in defining those components that are fundamental to port processes, not from a technical point of view but from the perspective of the management and of the global context associated with port activities. Examples of studies include those carried out by (Leon & Romero 2003), (Dang et al. 2012), (Iannone 2012), (Di Francesco et al. 2013) and (Lattila et al. 2013). All agree in defining a port not as an isolated business or as a dedicated terminal, but as the sum of many activities carried out within a multimodal context, which is fundamental in this thesis, as the concept of a port as defined here takes into account this amalgam of activities proposed by these authors.

4.2. Concession models and the relationships between the participants in port businesses

There are a multitude of concession models and consequently, the relationships between the project developer and the port authority are highly heterogeneous and particular to each case.

To define the developer-concessionaire rates, we are not interested in studying these two variables separately. Rather, they should be analysed jointly, as the relationships between both are the direct consequence of the concession model. Having arrived at this point, we find authors who defend the existence of a certain parallelism between the concession model and its associated competitiveness, including (Coto-Millan, Carrera-Gomez, et al. 2005) and (Low 2010).

Others, such as (Coto-Millan, Carrera-Gomez, et al. 2005), (Rua 2006), (Marques & Berg 2010) and (Asteris & Collins 2010), argue that the improvement in competitiveness is not achieved by only applying economic performance parameters. Rather, it is influenced enormously by how the relationship between the two business participants is regulated.

(Ferrari & Basta 2009) and (Medda & Liu 2012) define the parameters that regulate the relationship between terminal users, while (Fernández 2009) and (Aronietis et al. 2010) describe and characterise the concession models in certain countries.

However, the most important line to affect this thesis is that describing the relationships between private concessionaires and public entities. Studies that address this theme include (Pallis et al. 2010), (Saeed & Larsen 2010), (Marques & Berg 2011), (Cruz & Marques 2012) and (Albalade et al. 2013). These studies form the basis of the characterisation of the relationships between concessionaires and project developers.

4.3. A study of port processes

This line of investigation is, in most examples found, linked to the study of practical cases, since customs practices can be considered similar among various countries (for example, those in the Eurozone), the internal processes are particular to each organisation and, therefore, are

strongly conditioned by the characteristics and relationships of the participants of the business. Examples of studies in this field include those by (Coto-Millan, Banos-Pino, et al. 2005), which establish the fundamental parameters regulating the demand of import/export processes in maritime trade, and (Giner 2003) and (Coto-Millan, Carrera-Gomez, et al. 2005), which characterise port processes, disregarding the infrastructure components.

4.4. Trends that point towards the privatization of port infrastructures

The privatization of ports began in the early 1970s (Juhel 2001), (Peters 2001), (Panayides et al. 2015). There are authors who argue that small countries are more in favour of the privatization of their ports or port systems than larger countries, as these have national systems for the protection of the internal markets (Matsushima & Takauchi 2014).

There are three important trends in this line of investigation. Firstly, there is that represented by authors such as (Cullinane et al. 2002) and (Tongzon & Heng 2005), who argue that the privatization of a port has a fundamental effect on improving a port's efficiency, and the need for market expansion (Baird 2002). The second includes those who argue that the entry of the private sector revitalises a port installation in the form of new private operators seeking a yield from their investments. This second line of investigation is represented by authors such as (Ramos-real & Tovar 2010), (Cheon et al. 2010) and (Baird 2010). And thirdly, the last trend, represented by (Guan & Yahalom 2011), (Dekker et al. 2011), (Psaraftis & Pallis 2012), (Parola et al. 2012), (Nuñez-Sanchez & Coto-Millan 2012) and (Trujillo et al. 2013), defends the reformist theses and suggests a change in management models, which should not necessarily lean towards an entirely private exploitation model.

Nevertheless, despite the fact that examples of private ports can be found, including Grimsby, Immingham and Teesport in the U.K. (Baird & Valentine 2006) and that it is globally accepted that the involvement of private operators optimises the use of scarce resources, including land (Notteboom et al. 2012), it is important to determine that the model presented here is unique, since it is not based on privatization but on the design, development and management of a port with wholly private capital from the outset.

Further on, we explain that the difference lies in a fundamental fact: the treatment of investments in infrastructure. In privatized ports, these investments are the responsibility of a public entity when they are initiated; privatization does not mean that the private operator has to pay 100% of the full amount. In fact, there are many examples in which privatization does not include the payment for any of the investments made in infrastructure and the rates paid by the concessionaire are destined for other purposes than the amortization of these investments. In the model presented here, the concessionaire has to achieve cash flows sufficient enough to allow it to pay the rates established by the developer and consequently, the economic tension and the financing requirements mean that the concessionaire needs to achieve a high level of efficiency and optimisation of its processes. Thus, it can ensure that it achieves a yield from its own investments and manages to pay for infrastructure investments.

Privatization and design from the private point of view are, therefore, models of the development of a port that are totally different from the economic perspective.

5. SCOPE

We address the discussion of the rates that should govern the developer-concessionaire relationship and how variations in these rates affect the expected profits from the investments made by each. In this business model, both the developer and concessionaire are private entities and the structure is valid both for a port as a whole as for its individual terminals (container terminals, general cargo, solid bulk, liquid bulk, vehicles, etc.). However, it is important to point out that an isolated terminal with its own infrastructure is not the object of study of this investigation. We are more interested in a terminal that forms part of a port with

many terminals (either of the same type or that handle different cargos). These ports are referred to as multipurpose or multi-activity ports. The business model of these ports is different from that of isolated or dedicated terminals, since the investments in infrastructure made in a multi-activity port are shared between all its terminals. Therefore, dedicated terminals do not form part of this study.

To determine the type of rates that govern the developer-concessionaire relationship, a mathematical model has been built that allows the contextual conditions, prices, costs and investments of each participant to be introduced, evaluating the profits of each business participant.

Since the model can be applied to any type of terminal (as long as the previously established conditions are satisfied), we have chosen a container terminal as a model to study the fluctuations in the expected profits for each entity as a function of the variation in the rates.

With regard to the type of port in which the model may be applied, approximately 800 ports from around the world have been studied in order to determine the most common type and size. In this way, it is possible to determine the size of the calculation model adapted to these conditions that is, therefore, the most global possible.

The next determinant is the management of a port and port authorities. Europe, and more specifically the Eurozone, includes countries with fairly homogeneous political and management models. However, despite this homogeneity and the fact that they belong to a common area, this study demonstrates that firstly for Europe and then for the rest of the world that port systems and the management of port authorities is heterogeneous. We establish in which countries the proposed business model could be implemented, after analysing various aspects of more than 20 countries located close to the largest international maritime trade routes.

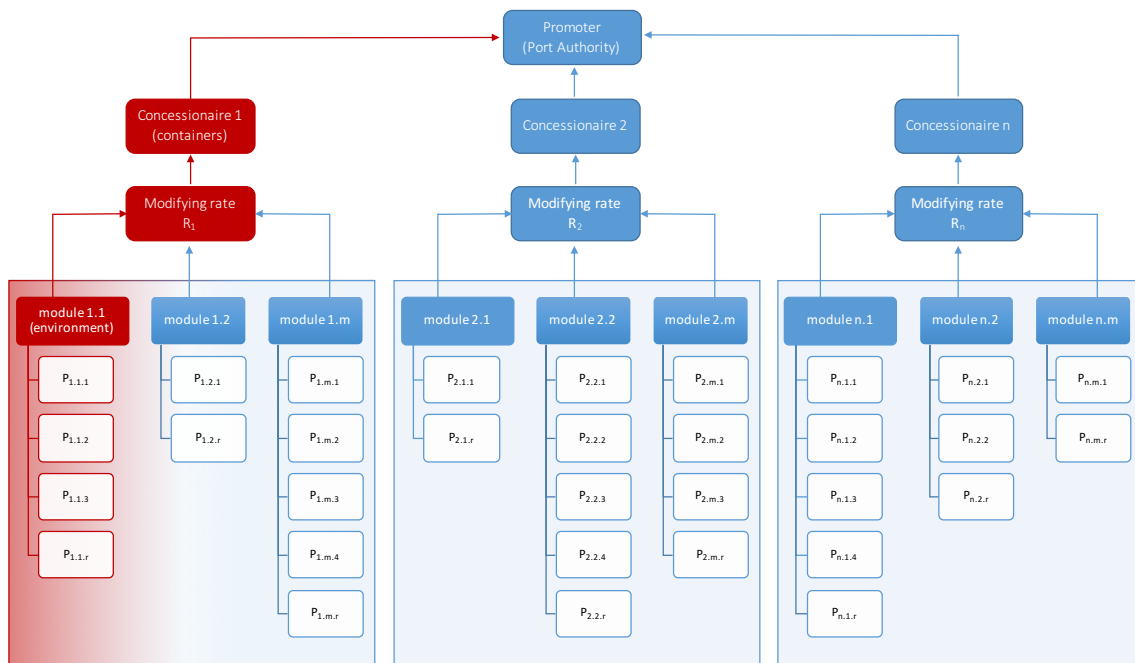
There is no international legislation applicable to the port sector in terms of public-private participants. To implement a new port, it is necessary to carefully study the conditioning factors of the country and region in which the project is to be developed. Since the business model proposed here is to be universally applied, we have studied the legal conditioning factors in the form of a checklist, which will allow a potential developer to determine the fundamental points to take into account both for the implementation of a port in a specific country and for the regulation of the relationship between the developer and the concessionaire.

With the aim of establishing the volume of investment necessary for the construction and exploitation of a port, we determine the size of a container terminal as an illustrative example on the basis of certain hypotheses that involve conditioning factors at the technical level (decisions about the type of seawalls or cranes, for example) or at the climate level (tides, bathymetry, etc.). All these conditioning factors should be compared and assessed in the case of a real application. In the same way, the size of a different type of terminal can be determined, the volumes of investment assessed and, thanks to the mathematical model, the economic flows of the participants can also be established.

The mathematical model analyses all the economic flows that should be generated between the business participants and assesses the situation of each entity separately and dynamically, allowing it to be determined whether the project is attractive for each entity and to modify investments, along with tariffs, demand and contextual conditions, thereby obtaining for each scenario and entity the values that make the business viable and allow the results of each party to be compared.

This model has been designed for one concessionaire. However, it could be designed analogously for “n” number of concessionaires. Figure 6 shows the structure of the mathematical model.

Figure 6. General structure of the mathematical model



Source: Author

As can be seen, the algorithm allows “n” number of concessionaires to be included for which a number of modifying modules of rate “m” can be analysed. Within each of these modules, “r” parameters can be evaluated. The algorithm is, therefore, capable of including a large number of variables.

Each of the rate modifying modules is designed to award a bonus or penalise the concessionaire as a function of its performance in determined aspects of operating a terminal. Figure 6 shows the work carried out in this investigation highlighted in red, in which the parameters 1 to ‘r’ of a single rate modifying module for the first concessionaire.

Similarly, it is possible to add more control modules for the first concessionaire or to analyse a greater number of concessionaires whose activity could involve any other type of terminal (vehicles, solid bulk, liquid bulk, etc.)

Lastly, a validation of the mathematical model has been carried out from the actual information of the construction and exploitation of a container terminal with the aim of checking that all participants can be assured the expected profits. Moreover, a sensitivity analysis has been carried out, the results of which demonstrate that the fundamental parameters of the system, in addition to the volume of sales and price, are certain rates paid by the concessionaire.

6. RESEARCH QUESTIONS

This section sets out the research questions that represent the fundamental guidelines for this thesis.

Question 1: What type of relationship should there be between the participants such that a discussion of the rates as described here can take place?

The business model described here requires land to be purchased by the developer, who concedes spaces to private terminal operators.

There are, therefore, two types of relationship. Firstly, the relationship between the developer and the state in which the port is to be built, since independently of who purchases

the land and consequently earns the right to operate, it is probable that it has to pay for certain rights for the use of, say, the sea floor.

The second relationship is between the developer and its concessionaires or terminal operators. These operators pay different rates to the developer, so that a) it can amortise its investments in infrastructure and b) it obtains profits from its investments. This means that the economic flow between the developer and concessionaire is bidirectional, since the concessionaire receives land in which infrastructure investments have been made (landfills, seawall construction, roads and rail transport connections) and pays the mentioned rates.

It is necessary, therefore, to regulate the relationship between the developer and the concessionaire in order to ensure that both obtain the expected profits from their investments. If the developer obtains exceedingly high profits and the concessionaire, extremely low profits, it will be difficult to attract operators to exploit the terminals. If it were the other way round, the port would not come to exist, as the developer would not take on the project. Therefore, it should be determined exactly how these relationships should materialise.

Question 2: How are investments in infrastructure to be undertaken?

The key to the business model designed from the relationships between the participants is the way in which the investments in infrastructure are undertaken. The main difference between privatization and the private conception of the business model port lies precisely in how these investments are undertaken.

The structure of the relationships proposed here and, with it, the developer-concessionaire rates, should generate sufficient economic flow between them so that the one who has invested in the infrastructure—the developer—, assumes them and makes a profit from them. This requires the concessionaire to have a business that a) allows it to pay for its own investments in superstructure and b) allows it to pay enough rates to the developer so that the developer can pay back its investments and make a profit.

The infrastructure investments are addressed, in principle, through an infrastructure rate R_i , paid by the concessionaire, which helps the developer pay for its investments and make a profit. However, it should be determined how this rate affects the concessionaire and the amount that allows the business to develop.

Question 3: In the business model derived from the study of the rates, is the participation of the public sector necessary for infrastructure investments?

The model has been designed to avoid the participation of the public sector in any of the project's development stages, so long as certain assumptions and adequate contextual conditions exist. In a traditional port, a public entity, with access to better capital market conditions than private entities, undertakes investments in infrastructure and concessions spaces to private operators. These investments are not only the most capital intensive, they are the slowest to be executed. Consequently, the time that passes between the moment the port starts to be built and the moment returns are made is long and therefore should be made by an entity with sufficient financial strength. Traditionally, this is a nation state.

This situation aims to limit itself to the model and avoid any type of public sector participation through the design of economic flows that enable private entities to develop the project. However, two situations may arise in which public participation is essential: a) if the model is to be implemented in countries in which port management is public and there is no possibility of proposing alternative options and b) if the flow of investments and returns prevents private entities from taking on all the investments and public participation is required to fund certain blocks of investment. It is necessary, therefore, to determine whether the business model

described here allows for the possibility that the port can be developed without public participation.

Question 4: The private management of a port is possible, as proven by the existence of various examples in the world. However, if the project developer is private and is also the entity that manages the port, is the private management of a port possible from its design stage, addressing investments in infrastructure?

The discussion set out here not only addresses whether a port can be managed from a private perspective, but also whether the port authority that manages the ports can at the same time be the entity that develops the project.

There are various examples throughout the world of privatized ports and ports that, under different conditioning factors from those proposed here, arise as a mixed public-private model. These ports are managed from a private perspective and, therefore, the first part of this question would be: yes, private port management is possible.

However, there are no precedents of port authorities that a) are private and manage a private port and in turn, b) undertake the investments in infrastructure from a private point of view.

In this thesis, we analyse the activities carried out by port authorities in the field of management in countries in which the system is fairly rigid. The aim of the analysis is to establish which activities a port authority should carry out in these countries. In this way, to answer the research question, these activities need to be determined and ask the relevant questions that allow the creation of a model that allows the port authority to assume these activities and, moreover, ensure that the project developer is the one to finance them.

Question 5: What type of port can the business model be applied to?

It is important to establish what we mean by a port. There are various examples throughout the world of dedicated terminals that have arisen from a private initiative. These dedicated terminals usually handle one type of cargo, which is usually to property of the operator. Usual examples include solid bulk terminals that handle coal, soya and other cereals, or liquid bulk terminals that handle petroleum derivatives. The cargo alone usually allows a private operator to undertake investments to create a port usually close to production zones and occasionally consumption zones.

However, this thesis addresses the development and management of a private port, in which a port is understood to be a set of similar or different terminals, the connecting infrastructures, the services provided by the port authority, etc. A port is, therefore, a set of services much more complex than those found in dedicated terminals and should be designed to serve various types of cargo.

Having set out the concept of a port, its type and size need to be studied. There are hundreds of examples of ports throughout the world, since each has been adapted over the years to the needs of a) the territory in which they are located and b) the operators that exploit them. Theoretically, given the ratio between seaports and river ports, it appears that the most usual port model is the seaport. With regard to size, there are examples of extremely large ports in regions in which maritime trade is of fundamental importance and also examples of very small ports of a limited area of influence. Using a statistical model based on the Gaussian distribution, it can be established that, theoretically, the most usual port is medium sized.

The type and size of a port are fundamental aspects in the characterisation of the relationships between the participants in the model, since we will see that the volume of business of a port affects the way in which it is managed. Consequently, the port type should

be determined with the aim of designing a business model for its size and characteristics, making it, therefore, as universal as possible.

Question 6: Are there similar business models to the one described here?

We start from the idea that the business model proposed here is unique and that there are no prior examples. It should be confirmed that, in effect, there is no model analogous to that presented here and, therefore, that it represents a new contribution to the sector. We know that there are models that share certain characteristics with the one proposed here. For example, there are private port authorities and dedicated terminals that have purchased the land on which they sit. Nevertheless, the characteristics of the business model should be defined in order to establish that there are no similar examples in existence.

Question 7: Are there any calculation models similar to the one presented in this thesis?

Previous reviews of the literature did not reveal any analogous models, which leads us to believe that there may be no model of this type of port proposed as a totally private business model.

No similar model was found either during this stage or during the writing of this thesis that combines a) a description of the relationships between the participants, b) the regulation of the economic flows in terms of the investments made by both, c) the determination of the contextual conditions that allow the model to function and generate the expected profits for each participant, d) the construction of a calculation model that allows the concessionaire to be awarded a bonus or penalised based on its performance in various areas and e) an economic-financial study that explains the conclusions drawn.

Question 8: Are there any legal determinants for the implementation of the business model derived from the discussion about rates?

One of the fundamental axes of this thesis revolves around determining whether there are any legal determinants that would prevent the implementation of the business model presented here. In theory, the starting hypothesis was that there should be international legislation that covers these types of actions and legislations particular to each country that regulates the specific conditions of implementation in their territory.

Having finished writing this thesis, we have confirmed that there is no international regulation or legislation in this sector. It could be inferred that everything is based on the *Lex Mercatoria*, whose principle is that the market regulates itself. Not all the countries analysed have specific regulations for implementing the business model. While some have very defined legislation and action protocols, others allow the entry of foreign capital for these types of projects, with very few limitations. Therefore, the implementation of the business model in a specific country requires an in-depth legal study. Since no generalisation can be made in this respect, this thesis defines the aspects a developer should bear in mind on approaching this business model and implementing it in a specific country. This definition is bidirectional, since this thesis analyses how to manage the developer-state relationship in addition to the developer-concessionaire relationship.

7. MAIN CONTRIBUTION

Currently, there are business models similar to the one described here. However, there are for dedicated terminals. These terminals handle just one type of cargo, which is usually owned by it. Most of them handle solid bulk cargo and handle products such as soya, rice or coal. Others handle liquid bulks, such as petroleum-derived products.

In the container terminal sector, there are throughout the world initiatives for the design, construction and exploitation of installations aimed at handling containers, some of which are already operating. However, these business models do not have the same involvement as the model described in this thesis. The model put forward here differs in two main ways from other current models:

- In certain cases, the difference is that the port as a whole has been privatized. It will be demonstrated here that the concept of a port from a private perspective and privatization are diametrically opposed concepts in terms of investments.
- In others, the difference lies in the concept of “port” and “dedicated terminal”. This thesis addresses the concept of a port as a collection of terminals that create synergies between them; it does not focus on just one type of port nor a single type of cargo. Therefore, the model presented here differs from the traditional concept of a dedicated terminal (which is usually privatized) or a privatized port.

Thus the main novel contributions of this investigation include:

- At the conceptual level, a) the definition of a new business model for a commercial port conceived from a private perspective, from the earliest stages of the project, including the ownership of the land on which it is to sit and the definition of the relationships with the country in which it is to be built in order to avoid conditioning factors to arise and b) the creation of a private model —not privatized—, a concept with common characteristics but with a major difference in the treatment of the infrastructure investments.
- At the operative level, the creation of a calculation algorithm that allows contextual conditions, the investments and the system’s regulatory parameters to be introduced, establishing the expected profits for each participant and ensuring the general stability of the system through the optimization of these parameters.
- At the strategic level, designing modules that allow the algorithm to include an analysis of certain aspects of the operating of each terminal, with the aim of applying bonuses or penalties to the rates paid by the concessionaires as a function of their performance in these areas.

8. METHODOLOGY

This thesis addresses the characterisation of the developer-concessionaire rates in the exploitation of port terminals. To carry out this characterisation, it is necessary to address various knowledge fields whose study is diametrically opposed. Given the importance of the methodology in this investigation, a detailed methodology is defined in each chapter.

The method used to execute this thesis includes the analysis of the scientific documentation on the definition of port models and the design and execution of various interviews with experts. This has resulted in the design of a terminal on which the model has been validated.

A parameterization of this terminal was then carried out through processes or types of rates. Variables have been introduced to apply penalties or bonuses to the rates as a function of the concessionaire’s performance and the impact of the application of these measures on the developer and concessionaire have been analysed.

The next section describes some of the tools that have allowed the methodological characterisation to be carried out.

8.1. The use of software

As a support for achieving the established aims, Table 2 shows the main software used.

Table 2. Computer software employed

Software	Developer	Version	Description	Application
Word for Mac	Microsoft	15.19.1	Software for writing text	Writing the thesis
Excel for Mac	Microsoft	15.19.1	Software for calculation sheets	Economic-financial model and tables for generating various figures
PowerPoint for Mac	Microsoft	15.19.1	Presentation software	Construction of certain diagrams
Mendeley Desktop	Mendeley Ltd. - Elsevier	1.16	Software for managing references and PDF documents	
Minitab	Minitab Inc.	15.1.30.0	Program designed to execute basic and advanced statistical functions	Creation of 3D figures
BLM Shipping	BoLooMo International Group	2.0	Advanced database for maritime transport	Definition of the main maritime transport routes and obtaining data about ports
Visio	Microsoft	2010	Program for creating diagrams	Flow diagrams
CmapTools	IHMC	6.01.01	Tool for creating conceptual maps	Conceptual maps of the relationships between the participants in the port business
Skype / Facetime	Skype / Apple	7.20 / 3.0	Software for videoconferences	Interviews

Source: Author

8.2. Interviews

A part of this investigation is based on carrying out interviews as a means of obtaining information. The interviews were, in all cases, non-structured, since although the interviewer always had to hand a script of the subject matter being discussed, the questions were adapted as a function of the interviewee's answers.

All the 42 interviews were recorded and the average length was approximately 40 minutes.

Table 3 shows the template with the script used for the interviews with port authorities. These 37 interviews were not always conducted in person due to the geographic location of the interviewees.

In those cases in which the interviews could not be done in person, they were conducted via a telephone call or videoconference.

Table 3. Port Authority interview template

Interviewee	Jordi Vila	
Entity	Barcelona Port Authority	
Post	Director of environment department	
Reason for interview	To gather information about the environmental parameters that the BPA controls and to determine whether they have bonus systems for rates	
Date and time	27/07/15, 16.00h	
Script	Answers	Comment
Does BPA currently have a system for awarding bonuses to rates?	No, despite the fact that it is established by law that a bonus can be applied to concessionaire activity rates.	Review laws 48/2003 and 2/2011
After reviewing in depth the law on the environment, we have not found the range of application of environmental parameters such as CO ₂ emissions. Is there any specific legislation for the port sector?	No. Port legislation is basically contained within in EMAS and ISO rules. However, each focus of potential environmental impact is defined in individual regulations.	Review EMAS, ISO rule 14001, RD 239/2013, MARPOL
Does BPA have a system for controlling emissions and other environmental parameters?	Yes. It has a network of sensors that measure emissions of not only CO ₂ but also particulates. However, this is only for the air. There are other impacts on the water, on the seafloor silt and on the land itself due to oil spillages, for example.	Review PVMALC plan and law 34/2007
Would it be of interest to BPA to have a system for awarding bonuses to or penalising concessionaires as a function of their environmental performance?	Yes, of course. These days, BPA is championing a project called the "Efficiency Network" to which companies adhere in order to acquire certification. They are audited for certain parameters related to management, but it would be useful to have this calculation system even for them, although not all are concessionaires.	Study the bases of the "Efficiency Network" and determine what types of businesses are covered by this project.
Duration and schedule for next interviews.	40 minutes. Next meeting scheduled for reviewing proposed parameters.	

Source: Author

As can be seen in Table 3, the questions are not too closed, since it is a guide to issues to be addressed. The answers provided a large amount of information. As a result, a second round of interviews had to be carried out for several cases in order to review the comments and ideas that came up in the interview. In the specific case shown, with Jordi Vila, a total of 4 interviews were conducted.

Table 4 shows the template used with the script of the interviews conducted with the concessionaires of port terminals. The geographical distribution of the port terminal concessionaires is similar to that of the port authorities. Likewise, the interview was conducted in person but, when not possible, it was conducted via telephone or videoconference.

Table 4. Concessionaire interview template

Interviewee	Eduardo Durán	
Entity	Portcemen, S.A. (cement terminal in the Port of Barcelona)	
Post	Director General	
Reason for interview	To study how a concessionaire perceives its relationship with Barcelona Port Authority and to gather information about the way in which the renewal of an administrative concession is carried out.	
Date and time	19/02/15, 14.00h	
Script	Answers	Comment
How far in advance of the expiry date of a contract can a concessionaire negotiate renewal with BPA?	In reality, there is no set period. It depends on the needs of both parties.	
Does BPA require concessionaires to revert their assets at the end of the concession period?	Yes. In fact, in the case of Portcemen, the asset has already reverted to BPA and as a consequence these days Portcemen rents it from BPA	Review RD 2/2011
What happens if the public developer is not interested in the concessionaire's installations at the end of the concession?	It could call for it to be demolished and for the land to be handed back in its original form. It depends on whether the concessionaire is interested in continuing, on the condition of the installations and the plans the port authority has for this area.	Study how this affects the calculation model. Regardless, bear this in mind on drafting the legal checklist, as the situation with the concessionaire should be analogous to that demanded of the developer by the State.
What happens when a concessionaire invests in specific equipment and then ceases to exist as a business?	In reality, this scenario is complicated. On bidding, a concessionaire provides a deposit of a specific sum. I suppose that in this case, the port authority would retain the deposit to have access to this sum available and return the land to its original state or it could look for operators interested taking over the concession with the installation left behind by the previous operator.	Study the amount of the deposits paid down by a concessionaire when it wins a concession. Is it a percentage? Does it depend on each case?
Is the concessioning of a space on port land always initiated by	No. There are examples in which the port authority is interested in a terminal	

the port authority?	operator occupying its one of its terminals. In this case, a bidding process is opened and, after bidding, it awards the concession. However, a scenario may exist in which the operator is interested in a concession and approaches the port authority. As it refers to public land, it cannot be awarded even though there was an interested party – it must open a period in which others assess whether they are interested.	
Duration and schedule for the next interviews.	1h. Meeting scheduled for the 18/03/15, at 9.30 am.	

Source: Author

Similar to the previous example, it can be seen that the questions are a guide. In the case of Eduardo Durán, several interviews were conducted to refine the results.

In other areas of this investigation, when the aim was to gather information on port systems and the way the port authorities are organised in the more than twenty countries studied, interviews via email were conducted. Following the first conversation, in this case via telephone in nearly all cases, an email, shown in Table 5, was sent, which was the first step in developing chapter 5.

Table 5. Table included in the email

Entity	Adani Port and Especial Economic Zone, L.T.D. (India)
Contact person	Narendra Gupta
Post	Senior Manager, CEO Office
Contact details	narendra.gupta@adani.com / +91 96876 99061 Adani House, PO Box No. 1, Mundra, Kutch 370421, Gujarat
Message sent	
Following our conversation on the telephone, here is a description of the information required to complete my investigation:	
<ul style="list-style-type: none"> ▪ The legislative framework regarding port concessionaires ▪ How the port system functions. Is it centralised in a Ministry? What legislation covers the model? ▪ Who awards port concessions? ▪ What are the requirements to bid for a port concession? ▪ What are the concession periods according to Indian legislation? 	
Answer	
Dear Mr Roa,	
Thank you for your interest in the Indian port system. I have sent a copy of this email to Capt. Abhyankar, who has asked me to provide you the information requested.	
As we mentioned on the telephone, the information can be found in the following two sources:	
a) regulations and rules: http://shipping.nic.in/index1.php?lang=1&level=0&linkid=36&lid=48	
b) information on concessions and model documents:	

<http://pppshipping.nic.in/modules/login.aspx>

These links include information in PDF format so that you can quote specific regulations without using webpages, as you commented. I hope this information is of use to you.

Final result

In this step, the following information has been obtained:

- Ports Act 2010, Ministry of Shipping, PD-24018/8/2009 – PD. III, Delhi, August 2nd, 2010
- Public Private Partnerships in India, developed by the Department of Economic Affairs of the Finance Ministry

Only partial information on the Indian port system was obtained, in which case jump to step 3 and complete it with the information available from multilateral entities.

Source: Author

Table 5 shows that this interview format is more open than the previous, since as several pieces of information were required, the interviewee answered by email to provide sources in which the information is available. On many occasions, the information provided did not match the information requested and, as a result, the process was completed by research articles, websites, etc. All this is described in detail in chapter 5.

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3

Port type. Analysis of ports and port installations

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1. AIM

Worldwide, there is an extensive variety of port installations that are adapted and sized according to the types of traffic they handle (volume, cargo type, type of vessel, etc.).

The aim of this chapter is to study large port facilities in order to determine what type of port should form the basis of the business model.

2. CHAPTER ORGANIZATION

This chapter is based on the article: “*Ports: definition and study of types, sizes and business models*”, published in the “*Journal of Industrial Engineering and Management*”, 2013⁴

3. INTRODUCTION

As emphasized by CEPAL⁵ reports on the Integration of Latin America into international trade, emerging and developing economies are perceiving new requirements and trends in international markets, which are evolving (CEPAL 2012), (CEPAL 2014). The current scenario presents new patterns in which centres of production or service are spread throughout the world regardless of the country origin, culture and language (World Bank 2007). Changes in the business model of international trade significantly affect the development of certain countries due to the composition of exports and imports (UNCTAD 2005).

The new scheme of market integration results in a team that does not need to converge under one roof (Burkhalter 1999). The result is the specialization in manufacturing, increased price competitiveness and a boost in trade. From this phase, supply, distribution and marketing synchronization becomes vitally important, going beyond geographical boundaries to span the entire globe. The integration process between users of different nations requires the promotion of transport, which becomes an essential tool that facilitates the flow of trade between states. Therefore, transport has a direct impact on the supply chain and the global economy (International Transport Forum 2012). Transport and logistics have a management base that allows specialization in international physical distribution operations through the use of premises known as ports. The introduction of new technologies into the maritime and port industry (Ramos-real & Tovar 2010), mostly fostered by the process of cargo standardisation (such as containerisation), marked the start of an increase in the demand for the privatisation of terminal operations and even of the whole port (Ferrari et al. 2015).

Ports are areas near a sea, ocean or river connected by a waterway and are essentially considered as entities. Equipped with infrastructure and technical facilities of any kind, ports can manage loads of any type. Ports have become growth hubs in regional economic development (Ying 2011). Their basic function is to provide shelter, to a varying extent, to ships, allowing the transfer of goods from one means of transport to another. They also function as a link between sea and land and are a clear example of intermodality (Tarantola 2005).

These sorts of facilities are structured under a complex legal concept and managed through an organizational model that requires the convergence of public and private sectors (Nijkamp et al. 2002). Proof of this lies in the fact that, since the 1990s, public-private partnerships (PPPs) and concession contracts have been widely used to develop major infrastructure projects (Moore et al. 2014). There are three main reasons to increase PPPs: Growing national budget problems, seeking improvements in productivity and efficiency and better location of risks and incentives (Rangel et al. 2012). This is a recent trend, having started within the last 20 years. A study of 116

⁴ JIEM, 2013 – 6(4): 1055-1064 – Online ISSN: 2013-0953 – Print ISSN: 2013-8423

<http://dx.doi.org/10.3926/jiem.770>

⁵ CEPAL - Economic Commission for Latin America of the United Nations

European ports that were awarded container terminals concessions found that approximately 40% of awarded ports were completed in the period 2003–2010 (Notteboom et al. 2012). This is therefore an organizational model whose study is by no means trivial (World Bank 2014).

The management model used in Spanish territory, called *landlord*, has not been implemented worldwide. However, there is a strong tendency towards this model (Ramos-real & Tovar 2010). The advantage of this organisational system is that the vertical separation of the port authority and service provision allows for competition between different service suppliers in a port (Reeven 2010). In this model, the infrastructure is publicly owned, service delivery is usually private and regulation is carried out by a public entity (Martin-Bofarull 2010). This regulation is based on a scheme that allows the combination of public ownership of the port infrastructure (docks, land, and so on) with private ownership of the superstructure (warehouses, cranes, etc.). The public authority determines the conditions under which the private initiative can operate by fixing maximum prices, characteristics and length of concessions, and other conditions (Tovar et al. 2004). Participation of public sector authorities is necessary for safety, security and national planning reasons as well as for certain service operations such as customs and immigration, whereas private sector participation may be sought for superstructure investment and commercial services provision (Rangel et al. 2012), (Yuen et al. 2013).

Obviously, although this is perhaps the most widespread model, it is not the only one. For the present article, we propose a study to determine the most common organizational model of this type of facility, first defining the types of ports by physical characteristics and under development activity. Furthermore, we study the size based on certain criteria and finally we specify the business model.

4. METHODOLOGY

For the development of this study, we have used a sample of 802 ports of different types, sizes and nationalities. This sample includes the 100 most prominent port facilities in the world in 2014 according to World Port Source. These port facilities handled 75% of the total annual global burden. In our case, we set a minimum percentage of ports studied by country and, by expanding the sample to 802 facilities, we have been able to cover a turnover close to 90% of the world market.

We analyse management facilities for goods only and therefore leave aside structures that focus on other areas such as fishing, military, tourism or recreational uses. This in-depth study identifies the most common size and type of ports and has been carried out in order to determine the optimal organizational model required by this sector to meet market demands by adapting its management to drastic changes in the economy.

This chapter starts with a classification of the type of ports based on geographic location. However, given the scope of the investigation, it is necessary to create categories whose difference is not strictly geographical but that also focus on aspects related to the type of facility (deepwater seaport, seaport, river port, harbour, pier, jetty or wharf terminal port, offshore terminal and canal with respect to the type), as well as its size.

This size is not strictly limited to the area occupied by the port, but to the TEUs managed. To define the size, we also study the amount of non-containerized cargo handled during the year and the port's area of influence.

4.1. Ports: Classification criteria

As noted previously, the types of categories studied here are based on the different features that each facility possesses that allow them to meet their business needs. The eight types of ports proposed for this study include:

- “Deepwater Seaport”: a deepwater port is considered to be a body of water whose draft⁶ in both the entrance channel and in the terminal area exceeds 13.72 m.
- We include in this classification all ports whose foreland⁷ is located within marine or ocean areas.
- “River Port”: All ports located on one of the banks of a river, regardless of depth.
- “Harbour”: This classification includes installations that, although not strictly considered ports, are used for loading and unloading goods and have sheltered water outside. The shelter structure consists of a dam⁸ constructed for this purpose. These facilities are marine or oceanic.
- “Pier, jetty or wharf”: this category includes those facilities that are no more than a simple dock or pier and that do not always have to be sheltered from open water.
- “Port Terminal”: Although this is strictly a classification that could be included in any of the above, the large number of such facilities worldwide makes it necessary to establish this subdivision. It is also those known as “a dedicated terminal”. In a strict sense, this category does not include ports in general but, rather, simple terminals whose loaded or unloaded material is always the same. Consequently, their facilities are accessible only to the type of goods they manage. The most common dedicated terminals are those managing soybeans, coal and other minerals. The vast majority handle solid bulk goods, although there are those that also specialized in liquid bulk goods such as oils, certain types of gas, etc.
- “Off-shore terminal”: Installations located entirely at sea. These terminals are constructed on a completely artificial foundation built specifically to house the equipment for the management of merchandise. They are devoted exclusively to the unloading of inbound cargo and shipment by short-sea shipping to the mainland and the loading of outward bound cargo coming through the same channel.
- “Canal”: There are certain port facilities that cannot be strictly classified as a river. This is the case for those located inside navigable marine inbound waterways, which can be many kilometres long. These facilities are connected to the sea or ocean through a single point. This category does not include artificially constructed installations or those whose activity is merely the passage of ships (such as the Panama Canal or the Suez Canal).

Both “River Port” and “Canal” fall under the category of “Waterway Systems”. There are currently 25 waterway systems (5 in Asia, 8 in Europe, 10 in North America and 2 in South America) with a total of 155 ports. In this study, however, these groups were ruled out and we consider each port separately.

Size is another classification and groups are formed as follows: very small, small, medium, large and very large. This classification of ports is not trivial and we apply a multicriteria analysis that takes into account:

- TEU managed throughout the year
- Tonnes of cargo handled during the year. There are still a wide variety of goods that do not lend themselves to containerization (Cudahy 2006). Ports such as Barcelona or Rotterdam handle both containers and bulk cargo. Consequently, these ports include the two types of goods in their total load managed.
- Hinterland⁹ size and importance. This is the balance between the size of a port’s inland catchment area (hinterland) and the importance of this area as a business zone. It is perfectly possible for a port to have a relatively small, but very important hinterland as a

⁶ Vertical distance from the water surface to the sea floor

⁷ Offshore area of influence

⁸ Barrier constructed to hold back water and raise its level

⁹ Inland area of influence

centre of business generation. The port therefore gets a higher score than another port with a much larger hinterland. Each port is subjected to this weighting individually.

- Foreland. Size and area of influence are also considered in the classification process.

To classify ports by size, it is important to identify whether they are managed by a public or private entity, as this will greatly influence investments.

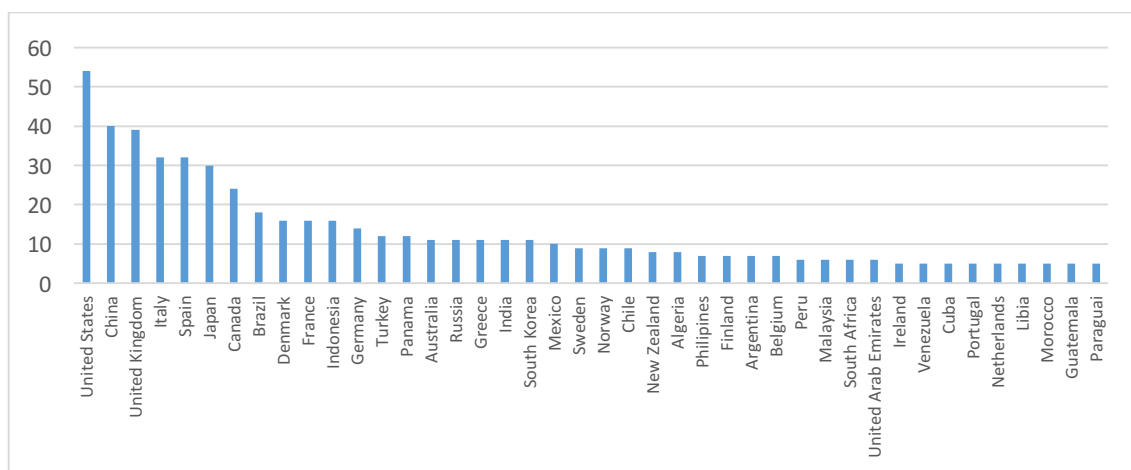
Another important aspect regarding ownership is the fact that the scope within the area of influence (hinterland) is often greater for public terminals, most of whose facilities are concessioned to private operators.

Currently, most ports are subject to privatization, which is the result of a new global trend that aims to achieve improvements in operational efficiency and that requires a new investment management system (Van Ham 1998). Accordingly, the associated parametric value in analysing their ownership may fluctuate over time.

5. RESULTS

The sample of the 802 port facilities mentioned above includes 196 countries. Figure 7 shows those countries in which we have studied more than 5 ports. There are a further 154 countries in which we have studied less than 5 ports. Taken together, these ports represent 16% of the total infrastructure and a turnover of close to 90% of the world market.

Figure 7. Ports studied in each country



Source: Own analysis

Notable countries include the U.S., China, Canada and Russia, which have many port facilities. This could be related to their level of development rather than their geographical extent.

For other countries such as Greece, importance is determined by their historically privileged strategic business location for rather than geographical location.

Table 6 shows the 16 countries with the greatest number of ports (regardless of their type), including those found in leading countries such as Britain, Italy and Japan, which have relatively smaller surface areas compared to other countries such as China, Australia or Russia.

Table 6. Geographical data of the countries with the highest number of ports

Country	Ports studied	Ports in the country	Surface	Length of coastline
			(km ²)	(km)
United States	54	531	9,158,960	19,924
United Kingdom	39	389	241,590	12,429
Italy	32	311	294,020	7,600
Japan	30	292	374,744	29,751
Canada	24	239	9,220,970	202,080
China	40	172	9,326,410	14,500
Denmark	16	159	42,394	7,314
France	16	159	545,630	3,427
Indonesia	16	154	1,826,440	54,716
Australia	11	105	7,617,930	25,760
Spain	32	105	499,542	4,964
Russia	11	105	16,995,800	37,653
Greece	11	103	130,800	14,880
Germany	14	98	349,223	2,389
Sweden	9	82	410,934	3,218
Brazil	18	81	8,456,510	7,367

Source: Own analysis

Clearly, therefore, commercial conditioning occurs, as in the case of Greece, or merely geopolitical, as in the case of Japan.

As can be seen in Table 1, there are countries for whom port management becomes a national issue of vital importance in the development of national economic policy due to the large number of ports these countries have.

Table 7 lists the pooled data for the type, shown in the rows, and size, shown in the columns (according to the selection criteria listed above)

Table 7. Overall study results

	Very large	Large	Medium	Small	Very small	TOTAL	%
Deepwater Seaport	18	10	4	0	0	32	4.0%
Seaport	15	81	333	70	0	499	62.2%
River Port	1	6	36	29	5	77	9.6%
Harbour	0	1	24	98	1	124	15.5%
Pier, Jetty or Wharf	0	0	3	31	28	62	7.7%
Port terminal	0	2	1	0	0	3	0.4%
Off-Shore Terminal	0	0	1	1	1	3	0.4%
Canal	0	1	1	0	0	2	0.2%
TOTAL	34	101	403	229	35	802	
%	4.2%	12.6%	50.2%	28.6%	4.4%		

Source: Own analysis

As we can see from Table 7 **Error! Reference source not found.**, the vast majority of ports studied are of the type "Seaport" (marine) and, taking into account their size, belong to the category of "Medium".

This makes sense, as there are many more waterfront shores overall than navigable rivers.

In terms of size, we find only 34 ports classified as very large among the 802 studied. Of these 34 ports, 20 are in the world's top 100 largest ports. However, it is surprising that, although classified as "very large", 14 of them do not appear in the top 100.

This reaffirms the view that size is not always the most important parameter: it is the geostrategic position of the port within a global trade framework that is really important.

Similarly, 37 of the 101 ports classified as "large" appear in the list of the 100 most important ports in the world, as indeed do 39 of the 403 medium ports included in the sample studied. Examples include the port of Guangzhou (China), which is ranked No. 6, the port of Jebel Ali (UAE), ranked No. 7, the port of Kaohsiung (Taiwan), ranked No. 12, and the port of Tanjung Pelepas (Malaysia), ranked No. 17 in the list.

From this data, it is again reasonable to ask whether a port's size is directly related to its importance in international trade or whether other factors more important than size have an effect. It would seem, therefore, that the geostrategic factor plays a significant role.

As can be seen in Table 8 **Error! Reference source not found.**, according to the IUEM¹⁰, container ships are increasing in size every year (Gonzalez-Laxe 2007).

Table 8. Increase in container ship size

Generations of container ships			
Vessel	Name	Years	TEUs
First generation	Early container ships & Fully cellular	1956-1970	500-800
Second generation		1970-1980	1,200-2,500
Third generation		1980-1988	3,000-4,000
Fourth generation	Panamax	1988-2000	4,000-6,000
Fifth generation	Post Panamax	2000-2005	6,000-12,000
Sixth generation	Suez Max	2005-2008	12,000-14,000
Seventh generation	Post Suez Max or Super Post Panamax	From 2009	>14,000

Source: IUEM

Consequently, since the development of fifth-generation container ships, it has become absolutely essential that ports are of the type "Deepwater Seaport", as the necessary draft exceeds 13.72 m. Until 2000, when the first fifth-generation container ships started being built, there was no need to use such deep port facilities.

All ports built to date are mostly of the type "Seaport". However, as can be seen in Table 9 **Error! Reference source not found.**, according to *Alphaliner*, the trend to 2014 reveals a substantial increase in vessels of 10,500 TEUs. Consequently, it is highly likely that in the near future new port facilities will need to be designed based on the requirements of this vessel size.

¹⁰ IUEM - Institute of Maritime Studies of La Coruña University

Table 9. Container ship fleet development

Container ship fleet			
Size in TEUs	Number of ships 2010	Number of ships 2014	Variation
100-499	268	265	-1.1%
500-999	806	826	2.5%
1,000-1,499	705	762	8.1%
1,500-1,999	583	608	4.3%
2,000-2,999	718	760	5.8%
3,000-3,999	322	367	14.0%
4,000-5,099	680	702	3.2%
5,100-7,499	432	408	-5.6%
7,500-10,499	264	366	38.6%
>10,500	71	233	228.2%
TOTAL	4,849	5,297	

Source: Own analysis

However, what becomes increasingly important, and which can be seen in the data presented here, is that a larger port will not have greater potential for handling goods. Rather, a number of factors, such as the volume of cargo handled (containerized or not) and the size of the hinterland and foreland, will minimize the importance of the purely geographical extension of the port itself.

6. BUSINESS MODEL

To develop the business model, this study focuses on a range of medium-sized seaports from different countries. All ports of this size in Spain —Malaga, Alicante, Algeciras, Bilbao, Cadiz, Las Palmas, Ferrol, La Coruña, Huelva, Marin, Palma de Mallorca, Santander, Tarragona, Vigo and Valencia— are managed by publicly owned port authorities. Notably, Valencia occupies position 26 in the 2011 Port Ranking mentioned above.

This sector includes 8 French ports: Fos-Sur-Mer, Pallice, Ballone, Boulogne-Sur-Mer, Cherbourg, Calais, Nantes and Sète. The French business model is identical to its Spanish counterpart, since ownership is public and certain areas are conceded to private operators. Something similar happens in the case of Italy, which has 10 ports in this segment, and Mexico, with 8, and Morocco, with 4.

By studying only this portion of the port market, it can be seen that the most common business model is a combination of public ownership with private concession (Rúa Costa 2006). In countries such as India, for example, dry ports are managed by the state company Concor, who owns the land and concedes spaces to private operators and, on occasions, provides certain services in exchange for a fee (Gujar & Yan 2010)

It is no surprise that this business model is the most common, since port infrastructures require a high level of investment in the early stages of project development, a fact that makes it difficult for private investors in these early stages to go into business (Saurí & Robusté 2012).

More often, for ports such as these, the infrastructure is planned and executed by the nation states themselves. They then offer, through administrative concessions, selected areas such as terminals, vehicle gathering places, deposits, etc., to private operators, who are then allowed to develop the superstructures or facilities for their activity.

Thus, the state recovers some of its investment by charging the appropriate fees to private operators. The current trend towards privatization (Van Ham 1998) is, therefore, necessary.

While public presence is greater during the initial stages, it gradually diminishes until state capital eventually disappears completely.

Consequently, privatization is nothing more than the complete transfer of control to (a) port operator(s) that ultimately pays for the investment (or most of it) initially made by the state.

Far from trying to enter into a debate on what kind of management is more appropriate for this segment, the truth is that for certain countries such as the Netherlands, certain reports have recommended privatizing ports as a dynamic means of improving port activity (Van Ham 1998). Indeed, some published reports recommend port privatization as an effective tool for improving the competitiveness of ports (Tongzon & Heng 2005).

7. CONCLUSIONS

This study confirms that the most common types of port are seaports, the most prominent of which are medium-sized, a finding which is in agreement with the investigations of various authors (Rodríguez-Álvarez et al. 2007). The projection of the global freight market predicts that container ships will increase in number and volume in the coming years. Therefore, although the study focuses on what is currently the standard port size and scope, it is foreseeable that more deepwater seaports will need to be designed and built. This change will allow the operations of larger vessels with a greater draft to be accommodated, since the specialization of the ports will gradually reduce competition, generating increasingly more pronounced differences between large operators and other ports.

The vast majority of port facilities are differentiated and are managed by public entities whose business model is the granting of spaces or terminals to private entities.

This is a widespread practice in which public ownership of the port is not an obstacle to development, in that it allows the entry of private operators to energise infrastructure performance and partially reduce the weight of the investments made by nation states.

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4

Heterogeneity in the management of port systems. Case study: The Eurozone

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1. AIM

In this chapter we analyse the developer-operator rates and establish what effects variations in these have on the individual businesses of each participant in the port business. However, the relationships between the developer or port authority and their operators vary according to the countries in which they operate and even within the same country.

This variation is apparent even in countries with similar political systems covered by community regulations, such as Eurozone countries. The aim of this chapter is to confirm this extreme variation in port systems in various countries and in the port authority management systems of countries considered similar. By highlighting this variation among very similar countries such as the Eurozone countries, we aim to demonstrate that differences in port management would be even more acute if the study were to be extended worldwide, since cultural, political and economic differences among the countries included in such a study would be greater.

2. CHAPTER ORGANIZATION

Firstly, the method used for the analysis of this descriptive chapter is described and is then followed by the study of seven port authorities in order to determine their degree of variation. For each of the countries analysed, we determine which port to study and then characterise the port system as a whole, the port authorities and their tariff system. The data is analysed through a general summarising table that confirms the considerable variety in the management of ports in different countries, while a chart groups the countries as a function of two attributes studied: the level of public funding received and the power their port authorities have to set rates.

3. INTRODUCTION

Currently, there are a wide variety of political systems and economic, cultural and religious realities that doubtlessly condition the activities that occur in each country, the way investments are evaluated and the way in which national priorities are determined. Ports are no exception and their management is appreciably conditioned by national and supranational policies, since they are strategic economic tools not only for national development but also local (Botasso et al. 2013), (Botasso et al. 2014).

When ports are studied at the international level, large differences between them can be discerned in terms of their management and even their service tariff policy and the concessioning of space within the port area. A recent study of 781 terminals throughout the world demonstrated that there was no common practice, even in port terminal concession processes (Farrell 2012). Proof of this is that even within the heart of the EU itself there are enormous differences in the management of ports in each country and even within them: from more rigid models such as that in Spain, in which port policy is directed by the State, to models such as those in the north of Europe (Germany, Belgium and Holland (Burkhalter 1999)), where the ports are the property of the local governments or municipals who, in addition, manage them; such ports do not therefore have any legal or economic autonomy.

Four port management systems are considered to exist: the Public Port system such as that in Ukraine (central planning, coordination among various national ports), the Tool Port system such as that in South Africa (central planning, private involvement), the Landlord Port system, as exemplified by Spain (community and local development oriented, PPP development) and the Private Port system typified by that in the United Kingdom (flexibility, market oriented) (Baird 2000). Their fundamental difference is the level of involvement of the private sector (Suykens & Van de Voorde 1998), which ranges from an active role of the PA in operations —as in the Tool Port model—, through to a solely planning and management role as in the Landlord model (Verhoeven 2010).

Each system has to be adapted to local needs (Caballini et al. 2012). Even within a system in the same country, differences may exist in the application of the models, a good example of which is the French model (Cariou et al. 2014). This global heterogeneity means that port authorities may exist with significant differences in their management models, their legal structure, their relationship with local or regional governments and their sources of finance (Brooks & Cullinane 2007).

The differences observed between port authorities that carry out their activities within the European common space strengthens the hypothesis that there exist large disparities in port management and functioning according to the country or geographical area in which the port is located. And if the EU, made up of a group of countries that have agreed to unify some of their policies, does not present a homogenous port system, it would logically lead one to think that other less-regulated countries or those with vastly different governmental systems will have even greater disparities among them.

Therefore, this chapter studies 7 Eurozone countries that satisfy, in principle, the requirements of political homogeneity and economic structure with the aim of determining the main differences in the management of their ports and in the characteristics of their port authorities.

4. METHODOLOGY

To establish the study framework, we will focus on the Eurozone countries, which are those countries that belong to the European Union and which, moreover, have a common currency. In this way, the rates, which are not subject to currency exchange rates, can be compared.

Given that in chapter 3 we demonstrated that the majority of the more than 800 ports studied are medium to large sea ports, we will use these characteristics as a filter but we will add an additional restriction, since we want to focus our investigation on those ports at the cutting edge of world commerce. Furthermore, as these are more regulated and controlled, we will focus our study on those countries whose infrastructures are included in the 2014 list of the world's top 100 container ports. Thus, after applying the filters previously described, the countries studied here include Germany, Belgium, Spain, France, Greece, Italy, Malta and Holland. The United Kingdom is not included in this analysis since, although it is a member of the European Union, it is not a Eurozone member. Moreover, its internal regulation is exceptionally uniform (Goss 1998), (Baird 2013).

Malta is a unique case. It is included in this initial list due to the fact that its main port, Marsaxlokk, which is situated in the southeast of the island, was listed 54th in the 2014 world ranking. However, Malta's container traffic consists mainly of transshipments and as an island, it has practically no import/export traffic. It joined the EU in 2004 but with surface area of just 316 km² and a population just over 400,000 inhabitants (as of July 2014), Malta cannot be compared equally with the other countries in our list.

Therefore, just 7 countries are included in this analysis: Germany, Belgium, Spain, France, Greece, Italy and Holland. To study them, we first carried out a review of the current regulations and legislations with the aim of determining the makeup of their port systems and the applicable laws. Having defined the context, we then analysed the annual reports of the various port authorities (PAs) together with the legislation itself in order to determine which tariffs are applicable and their origin i.e., whether the PA has the authority to decide its own tariffs or, if not, whether they are determined by another entity.

Thus, with the aim of demonstrating the uniformity or not of the port systems of the countries analysed here, a diagram has been created that compares the level of financing and the power of decision over the tariffs, thereby establishing the position of each country studied. Finally, a comparative summarising table has been generated whose function is to show the enormous inconsistency with respect to the application of tariffs and concession periods.

This way, we demonstrate our hypothesis. We confirm that, irrespective of the fact that we are analysing countries with a common regulatory framework within certain aspects, the application of tariff policies and the structures of the PAs are extremely divergent. Therefore, we have confirmed that in settings in which the political determinants result in large differences among countries, the aspects studied here —the power to set tariffs and the level of public funding— will have predictably greater differences.

5. EUROPE: A CASE-BY-CASE STUDY

The European continent is made up of 49 countries in total, some of which form part of today's EU, with the MT¹¹ being signed in 1992. The European Single Market came into force on January 1, 1993 and allowed the free movement of goods, services and capital between member countries. On March 26, 1995, the Schengen Agreement¹², which allows free movement across the borders between Spain, Portugal, France, Belgium, Luxembourg, Holland and Germany, also came into force. Along the same lines, the Euro, the Eurozone's single currency, entered into circulation January 1, 2002, with only the United Kingdom, Sweden and Denmark opting to retain their own currencies.

On March 2, 2012, now with 27 EU members, the Growth and Stability Pact was signed. Through this treaty, the signatories, which did not include either the UK or the Czech Republic, sealed their commitment to a common fiscal discipline. Within this unified framework, a series of laws and regulations aimed at homogenising the economic policies of the various EU signatories were approved. However, the operation and application of port policies was left in the hands of each State, since the internal regulation of each country is still based on their own laws. Consequently, there is no common port policy; each policy revolves around the interests and legislations of each member. Thus, even within a common development framework the policies of port management and organisation are so heterogeneous and disparate that it is impossible to establish a generalizable standard for the various countries.

We will analyse this variation by looking at each of the 7 ports mentioned above individually.

5.1. Germany: The Port of Hamburg

The Port of Hamburg is ranked 15 in the 2014 world ranking of container ports and is thus a very important facility, handling about 9.8 million TEUs annually.

Hamburg PA was created in 2005 by the Federal State of Hamburg as a public entity¹³ but following the classic structure of a private company. Its main functions are:

- The management and development of port area activities;
- The control, management and maintenance of roads;
- The planning and development of works (subject to approval from the Project Setting Office of the Ministry of Economic Affairs and Employment of the Government of Hamburg);
- The purchasing of new land and participation in companies (subject to approval by the Tax and Inspection Authorities).

The PA reports directly to the Government of the city-state of Hamburg. It is 70% owned by the Government itself with the remaining 30% belonging to private companies.

The German port system is one of the simplest in the EU. The PAs, whose legislation is not covered by a single law but several, consist of two entities:

¹¹ MT is the acronym for the Maastricht Treaty, which was signed in Maastricht by the 12 member states on February 7, 1992 and came into effect November 1, 1993.

¹² Which was signed 10 years earlier, on June 14, 1985.

¹³ Created October 2005 as the entity "*Anstalt öffentlichen Rechts*" (Institution Under Public Law).

- The Management Committee, whose mission is to develop and manage the accounting and annual reports, as directed by the big investment companies, along with the development of a five-year port development plan drawn up in collaboration with the Board of Management, which needs the approval of the city-state of Hamburg;
- The Board of Management, which approves the annual report and presents the accounts to the tax inspection authorities of the city-state, whose court of auditors oversees the management of the budget.

Except in singular cases, port lands are owned by Hamburg PA and cannot be sold to third parties. They can, however, be concessioned for a maximum period of 30 years and operators have the right to build on them, provided the constructions revert to the PA once the concession period has expired.

Hamburg PA is self-financing as a private company based on the principle of “*port finances port*”. It also receives some support from the German Federal government and occasional grants from the city-state of Hamburg, which are derived from the profits Hamburg receives from the shares it holds in the PA. Nevertheless, a large part of the investments is derived from self-financing and from the results obtained from the port’s exploitation. With regard to loading, operators have their own staff but may turn to a stevedoring company to cover production peaks (Flämig & Hesse 2011).

The activity of the port is ruled by the Port Development Law¹⁴ (Zachcial et al. 2006). With regard to rates, the PA is responsible for setting prices, which is not the result of German national strategy but internal decisions related to port development. Table 10 shows the rates applied by Hamburg PA on port activities.

Table 10. Rates applied by Hamburg PA (Germany)

Rate	Variable	Description	Formulation
Vessel	100GT ¹⁵	Rate applicable to passenger and merchant ships calling at port. Determined by: <ul style="list-style-type: none"> ▪ Type of ship: Oil tankers, bulk carriers, container ships, ro-ros, car-carriers, etc. ▪ Traffic Type: transoceanic, Baltic Sea and North Sea. ▪ Time in port (berth or anchor). Rate payment is valid for 5 working days. 	$Rate = x_i \frac{GT}{100}$ <p>Where: x_i= Amount depending on vessel type and traffic.</p>
Berthing	100GT	Rate applicable to passenger and merchant ships calling at Hamburg. Determined by: <ul style="list-style-type: none"> ▪ Traffic type: transoceanic or interior. ▪ Period of stay at berth. Payable from the fifth day of stay and quantified in periods of 24 hours.	$Rate = x_j \frac{GT}{100}$ <p>Where: x_j= Amount depending on traffic type and period of stay.</p>
Use of dolphins	100GT (annual)	Rates for the use of dolphins (auxiliary mooring structures).	$Rate = 21.20 \frac{GT}{100}$
Electronic communication	Annual	Paid annually for the electronic transmission of the ship’s signal.	$Rate = cte$

Source: Author

¹⁴ Hafenenwicklungsgesetz (1982). January, 25th.

¹⁵ GT is one hundredth of the gross tonnage of the vessel. 100GT applies to short stays and 50 GT to long stays.

5.2. Belgium: The Port of Antwerp

The Port of Antwerp is ranked 16 in the 2014 world ranking of container ports. Following a slight fall in traffic between 2011 and 2013, it returned to growth in 2014, handling close to 9 million TEUs.

Belgium is divided in four port territories:

- Antwerp
- Ghent
- Bruges-Zeebrugge
- Ostend

Each zone is a territorial and economic unit that answers to the regional Government of Flanders, which, in turn, is governed by the Federal Government.

Antwerp PA (Gemeentelijk Havenbedrijf Antwerpen) was created in 1997 and, following privatization, is currently a private company with public rights¹⁶. Despite having been separated by law from Flemish authorities and subjected to the Company Management Act, the Flanders Government still has some influence since:

- It owns lands within the port area;
- It awards grants to the PA;
- It sets the percentages of co-financing and subsidizing of those in which it participates;
- It acts as an intermediary for any eventual subsidies the PA may wish to apply for from the European Commission (EC);
- It is responsible for nominating the Regional Port Commissioner.

The Federal Government, in contrast, does not have such a presence, which is logical in a decentralised system. In this regard, the Federal Commission for Port Policy is the federal government entity created in 1999 that is responsible for decision-making in national port policy.

The Port of Antwerp is unique in that it has a Regional Port Commissioner, who is nominated by the Flanders Regional Government. The commissioner has to be invited to the PA Board of Directors meetings and informed of any decision taken regarding the creation of a company or the involvement of an already existing enterprise. The commissioner also has the right of veto over any decisions taken by the Board of Directors.

The entities making up Antwerp PA include:

- The Board of Directors;
- The Steering Committee (optional);
- The Coordination Council, which draws up a fortnightly development plan and advises the regional government when the Regional Port Commissioner does not agree with the rates applied by the PA.

Its obligations include:

- Fixing the rules and conditions of use of the port's services;

¹⁶ Under the Decree for Policies and Management of Maritime Ports, of 2 March 1999, and Company Management Act of 7 May 1999.

- Managing public properties within its territorial area or those whose management has been delegated to it;
- Maintaining and exploiting the communal port area;
- Establishing rates according the principle of *loyal competition* and not applying levels considered by the regional port commissioner to be abusive or harmful to other ports in the area. As a result, they depend on the decisions made by other Belgian PAs.

As established by law, the maximum limit of concessions is 99 years so long as no other regulation is contravened. However, the Port of Antwerp establishes in its own internal regulations¹⁷ that the Port of Antwerp itself will be responsible for determining the maximum period based on the following criteria (Antwerp Port Authority 2011):

- 40 years for port activities
- 30 years for service supply activities

Similarly, the Steering Committee reserves the right to award extensions to concessions for up to a further 40 years as a function of the anticipated investment per surface unit and its strategic importance for the port. Stevedoring companies are private and for the moment there are no plans to become a private legal entity (Stevens 1999), (Notteboom et al. 2013).

The Port of Antwerp has in any case quite a lot of freedom to act, since it is able to offer its own port services or delegate them to a third party. Nevertheless, there are certain decisions that, despite having been separated from the regional government, the Port of Antwerp must seek its authorization.

The rates applied by Antwerp PA are shown in Table 11.

Table 11. Rates applied by Antwerp PA (Belgium)

Rate	Variable	Description	Formulation
Vessel (<i>tonnage</i>)	GT	Rate applicable to merchant and passenger ships. Determined by: <ul style="list-style-type: none"> ▪ The berth location (The River Scheldt or behind the locks). ▪ Vessel type. ▪ Traffic type (regular lines, tramp traffic, short sea shipping, feeder lines and bulk traffic). Additionally, a fixed rate is charged for the use of the information system (VSTP).	$Rate = x_i GT$ Where: x_i = Amount depending on the three factors listed. VSTP = 16.37€
Goods (<i>berthing</i>)	Tons loaded and/or unloaded	This rate is determined by: <ul style="list-style-type: none"> ▪ Vessel type. ▪ Traffic type. ▪ Cargo type (general cargo, containers, etc.). A fixed rate (FR) is also charged per declaration.	$Rate = x_j Q(ton)$ Where: x_j = Amount depending on the three factors listed. FR = 31€
Waste collection	Vessel type and size (tabulated)	This is based on two factors: <ul style="list-style-type: none"> ▪ A fixed contribution (20f*). 	$Rate = 20f + 45f$ Where:

¹⁷ General Terms and Conditions for Concessions in the Antwerp Port Area

	factor)	<ul style="list-style-type: none"> A variable contribution ($45f^*$). <p>f is a factor defined by the Public Waste Company for the Flemish Region (OVAM).</p>	$1 \leq f \leq 6$
Priority of loading or unloading	GT	Rate for priority loading or unloading.	<p><i>Rate = cte</i></p> <p>Where:</p> <p>From 0 to 4,999GT: 112€ From 5,000 to 14,999GT: 336€ More than 15,000GT: 556€</p>
Inspections and electricity consumption	Number of containers	<p>There are 3 types of inspection rates:</p> <ul style="list-style-type: none"> For containers whose goods are destined for human consumption (a). For containers whose goods are destined for animal consumption (b). Electricity consumption necessary for inspection (c). 	<p><i>Rate = cte</i></p> <p>Where:</p> <p>(a): 56€ / container (b): 12€ / container (c): 16€ for the first 3 days and 49€ from the fourth day onwards</p>

Source: Author

5.3. Spain: The Port of Barcelona

Several Spanish ports satisfy the requirements established at the beginning of this chapter. In order of their 2014 container port ranking, these are: Algeciras, Valencia and Barcelona. Despite the strongly centralized nature of the Spanish port system, all three ports yield the same results. As such, we will choose the Port of Barcelona for the working relationship the author has with it and, therefore, the ease of obtaining information. The Catalan installation is ranked 79 in the 2014 world container port ranking, handling nearly 1.9 million TEUs and has enjoyed sustained growth in container traffic since 2012.

Spanish ports are of the Landlord type¹⁸, which is the most widespread system in the world (Ferrari et al. 2015). In general, in this system, the PA is responsible for the management and planning of the port zones in order to ensure growth in traffic, social and economic enrichment and but without direct involvement in any commercial activity (Van Hooydonk 2003), (Meersman et al. 2008).

The Spanish port system consists of 46 general ports managed by 28 PAs (Roa-Perera et al. 2015). Law 27/1992¹⁹ created the Public Institute of State Ports (PISP), an entity that answers to the Ministry of Public Works and Transport, which is responsible for implementing the Government's port policy. The same law establishes the port authorities, which are delegated with the management of ports. In 2011 the amended text to a new port act was approved through RD 2/2011²⁰, which sets the bases for the application of port tariffs and their bonuses. Loading is carried out by contracting labour from stevedoring companies (Saundry & Turnbull 1999), (Castillo-Manzano et al. 2008), (Díaz-Hernández et al. 2008).

For its part, the Ministry of Public Works and Transport approved the Annual Plan of State Port Objectives and established the system for monitoring these. PISP, however, has its own legal

¹⁸ The port authority owns the land and manages the infrastructures, awarding land concessions to private operators.

¹⁹ Law 27/1992, of November 24, of State and Marine Merchant Ports.

²⁰ Royal Legislative Decree 2/2011, of September 5, through which the Amended Text of the Law of State and Marine Merchant Ports was approved.

status and budget, and a full capacity to act. It is a public entity governed by private legal legislation in practically all of its functions, which include:

- The implementation of the Government's port policy and the coordination and control of the efficiency of the national port system;
- The general coordination of the various bodies of the General State Administration that establish the controls in port spaces;
- The setting up and development of port research and engineering;
- The development of measurement systems and operational procedures in marine oceanography and climatology necessary for the design, exploitation and management of port areas and infrastructure;
- The planning, coordination and control of the Spanish maritime signalling system.

With the same operating principle, Spanish PAs answer to PISP and, despite being public entities, are governed by private legal legislation. The following functions have been delegated to them:

- The provision of general services and the management and control of port services;
- The planning of the port service zone and port uses;
- The planning, building, maintenance and exploitation of port works and services and the maritime signalling system;
- The management of the public port domain;
- The optimization of the financial management and profitability of assets and allocated resources;
- The development of industrial and commercial activities related to maritime and port traffic;
- The coordination of operations of the various modes of transport within the port area;
- The planning and coordination of port traffic, both sea and land.

The entities that regulate the internal operation of Spanish PAs include:

- The Board of Directors, consisting of a President, a sea captain and between 10 and 16 members nominated by the autonomous communities;
- The President, nominated by the autonomous community in which the port is located. In the case of Barcelona, the President is nominated by the Generalitat of Catalonia;
- The Director General, whose main mission is the management of the PA;
- Navigation and Port Council: assistance and information entity of the Harbour Master in which any individual or legal entity wishing to participate can be represented, so long as they demonstrate a direct and relevant interest in the correct running of the port and maritime trade.

In terms of its financial resources, Barcelona PA receives:

- the profits and returns on its assets;
- port fees;
- the revenues, of a private law resources nature, obtained in the execution of its functions;
- the contributions received from the Inter-Port Compensation Fund;
- those that are allocated in the national budget or in other public administrations;
- aid and grants of any nature;
- credits, loans and other financial operations;

- the profits from the application of the sanctions system;
- donations, legacies and other contributions from individuals and private entities.

Table 12 details the rates applied by Barcelona PA. These are established by common national policy and Barcelona PA has little room for manoeuvre.

Table 12. Rates applied by Barcelona PA (Spain)

Rate	Variable	Description	Formulation
Vessel	100GT/h	Rate applied to merchant and passenger ships. Determined by: <ul style="list-style-type: none"> ▪ Short or long stay (a). ▪ Berth with or without concession (b). ▪ Berth type (alongside or prow) (c). 	$Rate = x_i \frac{GT}{100} h$ <p>Where: x_i= Amount depending on each PA and (a), (b) and (c)</p>
Passage	Per passenger or vehicle (unit)	Determined by: <ul style="list-style-type: none"> ▪ Passenger journey type (d). ▪ Tourist cruisers (embarking, disembarking and transit) (e). ▪ Vehicle type (f). <p>The machinery and mobile mechanical parts necessary for the loading and unloading operations are not subject to this rate.</p>	$Rate = x_j U d$ <p>Where: x_j= Amount depending on each PA and (d), (e) and (f)</p>
Goods	Tons (simplified unit)	Rate determined by: <ul style="list-style-type: none"> ▪ Transport element. ▪ Type of operation. ▪ Weight and class. ▪ Form of goods presentation or cargo unit. ▪ Intensity of port use and length of stay. <p>This rate is applied to goods and/or transport elements and to the occupation of the work area.</p> <p>The rate applied to goods distinguishes 2 types of system:</p> <ul style="list-style-type: none"> ▪ By group of goods (5 groups). ▪ By a simplified estimate (containers, lorries, trailers, articulated vehicles, etc.). 	$Rate = x_k Vol (ton)$ $Rate = x_l U d$ <p>Where: x_k, x_l= Amount depending on each PA and the stipulated system</p>
Maritime signalling	100GT	Distinguished by: <ul style="list-style-type: none"> ▪ Type of vessel or embarkation (g). <p>Goods ships pay this rate on the first three ports of call each year.</p>	$Rate = x_m \frac{GT}{100}$ <p>Where: x_m= Amount depending on each PA and (g)</p>

Source: Author

5.4. France: The Port of Marseilles

According to the 2014 world ranking previously mentioned, the most important port in France is Le Havre, located on the French Atlantic coast. In 2014 it was ranked 60th in the top 100 most important ports in the world, handling a little over 2.5 million TEUs. Its hinterland²¹ is in competition with the ports of Antwerp and Rotterdam and has consequently adapted its operations to compete with these big ports. Le Havre is a deep-water port and does not, therefore, strictly correspond to the port model being compared in this study.

However, France boasts another important port, Marseilles, whose hinterland competes with Barcelona and Genoa and which is more similar to the port model developed in this study. Marseilles is located on the French Mediterranean coast and has been consolidated in recent years to become the most important French port to compete with Barcelona. This, together with the difference in port type and our aim to study similar ports, leads us to study the port of Marseilles. Given the French port system, some of the considerations carried out for Marseilles are also applicable to Le Havre. However, there are certain peculiarities and application guidelines that will be explained later in this chapter that make the Port of Marseilles a unique infrastructure.

French ports follow the Landlord model, but before the French Code of Maritime Ports²² came into effect January 1 2010 (Institut Français d'Information Juridique 2014), most corresponded to the Tool Port model, since private operators could develop their own services in a public area without the possibility of having their own infrastructures (Debie et al. 2013).

From this date, French ports were classified into 5 main types:

- Large Maritime Port (LMP);
- Autonomous Port;
- Territorial Interest Port;
- Nation Interest Port in High Seas Territory;
- The Port of Port-Cros National Park.

This law of July 25 1994 (integrated into the decree 6/5/1995) is complemented by a series of decrees, among which is that specifically referring to the exploitation of container terminals in maritime ports²³. The creation of Marseilles PA was set out in decree 2008-1033²⁴ and its legal nature is that of a State Public Ordinance with an industrial and commercial character. It has three types of dependence:

- Economic: General System²⁵ with respect to the ministries responsible for the economy and budget.
- Territorial: Prefecture of the Department and Regional Government.
- Organizational: Ministry in charge of maritime ports.

Simplifying its operating system, Marseille PA depends on 4 entities:

²¹ *Hinterland* is a term of German origin that refers to the inland area of influence of a port.

²² *Code of Maritime Ports*, of January 1 2010, amended December 6 2014.

²³ Decree n°2000-682 of July 19 2000 approving the *convention of terminal exploitation within maritime ports*.

²⁴ Decree n° 2008-1033 of October 9 2008 establishing the maritime port of Marseilles.

²⁵ General Economic and Financial Control. Articles 190-225 of decree 62-1587 of December 29 1962 (General regulation of Public Accounts).

- The Supervisory Board, which defines the PA's strategy and controls its management. It is composed of 17 members who report their decisions to the ministers responsible for maritime ports, to the Government Commissioner (who may oppose them) and to the authority in charge of the economic and financial control.
- The Board of Directors, an executive entity of 4 members whose mission is to ensure the correct management of Marseilles PA. Its president, referred to the Director General, has the capacity to represent the PA. The Board is responsible for drawing up a plan for the management of waste and residues and participates in a consultative capacity in the Supervisory Board, in addition to fixing the tariffs for port services.
- The Development Council, formed by workers representatives and territorial collectives. Marseilles has 40 members, the maximum permitted by law. Its function is to give their opinion on PA strategy drawn up by the Supervisory Board and the tariff policy established by the Board of Directors.
- The Local Transport Safety Committee, whose functions are confined to activities related to safety. Its members include the Government Commissioner, who represents a direct connection with the Ministry in charge of ports. This entity answers to the Inter-Ministerial Commission of the Transport of Dangerous Goods, which also answers to the Ministry of Ports.

There are further entities that considerably complicate the organizational system of Marseilles PA, among which only the court of auditors and the prefecture, responsible for delimiting the port territory, are worth mentioning. It is a complex system with an intricate architecture in which the lands belong to the LMP and whose concession system allows a maximum period of 50 years²⁶. Financing for maintenance and dredging works is provided by the State; the rest is obtained mainly through self-financing. With regards to stevedoring, each operator can contract their own labour without having to depend on a public stevedoring society (Debie et al. 2013), (Lacoste & Douet 2013).

With respect to the tariffs, Table 13 shows a summary of those applied by Marseilles PA and stipulated by its Board of Directors:

Table 13. Rates applied by Marseille PA (France)

Rate	Variable	Description	Formulation
Vessel	Volume of vessel (m ³) $V = L * b * T$ Where: L: Length (m) b: Beam (m) T: Maximum summertime draught (m)	Rate applicable to merchant ships that handle passengers or goods in zones A, B and/or C. It is determined by: <ul style="list-style-type: none"> ▪ Vessel type (solid or liquid bulk, container carrier, etc.). ▪ Vessel volume / capacity (m³ / TEU). ▪ Importing or exporting of goods. 	$Rate = x_i Vol (m^3)$ Where: x_i = Amount depending on vessel and capacity
Passage	Per passenger	This rate will be charged for each passenger embarking, disembarking or transferring, except children under 4, military personnel, crew and other provisions.	$Rate = 0.5357€/pax$

²⁶ Decree n°2005-255 of 14 March 2005, art. 1 JORF 19 March 2005.

Goods	Tons – Unit.	Rate for goods handled in port. There are two rates: <ul style="list-style-type: none"> As a function of gross weight (bulk and various goods). Per unit of cargo (live animals, vehicles, trailers and half-trailers). 	<i>Rate = $x_j \text{ ton}$</i> Where: x_j = Amount depending on type of goods and whether it is being loaded, unloaded or transferred
Berth	Volume of vessel (m^3) Length of stay (days)	Two factors are taken into consideration: <ul style="list-style-type: none"> Volume (m^3). Stay (from 1 to 20 days and longer than 20 days). The minimum rate per port of call is 156€. Partial days are rounded up to whole days.	<i>Rate = $x_k n^9 \text{ days}$</i> Where: x_k = Amount depending on volume of vessel
Waste collection	Volume of vessel (m^3) $V = L * b * T$ Where: L: Length (m) b: Beam (m) T: Maximum summertime draught (m)	Rate applied to vessels that do not have in-port waste collection. Is determined by vessel type (solid or liquid bulk, container carriers, etc.).	<i>Rate = $x_l \text{ Vol } (\text{m}^3)$</i> Where: x_l = Amount depending on vessel type and goods transported

Source: Author

5.5. Greece. Port of Piraeus

The port chosen to represent Greece in this study is the Port of Piraeus. Piraeus has gradually lost its ability to attract cargo, since in 2012 it lay in 76th place in the world container port ranking but by 2014 had dropped out of the top 100.

This was due in part to the deep economic crisis in which Greece finds itself and the lack of foreign investment.

Piraeus PA was commercialised in 1999²⁷ (Pallis & Syriopoulos 2007), something which sets it apart from the management model of the other PAs studied here (Ng & Pallis 2010). These days, it follows the management model implemented in the other 12 Greek state ports and maintains both the infrastructure and the superstructure of all port services²⁸.

On 13 February 2002 a 40 year concession agreement was signed between the Greek State and Piraeus PA, ratified by law 3654/2008. According to it, the PA has the exclusive right of use and exploitation of land, building and infrastructure of the port land zone and, in particular, the concession agreement provides for the right of the PA to subcontract the operation of part of the port to a third party against payment (European Commission 2009).

The private sector only intervenes when the PA does not have the capacity to handle these services (Pallis & Vaggelas 2005). In this sense, the contract for new container terminal

²⁷ Law 2688/1999, (Gov. Gazette A 40/1.3.1999), repeatedly amended.

²⁸ Act No. 2932/2001.

All Greek ports come under the supervision of a Special Secretary, who answers to the Ministry of Merchant Marine. The public ports have been given the status of private company, with limited companies and the Port of Piraeus trading in the stock exchange since 2003, although the State owns 75% of the shares. This means that, although they have the status of private company, they cannot act as such as the Central Government is involved in nearly all of its decisions.

In 2010, after an agreement reached between the European Union, the International Monetary Fund and Greece, the Greek Government set up the HRADF²⁹ as a management and exploitation entity of State assets. It was then that the State-owned shares in ports became the property of HRADF.

In 2013, the Greek Government and HRADF awarded a master concession to the Port of Piraeus. With this, Piraeus PA is obliged to award sub-concessions to third parties with the aim of opening up the supply of port services.

In the first phase of the creation of this master concession, 51% of its shares were sold to a private investor, with a further 16% forecast to be sold before 2020 and the Greek Government retaining possession of the remaining 8%. The model is, therefore, en route towards a practically complete privatization (actually delayed by the approval of the memorandum between Piraeus PA and Cosco Pacific container terminal (Norton Rose Fulbright 2014), since only 8% will belong to the public with 67% forecast to be sold and 25% already owned by the private sector³⁰.

With regard to the internal management of Piraeus PA, the President and the CEO, together with the members of the Board of Directors, are nominated under political criteria. The Board of Directors includes two port workers representatives and a representative of the City Council.

For “minor” investments, the Board of Directors has the authority to decide on their execution. In contrast, for larger investments, the decision is taken by the majority shareholder, which in this case is the Greek Government. Bearing in mind that the Port of Piraeus manages its own infrastructure, these larger investments could even be those derived from the purchase of maintenance machinery.

With respect to tariffs, the Board of Directors has the power of decision over them, despite the fact that they need to be submitted to the Ministry for approval. Every November the tariffs are set for the following year. The Board’s decision is passed on to the Ministry, which draws up the National Policy on Ports (Ministry of Shipping and Insular Policy).

Once this decision has been approved, the tariffs are published in the Government Gazette. Consequently, the PA’s ability to fix the tariffs is limited since the Ministry is the one to decide on its application. Table 14 shows the rates applied by the Port Authority of Piraeus.

²⁹ Hellenic Republic Asset Development Fund. Established on 1st July 2011 (L. 3986/2011), under the medium-term fiscal strategy, was created to maximize the proceeds of the Hellenic Republic from the development and/or sale of assets.

³⁰ The obligatory possession of 51% per cent of the OLP share capital by the Greek State was abolished through the legislative act 7.9.2012 and law 4092/2012, besides certain benefits, rights and tax exemptions which were granted to OLP and were inherent in its public character, were abolished by law 4152/2013 (Norton Rose Fulbright 2014).

Table 14. Rates applied by Piraeus PA (Greece)

Rate	Variable	Detail	Formulation
Vessel	GT	Applied to all ships calling at port. It is determined by: <ul style="list-style-type: none"> Vessel type: Passengers, cruise, cargo ships. Time in port (berth or anchor). Is valid for 5 working days.	$\text{Rate} = x_i \text{GT}$ Where: x_i = Amount depending on vessel type
Berthing	Meter (LoA = Length of all)	Rate applied to all vessel types. It is determined by: <ul style="list-style-type: none"> Vessel type (passenger, cruise, cargo ships). Period of stay at berth. Payable from the first day of stay and quantified in periods of 24 hours	$\text{Rate} = x_j \text{LoA} * D$ Where: x_j = Amount depending on vessel type D = length of stay in days
Mooring-Unmooring	Provision of service	Applicable to all vessel types and depends on: <ul style="list-style-type: none"> Vessel type Length of stay 	A lump sum cost based on a monthly charge (for coastal ships) or per port of call

Source: Author

5.6. Holland: Port of Rotterdam

The Port of Rotterdam is the most important in Europe, being the first in terms of container traffic. It handles close to 12.3 million TEUs and lies in position 11 in the world ranking of ports, after a period of sustained growth since 2011.

Until 2013, it was the only European port to be among the world's top 10 most important. However, despite the growth it has experienced in recent years, Chinese ports have undergone yet greater growth, expelling Rotterdam from the top 10 in 2014.

Holland does not have a national directive for port regulation. Created January 1, 2004, Rotterdam PA is defined as a public limited society, dependent on private law, and is governed by the Corporate Governance Code (Code Tabaksblat³¹). Originally, it was a strictly municipal port, as Rotterdam City Council owned all of its shares. In 2006, however, the Government acquired a 33.3% shareholding, becoming in the process its second shareholder. Nevertheless, the City Council charges for the use of the PA and invests heavily in the port (which are not considered subventions).

For its part, the regional government is responsible for the infrastructures in the zone, while the Ministry of Transport, Public Works and Water Management exercises its control on traffic and safety through the PA's Harbour Master.

The State, thanks to its participation in the port, assures the financial balance of Maasvlakte (an industrial area with sea mooring close to the city of Rotterdam) and is responsible for the investments in national interest infrastructure and supervises the application of the principle of loyal competition, which in the case of Holland entails, among other things, the complete liberalization of port services. This separates tariff policies from the actions of the rest of the

³¹ Code Tabaksblat; Dutch Corporate Governance Code.

port such that Rotterdam PA is able to freely set its tariffs as long as it follows the principle of loyal competition with regard to neighbouring ports but without any entity or manager responsible for its supervision.

The particularity of this PA is that there is no legislation that regulates its internal organisation. Nevertheless, by law it depends on:

- Economically, the Corporate Governance Code,
- Institutionally, the Ministry of Transport, Public Works and Water Management
- Organizationally, there is no state regulation.

With respect to its organisation, Rotterdam PA bases its decision-making process on two entities:

- The Board of Directors
- The Steering Committee.

It also depends on the following entities:

- The Consultative Committee for Transport and Chartering, responsible for creating the working commissions for the studies and projects carried out;
- The National Council for Ports, which supervises the fulfilment of regulations and advises the Government on measures to adopt in the port;
- The Dutch Competition Authority, which is responsible for setting pilotage tariffs (an amount close to the cost of these services such that there is very little profit margin).

Rotterdam PA is free to associate with any private company in order to achieve *profitable* objectives, under Article 2.3³² of its statutes. It also draws up and develops the port's strategic plan, the budget and the four-year business plan.

In terms of bidding, it may apply a dual practice, since it can combine these with direct talks with potentially interested parties (De Langen 2012). There are authors who believe that Rotterdam PA is becoming a commercial organisation, gradually losing its identity as a traditional Landlord port (De Langen & Heij 2014).

As in many other countries, terminal operators have their own labour but may turn to stevedoring companies to cover peaks in demand (De Langen & Van der Lugt 2006).

With regard to investments, the Government gives Rotterdam priority over other national ports. Rotterdam port is forecast to receive a heavy injection of state capital until 2020 (Ministry of infrastructure and the environment 2013).

Similarly, the PA itself makes significant investments, not only within the port area but also in roads and rail and maritime networks within its hinterland. The port's internal infrastructures come almost entirely from investments carried out by the PA itself, which does not currently receive any aid or subventions from the region or municipality.

In terms of concessions, Rotterdam PA has the authority to award them within and outside the port area in the zones in which it has jurisdiction and it uses standard lease and ground rent contracts that are linked to its "General Terms for Rights of Use"³³ (Nitsche 2004).

³² *Articles of Association*, January 30, 2009.

³³ Standard lease and ground rent agreements, articles 5.3 and 5.4.

Within the port territory, it may award them for a maximum of 25 years (Aronietis et al. 2010). Table 15 shows its applicable tariffs.

Table 15. Rates applied by Rotterdam PA (Holland)

Rate	Variable	Description	Formulation
Vessel and goods	GT, volume of loaded or unloaded goods, in tons	<p>Determined by:</p> <ul style="list-style-type: none"> ▪ Traffic or service type: regular, short sea feeder, deep-sea, etc. ▪ Vessel type. <p>This fee covers a month's stay in port. From then on, rates are applied as a proportion of the excess stay time.</p> <p>The calculation takes into account the goods (C_r or Cargo Rate) and the type of vessel (S)</p>	<p>Calculated in 5 steps:</p> <ol style="list-style-type: none"> 1. Determine the (S) percentage as a function of vessel type (t_1) 2. Calculation of rate as a function of GT $T_2 = GT * t_1$ 3. Calculation of maximum rate as a function of cargo type (C_r) $T_3 = GT * S * C_r$ 4. Calculation of rate as a function of the goods, expressed in tons loaded or unloaded (Q) $T_4 = C_r * Q$ 5. The rate is determined by: $T_5 = T_2 + \min[T_3 + T_4]$
Waste collection	Main engine capacity (MEC) in kW	<p>There are two types of charges:</p> <ul style="list-style-type: none"> ▪ Fuel, oil and waste water (I). ▪ Plastics and other residues (V). <p>The rate is applied regardless of whether the service is used or not.</p>	<p>$25 \leq I \leq 550$ (tabulated)</p> <p>$195 \leq I \leq 275$ (tabulated)</p>
Use of quay or berth	Vessel length in metres (m)	Berthing rate for each 24hr period or a proportion thereof.	$Rate = 2.9 l / 24h$ <p>Where: I is the ship length</p>
Use of buoys	Vessel length in metres (m)	<p>Rate for use of buoys per 24hr period or a proportion thereof.</p> <p>Applicable from day 14 of use of buoy system.</p>	$Rate = 2.46 l / 24h$ <p>Where: I is the ship length</p>
Use of dolphins	Vessel length in metres (m)	Rate for use of dolphins	$Rate = 2.70 l / 24h$ <p>Where: I is the ship length</p>

Source: Author

5.7. Italy: The Port of Genoa

Italy has two main ports that satisfy the requirements of the applied filter: Gioia Tauro, ranked 51st in the 2014 port ranking, handling close to 3 million TEUs, and Genoa, ranked 72nd, handling around 2.2 million TEUs.

The first is located in the south of Italy, close to the Island of Sicily, while the second, in the gulf of the same name, lies very close to Marseilles and Barcelona and therefore has regular connections with both through short sea shipping lines³⁴.

The geographical proximity of two of the ports analysed in this chapter and the application of a specific supplement to its tariffs has been decisive in studying the Port of Genoa.

The Italian port system is based on two pieces of legislation: the Law of Port Reform³⁵ and the old Code of Navigation³⁶. Italy receives more than 60% of its imports via the sea and depends largely on this same form of transport for exports, moving 40% of its overseas-destined goods this way (Ridolfi 1995).

Italian legislation defines ports as publicly controlled spaces that are considered property of the State. The Italian port system consists of:

- Port organisations: Venice, Genoa, Palermo, Civitavecchia, etc.;
- Port authorities: Ancona, Civitavecchia, Genoa, Gioia Tauro, etc.
- Maritime authorities, which have authority over maritime safety and the control of navigation on waters within the port.

Moreover, Italian ports are divided into four categories:

- Category I: Military.
- Category II:
 - Class I: Port of international economic importance.
 - Class II: Port of national economic importance (with subdivisions depending on the activity carried out).
 - Class III: Port of regional and inter-regional economic importance.

The port system depends on two ministries:

- The Ministry of Infrastructure and Transport, via the Department of Transport, Navigation and Information Systems and Statistics, which delegates as part of the General Directorate of Ports the management and supervision of PAs with regard to the application of infrastructure programmes. It also assigns and controls the resources for infrastructure investment and regulates port services, among other things.
- The Ministry of Economy and Finance.

Italian ports were originally public and evolved into the Landlord model upon being approved by law in 1994³⁷. As in the German model, stevedoring is done through in-house personnel but operators may make use of a stevedoring society to cover production peaks (Valleri et al. 2006), (Ferrari & Musso 2011).

The Port Authorities are organs of the Ministry of Infrastructure and Transport with their own legal status and budget in addition to administrative and organisational autonomy. They enjoy therefore a degree of budgetary and financial independence.

³⁴ *Short sea shipping* is a concept coined from the EU's Marco Polo Programme for the sustainable transport of goods. Regular lines that employ this system aim to take lorries off roads and onto roll-on roll-off (ro-ro) vessels.

³⁵ *Law of Port Reform*, of January 2 1994 (84/94), modified July 1 2014 (*Fascicolo Iter DDL S. 370*).

³⁶ Code of Navigation (042U0327) (GU n.93 del 18-4-1942), modified February 26 2010 (*Parte aggiornata alla l. n. 25*).

³⁷ *National Law n°84*, of 28 January 1994.

Italian PAs are composed of:

- The President,
- The Port Committee,
- The General Secretary
- The Audit Commission.

Their main functions include:

- The management, planning, coordination control and development of activities that take place within the port;
- Maintenance of communal areas (including dredging);
- The administration of concessions for the exclusive use of public port terrain to private companies³⁸.

In the case of Genoa PA, tariffs are set by the Ministry of Infrastructures and Transport and are considered taxes paid by port users to the Government. In contrast, the Ministry invests in large strategic infrastructures, while the remaining investments in ordinary and extraordinary maintenance (for example, the periodic dredging of sea beds) are paid for by the PA's own exploitation revenues. Table 16 shows the details of the tariffs that Genoa PA is able to apply.

Table 16. Rates applied by Genoa PA (Italy)

Rate	Variable	Description	Formulation
Vessel (<i>ancoraggio</i>)	NT (<i>Net Tonnage</i>)	<p>Is determined by vessel type:</p> <ul style="list-style-type: none"> ▪ National vessels or foreign vessels classified as national. ▪ Foreign vessels (do not have the right to an annual subscription and pay double rate). <p>The rate for $50 \leq NT \leq 200$ covers a full year.</p> <p>The rate for $201 \leq NT \leq 350$ covers only 30 days.</p> <p>The rate for $NT > 350$ covers only 30 days.</p> <p>Annual subscriptions are available. Moreover, vessels that make only one port of call can pay a one-off special charge equivalent to 1/12 the annual fee.</p>	$Rate = \alpha\beta NT$ <p>Where:</p> <p>α: Value defined by certain NT intervals</p> <p>β: 1 for national vessels and 2 for foreign vessels</p> <p>A correction factor, γ, with values between 0 and 1 are applied to the <i>ancoraggio</i> rate for non-covered goods. Dependant upon the vessel type and, occasionally, the gross tonnage (GT)</p> $Rate = \alpha\beta\gamma NT$
Supplementary <i>ancoraggio</i> rate	NT (<i>Net Tonnage</i>)	A supplementary berth rate that is only applied in Genoa, Naples and Venice and that is paid on top of the vessel rate.	$Rate = 0.00258NT$

³⁸ Based on *decree-law, 5 October 1993, n. 400, Disposition for the Determination of Rates Relative to Maritime Demanial Concessions.*

Goods	Tons of goods to be loaded and/or unloaded	A loading and/or unloading port tax rate determined by type of merchandise.	$Rate = x_p Q(ton)$ Where: α_p : it determined by type of goods
Waste collection (Genoa)	Cubic metres of waste water	This rate depends on: <ul style="list-style-type: none"> ▪ Vessel type. ▪ Number of passengers. Distinction is made between USR residues ³⁹ , bilge water and residual (black) water.	$Rate = cte$ If the waste collection system is not used, a reduced rate equivalent to 35% of the goods rate is charged.

Source: Author

6. SUMMARY

In this chapter we have reviewed the organisational structures of the port policies with regard to the port authorities and their management. This study has focused on 7 Eurozone countries: Germany, Belgium, France, Spain, Greece, Holland and Italy. We have also analysed the tariffs that the PAs of Hamburg, Antwerp, Marseilles Barcelona, Piraeus, Rotterdam and Genoa apply to port activities that fall under their jurisdiction.

Figure 8 shows a graph in which the level of public funding received by the PAs is compared to their freedom to set tariffs.

The vertical axis shows the level of public funding^{*1}. The three levels are:

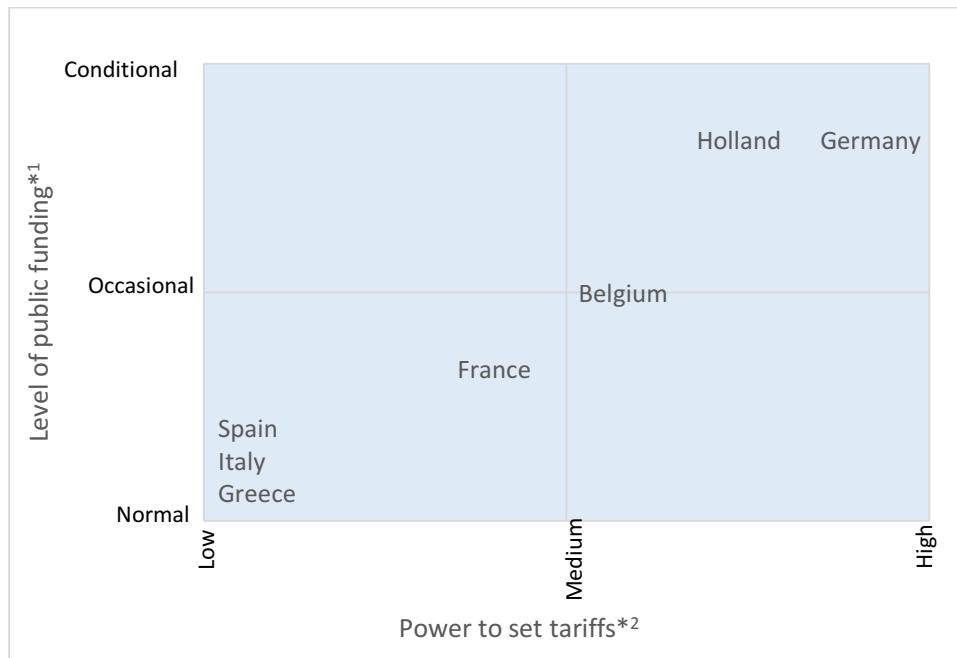
- Normal: By law.
- Occasional: Determined by the conditions of each particular moment.
- Conditional: Determined by the profitability of the investments made.

The horizontal axis shows the PA's power to set tariffs^{*2}. As for the vertical axis, three levels are defined as:

- Low: Set by the State, with little room for manoeuvre for the PAs.
- Medium: Set by the PA but subject to control.
- High: Complete freedom to set tariffs.

³⁹ USR, Urban Solid Residues

Figure 8. Level of funding vs. power to set tariffs of PAs studied



Source: Author

As can be seen from Figure 8, the countries analysed here can be grouped into three blocks. The first includes Spain, Italy and Greece (the ports of Barcelona, Genoa and Piraeus, respectively), where the level of public funding is normal and where the PAs have no power to set tariffs.

The second block, located in the centre of the graph, includes France and Belgium (the PAs of Marseilles and Antwerp, respectively), with an occasional level of public funding and a certain degree of power to set tariffs. The last group includes Holland and Germany (the PAs of Rotterdam and Hamburg, respectively), which only receive one-off investments under very specific conditions but have absolute freedom to set tariffs.

In terms of the number of containers handled by each port, it can be seen that those ports registering the greatest movements are located in the upper right of the graph, while as the number of containers handled annually decreases, the position of the ports moves towards the bottom left hand corner of the graph.

The only exception is France, represented by the Port of Marseilles, which lies in the centre but which moves the least number of containers of the seven countries studied.

Normally, a port's ability to capture cargo depends not so much on the policies of the country in which it is located but on its geostrategic position. Analysing in detail the direct relationship discussed above, it is unlikely that the increase in the cargo handled by the ports is conditioned by the application of certain policies.

However, there does appear to be a correlation between the volume of cargo handled and the freedom conceded to certain ports, when they become strategic pieces in their economies.

Table 17 summarises the rates applied by each port studied here. In general, there is a great deal of disparity among the tariffs and concession periods. There is also little consistency between the concession periods and the means of renewing them (Notteboom et al. 2012).

Rotterdam, the port that handles the greatest volume of containerised cargo, has established a system for calculating rates that groups those applied to both the vessel and the merchandise, something similar to that which occurs Hamburg, the port ranked second in terms of containers handled in 2014. Nevertheless, all the other ports apply different tariffs for vessel and cargo.

With regards to passengers, only Barcelona and Genoa apply rates on this collective. It is worth highlighting that Barcelona was the first European port and third in the world in terms of cruise liner traffic in 2014.

Analysing the conclusions drawn in graph 1, a comparison can be made of the tariff structure of the countries in the three zones described. Spain and Italy have similar tariff structures, as do Belgium and France, although Marseilles applies rates for berthing and per passenger, something which is not done by the Port of Antwerp.

Table 17. Summary of the tariffs and concession periods of the 7 European PAs analysed

Rate	Germany (Hamburg)	Belgium (Antwerp)	Spain (Barcelona)	France (Marseilles)	Greece (Piraeus)	Holland (Rotterdam)	Italy (Genoa)
Vessel	$\text{Rate} = x_i \frac{GT}{100}$ <p>Where: x_i = Amount depending on vessel type and traffic.</p>	$\text{Rate} = x_i GT$ <p>Where: x_i = Amount depending on the three items listed.</p> <p>VSTP = 16.37€</p>	$\text{Rate} = x_i \frac{GT}{100} h$ <p>Where: x_i = Amount depending on each PA and (a), (b) and (c).</p>	$\text{Rate} = x_i Vol (m^3)$ <p>Where: x_i = Amount depending on vessel and capacity.</p>	$\text{Rate} = x_i GT$ <p>Where: x_i = Amount depending on the type of vessel.</p>	<p>Calculated in 5 steps:</p> <ol style="list-style-type: none"> Determine the (S) percentage as a function of vessel type (t_1). Calculation of rate as a function of GT: $T_2 = GT * t_1$ <ol style="list-style-type: none"> Calculation of maximum rate as a function of cargo type (C_r): $T_3 = GT * S * C_r$ <ol style="list-style-type: none"> Calculation of rate as a function of the goods, expressed in tons loaded or unloaded (Q): $T_4 = C_r * Q$ <ol style="list-style-type: none"> The rate is determined by: $T_5 = T_2 + \min[T_3 + T_4]$	$\text{Rate} = \alpha\beta NT$ <p>Where: α: Value defined by certain NT intervals. β: 1 for national vessels and 2 for foreign vessels.</p> <p>A correction factor, γ, with values between 0 and 1 are applied to the <i>ancoraggio</i> rate for non-covered goods. Dependant upon the vessel type and, occasionally, the gross tonnage (GT).</p> $\text{Rate} = \alpha\beta\gamma NT$
Goods		$\text{Rate} = x_j Q(\text{ton})$ <p>Where: x_j = Amount depending on the three items listed.</p> <p>FR = 31€</p>	$\text{Rate} = x_k Vol(\text{ton})$ $\text{Rate} = x_l Ud$ <p>Where: x_k, x_l = Amount depending on each PA and the stipulated system.</p>	$\text{Rate} = x_j \text{ton}$ <p>Where: x_j = Amount depending on type of goods and whether it is being loaded, unloaded or transferred.</p>			$\text{Rate} = x_p Q(\text{ton})$ <p>Where: α_p: it determined by type of goods.</p>
Passage			$\text{Rate} = x_j Ud$ <p>Where: x_j = Amount depending on each PA and (d), (e) and (f).</p>	$\text{Rate} = 0.5357\text{€}/\text{pax}$			

Berthing	$x_j \frac{GT}{100}$ <p>Where: x_j = Amount depending on traffic type and period of stay.</p>			$Rate = x_k n^2 \text{ days}$ <p>Where: x_k = Amount depending on volume of vessel.</p>	$Rate = x_j LoA * D$ <p>Where: x_j = Amount depending on vessel type D = length of stay in days LoA = Length of all</p>		
Waste collection		$Rate = 20f + 45f$ <p>Where: $1 \leq f \leq 6$</p>		$Rate = x_l Vol (m^3)$ <p>Where: x_l = Amount depending on vessel type and goods transported.</p>		$25 \leq l \leq 550$ (tabulated) $195 \leq l \leq 275$ (tabulated)	$Rate = cte$ <p>If the waste collection system is not used, a reduced rate equivalent to 35% of the goods rate is charged.</p>
Others	<p>Use of dolphins:</p> $Rate = 21.20 \frac{GT}{100}$ <p>Electronic communication:</p> $Rate = cte$	<p>Priority of loading or unloading:</p> $Rate = cte$ <p>Where: From 0 to 4,999 GT: 112€; From 5,000 to 14,999GT: 336€; More than 15,000GT: 556€.</p> <p>Inspections and electricity consumption:</p> $Rate = cte$ <p>Where: (a): 56€ / container; (b): 12€ / container; (c): 16€ for the first 3 days and 49€ from the fourth day onwards.</p>	<p>Maritime signalling:</p> $Rate = x_m \frac{GT}{100}$ <p>Where: x_m = Amount depending on each PA and (g).</p>		<p>Mooring-Unmooring</p> <p>A lump sum cost based on a monthly charge (for coastal ships) or per port of call.</p>	<p>Use of quay or berth:</p> $Rate = 2.9 l / 24h$ <p>Use of buoys:</p> $Rate = 2.46 l / 24h$ <p>Use of dolphins:</p> $Rate = 2.70 l / 24h$ <p>Where: <i>l</i> is the ship length.</p>	<p>Supplementary <i>ancoraggio</i> rate:</p> $Rate = 0.00258NT$

Concession period	30 years	40 years for port activities and 30 years for service provision activities (extendable to 40 years as a function of investment per surface unit and strategic importance)	35 to 50 years ⁴⁰	25 to 30 years	40 years (extended to 45 years to adapt it to Cosco Pacific container terminal conditions) ⁴¹	25 years (extendable to 25 more) ⁴²	50 years ⁴³ (though not established by law)
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Source: Author

⁴⁰ Royal Decree-Law 8/2014 (and later, Law 18/2014) amended article 82 of Royal Legislative Decree 2/2011, approving the Consolidated Version of the State Ports and Merchant Marine Act, increasing the maximum term of a new concession from 35 to 50 years.

⁴¹ (Psaraftis & Pallis 2012)

⁴² (Zachcial et al. 2006)

⁴³ (Van Hooydonk 2013)

7. CONCLUSIONS

In this chapter, the port authorities of a total of 7 Eurozone countries have been characterised. The Eurozone forms part of the European Economic Community and includes all those countries that use the Euro.

All member countries of the Eurozone subscribe to community-applied policies and have, therefore, reached agreement in certain organisational aspects. However, port laws are not covered by community regulation. Nevertheless, the countries analysed here do not differ greatly in terms of culture or political organisation when compared to those of Asian or Middle Eastern countries.

The aim of this chapter was to determine whether port policies and the organisation of the port authorities were uniform in these countries. Having analysed 7 of these port authorities, it can be concluded that neither the national port policies nor the organisation of the port authorities can be considered homogenous.

Nevertheless, taking two of the most important aspects of this investigation in isolation, it can be seen that it is possible to group these countries. By analysing the power or independence the port authorities have to set tariffs and, on the other hand, the level of funding the ports receive from the State, we have been able to confirm the existence of three groups: a) Spain, Italy and Greece, b) France and Belgium and c) Holland and Germany.

In general, group “a” receives public funding and does not have much authority to set tariffs, which can be considered normal given that receiving public funds conditions the organisational structure and that the ports analysed are subordinate to various entities that can decide on the level at which tariffs are fixed. Group “b” occasionally receives public funding and has a moderate level of authority to decide on applicable tariffs. With regards to group “c”, we have confirmed that ports in this group rarely receive public finance and when they do, it is conditional. However, they have quite a lot of power to set tariffs. This reinforces that thesis that if a port is economically independent, it has greater power to set tariffs and to regulate its own business than if it were to receive funds from an entity to which it was subordinated.

However, it should be remembered that this analysis is only valid for the ports studied here, as the ports of one of the countries analysed are subject to different organisational systems.

In conclusion, it is evident that the analysis carried out here has not yielded uniform results for all the ports and thus opens up the debate about how port authorities of other countries are organised. If countries that are fairly comparable in terms of culture, political organisation or religion implement divergent port policies in terms of their organisation, it would be logical to think that different national realities would yield widely divergent organisational results and the heterogeneous character of Eurozone port authorities would be even greater if the national determinants were more pronounced.

However, the port sector is based on practices that are fairly common throughout the whole world, since opening to private operators has harmonised the “rules of play” and has resulted in all countries adopting systems that allow the inclusion of private entities in certain aspects of port business. The analysis carried out here leads one to think that if the Eurozone is highly heterogeneous in terms of port policies, then the rest of the world will be even more diverse within certain parameters that would assure normality and peace of mind for investors.

One of the aims of this present investigation is to determine how the variations in the developer-operator rates affect the businesses of each participant. In this chapter, we have been able to confirm that the relationships between the developer and operators in each country present differences that could yield divergent economic results. In chapter 5 we analyse the national policies in terms of PPPs in various countries to complement the analysis carried out in this chapter and to define a structure of developer-operator relationships that is the most universal possible.

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5

Public-Private Partnership systems in countries affected by major maritime trade routes

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1. AIM

The importance of this chapter lies in the need to determine whether there is a country in which the business model proposed in this thesis can be implemented such that, from a strictly private perspective, managing a port is viable. In order to carry out this, three attributes of a range of countries have been evaluated in order to establish in which country it would be possible to implement the business model described here. The aim is to define this potential implementation in order to determine which policies are being applied in this country or countries and to design mechanisms that allow the business model to be adapted to that country.

2. CHAPTER ORGANIZATION

The first part of this chapter introduces various Public-Private Partnership (PPP) schemes⁴⁴. It also aims to justify the importance of each of the three attributes measured for each country. The second section sets out the methods followed to collect the data used in this chapter.

The third section describes the three zones into which the analysis is divided and looks at each country in detail. The final section discusses which country (or countries) fits closest to the business model proposed here and finishes with the conclusions.

3. INTRODUCTION

PPPs are not a recent phenomenon, as they are usually implemented for complex infrastructure projects in which private entities are involved in the construction and development processes (Hodge et al. 2010). Their range of application has evolved in recent decades and between 1990 and 2010 they experienced strong growth (Parola et al. 2013) to become a more widely adopted funding structure (Engel et al. 2011).

In terms of port infrastructures, PPPs can be defined as an initiative of cooperation between the public and private sectors, characterised by their long-term nature and the underwriting of a large part of the financing by the private sector (Grimsey & Lewis 2007).

PPPs exist in various functional schemas⁴⁵ according to whether they are to be applied to port terminals, roads, railway networks or tunnels in the port area (Aerts et al. 2014). Among the various port management models covered by PPPs, the longest is the Landlord model, which forms the focus of this thesis. In this model, the public sector invests in the infrastructure and concedes port spaces to the private sector (Albalade et al. 2013). The greatest weakness of this model is precisely the management of concessions (Olmos et al. 2004). It is, therefore, important to study the most common concession systems and how projects involving public-private participation are handled.

In terms of maritime ports, investments in PPP projects have suffered a sustained decrease in recent years and during the first half of 2015, focused mainly on three projects in Panama, Mexico and India, which, while totalling some 828.6 million dollars, lies 71% below the annual average of the last ten years (World Bank 2015b).

⁴⁴ According to the U.S. National Council for PPPs, PPPs are a contractual arrangement between a public agency (federal, state or local) and a private entity. Through this agreement, the skills and assets of each sector (public and private) are shared in delivering a service or facility for the use of the general public.

⁴⁵ According to the United Nations Economic and Social Commission for Asia and the Pacific, there are four main systems: Build-Operate-Transfer (BOT) and its other variants, namely Build-Transfer-Operate (BTO), Build-Rehabilitate-Operate-Transfer (BROT), Build-Lease-Transfer (BLT). These are arrangements in which the concessionaire undertakes investments and operates the facility for a fixed period of time after which ownership reverts to the public sector. In this type of arrangement, operating and investment risks are transferred mainly to the concessionaire.

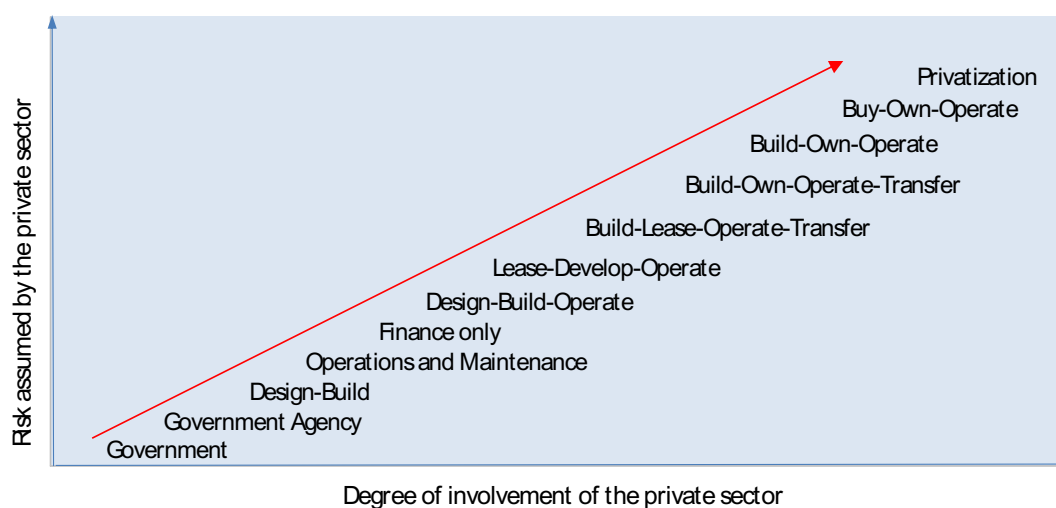
Beyond its specific application, the key feature of the PPP model is the creation of mechanisms to apportion the risks to the contractual party most able to mitigate or tolerate them (Marques & Berg 2011), (Hodge & Greve 2005), (Yescombe 2007), (World Bank 2009). This allocation of the risks is one of the main causes of failure of PPPs (Marques & Berg 2010). If, however, this is carried out correctly, it can be the key to their success (Murphy 2008).

However, it is a model that has been successfully applied to the management of port infrastructures. Evidence for this lies in the fact that China, the country that handles the largest amount of maritime cargo, sees this type of foreign investment contract as a means to improve the performance of port terminals (Yuen et al. 2013). It is for this reason that it is especially interesting to determine how PPP contracts are managed in those countries lying on the main commercial shipping routes.

4. PPP MODELS BASED ON RISK AND PRIVATE SECTOR INVOLVEMENT

There are currently many ways to classify PPPs, though the most widely accepted is to group them according to the amount of risk assumed by the private sector and its level of involvement in the project. Figure 9 shows the various PPP structures, starting with full public ownership with no involvement of the private sector through to a wholly privatised structure in which no public entity participates.

Figure 9. PPP models based on risk and private sector involvement.



Source: Author. Created from GPO Group data

This diagram shows 12 systems in which the public sector gradually decreases its involvement as that of the private sector increases. There are, however, various interpretations of this classification. There are various organisms that defend the existence of 8 levels with myriad intermediate variants (World Bank 2010), while others state that participation should be adapted to each specific case and that it is not therefore possible to establish closed categories (The National Council for Public-Private Partnerships 2015).

5. METHODOLOGY

The 21 countries analysed here were selected according to their close geographical location to the main international commercial shipping routes, which are shown in the lower part of Figure 10 and which use the main commercial maritime infrastructures: the Panama Canal for the USA to China route and the Suez Canal for routes between Asia, Europe and North Africa.

This diagram also illustrates the existence of three main zones:

- Zone 1: The American continent and the Panama Canal.
- Zone 2: Europe, North Africa and the Middle East, and the Suez Canal
- Zone 3: Southeast Asia, with a large concentration of maritime cargo.

Figure 10. Zones analysed in this chapter



Source: Own analysis

Finding data for the concession systems employed in each country has been rather complicated due to the fact that data is not covered by one law but several. Certain countries require the analysis of several laws and, moreover, require an expression of interest⁴⁶ for detailed information regarding certain aspects of particular PPP projects under development.

The data used here was gathered in four stages. Figure 11 shows a flowchart of the activities undertaken in this process, which basically consisted of four stages:

- Requesting information from port authorities. The first step consisted of directly contacting the port authority that manages the country's main port. In many cases, this request was redirected to the entity responsible for managing port concessions in that country. In other cases, the requested information was provided immediately. However, in some cases, no reply was received.
- Formally requesting information from Ministries. This step was taken either when redirected by the port authorities or after failing to receive enough information. In either case, it involved requesting information from the corresponding higher-level public entity.
- Searching for information in multilateral entities. Having carried out the first two steps listed above, we then proceeded to gather information from reports published by IDB⁴⁷,

⁴⁶ In many cases, a document stating the purpose for which the information is being requested and the applicant's details are required.

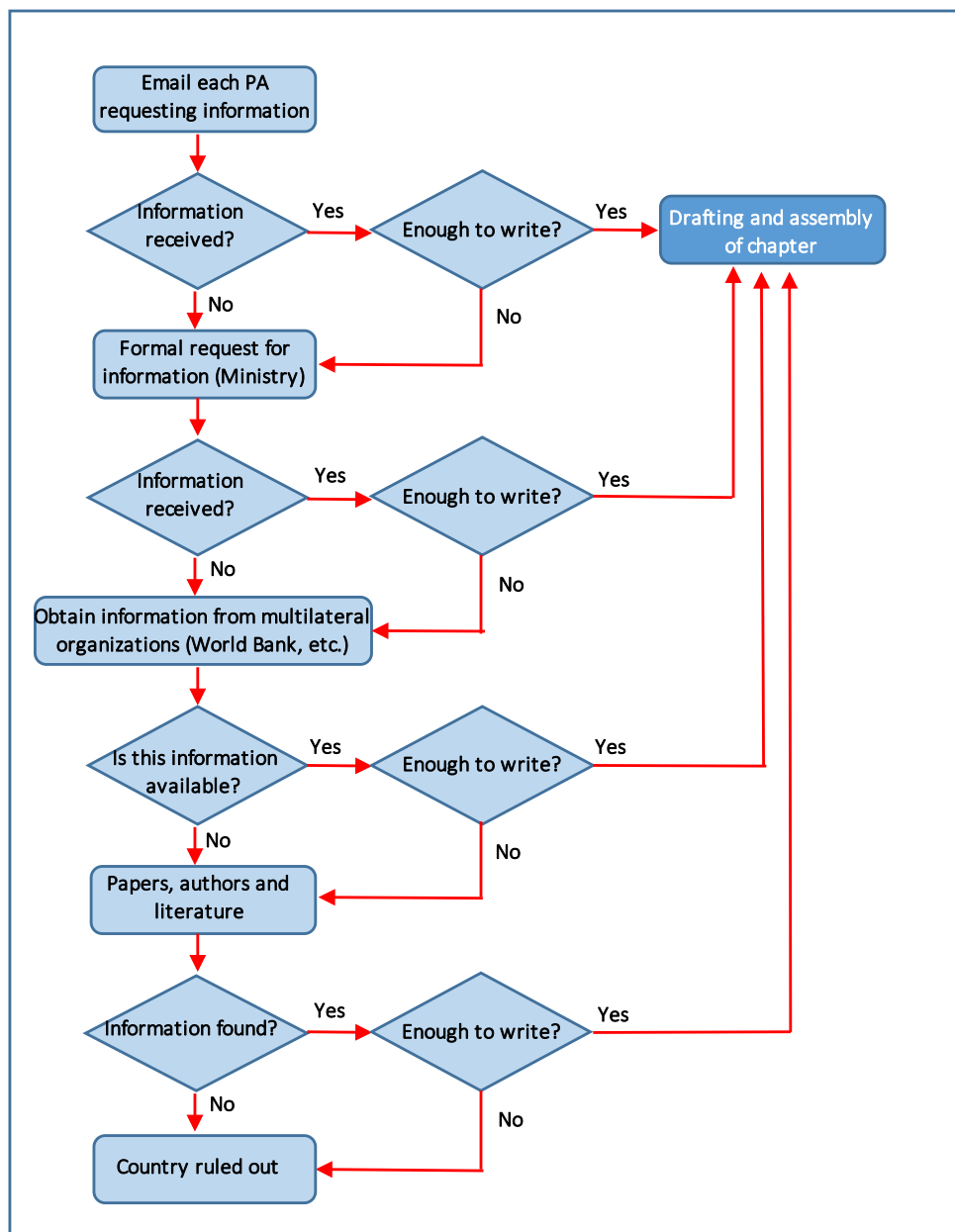
⁴⁷ IDB: Inter-American Development Bank.

the World Bank, ADC⁴⁸, the United Nations, ECLAC⁴⁹, etc. In this way, we collected information that was scattered throughout these various documents and collated it as it was gathered.

- Literature search. The final stage was to carry out a search of the literature in an attempt to gather information from published papers. Under normal circumstances this would be the first step to be carried out but, due to legislative issues, this was done directly from the entities and countries involved.

If insufficient information was collated after having followed these four steps, analysis of that country was ruled out. In the end, only three countries were not included in the final analysis due to the lack of information: Taiwan, Korea and Yemen.

Figure 11. Flowchart of steps undertaken to gather information



Source: Own analysis

⁴⁸ ADC: Andean Development Corporation – Development Bank of Latin America.

⁴⁹ The Economic Commission for Latin America and the Caribbean.

It is important to point out that, despite having been able to gather enough data for some countries to consider their study valid, the amount of information available varies among the countries analysed.

Some of these countries, therefore, have been studied more extensively than others, although this corresponds to the importance of the country in terms of the total world movement of maritime cargo.

With regard to the type of information required for this chapter, the following has been analysed:

- Data concerning the country, governing system and economy, with the aim of contextualising the PPP implementation framework.
- Port system. This involved the characterisation of the port system or, failing that, the functioning framework of the port authority of the main port in that country. The aim was to determine how the ports are managed and their relationship with state entities.
- PPP treatment: Not all the countries have the specific legislation in place for this type of business model. Therefore, we referred to either current legislation, if it existed, or reviewed a number of practical cases.

Three values were extracted from this information and were evaluated to determine which country or countries could best implement a private business model:

- Land ownership: Countries that allow coastal land to be purchased are those most likely to implement the private model described, since the purchase of these lands partially dissociates the project from the government.

The acquisition means that the State does not have to go through a process of land concession. In this example, the re-concession to terminal operators, which is carried out by the private port authority, would not be subject to the agreements established in a concession contract between the State and the port authority.

The Developer (in this case, the private port authority) – Concessionaire relation would therefore be subject to State commercial laws but not to those affecting the concessional system, creating a less restrictive regulatory framework.

- Port system: In certain countries, the port system is national and therefore regulated by the State.

Other countries allow the participation of municipal governments and there are even countries in which ports depend solely on their regional governments. In the most extreme case, certain countries have regulations in place that allow the implementation of a private port authority, something we view positively since implementation is easier in countries whose port system is less rigid and, as such, allow business models that complement strictly public models.

- PPP: This refers to the amenability of a country to accepting public-private partnerships. In general, almost all the countries analysed here are proactive in terms of private and/or foreign investment. However, the analysis conducted in this chapter has identified certain countries where conditions are not ideal, including operational problems with the management of PPPs, regulations that are not very well set out, etc.

The ideal regulatory framework for the implementation of the proposed project would be one in which there are no restrictions for PPPs, the country has entities in place that facilitate their implementation and management and the regulation is clear and adequate for the interests of the projects. A PPP requires, by definition, the State to be one of the parties involved.

It would seem, therefore, somewhat inconsistent to include this value among those studied, if the aim is to purchase the land and avoid State participation. However, the aim here is to identify which country or countries fit closest to the characteristics needed to implement a private port model.

We have therefore designed a flexible model that can analyse the three attributes together. Moreover, the PPP regulatory framework does not only affect concessions awarded by the State; it addresses wider issues and, as such, is fundamental to the implementation of the business model.

6. ZONE 1: THE AMERICAN CONTINENT: PANAMA CANAL

Zone 1 falls under the influence of the Panama Canal⁵⁰ and therefore boasts a great deal of port activity, as the ports located close to the Canal act as magnets for transshipment traffic (Notteboom 2012).

The enlargement of the Canal means that its locks will allow larger ships⁵¹ to pass through, therefore avoiding the need for certain transshipments. However, the fact that ships can avoid stopovers has led to the creation of new, more direct shipping routes (UNCTAD 2013) and ports that are geographically further away from the Canal can receive larger ships.

In fact, one of the desired outcomes is for ports lying on the east coast of the United States and the Gulf of Mexico to receive a greater volume of traffic and to increase their strategic importance (Jaffee 2015). The expansion of the Panama Canal will modify cargo flows in the area (Tavasszy et al. 2011).

Nevertheless, there are other important initiatives that will affect the way in which shipping in the area is currently managed and whose origins lie in the private sector.

Guatemala, one of the countries to experience an increase in the growth in infrastructure investment by private operators (Hoffmann 2001), is a good example of this, with the development of the Guatemalan Interoceanic Corridor⁵².

There are also other less realistic initiatives such as those being developed through the Nicaraguan Inter-Oceanic Canal⁵³.

Regardless, this is a zone that currently boasts significant shipping trade that will probably increase its cargo handling capacity in the next few years.

⁵⁰ The Panama Canal connects the Caribbean Sea and the Pacific Ocean and requires locks to overcome the difference in height between the two ends of the Canal and Lake Gatún, which lies 24m metres above them.

⁵¹ It currently allows the passage of ships of a maximum of 5000 TEU. According to the Panama Canal Authority, the expansion will allow the passage of post-Panamax ships up to a maximum of 14,000 TEU. However, it will still not allow the passage of larger ships of 18,000 TEU (Maersk Triple E), which cover the Asia – USA route, nor large oil tankers.

⁵² The construction is planned of a port on the Pacific coast to the east of San José and another on the Atlantic coast, south of Puerto Barrios and some 30 km from Puerto Cortés (Honduras), connected by an approximately 400km long railway track.

⁵³ Known as CINN or Canal Seco, since the 1990s the construction has been considered of two new deep-water ports in Monkey Point, on the Atlantic coast, and Pie de Gigante, on the Pacific coast, connected by rail.

Table 18 shows the total 2014 maritime traffic for each Zone 1 country and the main ports listed in the 100 most important ports in the world. As can be seen, the country with the greatest volume of traffic is the USA, with 8 ports in the 100 most important in the world, followed by Brazil, which handles just under a quarter of the volume of cargo managed by the US.

Table 18. Relevant data for Zone 1

	Total maritime traffic 2014 [millions TEU] ⁵⁴	Ports listed in top 100 in 2014
Bahamas	1,379,296	None
Brazil	10,176,613	Santos (38)
Ecuador	1,205,294	Guayaquil (87)
Jamaica	2,319,387	Kingston (86)
Panama	7,447,695	Balboa (42) Colon (47)
Puerto Rico	No data available	None
USA	44,255,378	Los Angeles (19) Long Beach (20) New York / New Jersey (25) Seattle (44) Oakland (62) Virginia (63) Houston (78) Charleston (81)

Source: World Bank. Adapted

Table 19. Relevant data for Bahamas

Bahamas	
Situation & background	<p>The Bahamas, officially known as the “Commonwealth of the Bahamas”, is a country made up of 700 islands, of which only 60 are inhabited. Its capital, Nassau, is located on the island of New Providence.</p> <p>Its political system is based on a hereditary constitutional monarchy and belongs to the Commonwealth of Nations. The British monarch, as Head of State, designates the Governor General. The Cabinet is presided by a Prime Minister, who wields executive power.</p> <p>It is strongly dependent on tourism, which makes up 60% of the country’s GDP and is strongly influenced by the US. Its financial sector is also an important activity, representing 15% of GDP.</p>
Port system	<p>The Caribbean enjoys considerable advantage in terms of the recent growth in the transshipment subsector of cargo transport and international logistics. The enlargement of the Panama Canal⁵⁵ has increased the opportunities for investing in port facilities and logistics through which the main commercial routes pass.</p> <p>As such, the Caribbean, the Bahamas and Jamaica are ahead of the race in the development of logistics and transshipment hubs⁵⁶. Specifically in terms of port</p>

⁵⁴ Source: World Bank development indicators 1981-2014 (World Bank 2016d).

⁵⁵ According to the Panama Canal Authority, work is expected to be completed by the end of 2016, when the infrastructure will double its capacity.

⁵⁶ The term “hub” is derived from the “hub and spoke” model, which consists of creating a nucleus in which the logistics and transshipment activities are concentrated.

Bahamas	
	<p>infrastructures, HWL⁵⁷ has invested heavily in this area: the port of Freeport and the Sea Air Business Center, fronting up 50% of the capital required, and 51% for the container terminal in Freeport. (Caribbean Development Bank 2014)</p> <p>The main port in the Bahamas is the Freeport Grand Bahama, located 65 nautical miles off the coast of Florida. It was built with investment from HPH⁵⁸. GBPA⁵⁹, the company responsible for the management and running of the port, is a private entity made up of HWL, which owns 50% of the company, and individual local investors. This company received a State mandate to construct the port in 1955 through the Hawksbill Creek Agreement, for which it was awarded a no-fee concession for the first 30 years. It has the state-delegated powers necessary to act as a municipal authority within the port area.</p>
PPP framework	Other important PPP-structured projects underway in the Bahamas are those included in the New Providence Program ⁶⁰ . For example, in the construction of the port maritime facilities from Downtown Nassau to Arawak Cay, APDL ⁶¹ provided 40% of the capital, the Government of the Bahamas provided another 40%, with other public entities providing the remaining 20%; in total, \$17 million. Another example is that of FITSEP ⁶² , which includes the renovation and expansion of the quays in Fresh Creek (Andros Island), Three Island (Eleuthera Island) and the island of Bimini, in addition to their ferry terminals (United Nations Ecosoc 2014).

Source: Own analysis

Table 20. Relevant data for Brazil

Brazil	
Situation & background	<p>The Federal Republic of Brazil is one of the largest countries in the world. Spanning an area of 8 million square kilometres, several of its rivers are navigable by ship, allowing the development of a number of river ports, of which Manaus is the most important.</p> <p>A country formed through the union of States, Federal Districts and municipals, Brazil is a democratic republic with a presidential system. The President is the Head of State and the Head of the Union Government.</p>
Port system	The Brazilian port system consists of 35 public ports located along the coast and on inland waterways (UNCTAD 1999). In 1993, Brazil implemented an important programme of reforms of its port sector ⁶³ promoted by the Government. As a result of this programme of reforms, public ports are administered by eight national

⁵⁷ Hutchison Whampoa Limited (HWL) is among the largest companies listed on the main board of The Hong Kong Stock Exchange.

⁵⁸ Hutchison Port Holdings.

⁵⁹ Grand Bahama Port Authority. GBPA is responsible for the development, administration and management, and provision of services within an area called the 'Port Area' (230 sq. miles).

⁶⁰ The New Providence Transportation Program Supplementary Financing II, Ministry of Works and Transport (BH-L1029), is a transformation and modernization program aimed at obtaining funding from the private sector.

⁶¹ Arawak Port Development Limited, owner and operator of the Nassau Container Port and Gladstone Freight Terminal.

⁶² Family Islands Transport Sector Enhancement Project, financed by the Caribbean Development Bank (CDB) in an amount equivalent to US\$10.146 million and conducted by the Ministry of Public Works and Transport (MPWT) through its Department of Public Works (DPW). This project aims to improve and sustain access to social and economic infrastructures for families.

⁶³ Law 8630, February 25, 1993, "Dispositions regarding the legal system for the exploitation of public ports and port facilities and other rulings".

Brazil	
	<p>companies in which the Government is the largest shareholder.</p> <p>The State is able to concede spaces to private operators, as is the case for the port of Imbituba, or to regions themselves, as in Rio Grande, Port Alegre, etc.</p> <p>Brazil also has dedicated ports⁶⁴ that can only handle their own cargo and not that of third parties. These terminals may be managed by public enterprises, as in the case of Petrobras⁶⁵, or by private entities, such as CVRD⁶⁶.</p>
PPP framework	<p>In March 2001 the State of Pernambuco implemented a PPP for the first container-dedicated terminal, TECON-Suape⁶⁷, with the aim of transforming it into a container hub in order to attract transshipment cargo, taking advantage of the fact that the northeast of Brazil has for several years enjoyed above-national-average economic growth. Suape is the most important port in Pernambuco, being strategically located at the intersection of the main long-distance commercial routes joining the eastern coast of South America with other continents in addition to connecting routes to the north and south of the country.</p> <p>The TECON-Suape concession was awarded through a public bid for the construction and exploitation of the infrastructure for a period of 30 years and is not renewable. ICTSI is obliged to fulfil certain strict quality and service requirements and shares must revert to the State when the concession period elapses. The concessionaire is obliged therefore to ensure funding, acquire and install facilities and operate the terminal as a general user, opening it to all cargo carriers, operators and consignees. With respect to transshipment tariffs, since they are determined by the market, no limits are specified (World Bank 2013).</p> <p>The bid by ICTSI was a record amount in Brazilian port concessions, reaching almost 175 million dollars for the lease (World Bank 2013). The company's forecasted investments rose to 282 million dollars plus an additional 103 million for the infrastructure. It aimed to handle more than 500,000 TEUs annually by the time the concession expires in 2031. Already by 2008, the port was handling 300,000 TEUs per year, nearly 500% more than before the terminal was conceded, and 5% of Brazilian containerised traffic at that time (World Bank 2013). Between 2001 and 2007, ICTSI invested approximately 80 million dollars in human resources, information technologies, equipment, ships and esplanades for the storage of general cargo and containers, which allowed a growing and continuous flow of traffic.</p>

Source: Own analysis

Table 21. Relevant data for Ecuador

Ecuador	
Situation & background	The Republic of Ecuador is the fourth smallest country in South America. According to the IMF, its economy ranked position 62 in the world (International Monetary Fund 2014). Its currency is the dollar and its political system is a democratic republic. It trades internationally, exporting petroleum and minerals (UNCTAD 2005).
Port system	The Ecuadorian port system includes state ports (Guayaquil, Esmeraldas, Manta and Port Bolivar), private ports (18 in total, located in the province of Guayas) and special

⁶⁴ Terminals that only handle one type of cargo and usually one product.

⁶⁵ Petrobras is the national petroleum company of Brazil.

⁶⁶ CVRD, Companhia do Vale do Rio Doce. CVRD is a mining company that was privatised in the 1990s.

⁶⁷ The container terminal of the port of Suape is part of the Philippine group International Container Terminal Service (ICTSI).

Ecuador	
	<p>ports, nearly all of which handle petroleum (Balao, Salitral and La Libertad). The port authorities are public law entities⁶⁸ and their jurisdiction is confined to the port areas only. Law 50⁶⁹, which allows the modernisation of the port sector in the form of PPPs via the private sector and which regulates the conceding of contracts, was approved. According to this law, ports must belong to the State and be governed by the Landlord model. As such, the Ecuadorian port authorities do not operate any service directly.</p> <p>The most important Ecuadorian port authority is that managing Guayaquil, the port handling the greatest volume of cargo. According to the Guayaquil Port Authority, 70% of the cargo handled by Ecuador passes through this port. It has public terminals that are exploited by specific concession operators (Andipuerto⁷⁰ and Contecon⁷¹), and other private terminals:</p> <ul style="list-style-type: none"> ▪ Bulk solids: Fertisa, Puerto Trinitaria and Ecuatoriana de Granos ▪ Containers: TPG ▪ Multipurpose: Bananapuerto ▪ Bulk liquids: Vopak <p>The Ecuadorian port system as a whole experienced growth of 14% in container traffic between 2013 and 2014, to a total of 1.7 million TEUs (International Monetary Fund 2014). Ecuador provides political stability, thus favouring foreign investment in national installations.</p>
PPP framework	Among the ports developed through the PPP model are Manta ⁷² (World Bank 2016c), Port Bolivar ⁷³ , with a terminal dedicated to perishable goods and services for the country's mining sector, and Posorja ⁷⁴ (a deep-water port).

Source: Own analysis

Table 22. Relevant data for Jamaica

Jamaica	
Situation & background	Jamaica is a small island in the Caribbean Sea. It was first a Spanish colony and then British. It gained independence from the United Kingdom in 1962 and since then its political system has been parliamentary, basing itself on the British Westminster model. The British monarch is the Head of State and is represented by a Governor, who is nominated by the Jamaican Prime Minister. The island's main industry is tourism and its industrial activities include the manufacture of cement, fertilisers and petroleum derivatives.
Port system	The Law of Jamaican ports was enforced in 1972 ⁷⁵ and created port authorities to be the maritime agencies responsible for the regulation and development of ports and

⁶⁸ Pursuant to Executive Decree 1043, of 28 December 1970.

⁶⁹ The State Law of modernisation, privatizations and provision of public services through private initiatives N°50, of 24 March 1993.

⁷⁰ Concession awarded in 1999 for a period of 25 years for the exploitation of a dry bulk terminal (the largest in Ecuador) and a further multipurpose terminal.

⁷¹ Concession awarded in 2007 for a period of 20 years for the exploitation of a container terminal.

⁷² Concession to Hutchison Port Holdings, for 30 years, via the BROT system, for a total of 160 million dollars.

⁷³ Concession to Yilport Holding NV, a Turkish family-run holding founded in 1963. The concession is for a period of 37 years and the expansion cost 90 million dollars.

⁷⁴ City located to the southeast of Guayaquil on the River Guayas delta. The port falls under the jurisdiction of the Guayaquil Port Authority and its expansion cost 250 million dollars.

Jamaica	
	Jamaican maritime transport. Jamaica's main ports are Kingston and Montego Bay.
PPP framework	<p>Jamaica is currently experiencing an increase in PPPs, confirming itself —along with Paraguay and Ecuador—, as one of the main American markets in the development of infrastructure projects and moving up the GCI ranking⁷⁶ where it was positioned 86 (out of 144) during the period 2014-2015 with a score of 4 (out of 7) (Schwab & Sala-i-martin 2014). Jamaica has implemented a new policy that establishes a comprehensive process of identification, development, evaluation, implementation and management of PPPs (Development Bank of Jamaica 2012). This policy received the support of the DBJ⁷⁷, which manages the implementation of projects, following the requirements established by the Ministry of Finance.</p> <p>The country aims to standardise the implementation of PPPs, attract private investment and to limit its financial burden (World Bank 2016a). The new national policy, together with an improved investment climate, should enable significant growth in these types of societies in Jamaica, although its weak financial conditions means it has to attract foreign capital (EIU - Economist Intelligence Unit 2014). The law states that the risk of construction should fall on the private party. In other words, that this party will not receive any payments until building is complete and should carry the burden of any extra charges should the project go over budget (EIU - Economist Intelligence Unit 2014).</p> <p>The most recent PPP operation in Jamaica has been the awarding of a concession for 30 years of a terminal in the port of Kingston⁷⁸. It's important to note that within this context not all the projects have materialised, since the Government recently announced its intention to invest between 7000 and 8000 million dollars in a logistics hub to expand the port installations with the aim of converting it into one of the largest global distribution centres. However, the CaPRI⁷⁹ advised against it, citing that Jamaica is not currently one of the economies best positioned to take advantage of the benefits of a logistics centre (Caribbean Policy Research Institute 2014).</p>

Source: Own analysis

Table 23. Relevant data for Panama

Panama	
Situation & background	The Republic of Panama is located in southeast Central America and boasts one of the largest infrastructures for maritime transport in the world, the Panama Canal, whose construction was started by a French consortium in 1869 and which is currently undergoing a process of expansion and improvement. It is a democratic republic and its economy is, after Chile, the most competitive, ranking first in Central America (Schwab & Sala-i-martin 2010), (Schwab & Sala-i-martin 2014). Its currency is the dollar and is highly dependent on the tertiary sector, which reaches 75% GDP.

⁷⁵ Port Authority Act, 14 February 1972.

⁷⁶ Global Competitiveness Index, created by the World Economic Forum in order to rank countries according to their macroeconomic indicators.

⁷⁷ Development Bank of Jamaica created in April 2000, from the merger of the Agricultural Credit Bank of Jamaica Limited and the National Development Bank of Jamaica Limited.

⁷⁸ Conceded to the French company Terminal Link, part of the CMA-CGM group, for a total of 600 million dollars with the aim of improving and expanding the Kingston Container Terminal (KCT).

⁷⁹ Caribbean Policy Research Institute.

Panama	
Port system	<p>The Panama Canal is managed by PCA⁸⁰, an entity independent of the PMA whose scope of action is limited specifically to the Canal. For the expansion of the Canal, the PCA required investment to the tune of 5,250 million dollars, 2,300 million of which were provided by IDB⁸¹, IFC⁸², EIB⁸³, JBIC⁸⁴, and ADC⁸⁵. The remaining costs will be covered by the income generated from canal operations and financed by the constructors involved in the process of expansion and improvement. The ports of Balboa and Colon, at either end of the Canal, are operated by HPH.</p> <p>The Panamanian port system consists of 26 ports divided into two large blocks: private ports, which were conceded to private operators after the privatization of a number of state ports (including the Colon Container Terminal and the Manzanillo International Terminal) and state ports, 19 of which (such as Aguadulce, Armuelles and Bocaparita) are operated by the State under the administration of PMA⁸⁶.</p> <p>The port concession system is coordinated by the Department of Concessions, part of the Auxiliary Maritime Industries Sub-department, which is dependent on the General Management of Ports and Auxiliary Maritime Industries.</p>
PPP framework	<p>There is no general legal framework for port PPPs in Panama. If the companies are national and own the infrastructure, then laws that cover private contracts are applied, with these companies acting as Landlords. With regards to the ports themselves, <i>ad hoc</i> laws for each installation are also in place (World Bank 2016b). The Panamanian Government is currently in the process of drafting a law⁸⁷ that unifies the criteria.</p>

Source: Own analysis

Table 24. Relevant data for Puerto Rico

Puerto Rico	
Situation & background	<p>The Commonwealth of Puerto Rico is a non-incorporated territory⁸⁸ of the United States of America located in the northeast Caribbean. An archipelago, its central island is Puerto Rico. It was a Spanish colony and the Spanish language is, thus, the official and vehicular language, with English being its second language. Although the Puerto Rican Government is fiscally independent, it has strong links with the US government, which regards Puerto Rico in many respects as one more state, though</p>

⁸⁰ Panama Canal Authority, a public law entity, dependent on the Ministry of Affairs of the Panama Canal and created by law N°19 “The Organic Law of the Panama Canal”, of 14 May 1997.

⁸¹ Inter-American Development Bank, headquartered in Washington D.C. (USA).

⁸² International Finance Corporation, which is a member of the World Bank Group, which operates in the private sector in developing countries, headquartered in Washington D.C. (USA).

⁸³ The European Investment Bank, the EU community finance entity headquartered in Luxembourg (Luxembourg).

⁸⁴ Japan Bank for International Cooperation, created through the fusion of the Japan Export-Import Bank and the Overseas Economic Cooperation Fund, headquartered in Tokyo (Japan).

⁸⁵ Andean Development Corporation - Development Bank of Latin America, headquartered in Caracas (Venezuela).

⁸⁶ PMA is the Panamanian Port Authority and was set up through resolution No.010-98-ADM, which is based on government law N°7 of 10 February, 1998, “Which establishes the Panamanian Maritime Authority, unifies the various maritime competences of the Public Administration and sets out other dispositions”.

⁸⁷ Project of law N°349, which establishes the “Public-Private Association (PPA) Regime” and whose first draft dates 27 April 2011 and is being promoted by the Ministry of Economy and Finances.

⁸⁸ Puerto Rico is a territory that, whilst under the sovereignty of the United States, does not form part of its national territory and therefore is not one of its 50 States.

Puerto Rico	
	certain precepts of the US constitution are not applicable and do not extend over the entire archipelago.
Port system	Puerto Rico has just one port authority, the PRPA ⁸⁹ . The main port is San Juan, which has a zone for handling cargo but which is, in the main, dedicated to cruise liners.
PPP framework	In Puerto Rico, the Law of Public Private Alliance ⁹⁰ authorises any government agency to establish a PPP with private enterprises for the design, construction, financing, maintenance and running of public installations in the port sector. The Authority for the Puerto Rican Public-Private Alliances and GDB ⁹¹ are responsible for choosing the projects and ensuring the fulfilment of the terms of the PPP contracts. One example of a PPP is that of Carnival Cruise Lines ⁹² , which reached an agreement in 2001 with PRPA to carry out improvement works on terminal 4 of the port of San Juan.

Source: Own analysis

Table 25. Relevant data for The United States of America

United States of America	
Situation & background	The United States of America is the fourth geographically largest country in the world, though its economy is the largest in nominal terms, with an estimated GDP of 15.7 billion dollars (Schwab & Sala-i-martin 2014). Its political system is a democratic, representative constitutional federal republic made up of a total of 50 States and a Federal District.
Port system	The US port system consists of 360 ports (Central Intelligence Agency 2013), many of which, though not all, belong to the AAPA ⁹³ . They include both public ports and private terminals. The national ports develop and maintain the infrastructure. Due to the legislative differences between states, there is enormous heterogeneity in port management. Thus, for example, the Port Authority of New York and New Jersey is a joint venture ⁹⁴ between both States jointly controlled by both respective Governors that receive aid in the form of public subsidies. By contrast, the Port of Los Angeles ⁹⁵ , the leading US port in container traffic, belongs to the city of Los Angeles and does not receive any subsidies from the tax-paying public.
PPP framework	The public-private associations are increasingly used to compensate for the lack of resources, since state funds for infrastructures are becoming increasingly limited (Deye 2015). An example of this is the Trapac terminal ⁹⁶ , completed at the end of 2008. For the construction of this port, the land was awarded in the form of a

⁸⁹ Puerto Rican Port Authority, a public corporation created by Law Num. 125 of 7 May 1942.

⁹⁰ Law 29/2009, of 8 June 2009, which created the Authority for the Puerto Rican Public-Private Alliances, was partially amended by law 237/2014, of 19 December 2014.

⁹¹ Government Development Bank for Puerto Rico.

⁹² A US cruise company based in Doral, Florida.

⁹³ American Association of Port Authorities, trade association founded in 1912 that represents 130 port authorities in the United States, the Caribbean and Latin America. Its headquarters is located in Virginia, EUA.

⁹⁴ A commercial agreement in which the parties are committed to developing, during a specified period of time, a new entity and its assets (Seung & Ungson 1997).

⁹⁵ Also known as America's Port since it the largest US port in terms of containerised cargo.

⁹⁶ The Trapac terminal in Port Jacksonville is managed by Trapac, Inc., a terminal operator and shipping company founded in 1987 and headquartered in Wilmington, California

	<p>concession and an initial subvention of 20 million dollars was provided to start the project off. MOL⁹⁷, the terminal operator, bore the cost of the debt, which totalled approximately 305 million dollars (AAPA 2013).</p> <p>Due to the high cost of the project and the lack of State liquidity, the Jacksonville Port Authority intends to employ a new model of PPP exploitation based on TPF⁹⁸ for the construction of its new intermodal container terminal (AAPA 2013).</p> <p>The US has also seen the emergence of entities specialised in developing PPPs in its territory. An example of such an entity is Ports America⁹⁹, which has established 4 PPPs within the last 5 years: the Port Newark container terminal in New Jersey; the Bayonne automobile terminal, also in New Jersey; Outer Harbor in Oakland, California; and Chesapeake in Baltimore, Maryland, to operate the Seagirt maritime terminal (Ports America 2012).</p>
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Source: Own analysis

The Panama Canal and its enlargement –nowadays in process– is a key factor for the maritime dynamics development of the area, especially in the Caribbean side, fostering a great activity on the ports located there by the attraction of transshipment traffics and, in consequence, the growth of the cargo transport and international logistics.

As well as this, despite the enormous heterogeneity in port management through the whole area –even in the USA itself, due to the legislative differences between states–, PPP are increasingly used by the different countries to compensate for their lack of resources in infrastructures. In this sense, while Brazil has experienced a decline of this kind of investments, Jamaica and Ecuador are strengthening themselves as the main American markets in the development of infrastructure projects.

7. ZONE 2: EUROPE, NORTH AFRICA AND THE MIDDLE EAST: SUEZ CANAL

Zone 2 is conditioned by the presence of one of the most important commercial maritime infrastructures in the world: the Suez Canal¹⁰⁰, which, unlike the Panama Canal, is a natural route that has been improved and has not required any infrastructure investment.

The Suez Canal is a waterway that requires little investment or maintenance and, thanks to its size, is seeing a year-on-year growth in traffic (Notteboom 2012). With the opening of the Suez Canal, traditional routes that passed for example around the Cape of Good Hope were considerably shortened. Using this infrastructure, large oil tankers are able to travel from the Persian Gulf to the United States (González-Cancelas 2007). Therefore, it is a canal that allows the passage of not only large container ships but also allows the access of other types of large ships and has become the most important shipping route in Africa (Trujillo et al. 2013). Consequently, projects are planned for the expansion and improvement (OECD 2014) in order to increase its capacity.

⁹⁷ Mitsui OSK Lines Ltd, headquartered in Tokyo and founded in 1964, is a business group dedicated to multimodal transport.

⁹⁸ Third Part Financing. This model consists of an entity interested in obtaining an economic profit that invests in the project but does not itself exploit the installation.

⁹⁹ Ports America Inc. was founded in 1922 and has its headquarters in Jersey City, New Jersey. It is the largest operator of terminals in the US and operates as a subsidiary of Port America Holdings, Inc.

¹⁰⁰ The Suez Canal connects the Mediterranean Sea and the Red Sea, separating Africa from Asia and running from Port Said to the Gulf of Suez. It does not require locks, since the sea levels at either end of the Canal are similar. It has a draught of 68m, is 200m in width and can handle ships of close to 200,000 DWT (deadweight tonnage).

As a result, Mediterranean ports will register a significantly greater volume of traffic, not only from ships from the Persian Gulf but also direct lines from China, increasing the ability of ports on the east coast of Spain, for example, to attract cargo¹⁰¹. Table 26 demonstrates that those countries lying close to the China-Suez Canal-Europe route are those that are seeing a greater volume of maritime cargo.

Table 26. Relevant data for zone 2

	Total maritime traffic 2014 [millions TEU]	Ports listed in top 100 in 2014
Belgium	10,733,057	Antwerp (16) Bruges (75)
Egypt	7,143,083	Port Said (29)
Malta	2,848,005	Marsaxlokk (54)
Morocco	2,500,000	Tanger-Med (49)
Oman	3,930,261	Salalah (50)
Saudi Arabia	6,742,397	Sharjah (30) Jeddah (36) Dammam (82)
Spain	14,020,162	Algeciras (31) Valencia (34) Barcelona (79)
United Arab Emirates	19,336,427	Jebel Ali (9)

Source: World Bank (adapted)

As can be seen, Spain as a whole registers a greater movement of containers than Belgium and is the second country after the United Arab Emirates, with three of its ports listed in the 100 most important in the world.

Table 27. Relevant data for Belgium

Belgium	
Situation & background	Belgium is a member country of the European Union with its capital in Brussels. Its political system is the constitutional federal monarchy. The monarch is the Head of State, the leader of which is the Prime Minister and the federal governments. Its constitution is based on continental, or Roman, law, which has written rules in all ambits and contracts, including public ones, that are subject to the civic code.
Port system	The Belgian port system and the functioning of Belgian port authorities are detailed in chapter 4, specifically for the case of the Port of Antwerp.
PPP framework	With regard to PPPs, one of the main preoccupations for public entities looking to set up this type of collaboration is to eliminate the debt these projects generate in the public coffers with the aim of fulfilling the obligations of the Maastricht Treaty convergence criteria according to the criteria for the classification of SEC ¹⁰² assets. The setting up of joint ventures with private operators for providing of services is a good way of achieving this, as it always guarantees an adequate transfer of the risks and prioritises the public interest. In terms of ports, one of the main PPP projects is the port of Brussels, a multimodal installation that cost 55 million Euros.

¹⁰¹ There are currently routes from China to the Port of Rotterdam that use the Panama Canal and whose goods are destined for the Spanish market. These lines are losing cargo to those that use the Suez Canal and access the east coast of Spain directly from China.

¹⁰² European system of national and regional accounts in the European Union. Regulation EU 549/2013 of the European Parliament and of the Council of 21 May 2013.

	<p>In the case of PPPs, there is no general legal definition for these types of societies, but a Belgium decree (18 July 2003) describes them as projects carried out jointly by public and private organisms or entities in the form of a society with the aim of creating value added for them. This definition differs from those of other European countries and from that set out in the European Commission’s Green Paper¹⁰³, which defines them as “<i>forms of cooperation between public authorities and the business world that aim to guarantee the funding, construction, renovation, management of an infrastructure or service provision</i>”.</p> <p>The popularisation of PPPs does not, therefore, represent the emergence of new legal framework, but rather the use of a public management method that can be implemented both through the new forms as well as the more traditional forms of administrative contracts, or even a combination of them in the case of complex situations.</p> <p>With respect to public contracting, the Belgian legislation on adjudication procedures adheres fundamentally to the application of EU directives regarding public services¹⁰⁴ and public contracts¹⁰⁵, both of which form the basis of a PPP: the concessioning of works, where the private entity is responsible for financing and carrying out the works and exploits them for a specified period of time, and the development contract, in which the operator only finances the works and is responsible for carrying them out.</p>
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Source: Own analysis

Table 28. Relevant data for Egypt

Egypt	
Situation & background	The Arab Republic of Egypt is a country of strategic importance in maritime commerce, as it is the location of the Suez Canal. Most of its territory is made up of the Sahara desert and it has one of the largest navigable rivers in the world, the Nile. Its economy is based mainly on agriculture. Politically, it is a democratic republic and the President is, in addition to Head of State, the supreme commander of the country’s armed forces.
Port system	The most important port in Egypt is Port Said, which is managed by its own port authority, which differs from that of the Suez Canal. As occurs in Panama, the Suez Canal Authority is independent of other Egyptian port authorities, has its own legal character and depends only on the Prime Minister. The remaining port authorities depend on the MTS ¹⁰⁶ .
PPP framework	The Ministry of Finances has established a central PPP unit ¹⁰⁷ for the fostering and implementation of these types of projects. This model of contracting in this country dates back to the 19 th century, although was not legislated until 1947 ¹⁰⁸ . As exceptions to this law, at the end of the 1990s laws specific to the electricity sector,

¹⁰³ Green Paper on public-private partnerships and Community on public contracts and concessions. COM (2004) 327, of 30 April 2004.

¹⁰⁴ Directive 2004/17/EC of the European Parliament and of the Council of 31 March 2004 coordinating the procurement procedures of entities operating in the water, energy, transport and postal services sectors.

¹⁰⁵ Directive 2004/18/EC of the European Parliament and of the Council of 31 March 2004 on the coordination of procedures for the award of public works contracts, public supply contracts and public service contracts.

¹⁰⁶ Maritime Transport Sector, which in turn is dependent on the Egyptian Ministry of Transport.

¹⁰⁷ Supreme Committee of Public-Private Partnership (PPP) Affairs.

¹⁰⁸ Law 129/1947 concerning concessions of public utilities, and Law 61/1958 concerning concessions relating to the investment of natural resources and public utilities, as well as Public Tenders.

	<p>airports, specialised ports and land transport were enacted that allowed a greater flexibility when drafting related concession contracts (OECD 2014).</p> <p>In 2010 a specific programme aimed at regulating PPPs in infrastructure¹⁰⁹ was set in motion. This programme has not managed to increase in any significant way investments in this area and many of the projects are suffering delays (OECD 2014). Moreover, the law is only applicable to PPP-based contracted projects with a minimum investment of 100 million Egyptian pounds (a little over 12 million Euros). However, there is no restriction to the sectors that can access them. Furthermore, there may even be overlaps with other laws on public contracts¹¹⁰ and other public authorities that may fall under various regimes (Center for International Private Enterprise 2001).</p>
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Source: Own analysis

Table 29. Relevant data for Malta

Malta	
Situation & background	The Republic of a Malta, an archipelago located south of Italy, is a member of the European Union. This political system consists of a House of Representatives elected through universal suffrage. The House elects a President every 5 years.
Port system	Malta's most important port is Marsaxlokk, managed in the first instance by Malta Freeport Authority ¹¹¹ . An initial 30-year concession, awarded to CMA-CGM ¹¹² in 2004, was subsequently extended to a total of 65 years in February 2008. After various transfers of assets ¹¹³ , the Port Authority is nowadays a private entity and belongs to Malta Freeport Corporation Limited, which acts as Landlord, while activities are carried out by Malta Freeport Terminals, which is the sole operator of the container terminals (Pallis & Vaggelas 2005).
PPP framework	The Maltese Ministry of Economy set up the PPP Unit in 2011 to encourage these types of contracts and to facilitate the entry of foreign capital, meaning that Malta is a country open to overseas investment and receptive to privatisations.

Source: Own analysis

Table 30. Relevant data for Morocco

Morocco	
Situation & background	The Kingdom of Morocco is a North African country with coasts adjacent to both the Mediterranean Sea and the Atlantic Ocean. It is the only country in Africa not to be a member of the AU ¹¹⁴ . It is a constitutional monarchy with an elected parliament, though in practice, the King has executive power and is, moreover, the Commander

¹⁰⁹ Law 67/2010 regulating partnership with the private sector in infrastructure projects, services and public utilities.

¹¹⁰ As occurs with the Public Tender Law 89/1998.

¹¹¹ Malta Freeport Corporation Ltd, created in 1989 through Act XXVI of 1989, chapter 334, Malta Freeport's Act "To provide for the establishment of a Freeport system in Malta and to regulate its operation". Initially, it was a public entity.

¹¹² CMA, Compagnie Maritime d'Affrètement, was founded in Marseille in 1978. In 1996 it merged with Compagnie Générale Maritime (CGM) to give rise to the CMA-CGM group.

¹¹³ In November 2011, CMA-CGM transferred half of its shares in Malta Freeport Terminals to the Yildirim Group of Turkey. In June 2013, CMA-CGM sold a 49% interest in port operator Terminal Link to China Merchants Holdings (International) Company Limited.

¹¹⁴ The African Union, created 26 May 2001 in Addis Ababa (Ethiopia), which brings together 54 African nations. Morocco left the Union when, in 1984, the Organisation for African Unity, of which it was founder, accepted the Democratic Saharan Arab Republic.

	of the Military Forces.
Port system	Morocco's main port is Tanger-Med. Despite being a public port, the entire project is managed by the private company TMSA ¹¹⁵ , dependent upon which is the Port Authority ¹¹⁶ , which is responsible for the construction and maintenance of the port. TMSA represents the State and has the capacity to sell and concede lands in the port. Thus, terminal 1 belongs to APM Terminals and MAG ¹¹⁷ , terminal 2 is the property of the consortium Eurogate Tanger Ltd. ¹¹⁸ . Terminal 3 is due to be operated by APM Terminals and MAG, while terminal 4 is in the process of being conceded to Marsa Maroc ¹¹⁹ , a terminal operator (Pallis et al. 2010).
PPP framework	PPPs are governed in Morocco by a 2006 law ¹²⁰ aimed at demonstrating the opening up of Morocco's economy and its desire for transparency in the adjudication of delegated management contracts. The law itself is somewhat limited and is not applicable to concessions from central government authorities or state enterprises (OECD 2014).

Source: Own analysis

Table 31. Relevant data for Oman

Oman	
Situation & background	The Sultanate of Oman is located on the southeast coast of the Arabian Peninsula. Its political system is based on an absolute monarchy in which the monarch exercises almost complete power except for certain legislative powers retained by Parliament.
Port system	The main port in Oman is Salalah, which is one of the ports that emerged in the 1990s as an intermediate hub (Ducruet & Notteboom 2012), (Tavasszy et al. 2011), (Notteboom 2012) and is, moreover, one of the ports to have most improved its efficiency (Cheon 2007), (Cheon et al. 2010). Its construction dates back to 1998, as two years earlier APM Terminals was awarded a 30-year concession and set up a consortium to exploit it ¹²¹ . It is, therefore, a joint venture between a foreign company and the Omani Government. This port diverted its traffic in bulk materials to other ports in order to focus its efforts on becoming the largest container transshipment installation in the Persian Gulf (Turpin 2013).
PPP framework	With regard to PPPs, their exploitation is regulated by Law 77/2004 ¹²² . This law sets out, among other things, the awarding of concessions and the selling of shares of state-owned companies. There is no specific complete legislation on their implementation but they are regulated by rules specific to each sector. For its part, the text that forms the basis of public contracting is the Tender Law ¹²³ , which places

¹¹⁵ Tangier Mediterranean Special Agency, created in February 2003 by Decree N°2-02-644 of 10 September 2002. 91% of TMSA shares are owned by the Hassan II Fund for Economic and Social Development, 7% are state-owned and the rest are owned by the company, CDG.

¹¹⁶ Tanger-Med Port Authority.

¹¹⁷ Moroccan Akwa Group, with headquarters in Casablanca.

¹¹⁸ Comprising CMA-CGM, MSC, TangermedGate Management and CoMaNac.

¹¹⁹ Marsa Maroc is the main port operator in Morocco. Marsa maroc is the trade name of Société d'Exploitation des Ports, Ltd., presided by the Ministry of Equipment and Transport.

¹²⁰ Law N°54-05 on the delegated management (Loi sur la Gestion Déléguée) of services and public works promulgated in February 2006. This law allows the State or local authorities to concede the management of a public service to a private entity.

¹²¹ Comprising APM Terminals/AP Möller Maersk Group (30%), the Government of Oman (20%), the Government Pensions Fund (29%) and institutional investors (21%).

¹²² Royal Decree 77/2004 promulgating the privatisation law.

¹²³ Royal Decree 36/2008 issuing the Tender Law.

Oman	
	the main responsibility for the offers on the Tender Committee both with respect to their publication and the ways the offers are presented, together with their calendar and assessment (Courtney-Hatcher et al. 2013).

Source: Own analysis

Table 32. Relevant data for Saudi Arabia

Saudi Arabia	
Situation & background	The Kingdom of Saudi Arabia is located in the Arabian Peninsula. Its governing system is based on an absolute monarchy, which in turn is based on the principles of Islam. The King controls the three powers (Executive, Legislative and Judicial) and the Governor only has the jurisdiction to apply Islamic Law. Saudi Arabia is a member of the United Nations and OPEC ¹²⁴ and is the world's largest exporter of petroleum and the 19 th world economy in 2013 (Central Intelligence Agency 2013). It is currently trying to increase its petroleum production and has experienced and rise in internal consumption (Lattila et al. 2013).
Port system	The ports are controlled by KSAPA ¹²⁵ . At the end of 1997, this organisation began the transfer of responsibility of the management of ports to the private sector and nowadays contracts are drawn up directly between the port operators and the Government. The norms established by KSAPA are applicable to all Saudi Arabian ports with the exception of certain contradictions with GCC ¹²⁶ regulations, of which Saudi Arabia is a member. The main port is Sharjah.
PPP framework	With regards to PPPs, law 110/1425 ¹²⁷ establishes the regulatory framework and four types of collaboration between the public and private sector (Alkhiary 2012). Nowadays, the Government is prioritising these types of port contracts as part of its privatisation framework (Tahat 2014).

Source: Own analysis

Table 33. Relevant data for Spain

Spain	
Situation & background	Spain is a member of the European Union and its political system is based on a parliamentary monarchy.
Port system	The Spanish port system, the nature of the port authorities and the tariff system are set out in detail in Chapter 4. Currently, the model of port exploitation is based on the landlord system, which requires a PPP schema for the financing of the infrastructure. The legal method of contracting in these cases may be in the form of a public port works concession or a <i>demanial concession</i> ¹²⁸ . Public port concessions are awarded for a period of 40 years,

¹²⁴ Organisation of Petroleum Exporting Countries, with headquarters in Vienna and founded in Bagdad (Iraq), 14 September 1960.

¹²⁵ The Kingdom of Saudi Arabia Ports Authority, created in 1976 as an independent body of the Office of the Prime Minister.

¹²⁶ Gulf Cooperation Council, created 25 May 1981, is a customs union between the seven member countries.

¹²⁷ Council of Ministers resolution N°110 dated 5/4/1425 (Islamic year for 2004).

¹²⁸ According to the Law of Ports, a *Demanial Concession* consists of a contract in which the administration owning a public commodity awards an individual or a legal entity the right to exclusive private use.

Spain	
	<p>with the possibility of extending to 60 years with the aim of re-establishing the contract's economic balance. Demanial concessions are not strictly PPPs, as they are the provision of a port service using exclusively a part of the installation and its occupation for a period of 3 years with works and installations that can be dismantled. As of 2014, the period of 35 years has been extended to a maximum of 50.</p> <p>The demanial concessions are awarded in accordance with the Law of State Ports¹²⁹. The port establishes the conditions for exploitation and other economic conditions. With regard to the exploitation conditions, a minimum volume of activity or traffic is obligatory¹³⁰ otherwise a fine is imposed which is proportional to the difference between the minimum traffic demanded and the actual traffic. Inactivity on the part of the concessionaire during a period of one year will result in the termination of the concession¹³¹.</p> <p>The economic conditions for exploitation consist of a fixed occupation rate¹³², an activity rate (variable), a use rate (variable) and a navigation aid rate.</p>
PPP framework	<p>With respect to port PPPs, one of the most outstanding examples in terms of the necessary capital is that of Moll Prat in the Port of Barcelona, in which investment in the infrastructure reached an estimated 500 million euros (Rebollo 2009). The concession was awarded to BEST¹³³ and included the construction design, building and required financing together with its operation and maintenance.</p>

Source: Own analysis

Table 34. Relevant data for U.A.E.

United Arab Emirates	
Situation & background	<p>The United Arab Emirates is a federation whose political system is based on a federal constitutional monarchy. It is one of the richest countries in the world (Central Intelligence Agency 2013) and, as an exporter of petroleum, is a member of OPEC, although it exports an important volume of natural gas.</p>
Port system	<p>The main port in the UAE is Jebel Ali. The Port Authority of this and other ports in the country is DP World¹³⁴, a public enterprise that, in addition to Jebel Ali, operates a further 65 terminals throughout the world.</p> <p>The construction of the port infrastructure is the responsibility of DED¹³⁵ (Kerr et al. 2013). The requirements for obtaining permission for exploitation vary according to the type of activity of the contractor and also depend on the contractor's experience, the capital to be invested and the approval of the authorities. In the case of projects</p>

¹²⁹ Article 86 of Royal Legislative Decree Real 2/2011, of 5 September, by which the rewritten text of the Law of State Ports and Merchant Marine is approved.

¹³⁰ According to rule 27 of Order FOM/938/2008.

¹³¹ According to rule 23 of Order FOM/938/2008.

¹³² Articles 10, 11 and 12 of Law 33/2010 of 5 August, a modification of Law 48/2003, of 26 November, of the economic regime and the provision of services in ports of general interest.

¹³³ Barcelona Europe's South Terminal was awarded the concession in May 2006. The company was initially made up of HPH and Grupo Mestre, with HPH becoming the sole entity from 2011. It was inaugurated 27 September 2012.

¹³⁴ Dubai Ports World, founded in 2005 through the merger of Dubai Ports Authority and Dubai Ports International, is a public enterprise headquartered in Dubai.

¹³⁵ Department of Economic Development, founded March 1992 and thanks to decree 25/2008 "appointing two Deputies to the Head of the Executive Council" obtained jurisdiction over ports and infrastructures.

United Arab Emirates	
	with a potential environmental impact, a specific licence is also required.
PPP framework	The financing of projects through PPPs is not common in the UAE. There is no specific legislation in this regard, although some emirates have rules for the contracting of works and projects on behalf of government entities with variable requisites depending on the case. For example, in Dubai, the Roads and Transport Authority ¹³⁶ has competences in terms of PPPs in this sector (Kerr et al. 2013). The usual procedure for awarding long-term concessions takes the form of bidding for conventional tenders.

Source: Own analysis

The Mediterranean and Middle East area are clearly conditioned by the existence of the natural route of the Suez Canal, which brings to the ports of these countries a significantly greater volume of traffic, not only from ships from the Persian Gulf but also direct lines from China. In this regard, the Suez Canal Authority is independent of other Egyptian port authorities, has its own legal character and depends only on the Prime Minister.

In the EU area, as are the cases of Belgium and Spain, the fulfilment of Maastricht Treaty convergence criteria set the premises of the PPPs national policies and public contracting is regulated from the national transposition of EU directives. Regarding the Arabic environment countries studied, Morocco and Egypt have laws and specific programs for PPPs, but its scope of action is quite limited yet and, especially in second one hasn't achieved any remarkable results in practice. On the contrary, among the countries studied in the Middle East area, the private investment option is much more common, with the exemption of the UAE.

8. ZONE 3: SOUTHEAST ASIA: CHINA

The last of the three zones analysed in this chapter comes under the undeniable influence of China and its area of influence. Already by 2009, China boasted 14 ports among the top 20 in the world (Ducruet & Notteboom 2012). As can be seen in Table 35, by 2014 19 of its ports were among the world's 100 most important, 6 of which were in the top 10, and it handled more than 174 million containers. It has, therefore, become a hub in its area of influence (González-Cancelas 2007).

Table 35. Relevant data for zone 3

	Total maritime traffic 2014 [millions TEU]	Ports listed in top 100 in 2014
Bangladesh	1,571,461	Chittagong (83)
China	174,080,330	Shenzhen (3) Hong Kong (4) Ningbo – Zhoushan (5) Guangzhou (7) Qingdao (8) Tianjin (10) Dalian (14) Xiamen (17) Yingkou (26) Lianyungang (27) Suzhou (33) Dongguan (55)

¹³⁶ Roads and Transport Authority of Dubai, by law 17/2005 on the establishment of Dubai's Road and Transport Authority. Responsible for planning and executing transport and traffic projects.

		Nanjing (57) Rizhao (61) Yantai (66) Zhongshan (74) Fuzhou (77) Quanzhou (80) Dandong (85)
India	10,653,343	Jawahartal Nehru Port (32) Chennai (90)
Indonesia	10,790,450	Tanjung Priok (22) Tanjung Perak (48)
Malaysia	21,426,791	Port Kelang (12) Tanjung Pelepas (18)
Thailand	7,702,476	Laem Chabang (21)

Source: World Bank (adapted)

Under the influence of China are other countries that handle much smaller volumes of cargo (for example, Malaysia) that have benefitted from the routes connecting to China through the Suez Canal to become important production centres.

However, the enormous growth seen in China has been conditioned partly by the efforts of the Chinese Government to strengthen the zone (Feng & Notteboom 2013) and partly by the geographical advantages conferred by the Chinese river systems. The Yangtze River plays an extremely important role in the development of Central and West China (Veenstra & Notteboom 2011) and, like others, enables the circulation of barges from production centres to coastal ports (Gujar & Yan 2010).

Table 36. Relevant data for Bangladesh

Bangladesh	
Situation & background	The Popular Republic of Bangladesh is a country bordering India. Its political system is based on a parliamentary republic. It is included with the Next Eleven Group ¹³⁷ and is a founding member of SAARC ¹³⁸ . It is a developing country with a mixed economy.
Port system	The main Bangladeshi port is Chittagong, situated on the estuary of the River Karnaphuli and owned by CPA ¹³⁹ , a public entity that depends on the Ministry of Shipping, which is run by a committee composed of a President and four members, all nominated by the Government. Its close proximity to other ports obliges Bangladesh in general and the port of Chittagong in particular to share areas of influence with competitors (Burkhalter 1999), generating thus the need to boost competitiveness.
PPP framework	The Government of Bangladesh is attempting to attract private investment in the transport sector, which has resulted in the creation of the Private Infrastructure Committee ¹⁴⁰ , which is dependent of the Office of the Prime Minister for the application of PPP policies (Bangladesh Ministry of Finance 2009).

¹³⁷ The group of countries considered by the multinational investment bank Goldman Sachs as the future economic powers of the 21st century.

¹³⁸ South Asia Association for Regional Cooperation, which groups 8 countries and has headquarters in Kathmandu, Nepal.

¹³⁹ Chittagong Port Authority, created in 1976 by the LII OF 1976, Ordinance to provide for the establishment of the Chittagong Port Authority, amended by Act N°19 of 1995.

¹⁴⁰ Private Infrastructure Committee (PICOM), created in 2004 to facilitate and promote PPPs.

Bangladesh	
	<p>The Bangladesh PSIG¹⁴¹ was also created and, in 2010, the PPP Authority, which is also dependent on the Office of the Prime Minister, was established with the aim of facilitating the boost in infrastructures (The Asia Foundation 2010).</p> <p>One of the projects currently underway to boost this collaboration is the development of the general cargo docks and the container terminals in Chittagong Port, whose running has been offered to the private sector by the port authority through a SOT¹⁴² concession.</p> <p>However, foreign investment in PPPs is not being secured. This may partly be due to the large number of determining factors imposed on concessionaires (Asian Development Bank 2010).</p>

Source: Own analysis

Table 37. Relevant data for China

China	
Situation & background	<p>The People's Republic of China is the most populous country in the world and the world's largest economy in terms of GDP (Central Intelligence Agency 2013). Its governing system is a one-party system ruled by the Communist Party. It is the third geographically largest country in the world and since joining the WTO¹⁴³, its ports have undergone rapid growth (Montero 2006).</p> <p>The rise of China as the world's factory has meant that ports in the region have undergone significant development in recent years (Hung et al. 2010). Moreover, this growth has been so intense that, despite the substantial increase in investments in ports, the amount invested has not been enough to cover demand (Yuen et al. 2013).</p>
Port system	<p>In the last decade, China has had to complement maritime and river ports with inland dry ports (Monios & Wilmsmeier 2013), following a development model very similar to that observed in much better integrated networks such as those in Europe and the US (Monios & Wang 2013), since the Hinterland model of the east coast of Asia has traditionally been characterised by high coastal urbanisation and low inland development (Lee et al. 2008).</p> <p>In 2014, 19 Chinese ports were listed among the world's top 100, with 6 in the top 10, highlighting the importance of China in world maritime trade.</p> <p>The Government has implemented a programme of reforms in the port sector¹⁴⁴, which has evolved from a centrally controlled model characterised by inadequate investment and inefficiency to a highly competitive system that caters for various PPP options and that is undergoing rapid growth with substantial foreign investment, which is leading to the liberalisation of port policies (Guan & Yahalom 2011). Decentralization and privatization are two of the main features of the port reform process in China (Morris et al. 2002). Currently, Chinese ports belong to various levels of Government and private entities, including foreign investors (Cullinane & Wang 2006).</p>

¹⁴¹ Private Sector Infrastructure Guidelines, created in 2004 to facilitate projects in line with a PPP concept.

¹⁴² SOT is the acronym for Supply-Operate-Transfer. In this model, the port infrastructure already exists and the private operator supplies the superstructure, i.e. the equipment.

¹⁴³ World Trade Organization, established in 1995 and with its headquarters in Geneva.

¹⁴⁴ The Law of Ports of the People's Republic of China, approved in the third meeting of the Permanent Committee of the National People's Assembly, 28 June 2003, implemented 1 January 2004.

China	
PPP framework	<p>In terms of Chinese port infrastructure construction, it is difficult for the Government to raise funds due to the large shortfall in financing (Shen et al. 2006) and, as such, there is great market potential for financing via PPPs.</p> <p>The spread of risk between the Government, private operators and end users means that PPPs are suitable for these types of projects that involve large quantities of funds and that require a long investment period (Zhu et al. 2012). A number of studies have already been carried out that analyse the implementation of container terminals in China based on the PPP model (Bing et al. 2005).</p> <p>Moreover, establishing the length of the concession and the stipulated period in the agreement between the Government and the company have been shown to be the main variables (Liu et al. 2015).</p> <p>Private capital comes up against a multitude of restrictions at various levels: in terms of the tax structure, financial aid, legislation (private investment in Chinese ports is not prohibited but foreign companies cannot freely set their tariffs), etc. (Liu et al. 2015).</p> <p>The cooperation and the trust between the public and private players are also fundamental for the correct functioning of these types of projects, although the Government maintains its usual competencies in terms of supervision, which certainly reduces the financial risk by guaranteeing the efficient use of funds and the corresponding payment of acquired debts (Liu et al. 2015).</p> <p>The Chinese system, therefore, is one that allows foreign private investment and, indeed, encourages it. However, there are still a number of uncertainties, making it a country that is attractive for investment but, at the same time, somewhat risky.</p>

Source: Own analysis

Table 38. Relevant data for India

India	
Situation & background	India is the second most populous country in the world (Central Intelligence Agency 2013). It is a federal republic with a parliamentary democratic system. It became a British colony in the mid-19 th century but gained independence in 1947 ¹⁴⁵ .
Port system	<p>According to the 2010 Ports Act¹⁴⁶, the Ministry of Shipping retains power of decision regarding port policy. It also runs the main ports (Jawahartal Nehru Port and Chennai). A number of these ports are managed by IPA¹⁴⁷, while some of the smaller ports are managed by the relevant departments or ministries of the nine coastal States.</p> <p>The most important port is Jawahartal, which is owned and operated by JNPT¹⁴⁸. It only has one second terminal, the NSICT¹⁴⁹, which has been conceded to DP World Mumbai (Shashikumar 1998). India suffers from serious port congestion (De Monie 1995) and, as such, needs to attract foreign investment to improve efficiency</p>

¹⁴⁵ On 15 August 1947, the Union of India was established. On 26 November 1949, the Constitution was approved and India became a Federal Republic. It is a member of the Commonwealth.

¹⁴⁶ Ports Act (consolidated), 2010.

¹⁴⁷ Indian Ports Association, which manages the ports of Mumbai, Kolkata, Kandla and Paradip.

¹⁴⁸ Jawahartal Nehru Port Trust, created in May 26, 1989, is an autonomous corporation wholly owned by the Government of India.

¹⁴⁹ Nhava Sheva International Container Terminal, Pvt Ltd. A 30-year concession awarded in 1997.

India	
	<p>(Cullinane et al. 2004).</p> <p>In order to avoid the monopolisation of ports by foreign operators, the Indian Government has drafted regulation to such effect¹⁵⁰. It has also created a series of guidelines¹⁵¹ that establish the limits of tariffs (article 42), which must be reviewed every 5 years so that they can be adapted to the current circumstances and to inflation.</p> <p>They also fix the maximum revenue percentage for each type of service (annex I, articles 1 to 3) and the daily cargo limits with the aim of preventing the system becoming saturated.</p> <p>The Indian port model is, therefore, a highly regulated and restrictive environment that, whilst allowing foreign investment, experiences frequent problems as a result of the poor management of the contracts (Mahalingam et al. 2011).</p>
PPP framework	<p>In terms of PPPs, the Indian Government created a specific authority¹⁵² for their development. Furthermore, CCI¹⁵³, which depends on this organism, is responsible for specifically managing infrastructure projects developed through PPPs (World Bank 2015a).</p> <p>Nevertheless, despite the fact that there are agencies responsible for the development of PPPs, the failure rate is high and projects require more thorough monitoring throughout their whole lifetime than currently occurs (Mahalingam et al. 2011).</p>

Source: Own analysis

Table 39. Relevant data for Indonesia

Indonesia	
Situation & background	<p>The Republic of Indonesia is an island nation located in southeast Asia whose governing system is based on a presidential republic. It is a member of the G20¹⁵⁴ and its economy is based on the services sector.</p> <p>In the World Competitiveness Index, in 2010 Indonesia was in 44th place, having climbed 10 places from the previous year (Schwab & Sala-i-martin 2010). By 2014, it had climbed to 34, gaining 4 places with respect to the year before and climbing close to 20 places in the space of 5 years (Schwab & Sala-i-martin 2014).</p> <p>Indonesia is therefore a competitive growing country, especially in the maritime transport sector. Evidence of this lays in the fact that it was invited to participate in the World Competitiveness Index in 2012, when it was presided by Japan (International Transport Forum 2012).</p>
Port system	<p>Indonesia's main ports, Tanjung Priok and Tanjung Perak, are among Asia's most important (Low 2010), not only in terms of containers but also for their volume of bulk solids. As such, Indonesia is considered one of the most important emerging</p>

¹⁵⁰ Ministry of Shipping, PD-24018/8/2009 – PD.III, Delhi, 2 August 2010.

¹⁵¹ PR-14019/25/2007-PG, February 12, 2008 "Guidelines for upfront tariff setting for PPP Projects at Major Port Trusts, 2008".

¹⁵² Public Private Partnerships in India, developed by the Department of Economic Affairs of the Finance Ministry.

¹⁵³ Cabinet Committee on Infrastructure.

¹⁵⁴ Group of 19 industrialised countries plus the European Community. Indonesia has been a member since the creation of the G20 in 1999.

Indonesia	
	<p>countries in the handling of this type of cargo (UNCTAD 2013). Indonesia's ports are managed by the four State Corporations, the ICTs¹⁵⁵, which own, maintain and operate them.</p> <p>In terms of maritime transport, Law 17/2008¹⁵⁶ has amplified the possibilities of competences among ports through the elimination of monopolies among the four Indonesian port corporations (Eswaran 2008).</p> <p>Moreover, Government programme MP3EI¹⁵⁷, promoted by Bappenas¹⁵⁸, includes maritime infrastructure projects, such as the development of the international port of Maloy, in East Kalimantan; the expansion of the port of Tanjung Priok, in Jakarta; and Tanjung Sauh terminal, on the island of Riau (Bappenas 2013).</p>
PPP framework	<p>The World Bank, through funding from the IIFF Project¹⁵⁹ and a great deal of effort (World Bank 2015a), attempted to create the appropriate conditions to enable the arrival of private foreign investment in infrastructure projects.</p> <p>In 2012, the World Bank once again financed the IIGF Project¹⁶⁰ as a one-stop-shop system to assess PPP applications requiring Government guarantees.</p> <p>There are currently no laws in Indonesia that regulate PPPs. In fact, despite the efforts to modify the legislative framework of PPPs (Oxford Business Group 2012), there is only one decree¹⁶¹, which is the next level down from a law. This creates difficulties in attracting capital, since governmental regulations are inconsistent with the decree on PPPs (World Bank 2015a).</p> <p>Similarly, the new decree on PPPs¹⁶², which establishes a clearer framework for accepting PPP proposals, is awaiting approval.</p>

Source: Own analysis

Table 40. Relevant data for Malaysia

Malaysia	
Situation & background	<p>Malaysia is a southeast Asian country whose political system is based on an elective constitutional monarchy. Its parliamentary system is based on that of Westminster¹⁶³, a legacy of British colonial rule.</p> <p>Its economy is based on agriculture and mining and in recent years has become increasingly linked to commercial exchange and the maritime sector (Central Intelligence Agency 2013).</p>

¹⁵⁵ Indonesian Port Corporations numbered 1 to 4, depending on the regional coverage.

¹⁵⁶ Law of the Republic of Indonesia No. 17/2008 on Shipping, 7 May 2008.

¹⁵⁷ Master plan for the acceleration and expansion of Indonesia's economic development 2011-2025. Ministry For Economic Affairs, Republic of Indonesia.

¹⁵⁸ National Development Planning Agency.

¹⁵⁹ Infrastructure Finance Facility Project (P092218), financed by the World Bank in 2009, is a non-bank private entity.

¹⁶⁰ Indonesia Infrastructure Guarantee Fund (P118916), financed by the World Bank in 2012, is wholly owned by the Indonesian government institution.

¹⁶¹ Perpres (Peraturan President) 67/2005, amended by Perpres 13/2010, concerning cooperation between the Government and business entities in the provision of infrastructure.

¹⁶² Perpres 38/2015, "Cooperation Between Government and Business Entities in Infrastructure Provision".

¹⁶³ A two-party system that designates the Head of the Opposition as the president of the Shadow Cabinet, whose members act as the opposition to each Ministry.

Malaysia	
Port system	<p>In Malaysia, the Port Authorities Act of 1963¹⁶⁴ fixes the powers of port authorities and stipulates that each port be managed and operated by a separate public port authority, which can acquire land (article 486) and concede spaces to private operators. Port authorities initially depended on the Ministry of Transport.</p> <p>At the beginning of the 1990s, port regulations were reduced in certain Asian countries, including Malaysia (Trujillo & Nombela 1999), (Chiu 2010). In this context, PPA 1990¹⁶⁵, which provides for the privatisation of ports and which establishes the legal framework for the participation of the public sector in port investments, was enacted.</p> <p>Malaysia thus became the regional leader in terms of port privatisations (Eswaran 2008), examples of which include Port Klang and Penang Port. The former includes KCT¹⁶⁶ and Klang Port container terminal, which is relatively inefficient (Tongzon & Heng 2005). These days, both installations are conceded to private operators (Verougstraete et al. 2015).</p>
PPP framework	<p>Malaysia's most important ports are Port Kelang and Tanjung Pelepas. The latter involves the implementation of an important BOT-format PPP project (Notteboom 2007).</p> <p>Port tariffs are regulated by the Port Authorities Act and each PA establishes their limits by taking into account the costs of service provisions and installation maintenance and an agreed percentage of return on the investments made.</p> <p>In addition to the tariff control, a regulating function of the PA also includes guaranteeing adequate access to the port infrastructure. In order to achieve this, the Malaysian Government has invested in the improvement of the ports' land connections.</p> <p>All forecasts predict that in the near future the Port Kelang installations will reach the limits of its capacities, in which case a new port will be necessary in which the collaboration of the private sector will be paramount (Verougstraete et al. 2015).</p>

Source: Own analysis

Table 41. Relevant data for Thailand

Thailand	
Situation & background	<p>The Kingdom of Thailand is the southeast Asian country formerly known as Siam. It is a constitutional monarchy and its economy is based mainly on agriculture, farming and tourism.</p> <p>The short-term outlook for Thailand is not promising. The political situation is unstable, the economy is experiencing a downturn due to the weakening of private demand and plans for public investment have been delayed (International Monetary Fund 2014).</p>

¹⁶⁴ Act 488, Port Authorities Act of 1963, incorporating amendments up to 1 January 2006. LN 154/1963 "Act to provide for the establishment of port authorities, for the functions of such authorities and for matters connected therewith".

¹⁶⁵ Act 422, Ports Privatization Act 1990, P.U. (B) 198/1990 1 April 1990 "Act to facilitate privatization of the port undertakings of any port authority and for matters connected therewith".

¹⁶⁶ Klang Container Terminal, initially a public enterprise that later sold 51% by auction to Konnas Terminal Klang, KTK, the remaining 49% remaining in the hands of the Port Authority.

Thailand	
Port system	<p>The Thai port authority is an independent state company¹⁶⁷ that regulates and manages Thailand's two most important ports (Laem Chabang and Bangkok). It lies in second place behind Malaysia in the application of port privatisation policies in East Asia (Eswaran 2008).</p> <p>The private initiative in the development of Thai ports achieved its first success in 1988, when CTIC¹⁶⁸ was awarded the concession to operate the ports of Songkhla and Phuket, a project implemented under the protection of a loan from ADB¹⁶⁹.</p>
PPP framework	<p>In terms of PPPs, until 2013 the responsibilities for these types of societies were divided among various ministries and agencies. However, with the coming into force of PISU¹⁷⁰, the task was brought under the control of a single entity with the creation of SEPO¹⁷¹ as the central body for the coordination of PPPs.</p> <p>The PISU Act was not created specifically for the port sector but it does cover it (Eswaran 2008) and allows for the adjudication of contracts either through a bidding process or direct negotiation. It is not a law of privatization as such, but it does open the way to new ventures.</p>

Source: Own analysis

Far East Asia dynamics are built under the certain influence of the Chinese giant. Its ports capture the top positions in the world's ranking and the surrounding countries invariably get the benefits of it. Likewise, China has implemented a programme of reforms in the port sector and it has become a great potential market for PPPs, but, though foreign investments are encouraged, actually a multitude of restrictions and uncertainties arises there in practice.

The other big power in the region, India, has a highly regulated and restrictive port model, which, added to its collapsed infrastructures, provokes a high index of failures for the PPPs installed there.

The same happens in Bangladesh that, despite the attempts to attract private investment in the transport sector by the creation of infrastructures committees and specific institutions, the foreign investment in PPPs is not being secured. Indonesia not even has a proper law to regulate them, but a renewed decree about the subject is expected to be approved soon.

Nevertheless, at the beginning of the 1990s port regulations were reduced in certain Asian countries, what makes Malaysia become the regional leader in terms of port privatisations, with Thailand closed up behind him.

9. STUDY OF ATTRIBUTES PER COUNTRY

Methodologically, we have organized the review of the 21 countries under analysis in standardized tables which include, case by case, relevant the information regarding the national context and background, its port system and main maritime infrastructures and the legal and technical environment where PPP projects have to be developed, in order to facilitate the understanding of the great amount of data collected. Having completed this necessary revision, our attention now turns to the analysis of how the results obtained should be presented with the aim of determining which countries are closest to the proposed business model in their treatment of the three attributes under study.

¹⁶⁷ According to Port Authority of Thailand Act, B.E. 2494 (1951), amended by the Act B.E.2543 (2000).

¹⁶⁸ Chaophaya Terminal International Company Limited.

¹⁶⁹ Asian Development Bank, created in 1966. Headquarters in Mandaluyong City.

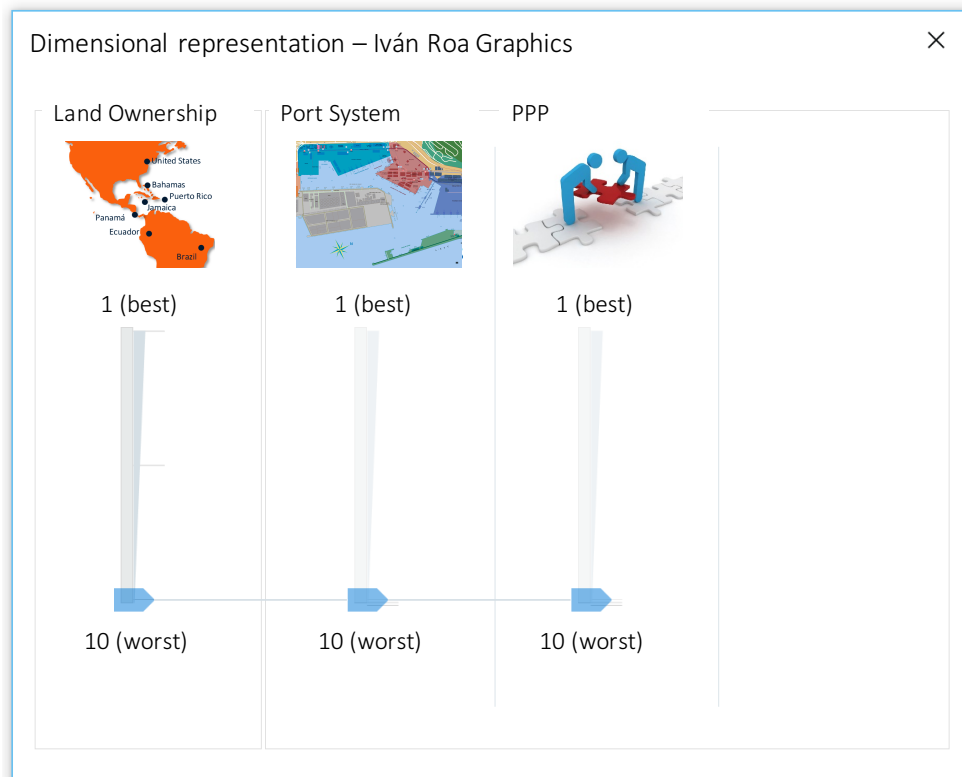
¹⁷⁰ Private Investment in State Undertakings Act (PISU Act) of 2013.

¹⁷¹ State Enterprise Policy Office (SEPO) under the Ministry of Finance.

In order to achieve this, a three dimensional graph was created in which each country is represented as a function of their coordinates X, Y and Z. Each coordinate represents one of the attributes analysed here (land ownership, port system and PPP) and the numerical values awarded to each are determined as a function of each countries' treatment of the attributes.

To simplify the grading of each attribute, the dialogue box shown in Figure 12 was created. This is an equalizer that enables each attribute to be graded from 1 (closest to what would be desirable for the model and, therefore, the best) to 10 (the worst).

Figure 12. Equalizer used to assess each country.

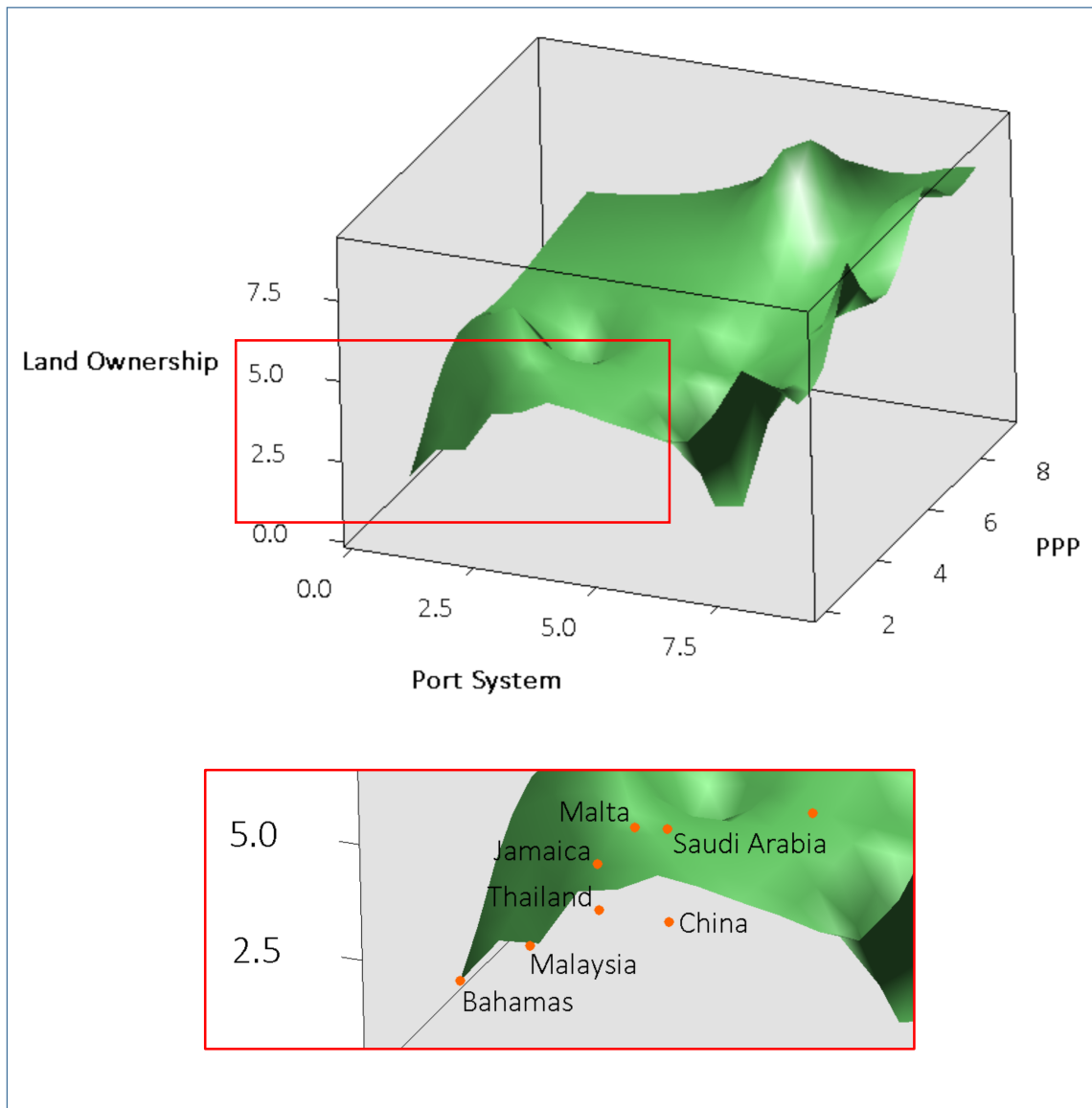


Source: Author

Using this equalizer, each countries' attribute is graded, resulting in a cloud of points that make up the three-dimensional diagram shown in Figure 13, which was created using the software program Minitab 15¹⁷² in which the distance method (distance power = 2 units) was employed, with the X and Y values standardised.

¹⁷² Minitab® 15.1.30.0. (purchased for academic use only)

Figure 13. Dimensional representation based on the value of the attributes of each country



Source: Author

Figure 13 also shows a close-up of the area representing all the countries whose grades are nearer to 1,1,1 –the desired vector– in at least one of the three attributes and to which, therefore, the proposed private business model would be best fit. These countries are, in increasing order: Bahamas, Malaysia, Thailand, Jamaica, Malta, China and Saudi Arabia. Using this classification as a starting point, more filters can be applied, such as country risk, which will be defined from the indicators used by the OECD for officially supported export credits. According to this filter, with the exception of Jamaica, all the countries have adequate country risk values: Bahamas (3), Malaysia (2), Thailand (3), Jamaica (7), Malta (N/A), China (2) and Saudi Arabia (2) (OECD 2016).

Malta is not reviewed or classified by the OECD since it is considered a member of the Eurozone. Therefore, according to the criteria defined here (adaptation to the established attributes, namely: land ownership, port system and PPP; and lower country risk), the countries of different geographical areas that would best fit the proposed private port business model are the Bahamas, Malaysia, Thailand, Malta, China and Saudi Arabia.

10. CONCLUSIONS

In this chapter, we have confirmed that port and PPP application policies vary widely. Three attributes have been analysed for each country and it is evident that the treatment of each differs among the various nations.

The aim of this chapter was to determine in which of the countries located along the main global maritime trade routes it would be possible to implement a business model based on a private developer that purchases land (or at least applies for a concession) on the shorefront and concedes it to private operators to run port terminals.

For the model to function, firstly, the country must allow land located on the shorefront to be able to be purchased or, if not, have legislation in place that is not completely restrictive in this regard. Secondly, port management should not be based on a central regulatory body. Rather, each port should be allowed to implement its own strategies, with the best possible scenario being that in which the port authority is a private entity. Finally, the application of PPP policies is decisive, with the best possible scenario being that in which the country allows foreign investment and fosters the creation of PPPs.

Having analysed all the countries and their attributes, the countries that could best fit with the proposed business model were determined. These were: the Bahamas, Malaysia, Thailand, Malta, China and Saudi Arabia. None of these countries fits perfectly with the model simply because this model, whose viability is being analysed in this present investigation, does not currently exist. Nevertheless, by studying these countries, we have been able to reach an interesting conclusion: while the model may not be feasible in a range of countries, it could be applicable to a not inconsiderable number of other countries since its formulation does not differ notably from their policies. Having completed this analysis, the next step would be to set out the requirements of the business model to each country and to negotiate its potential implementation, knowing that of all the countries analysed, those listed above are those most capable of accepting it. Moreover, it should not be forgotten that the determining factors in most countries are legal rather than operative. Therefore, in this regard, a study of the applicable international legislation should be carried out followed by a detailed analysis of each country in order to establish the most important parameters to consider in each case, given the universal character of the proposed model. This task intends to be facilitated by the two check-lists (State-promoter and promoter-concessionaire) raised in chapter 6.

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6

International legislation and relations between the state, developer and concessionaire

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1. AIMS

Having studied the heterogeneity of port authority organisational systems in chapter 4 and port systems at the international level in chapter 5, it is now important to determine whether there are any international regulations that affect the definition of the business model presented in this thesis.

In this area of international commerce, each country applies its own laws and regulations and, as a consequence, the implementation of a private initiative port must comply with each state's particular rules.

The study of developer-concessionaire rates requires certain precepts to be fulfilled that affect both the relationships between the developer and the concessionaire and the developer and the state in which the port is to be built. In the absence of international regulations and attempting to develop a model that is as globally applicable as possible, the main objective of this chapter is to draw up requirement lists for the two (State-developer and developer-concessionaire) with the aim of serving as a reference for a private developer of a multi-activity port in defining the legal determinants for the application of their business model.

2. CHAPTER ORGANIZATION

This chapter is headed by the introduction and the methods, the latter being different in section 5 compared to sections 6 and 7, which have required a specific procedure to obtain the data necessary for drawing up the requirement lists.

After outlining the methods, section 5 describes the two main types of contracts that give the leaseholder or concessionaire the freedom to operate on the port territory: the full concession and the leasehold. It also defines which of the types of contracts will be used to generate the developer-concessionaire relations that will enable us to study further on in the chapter the rates that generate the economic flow between them.

Next, section 6 describes aspects affected by the developer buying the land on which the port is to be situated, as defined in the business model. Section 7 presents a list of considerations to be taken into account when characterising State-developer and developer-concessionaire contracts. And finally, the last section presents the conclusions.

3. INTRODUCTION

The main feature of the scenario in which port PPPs are put into practice is that there is no international agreement that frames it and, therefore, none that specifically frames the concessions scenario. The relationships between the port authorities and the companies awarded concessions to their lands are individually governed by each country's legislation in terms of the fostering of private investment in infrastructures in certain cases or by legislation specific to the port sector in other cases; no internationally applicable standardised rule with regard to this issue exists other than *Lex Mercatoria*, otherwise known as *Third Legal Order*. This instrument of private international law includes universal rules drawn up by the business sector without state intervention with the aim of overcoming the lack of legal concordance between nations (Ruiz Castellanos, 2016). The most widely accepted idea is that it comprises uses, customs and practices used in international commerce (Silva, 2006) and that it is based on the self-regulation of the market. It is not necessary, therefore, to establish specific rules for particular situations, since it is the market itself which guides its functioning (Gonzalez García, 2009).

Its origin lies in the belief that a national legal system may not be sensitive to the expectations of a foreign company and international law may not be adequate for dealing with international commercial transactions (Shing, 2007). It is a law that cannot be applied to international

contracts if no specific mention of it is made by the parties (Chang, 2015) and its existence is justified by the mobility of commercial relationships and the need for it to adapt quickly to the changes brought about by this mobility.

In the absence of international regulation, the developer-private operator contracts are governed by the rules of the administrative law of each country. The type of contract will vary according to the characteristics of the contracting authority: a public administration, an entity decentralised from the State, a public company, a private entity (as in this case), etc. This occurs both in public contracting¹⁷³ and in contracting established by the sector's own legislation (which regulates not only specific markets but also often the manner of contracting) and by relevant commercial and fiscal legislation (Rebollo, 2009a).

Beyond the applicable legal framework, in programmes of privately-financed infrastructure investment it is important to consider the experiences gained in other countries and to assess the types of contract adopted in them (Leon, 2008). In this way, these practices can be used as a model.

4. METHODOLOGY

As mentioned above, the methods used to obtain information have followed two different lines.

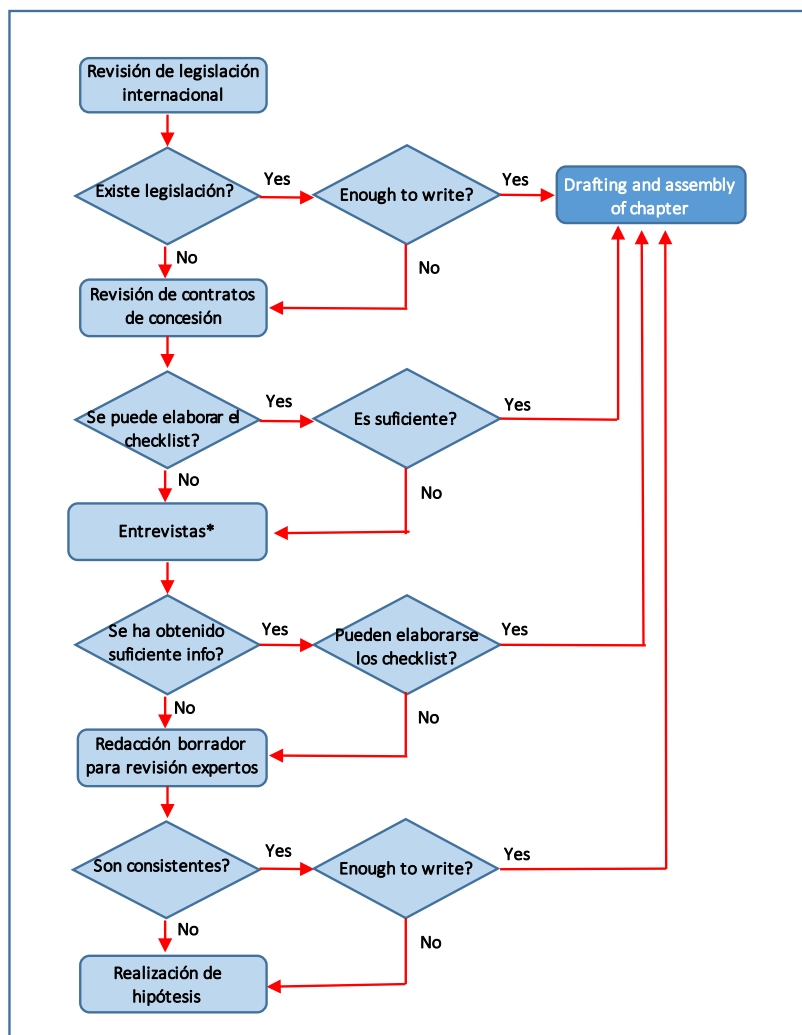
The first, aimed at comparing the legal nature of concession contracts, involved a literature search of online archives of the most reputable multilateral institutions, mainly the World Bank, the Inter-American Development Bank, etc. The aim of this was to find the most general and least biased description that would allow the characterisation of international legislation and state, developer, concessionaire relationships from a neutral point of view. A phase-structured investigation was not necessary since it is relatively straightforward to get information on this subject from these entities' publications.

In contrast, for the purchase of land by the developer and the considerations regarding the contracts to be signed by the parties, it was necessary to structure the investigation into phases due to the crosscutting nature of the subject matter.

Figure 14 shows a flow chart of the activities carried out. From the data obtained over the four stages, we have formulated a hypothesis on the specific business model that could be implemented.

¹⁷³ In Spain, public contracting is regulated by the Law of Public Sector Contracts, (LPSC; Royal Legislative Decree 3/2011, of November 14, approving the rewritten text of the LPSC).

Figure 14. Structure of the methods followed



Source: Author

The method followed to obtain information entailed interviewing, the format of which is defined in chapter 2, members of the Barcelona Port Authority¹⁷⁴, and nine port terminal concessionaires¹⁷⁵.

Finally, the information obtained was checked by a group of lawyers specialised in international law and maritime transport¹⁷⁶. In this way, following the Delphi method¹⁷⁷, the initial versions of

¹⁷⁴ Including Jordi Vila, environmental director (jordi.vila@portdebarcelona.cat), Ramon Rull, head of quality brand development (ramón.rull@portdebarcelona.cat), Josep Otero, director of concessions (josep.otero@portdebarcelona.cat), Jordi Torrent, director of strategy (jordi.torrent@portdebarcelona.cat), and Manuel Galán, director of port community development (manuel.galan@portdebarcelona.cat)

¹⁷⁵ Including Eduard Durán, director general of Portcemen (eduran@portcemen.com), Javier Vidal, director general of the BEST terminal (javier.vidal@tercat.es) and Xavier Vázquez, director general of Autoterminal (xvazquez@autoterminal.es), all three from the Port of Barcelona.

¹⁷⁶ This panel included Eleuterio Acosta (eleuterio.acosta@gmail.com), Alfons Esteve (aesteve@lawyer.com), Rosa Romero Serrano (rosa.romero.serrano@gmail.com), Norma Vela Massons (norvela@icab.cat), Carmen Parra (cparra@uao.es), Miquel Roca (mroca@bdlezo.com) and José Antonio Pejovés

¹⁷⁷ The Delphi method is an information validation procedure that consists of sending a questionnaire to a group of experts, preparing a summary of their answers and sending this back to the group for their

the previously mentioned documents were complemented by the opinions of each expert, thereby generating new additional documents, which were pooled in order to be validated, and, at the same time, generating new ideas. Despite the fact that some of the experts knew each other, their participation in the process was totally anonymous in order to prevent interferences in the method. Finally, after three iterations, the analysis of the documents was concluded and subsequently written up.

5. LEGAL NATURE OF CONCESSION CONTRACTS

The first important legal discussion a developer or concessionaire may encounter in the characterisation of their business model lies in the nature of the concession contract on offer. In this regard, there are two important business models.

The first and most widespread is the full concession, in which the developer (normally public) is the landlord and allows a private entity to invest in specific installations for their activity in the port. The concessionaire conducts its business under established parameters, attempts to make a profit through its investments and pays rates.

At the end of the concession period, the installations in which the concessionaire has invested revert to the developer.

The second is an Anglo-Saxon model termed leasehold. In this model, the land belongs to the developer or landlord and the private entity purchases a series of installations built in the port, exploits them and makes a profit.

It may also build them, but the model charges ground rent. This rent gives the concessionaire the right to be installed in the port for a pre-established period. At the end of the contract period, the concessionaire must vacate it or pay the landlord for the rights to extend the contract, which would allow the former to pay ground rent monthly (World Bank, 2007b).

There are significant differences between the legal nature of both models, which translates into different business models. These differences are detailed in Table 42.

Table 42. Concession and leasehold contracts in a Landlord port

Characteristics	Concession	Leasehold
Period	25-35 years	10-25 years
Governmental guarantees (loans, rates, exchange rates and competition conditions)	Yes	No
Obligation to bear civil responsibility of the port	Often, but depends on the case	No
Shares in the port as a guarantee of safety	Yes	Possibly, depending on the legislation
Output supervision by the PA	Yes	According to the contract
Traffic guaranteed by the concessionaire or leaseholder	Yes, according to the contract	Normally, no
Private investment in port superstructure	Yes	Normally, no
Private investment in port superstructure and	Yes	Yes

approval. This process is usually carried out at least twice. In this case, the process was conducted three times (initial version + two reviews) with a panel of seven experts.

Characteristics	Concession	Leasehold
equipment		
Tariff control by Government or PA	Depends on the situation	No
Management of the terminal	The concessionaire or an operator of their choice	The leaseholder
Payments	Fixed and variable	Fixed one-off payment or a share of the profits
Legal character of private party	Joint venture, often including a shipping company	In general, limited companies ¹⁷⁸
Environmental responsibility	Yes	Depends on the legislation
Obligatory business plan	Yes	According to the contract
Restitution of the rights of use at the end of the contract period	Yes	Yes
Compensation for investment in infrastructures	According to the contract	Transferred to the new leaseholder or are terminated

Source: Author, based on information from the Port Reform Toolkit (World Bank, 2007b).

As can be seen, there are considerable differences in aspects such as the period in which the land can be used, the traffic the private operator should guarantee the developer, etc. For the definition of developer-concessionaire relations that will enable us to study the rates that generate the economic flows between them, we will assume that the developer-concessionaire contract is a concession, which is the most widely used, and not a leasehold contract.

Moreover, we will assume that the developer buys the land from the state and becomes the landlord, also acquiring the capacity to concession land to private operators. In this way, government intervention in certain aspects such as tariff control is avoided, although others are maintained, such as urban legislation, which allows building to take place under certain parameters, and the environment, which requires the business model to be implemented according to certain sustainability-related policies.

6. IMPLICATIONS OF THE PURCHASE OF LAND BY THE DEVELOPER

Given that it is a particular consideration established in the present, Table 43 details the implications for the business model that the developer purchases the land with regard to the application of regulations, laws and government controls.

Table 43. Implications of the purchase of land by the developer

Area of application	Description
Control by the state of port output or tariffs	The port does not belong to the national port system and, therefore, is autonomous in its decision-making processes and in establishing tariffs. However, it needs to have a degree of voting power and consideration within global port politics.
Port Authority organizational structure	The Port Authority will enjoy the freedom to determine its organizational structure and government organs.

¹⁷⁸ The term “limited company” usually refers to trading entities with their own legal status and independent assets in which the partners hold no personal responsibility for corporate debts.

Area of application	Description
Hinterland	A port's hinterland should not be violated by the construction of another port by the state or another private operator. The port's hinterland is exclusive.
Economic determinants (regarding the developer exploitation model)	The developer will need to bear the costs of the investments in the purchase of lands but will not have to pay the corresponding annual fee.
Other rates to pay to the state	Even having purchased the land, the developer has to pay a sea use rate since it will have to encroach upon coastal waters to build its breakwaters and use these same waters for the navigation of ships calling at its port facilities.
Determining factors regarding investments in assets	In the business model presented here, asset investments made in the port do not revert to the state at any moment, since the developer has purchased the land. Therefore, it is up to the developer to determine whether it will require concessionaires to return ownership of the asset to the Port Authority at the end of the concession period or not.
Urban regulations	The port will be governed by a special urban development plan that must be approved by the municipal in which it is situated and that will give the Port Authority powers to regulate the concessioning of licences and the application of urban parameters.
Environmental regulations	The port and all its activities will be subject to local, national and international regulations.

Source: Author

As can be seen from Table 43, there are economic and legal determinants. However, perhaps the most relevant are those that dissociate the management of the port from state influence, converting the business model into a wholly private affair.

7. CONSIDERATIONS REGARDING THE CONTRACTS TO BE SIGNED BY THE PARTIES

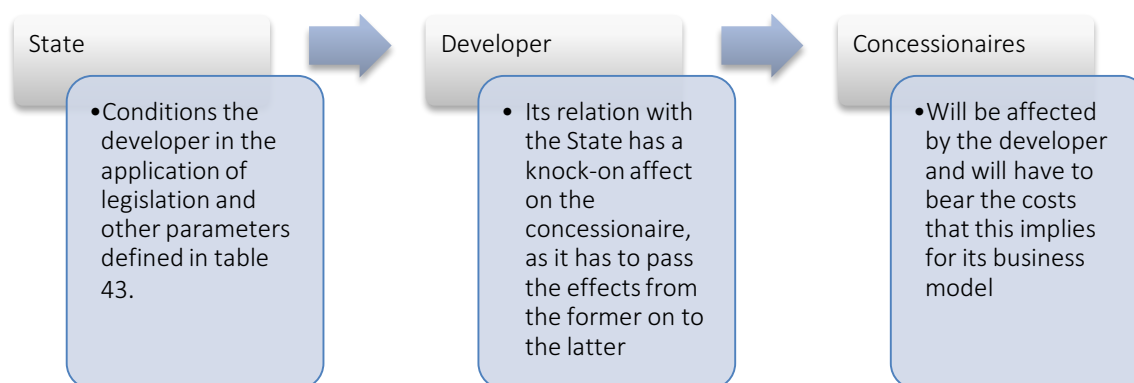
The lack of international legislation complicates the process of standardising the implementation of the private business model in any country.

This is due to the fact that it is complicated to design a single business model that can be implemented in any national setting.

Moreover, the business model presented here, in which the developer purchases the land on which the port will be built, is not conventional and lacks specific examples that exactly match all the characteristics previously defined.

For this, we now present two lists that bring together the most important parameters that should be taken into account in order to implement the proposed business model. The first concerns the developer with respect to the state and the second, the developer with respect to the terminal concessionaires. Figure 15 shows the knock-on relationship.

Figure 15. The knock-on relationship structure



Source: Author

Figure 15 shows the dependence of the developer on the State, even having purchased the land, which, in practice, conditions the relationship it has with concessionaires.

Therefore, it is important to point out that the relationship between the developer and concessionaires is, in principle, closed and does not depend on which state the project is implemented, except for special cases determined by the relationship between the developer and state, which is more open and depends on the variables of each particular case. Therefore, the list of the project's state-developer requirements may be considered adaptable to each particular case, while the list for concessionaires is designed to be the most universal possible.

7.1. Particular state-developer considerations

Table 44 details the particular considerations that the project developer should take into account on assessing the potential implementation of a business model such as the one described here in which it purchases the land and concessions to private operators. These considerations are unidirectional and only show what the developer should bear in mind in terms of the state in which the port is to be built.

Table 44. List of state-developer requirements

Requirement	Description
Land ownership and nature of developer	Purchasing land does not necessarily confer condition-free ownership. In the example presented here, the land is acquired and rates and rents are not paid. Moreover, ownership is permanent. However, it should be borne in mind that occasionally public infrastructure management companies are created, especially in the transport sector, for the development and execution of investment projects. In practice, they are simply instrumental entities set up <i>ad hoc</i> between the Administration and the contractor and are responsible for the building, financing and occasionally the exploitation and refurbishment of a specific facility, which enables the subsequent participation of the private sector through one contract form or another (Rebollo, 2009a). On other occasions, as described in chapter 5, it is necessary to set up joint ventures, as the country's legislation does not allow access to foreign private capital if it is not accompanied by a local partner.
Investment in infrastructures	In the conventional landlord model, the public sector is the owner of the basic infrastructure (it carries out dredging, builds fairways, constructs landfills, etc.) and is responsible for maintaining it

Requirement	Description
	(Cerbán & Ortí, 2013). In a private service port, or private port, the land is privately owned and therefore so too are the investments in port infrastructure. The developer must, therefore, assess two large volumes of investment: a) the purchase of land and b) the investment in infrastructures and establish whether the economic flows generated by the business are enough to make a profit from the levels of investment.
Quality of the institutional structure	It is important to assess whether the country has experience in initiatives that enable private capital to enter the port sector. This experience usually translates into the creation of contracting and/or regulatory agencies and PPP offices at the ministerial level (EIU - Economist Intelligence Unit, 2014).
Operational maturity	The public capacity to plan and supervise PPPs, methods and criteria for the adjudication of projects, records of the allocation of risks of the regulators, and previous experience should be assessed (EIU - Economist Intelligence Unit, 2014).
Rates	In the forecast exploitation model, a rate for the use of the sea floor has been taken into account. It is vital for the good planning and design of the project to determine whether the state requires certain rates to be paid or whether the purchase of land exempts the developer from any of these.
Possibility of purchasing land on the waterfront	Not all countries allow land on the waterfront to be purchased for commercial purposes. Therefore, it should be established whether it is possible to purchase land or whether hybrid models need to be employed. Similarly, the conditions in which this sale occurs should be assessed, since purchasing land from the state is not the same as seeking permission to do so from private owners and building a port.
Supervision of the PA	Irrespective of who owns the land, in the case of full concessions the Government must guarantee loans, rate, exchange rates and competition conditions. This is not the case for leasehold contracts (World Bank, 2007a).
Tariff control	<p>In concessions, the PA exercises a certain degree of control of the reliability and output of the installation, always through clear regulation and with a degree of flexibility to allow the operator to respond quickly to market needs. This is also often the case for leaseholds, but it depends on what the contract stipulates (World Bank, 2007b).</p> <p>The model proposed here assumes there is no tariff control imposed by the country in which the port is to be built due to the purchase of the land and the dissociation from the national port system. It is, however, necessary to confirm that there will be freedom to fix tariffs and seal competition agreements.</p>
Technical studies	<p>The developer is responsible for carrying out the technical studies necessary to determine whether it is possible to implement the port in the desired location and, if so, to proceed on to the drawing up of the construction projects. Among the most usual technical studies, the following should be considered:</p> <ul style="list-style-type: none"> ▪ Seafloor bathymetry, with the aim of establishing whether the natural seabed is deep enough for the vessels to operate in.

Requirement	Description
	<ul style="list-style-type: none"> ▪ Sea conditions: a study of the waves, tide and coastal transport of sediments will determine the position and type of breakwaters to be built. ▪ Topography of the inland platform. If there is one and the port is located partly on dry land, the position of the platform should be determined in order to assess the volumes of investment, mainly in the movement of soil. If the port is located on land reclaimed from the sea, the bathymetry study will determine the volume of landfill necessary to build the platform. ▪ Geological and geotechnical studies: These are fundamental for determining the characteristics of the material found on the seafloor and for establishing the cost of dredging works. They are also necessary for determining how the foundations of the port constructions should be laid.
Assessment and management of risks	<p>The country risk and political and economic uncertainty need to be taken into account. Similarly, there are religious factors that may be fundamental in certain countries.</p> <p>It is also important to establish a chronology that enables the project to be addressed with enough guarantees and that, in the case of delays or uncertain situations, assures sufficient compensation for the project developer.</p> <p>There is also the possibility that the country changes its legislation to one that favours an investment climate, strengthening stability, the development of a business environment and providing financial aid.¹⁷⁹ It is also important to bear in mind the distribution of risk between the public and private sectors in order to establish a win-win situation (Koppies, 2012).</p>

Source: Author

Table 44 shows how the state maintains a certain level of control over the relationship with the developer despite the fact that the latter, often through a joint venture, purchases the land and takes on the responsibility of investing in its infrastructures. Similarly, it corresponds to the developer to establish the operating practices and to control the output of the installation. Other variables that should not be overlooked include the country risk, the political context of the territory and its experience and operational maturity in the area of port concessions.

7.2. Particular developer-concessionaire considerations

Having clearly determined the precepts established by the state in which the port is to be located, it is possible to describe in detail the particular considerations of the concessionaire model. As has been discussed previously, the developer-concessionaire model involves pre-established relations that are only conditioned when the host state imposes certain demands, such as the reversion of the investments to the state at the end of the concession period. Since the land is purchased, it is unlikely that this will occur. However, there may be other factors that affect the concessionaires' business models but not the developer-concessionaire relations, since it is a requirement of the model that they are established in a certain way. Table 45 shows a list of developer-concessionaire requirements.

¹⁷⁹ As in the case of Bangladesh (World Bank, 2015) or Jamaica (World Bank, 2016).

Table 45. List of developer-concessionaire requirements

Requirement	Description
Guarantees of the project's economic viability	Using a practical example based on the Spanish port system, whose details are set out in chapter 4, a provisional guarantee to a maximum of 3% of the total estimated investment may be sought as proof of the seriousness and maintenance of the proposal presented in the selection process ¹⁸⁰ , which then becomes definitive, at 5%. The demand for guarantees greater than those set out should be duly set out in the contract dossier (Rebollo, 2009a) ¹⁸¹ . In the case of concessions, a business plan must be presented, while for leaseholds, whatever is set out by legislation (World Bank, 2007a). Regardless, a system of guarantees should be established that satisfy both the developer and concessionaire.
Forecast minimum traffic	Regardless of the fact that the state does not demand it (in that it does not have control in the model described here), the developer will demand that a minimum volume of trade takes place with the aim of incentivising activity in the port and avoiding the inclusion of concessionaires that may lower the port's competitiveness.
Nature of the private operator	In the case of concessions, a joint venture may be required. This may consist of the infrastructure developer and an intermediate business with a presence in the region in which the port will be built (Rebollo, 2009a). Regardless, it is subject to the current law of the country. In some countries, such as China, the joint venture must be established with a local partner for its implementation. If the setting up of a joint venture is obligatory, the following should be taken into account (PPPIRC, 2015): <ul style="list-style-type: none"> ▪ The capital and the shares. ▪ The financing. ▪ The corporate governance. ▪ The protection of smaller participants. ▪ The policy of dividends distribution. ▪ The non-competition clause. ▪ The finalisation of the agreement and the arrangements for withdrawal. ▪ Purchase and selling options. ▪ Preemptive rights, carry forward and co-sale. ▪ The resolution of potential deadlocks. ▪ The business plan. ▪ The responsibilities. ▪ The accounting policies. ▪ Intellectual property. ▪ The resolution of disputes. ▪ The applicable resolution. In the case of leaseholds, operators are normally limited companies.
Legal and regulatory	<ul style="list-style-type: none"> ▪ Bidding process schedule: The bidding process is the first step in

¹⁸⁰ With the previously mentioned LPSC, this guarantee is optional.

¹⁸¹ According to article 84 of the LPSC, the guarantees demanded in the contracts signed with the Public Administrations in Spain can either be paid in cash or in public debt bonds, or through an underwriting or through a surety bond contract (Rebollo, 2009a).

Requirement	Description
framework	<p>establishing the developer-concessionaire collaboration. This process should be transparent and provide security for both parties.</p> <ul style="list-style-type: none"> ▪ Length of concession: The length of the concession should be determined. It is usually determined according to the length of the state-developer contract. If the land is purchased, this date is irrelevant and the developer therefore has the freedom to negotiate the concession period. ▪ Regulations and legislation: The concessionaire must give assurances that it can fulfil the regulations and laws applicable to it due to the port belonging to the state in which it is located and, in turn, that it will comply with the particular instructions established by the Port Authority. ▪ Customs and tax requirements: It is important to take into account the different situations and customs regimes that coexist in the installation (duty-free zones, goods for inward processing...) both to guarantee the fulfilment of legality and to facilitate the payment of the corresponding taxes by the operators. ▪ Fulfilment of national tax regime and import/export regulations. ▪ The possible obligation of contracting public workers for the supply of port services: dockers, tugs, crew...
Assessment and management of risks	Analogous to that state-developer list in Table 44.
Investment in infrastructure	The project developer invests in infrastructure. The concessionaire has to pay rates that allow it to bear the volume of investment necessary but does not invest in commonly used infrastructure.
Investment in superstructure ¹⁸²	The concessionaire should invest in the equipment for its activity (superstructure) and moreover must be able to pay the rates established by the project developer that will help the latter pay for the investments made in the infrastructure.
Payment of port rates	<p>The Port Authority defined here is self-financing. Revenues should cover at least the exploitation and financial expenses, tax burdens, asset depreciation and, in general, results that guarantee a positive operating balance. Moreover, it must bear the cost of new investments. The main source of a conventional PA's revenues are the rates on the different uses of its facilities: private occupation of a public port domain; the special use of port installations; special use in conducting commercial, industrial and service activities; general services; and maritime signalling service (Rebollo, 2009b). The rates may be charged upfront in the corresponding amount, with updates, if any, and by the deadlines stipulated in the concession clauses.</p> <p>Regardless, it is important to correctly determine which rates the concessionaire will be charged and how much.</p>
Customs operations	The concessionaires must know and assess the national customs operations process: the procedures, the application times and the possible delays they may entail, the frequency of unforeseen events

¹⁸² Works that serve to support port services, such as a warehouses, administrative buildings, workshops, etc. (RCM Freight, 2016)

Requirement	Description
	(accidents, theft...)
Exclusive rights	The contract may include a specific clause so that the operator and its subsidiaries does not have to compete with other terminals for the particular traffic for which the concession was awarded in established geographical areas and time periods after finalising the agreement. The conditions should be reasonable in comparison the length of the contract (World Bank, 2007b)
Mechanisms for the resolution of disputes	It is important to also anticipate a breach or dissolution of the contract, abandonment of the project by some of the partners, that some of its characteristics might change... and, if so, what procedures should be adopted to settle the differences and which rates and measures will be applied.
Restitution of the rights of use at the end of the contract	The transference may be carried out with or without compensation, depending mainly on the length of the contract and the value of the investment in fixed assets. Regardless, it would not be unusual for the PA to pay the concessionaire or leaseholder their value with depreciation included at the end of the concession period (World Bank, 2007a)
Compensation for the investment in infrastructures	This clause is stipulated in concessions, while in leaseholds either they are transferred to the new leaseholder or are cleared (World Bank, 2007a)
Possibility of purchasing the land	In the case of a private port model, there is a risk that on transferring the ownership of the land, it may be destined for a non-maritime use and even for speculation if the land lies close to cities (World Bank, 2007a). Similarly, it should also be borne in mind that the purchase of the land by the developer implies a decrease in the power of the government to influence the economic development of the port environment and to implement economic policies related to the sector in the long term (Brooks & Cullinane, 2006). The model proposed here does not contemplate <i>a priori</i> the possibility that the concessionaire will purchase the land and adequate systems should be established to avoid this situation.

Source: Author

Table 45 shows that foremost among the fundamental requirements for the concessionaire are the presentation of a provisional guarantee (to be determined according to the case) and a business plan, both of which should guarantee the viability of the project. Joint ventures and a demand by the developer to satisfy the minimum forecast traffic in order to maintain the competitiveness of the port are also common. It is extremely important to know the prevailing legal and regulatory framework and to comply with the rules it establishes, especially in relation to the time, fiscal and operative parameters and the payment to the developer of appropriate rate for the occupation and exploitation (among other activities) of the infrastructure. The responsibility for the superstructure falls to the concessionaire.

8. CONCLUSIONS

The aim of this chapter has been to determine there is any internationally applicable legislation that regulates concession contracts and PPPs. After writing this chapter, we have been able to confirm that there is no international regulation and that we have only been able to find certain

attempts without a formal basis, such as the *Lex Mercatoria*, which has an origin and application similar to that of the *Incoterms Rules*.

In the absence of international legislation and given that this chapter aims to serve as a guide to the legal aspects to be taken into consideration for the implementation of the business model presented here, lists have been drawn up detailing on the one hand a range of aspects that the developer needs to bear in mind on attempting to install its port in a specific country and, on the other, those it should take into account on regulating its relationship with the concessionaire(s) of its port spaces.

The nature of the main types of contracts existing at the international level to regulate the developer-concessionaire relations has also been defined. We have opted for the full concession over the leasehold to regulate the relations between the participants in the business.

We have also confirmed that there are aspects that necessarily affect the relationship between the developer and the concessionaire, such as, for example, the fairly widespread custom in which, at the end of the concession period the concessionaire's assets revert to the developer. To avoid these types of effects, we have determined that the developer should purchase the land and should avoid being subordinate to the decisions of the country in which the port is located, thereby gaining economic, organizational and managerial independence.

This chapter does not aim to provide an in-depth guide. Instead, it aims to show those aspects considered the most important in the way they affect the business model as proposed in this investigation: a private developer that purchases the land on the waterfront with the aim of building a multi-activity port and concessioning spaces to private terminal operators. In the case of an actual application, a comprehensive study should be carried out, taking into consideration the characteristics and limiting factors of the country in which the port is to be located.

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7

Characterization of container terminals

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1. AIM

In this investigation, we study developer-operator rates and the effects of their variation on the business of each participant. With certain adaptations, the model can be applied to any type of terminal, independent of its activity. However, common to all business models is the need to define the amount each participant is to invest in the business, since the rates, in one form or another, depend on the amount invested.

This chapter is fundamental because it defines the demand, or the volume of operator business, in relation to the investment needed to build the terminal that services it. Therefore, we will analyse on the one hand the operator's potential volume of business and, on the other, the investments that both the developer and operator need to make.

2. CHAPTER ORGANIZATION

The organization of this chapter is based on the characterization of the areas of a container terminal, which is done through a description of the various subsystems found in a port. We then discuss how to carry out the demand analysis and formulate the initial hypotheses, determining the annual demand the terminal should serve.

On the basis of this demand, the type of vessel to be used for determining the size of the terminal will be established and the cranes necessary to operate it. A description of the terminal characteristics then follows. First, the basic characteristics are detailed. The number of berths and cranes required per berth are then calculated before establishing the length of the quay and the size of the container storage area.

The size of the vessel manoeuvre area is then calculated with the aim of defining the area of water that needs to be enclosed within the seawalls. The investments for all the terminal components are then characterized based on the project development phases. Finally, the after characterizing the model, the conclusions are drawn.

3. INTRODUCTION

In the last thirty years, the maritime transport industry has undergone significant advances as a result of the constant process of globalisation, including the invention of the sea container and other important changes in the management of cargo (Olivier & Slack 2006). This has meant that some ports have had to be relocated to more peripheral sites in order to comply with the current standards of containership size and type (Asteris & Collins 2007).

The maritime transport industry is on the rise, having rapidly increased over the last few decades. In fact, the market has gone from handling 36 million containers in 1980, to 237 million in 2000 and 545 million in 2010 (Yang et al. 2012). This has meant that the demand for port installations capable of handling the new generation of containerships has increased substantially (Ramos-real & Tovar 2010).

The new needs mean that the design of a terminal is key to its success and that defining its size should be done in accordance with environmental legislation to avoid problems typical of city ports or ports with a strong industrial element (Ying 2011). To cover these and other regulatory aspects in the design of a terminal, international recommendations need to be implemented in the design and exploitation of containers terminals.

The development and operation of a container terminal or port involves the management of a capital-intensive project (Panayides et al. 2015) that should be designed to independently serve transport and logistics companies, since these are the main users of port installations (De Langen 2015), (Monios & Wilmsmeier 2012).

4. METHODOLOGY

In this chapter, the characterization of a container terminal is carried out. The design of a terminal of any type is highly conditioned by the area's maritime conditions. Given that the model presented here is designed to be universal, the following hypotheses have been established as a result of the lack of necessary previous studies:

1. Lacking specific maritime climate studies, normal parameters will be used. Extreme parameters, such as the effect of tides, will not be considered; the transport of coastal sediments will not be considered invasive in the port estuary.
2. Similarly unavailable are a bathymetry of the sea floor, the topography of the continental shelf and a geotechnical analysis of the seabed material. Therefore, we will assume that the seabed, either rock or coral, will need to be dredged to a depth of 5m below the level of the seafloor and that the continental shelf is 1m above sea level at high tide.

Given that terminals also vary greatly in both their sizes and in the characteristics of their components, the *Martiport*¹⁸³ terminal will be used as a model. This terminal has a single-faced quay. Once its two building phases are completed, it will have a depth of 16.5m, a 1,500m long quay, a surface area of 100Ha and a total of 11 container cranes that will allow it to handle 2.65 million TEUs annually.

Using this terminal as a model, we can proceed to the predesign of the container terminal studied here. For this, the following fundamental variables are:

- Demand. This is the most important variable. The demand is the number of containers forecast to arrive at the port during the year. All terminal installations should be adapted to handle an adequate volume of containers. As a result, this variable determines all the others. We will analyse how a quantity of containers equivalent to that handled by *Martiport* at the end of its expansion process (2.65 million TEUs) can be managed.
- Traffic type. The location of the port and the nature of the vessels that dock in it determine the traffic type. Transshipment and import/export ports are not the same and neither are their installations. This definition is not important in this chapter, but it should be taken into account —and, indeed, is in chapter 11—, as the tariffs for TEU movement for transshipment processes differ from those for import/export processes. Within the traffic type variable, we have to consider the proportion of 20ft and 40ft containers that arrive at the port and the proportion of empty and full containers. We do not know the proportion that has been assumed for the design of the *Martiport* terminal. Therefore, in this aspect the design described here will differ from those *Martiport* characteristics. We will assume that 60% of the traffic is composed of 40ft containers with the remaining 40% being made up of 20ft containers. With regard to the ratio between transshipment containers and import/export containers, we will assume that the former make up 75% of the total traffic and the latter, the remaining 25%. We will also assume that full containers comprise 60% of the traffic, while empty containers make up the remaining 40%.

¹⁸³ *Martiport* is a fictitious name that will be used during the development of this work, to refer to a real terminal whose project is running but that, due to the confidentiality of its data, cannot be located or defined exactly.

- Vessel type. In the same way that the geographical location and the nature of the vessels that dock in a port determine the previous point, the type of vessel is also important. While the shipping networks that connect the east coasts of Asia with the west coast of the American continent tend to be sailed by large ships, other ports handle smaller vessels. The calculation carried out here takes into account the largest ships currently in existence, since, as justified later in this chapter, the trend is to use increasingly larger ships. Moreover, the *Martiport* terminal is able to handle these types of vessels.
- Quay capacity. This capacity depends on the occupation rate of the quay itself and the forecast waiting times for the ships. This is one of the fundamental parameters, as small variations in forecast waiting times can yield designs with capacities completely different from those of the *Martiport* terminal. In this case, a ship's maximum waiting time will be taken to be 10% of the time necessary to carry out its operations. Later on in this chapter, we will discuss the occupation rate of the quay.
- Types and quantities of cranes. This variable depends on the hypotheses established for the previous variable. The terminal will be equipped with cranes capable of servicing the largest ships. This conditions not only the size of the cranes but also their operative characteristics, since the number of containers they are able to handle per hour is the most important factor. However, the number of cranes depends on how the traffic is defined and the arrivals distribution and the service distribution, which are explained further on.
- Quay length. This is directly proportional to the size of the largest vessels that can berth at the terminal and to the safety distances between moored ships, which are also proportional to the vessel sizes.
- Terminal storage capacity. All the previous determinants mean that storage areas are needed in the terminal. A certain amount of space and specific installations should be available for handling containers that enter the port regardless of whether they are destined for export, import or transshipment.
- Size of sheltered water. The term *sheltered water* refers to the area of water enclosed within the port and protected by the breakwaters. Its size is also proportional to the size of the largest vessels that can be handled by the terminal. With berthed vessels, a ship should be able to make a complete turn in the sheltered water. As such, the dimensions condition the space necessary within the protected area.

Having defined the variables present in the design of the terminal, the areas and subsystems of the terminal will now be described with the aim of establishing a preliminary operative layout. Once this definition has been completed, we will then carry out the calculations involving the characterised variables and lastly, the designed terminal will be described in order to calculate the amount of investment necessary to build it.

5. TERMINAL AREAS

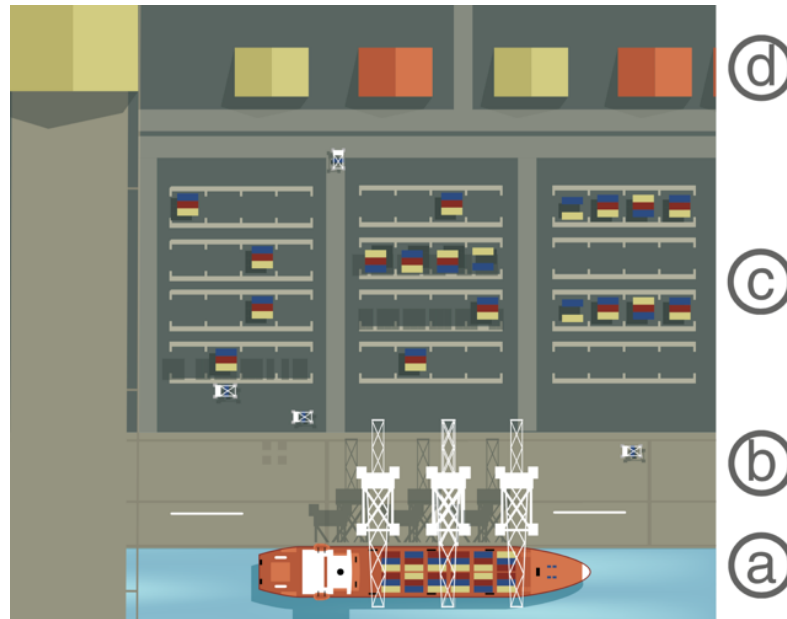
In terms of its administration and running, a container terminal is an independent system within a port (González-Cancelas 2007). Four subsystems can be defined within a terminal (Holguín-Veras, J; Walton 1996):

- The dock subsystem (a), where the berths and container loading and unloading cranes are located.
- Internal transport subsystem (b). This is the part of the terminal responsible for transferring the containers from the dock to the storage depot.

- Storage subsystem (c). These are areas where containers are stored in stacks.
- Delivery and reception subsystem (d). This is the link between the storage depot and the land/rail transport vehicles that bring in or take out containers.

Figure 16 shows a schematic representation of the location of the subsystems.

Figure 16. Terminal subsystems.



Source: Author

5.1. The dock subsystem

This is the most important area, as it receives the largest investment and, moreover, the success of the terminal depends largely on its capacity to handle the demand. The analysis of this area will be carried out in greater detail with the aim of establishing as precisely as possible the types of installations required to serve the terminal's demand. This area also depends on the variables described above. All the other areas are built to a size that avoids restrictions and allows them to be able to serve the docks.

It comprises the vessel itself and the area housing the container loading and unloading cranes. The vessel is considered the "client" of the terminal and is not, therefore, viewed as part of the terminal, even though it is the platform onto and from which the containers are loaded and unloaded.

Some authors are of the opinion that the fundamental activity that determines the terminal's performance —the loading and unloading— is carried out in this subsystem. For this reason, they define part of the docks subsystem as a system in itself and analyse how to cut down the time the vessel spends at the terminal (Camarero & González-Cancelas 2005).

5.2. The internal transport subsystem

The transfer of the containers from the cranes to the storage and management depot and vice versa is carried out by machinery specialised in the transfer of containers. For the terminal designed here, this operation will be carried out by straddle carriers¹⁸⁴.

Each gantry crane will be complemented by 3 straddle carriers. This scenario may generate differences with the *Martiport* terminal, as it depends on the terminal's forecast operation, the

¹⁸⁴ These are cranes on wheels that are capable of transporting a container inside it underneath the driver's cabin parallel with the direction of travel. They handle only one container at a time.

time the cranes spend unloading the containers, the vessel's waiting time in the following subsystem and factors such as the distance from the unloading zone to the container depot. It is, therefore, specific to each terminal. It also depends on the average output of the unloading cranes and the type of traffic the terminal serves, as the output differs depending on whether an entire ship is unloaded or whether containers need to be moved inside a ship in order to only carry out transshipment tasks.

Similarly, terminals normally have reach stackers¹⁸⁵ and in this case, there is usually no parameter to fix the number of reach stackers per gantry crane, since handling is usually carried out by both straddle carriers and reach stackers, which are normally included in the storage subsystem and which require wider lanes as they carry the container at 90° to the direction of travel.

5.3. The storage subsystem

This is the subsystem in which the containers are stacked in rows and columns by lifting and stacking machinery. This subsystem normally includes RTG cranes¹⁸⁶. As for the cranes described above, there is no universal parameter to define the number of RTG cranes needed per loading/unloading crane. In our case, 3 RTG cranes per dock crane will be used.

Straddle carriers are also used in this subsystem, since they are one of the most versatile crane, though not the most practical for moving containers. They are occasionally used to load and unload specific containers from a row or to move empty containers to a distant depot where they can be stacked 4 high, which RTG cranes cannot do.

5.4. The delivery and reception subsystem

This subsystem depends on the design used for its management. The most frequent scenario is one in which loading is carried out by RTG cranes, especially for loading containers onto lorries. For our design, the auxiliary facilities that serve the terminal will be located in this subsystem. These include:

- Access control. This is an installation that controls the entry and exit of vehicles into and out of the terminal. Each lane has a weighbridge and, in the most modern terminals, cameras that record the condition of the container.
- Scanner. With the enforcement of CSI¹⁸⁷, all ports that handle containers for export to the USA are obliged to have scanners for the passive pre-screening of containers.
- Administration building. This building will house those responsible for the terminal's administrative and management tasks.
- Maintenance workshop. This is where maintenance of terminal equipment takes place.
- Auxiliary installations and services. Within a terminal, it is usual to find an area where lorries and containers can be washed, a fuel station for the terminal machinery and

¹⁸⁵ These cranes also have wheels. However, the container is lifted by the crane's arm, which attaches itself to the top of the container. The container is lifted in front of the driver perpendicular to the direction of travel. These cranes handle only one container at a time.

¹⁸⁶ Rubber Tyred Gantry. These are gantry cranes that travel on rails and whose main function is to stack containers within rows. These cranes are wide enough to handle up to 6 containers and 4 containers high.

¹⁸⁷ The Container Security Initiative forms part of the programme implemented by the White House following the 9/11 attacks in 2001. Its purpose is to prevent the transport of terrorist armaments in containers, which are non-intrusively inspected. This programme is included within a larger project termed "Megaports", an initiative enforced in 2003 by the U.S. National Nuclear Security Administration (NNSA), which includes ports from around the world to improve the detection of cargo in the main international maritime ports (Barcelona Port Authority 2012).

even a specific area where containers carrying dangerous goods can be stored physically separate from other containers in accordance with the IMO¹⁸⁸.

Of the 4 subsystems analysed, it is clear that the most important is the dock subsystem. For this reason, we will start with the calculation of the terminal's capacity, establishing what takes place in this system and assuring that its installations are of a size that it can handle the estimated demand.

6. DEMAND ANALYSIS

Demand is one of the fundamental aspects of a business model, not just a port business, but any type. All businesses depend on the volume of sales and the unit price of each sale. A maritime business also depends on the container traffic demand and the shipping cost for each container. This demand is not fixed and depends on the value of the cargo. Businesses are aware of this and adjust the values weekly (Wang, Liu & Bell 2015). Therefore, time can be considered an important variable in demand. The capacity of a terminal to handle the demand for which it was designed will impact on service capacity and use of installations requirements, especially at times of uncertainty (Dong et al. 2015).

Determining demand has for a long time been a challenge for the maritime industry (Dong et al. 2015) and many studies on this subject have been carried out, some of the most recent of which include those by (Wong et al. 2015) and (Xu et al. 2015). Nevertheless, it is a fact that demand is seasonal (Wang et al. 2014) and that the maritime market is uncertain and variable (Zhen 2014).

Therefore, it is important for the success of a terminal to carry out a correct study of demand before designing it. The demand analysis should take into account several variables, the most important of which include:

- An economic, political and legislative analysis of the country in which the terminal is to be built, with the aim of defining the determining factors of that country.
- An analysis of the country's imports and exports. Since, as will be shown in later chapters, the main activities of a container terminal are related to import and export traffic, it is important to determine how these needs are currently being covered, the type of products, whether they can be containerised or not etc.
- An analysis of the range of container traffic supplied in the region: this involves studying the competition and determining the volume of containers handled by each competitor, the shipping lines and carriers that call in at the port, the size of the installations of rival ports, the potential expansion and improvement projects they may be planning and the operators that manage these terminals.
- An analysis of future projects in the same region. Initiatives similar to those proposed in this study should also be analysed. The aim is to avoid designing projects that are implemented at the same time and that could result in a fall in cargo capture.
- Evolution of maritime traffic in the region. Some regions have experienced a greater growth in traffic than others. The region's records should be studied in order to be able to draw conclusions on forecasts of future demand.
- Defining the location of the main container terminal operators not currently located in the region. The installations of the main global terminal operators not operating in the region should be defined in order to determine the potential need for these operators

¹⁸⁸ International Maritime Organization. IMDG1 (International Maritime Dangerous Goods, Vol. 1), Section 49 CFR 172.519 (f). The segregation of containers carrying dangerous goods is also regulated by SOLAS (International Convention for the Safety of the Life at Sea) and the MARPOL convention (International Convention for the Prevention of Pollution from Ships).

to become established in the area and, therefore, be awarded a concession for the terminal.

- Forecasts of economic growth of the country and of the region in which the terminal is to be built.

As previously discussed, the terminal defined here will use the estimated demand for the *Martiport* terminal (2.65 million TEUs per annum). This will yield the boundary conditions that will be modelled in Chapter 11 to validate the model. Tariffs also depend on the region and competition and as such the exact values should be determined through the characterisation of the environment and the demand analysis. In Chapter 11, in which we validate the model, we also establish the tariffs and their evolution over time and how they can be modelled.

7. TYPES OF VESSELS AND GANTRY CRANES

In recent years, the container carrier fleet has grown both in terms of the number of vessels and the size of the ships (Imai et al. 2006). There have been many studies that have addressed this issue over the years, including works by (Lim 1998), (Cullinane & Khanna 1999), (Gilman 1999) and (Ircha 2001) and, more recently, (Dekker et al. 2003), (Xu et al. 2011), (Asteris et al. 2012) and (Tran & Haasis 2015).

There are two direct consequences of this increase in size: on the one hand, the need for larger berthing areas and better designed and optimised terminals (Luberoff & Walder 2000), (Stahlbock & Vob 2008) and, on the other, a reduction in the unit cost of transport of a container when carried by the largest vessels (Liu 2010). Companies are investing in new vessels to cover the growing demand in container traffic (Shintani et al. 2007).

Table 46 shows the sizes of the containerships that have been used on maritime shipping lanes since their inception.

Table 46. Sizes and characteristics of containerships.

Name	Year of manufacture	Length x width x draught ¹⁸⁹	Capacity [TEU]
Early containerships	1956	137 x 17 x 9	500 – 800
Fully cellular	1970	215 x 20 x 10	1200 – 2500
Panamax	1980	250 x 32 x 12.5	3000 – 3400
Panamax Max	1985	290 x 32 x 12.5	3400 – 4500
Post Panamax	1988	285 x 40 x 13	4000 – 5000
Post Panamax Plus	2000	300 x 43 x 14.5	6000 – 8000
New Panamax	2014	366 x 49 x 15.2	12,500
Post New Panamax	2006	397 x 56 x 15.5	15,000
Triple E	2013	400 x 59 x 15.5	18,000

Source: (Gonzalez-Laxe 2007)

As can be seen, the capacity of the ships has increased over the years and with it, their sizes. The container terminal being designed in this study must be able to handle the largest ships currently in operation, since the trend is for increasingly larger vessels. Therefore, it must be of a size capable of handling Triple E ships.

¹⁸⁹ Vertical distance from the ship's keel to the flotation line

Similarly, cranes have also increased in size in proportion with that of containerships, since they are needed to load and unload them. Cranes are measured by the length of their tower and their height; in other words, by its outreach (its reach in terms of the number of containers that fit within the ship's width). Early cranes had a maximum outreach of 10 containers. Later, Panamax cranes had an outreach of up to 13 containers and post-Panamax, 16. Triple E vessels, with a beam of 59m, need STS cranes¹⁹⁰ with an outreach of 23 containers in width with an arm measuring 65m. These cranes are commonly referred to as Super-post-Panamax.

8. TERMINAL DIMENSIONS

A container terminal's type is intricately linked to certain determining factors of the region in which it is located. Beyond its size and operating capacity, which are defined by demand, there are a range of technical factors that condition aspects, such as the position of the port's seawalls, the need to carry out periodic dredging of the approach channel, etc.

As has been discussed previously, the lack of studies on maritime climate, bathymetry of the sea floor and topography conditions the potential implementation of the terminal described here in a real situation. Consequently, the previously defined hypotheses are assumed. A terminal's capacity is defined as the volume of containers it is capable of handling in a unit of time (in this case, years). The importance of this parameter is that it conditions the sub-activity ratio¹⁹¹, a value that determines when the terminal is being used below its capacity (Ministry of Public Works and Transport 2014).

The efficiency of a terminal is measured in the number of TEUs loaded and unloaded per berth per hour (Tongzon 1995). If the terminal handles a quantity of TEUs greater than it is designed to handle, problems with inefficiency begin to arise and costs increase. The end client suffers delays as a result of bottlenecks, while the operator is burdened with excess costs due to the need to take on extra staff or purchase more machinery.

Many studies have addressed how to determine the efficiency of a container terminal, including those by (Turner et al. 2004), (Tongzon & Heng 2005), (Cullinane & Song 2006), (Lin & Tseng 2007), (González & Trujillo 2008), (Liu 2008), (Simoes & Marques 2010a), (Simoes & Marques 2010b) and (Wu & Goh 2010), among others. With the aim of being as efficient as possible in terms handling the demand for which the terminal is designed, we will focus on three fundamental parameters: the time the ship remains in port, the waiting time and the operating time.

The total time a ship remains in a port is a linear function that depends on the number of containers handled (Wang, Liu & Meng 2015). This total time can be broke down into the waiting time and operating time and depends on the queuing theory to establish the relationship between the waiting time and the estimated occupation time of the berth.

We will define regular traffic with an arrival distribution at the port that corresponds to an E2 distribution (UNCTAD 1987). Following UNCTAD¹⁹² recommendations, the service distribution approximates to a grade E2 Erlang distribution¹⁹³, since it depends on two random independent

¹⁹⁰ 100ft high ship-to-shore gantry cranes equipped with a gauge between rails at the base.

¹⁹¹ Sub-activity ratio = TEU per annum/Terminal. If the terminal handles exactly the TEUs per year it is designed to, the ratio is 1. Any smaller value for TEUs handled implies ratios that tend towards zero as the number of containers handles decreases. This parameter is only observable when the terminal is in use. It is not, therefore, a design parameter.

¹⁹² United Nations Conference on Trade and Development, founded in 1964, with headquarters in Geneva.

¹⁹³ Continuous distribution of probability with two parameters, κ and λ , introduced by Agner Krarup Erlang in 1909

variables. In this way, the waiting queue at the quay will follow the formula $E^2/E^2/n$, where n is the number of berths.

The waiting time for a containership in port should lie within 10% to 15% of its operating time (UNCTAD 1987). With the aim of obtaining greater efficiency values, waiting times greater than 10% of the operating time shall not be considered here. Consequently, if in this way a vessel avoids having to wait longer than a specified period in the terminal, the efficiency of our design will increase.

It is important to point out that the total capacity of a terminal depends on the relative capacity of the subsystem with the smallest capacity¹⁹⁴ (Goldratt & Cox 2004). It is vital, therefore, to define the capacity of all the subsystems so that none of them forms a bottleneck that impairs the terminal's total capacity.

Looking back at the section in which we discussed subsystems, the most important is the dock subsystem. We will therefore start with this subsystem in defining the size of our terminal.

8.1. Dock capacity

The dock subsystem must be able to handle 2.65 million TEUs annually, which has been established as the demand for our terminal and which will allow it to be compared with the *Martiport* terminal.

Taking into account that the waiting times will be 10% of the operation time at most, we now look at Table 47 to determine the corresponding utilization factor. To do this, we need to determine the number of berths in the terminal. In a scenario with two berths, we need to look at the third column (headed "2" under the title "Number of berthing points"). We now look in this column for the value 0.10. Since this value is not present, we need to interpolate between 0.09 and 0.12. We then follow this line across to the far left hand column (under the heading "Utilization") to obtain an occupation rate of 47%.

Table 47. Average waiting time of ships in queue, according to $E^2/E^2/n$.

(In units of average service time)

Utilization	Number of berthing points							
	1	2	3	4	5	6	7	8
0.10	.02	0	0	0	0	0	0	0
0.15	.03	.01	0	0	0	0	0	0
0.20	.06	.01	0	0	0	0	0	0
0.25	.09	.02	.01	0	0	0	0	0
0.30	.13	.02	.01	0	0	0	0	0
0.35	.17	.03	.02	.01	0	0	0	0
0.40	.24	.06	.02	.01	0	0	0	0
0.45	.30	.09	.04	.02	.01	.01	0	0
0.50	.39	.12	.05	.03	.01	.01	.01	0
0.55	.49	.16	.07	.04	.02	.02	.02	.01
0.60	.63	.22	.11	.06	.04	.03	.02	.01
0.65	.80	.30	.16	.09	.06	.05	.03	.02
0.70	1.04	.41	.23	.14	.10	.07	.05	.04
0.75	1.38	.58	.32	.21	.14	.11	.08	.07
0.80	1.87	.83	.46	.33	.23	.19	.14	.12
0.85	2.80	1.30	.75	.55	.39	.34	.26	.22
0.90	4.36	2.00	1.20	.92	.65	.57	.44	.40

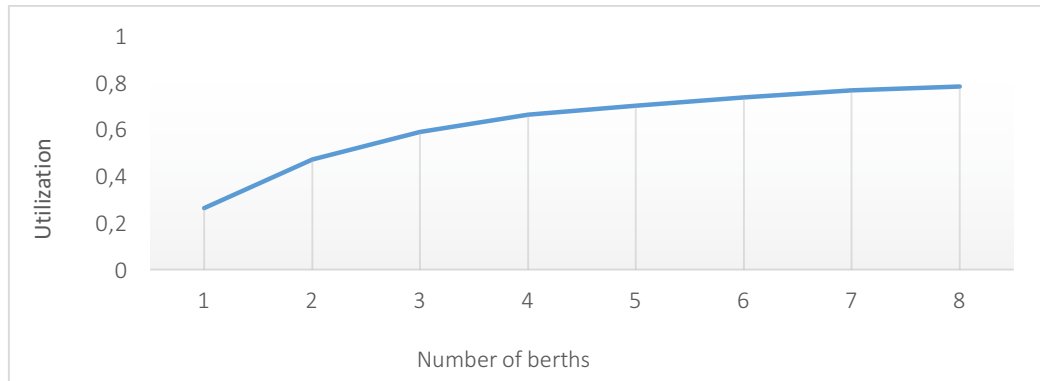
Source: E. Page, *Queuing Theory in OR* (London, Butterworths, 1972) p. 155.

Source: UNCTAD

¹⁹⁴ According to the restriction theory, the total capacity of a process of "n" stages depends on the stage with the least capacity. Thus, if all the systems in a port have a capacity 100% except one, which has a capacity of 40%, then this area will drag down the rest and reduce the total capacity.

Following an analogous procedure, we obtain occupation rates of 59% for three berths, 66% for four berths etc. Given that the number of berths needed has not been established, Figure 17 was generated, which shows that there is no linearity in waiting times in terms of occupation rates and that the values tend towards 0.8.

Figure 17. Number of berths and utilization



Source: Author

From Figure 17, it can be concluded that to obtain higher occupation rates, the waiting times need to be raised considerably. For example, looking at Table 47 once again, we see that to obtain an occupation rate of 90% for two berths, the waiting time is double that of the operation time.

Therefore, any attempt to increase a terminal's capacity in terms of a greater dock output results in a considerable increase in waiting times. Consequently, we will calculate the capacity of the dock (C_t) using equation (1):

$$C_t = n_a \times n_g \times p_g \times r \times t_{\text{año}} \quad (1)$$

Where:

n_a is the number of berth points

n_g is the number of cranes per berth point

p_g is the output of the cranes [TEU/h]

r is the occupation rate

t_{year} : Total annual terminal operation hours (days / year x hours /day)

To carry out the calculation shown in equation (1), we need to use the demand, previously set at 2.65 million TEUs.

Table 48 shows the various configurations of berth points and number of cranes per berth point, modifying the occupation rate r .

Table 48. Occupation rates as a function of berth points and terminal capacity

SPPX crane output [TEU/h]	128 ¹⁹⁵				
Number of working days per year	360				
Number of working hours per day	23				

Berth points	1				
Number of SPPX cranes	2	3	4	5	6
Occupation rate [r]	1	0.84	0.63	0.51	0.42
TEUs / year	2,119,680	2,670,797	2,670,797	2,702,592	2,670,797
Proximity to optimal r (26%)	385%	323%	242%	196%	162%

Berth points	2				
Number of SPPX cranes	2	3	4	5	6
Occupation rate [r]	0.63	0.42	0.32	0.26	0.21
TEUs / year	2,670,797	2,670,797	2,713,190	2,755,584	2,670,797
Proximity to optimal r (47%)	134%	89%	68%	55%	45%

Berth points	3				
Number of SPPX cranes	2	3	4	5	6
Occupation rate [r]	0.42	0.28	0.21	0	0
TEUs / year	2,670,797	2,670,797	2,670,797	-	-
Proximity to optimal r (59%)	71%	47%	36%	0%	0%

Source: Author

Essentially three scenarios, with 1, 2 and 3 berths respectively, will be analysed. For each one, we will simulate what would happen with configurations of 2 to 6 cranes and will establish a demand of 2.65 million TEUs as a comparative value.

Using as an example a scenario with two berth points, it can be seen that the occupation rates r vary as a function of the number of cranes. Thus, for a configuration with two cranes, the occupation rate r is 0.63 units, while for 6 cranes, the same rate is 0.21.

We have previously assumed a waiting time of 10% of the operation time. This implies that the rates of occupation will be conditioned to a certain range. Table 47 shows that for this waiting time, the occupation rate will be 26% for a single berth point, 47% for two and 59% for three.

Therefore, for a scenario with two berths, an occupation rate of close to 47% should be achieved in order to fulfil this established restriction. The rate of occupation r closest to 47% is 0.42, which is obtained with a configuration of three cranes. In fact, this is appreciably lower than 47% such that, even when handling the necessary demand, there is a degree of latitude in terms of the occupation rate and, consequently, the waiting times will not be greater than 10%, thereby improving the efficiency as we had defined.

To facilitate the comparison of the occupation rate with the optimal value it should achieve, a row has been added which shows a comparison of both values. As can be seen in the scenario with two berths and three cranes, the value is 89%, which is the closest to 100%.

Finally, the following options exist to handle the demand:

¹⁹⁵ Super post-Panamax. These are twin lift Boxer 5000 cranes made by Kranunion (Kranunion 2016) capable of handling 80 containers per hour (128 TEU/h applying the conversion factor of 1.6 TEU/container).

- A scenario of 1 berth with 6 cranes ($r = 0.42$). Despite the fact that this is the closest value to the desired 26% for this group, it is still considerably higher and this scenario is, therefore, ruled out.
- A scenario with 2 berth points and 2 cranes each ($r = 0.63$) or 3 cranes each ($r = 0.42$). When various options are compared, the most advantageous from an operational point of view is a lower occupation rate r , since this generates lower waiting times. The scenario with 2 cranes is the furthest from the optimal value. Therefore, the most viable option for this group is 2 berth points with 3 cranes each.
- A scenario with 3 berths with 2 cranes each ($r = 0.42$). The absolute value is identical to the previous scenario. The difference is that one more berth point is required and, as such, a longer dock, which would imply greater costs.

Therefore, with the aim of achieving a minimum capacity of 2.65 million TEUs/year and for occupation rates that mean that the waiting time will be at most 10% of the vessel's operation time, the scenario of 2 berths with 3 cranes each represents an annual capacity of 2.67 million TEUs.

This configuration allows the demand of containers for which the terminal is designed to be met. The main difference with the option of three berth points is that less space is taken up.

In comparison to the *Martiport* terminal, which has been used as a model for the calculation, we can see that the differences are considerable, since a total of 11 cranes have been installed in the *Martiport* terminal to handle the forecast demand.

The difference lies in the type of traffic for which both terminals have been designed and in the scenarios described for the waiting times, the occupation rate and the proportion of 20ft and 40ft containers.

8.2. Dock length

To calculate the length of the dock, three factors need to be taken into account. Firstly, the number of berth places, which in this case is two. Secondly, the size of the project vessels and thirdly, the safety distances, which are proportional to the vessel size, as specified in the Recommendations for Maritime Works¹⁹⁶ for docked vessels.

These safety distances are 20 metres for ships 151 to 200 metres in length, 25 metres for ships between 200 and 300 metres in length and 30 metres for those longer than 300m.

As can be seen, the recommendations set a safety distance of approximately 10% of the maximum value range. These recommendations do not specifically take into account ranges for vessels reaching 400m in length and, given that our terminal is designed to accommodate the largest vessels that are currently being built, which can reach this length, we will set the safety distance at 10% of the largest ship that can dock in our terminal. Thus, for our terminal, this safety distance will be 40m.

Consequently, the total length of the terminal will be 920m, which corresponds to two vessels of 400m each and three safety distances (two on either side of the two vessels and the third between docked vessels).

Although not usual, in certain cases it may be necessary to increase the length of the dock if the study on the access navigation and port interior determine that this is required in order to allow manoeuvres or other safety-related activities to be carried out. In subsequent sections, we carry out a study of the vessel manoeuvre area to confirm the proposed dimensions.

¹⁹⁶ Recommendations for Maritime Works – ROM 3.1-99, of State Ports (Spain) “Project for the Maritime Configuration of Ports, Access Canals and Flotation Areas.”

8.3. Terminal storage capacity

If the dock capacity is 2.67 million TEUs/year, the terminal must be able to store the containers entering or leaving it. Containers are stored in rows whose width is a multiple of 6, a restriction brought about by the width of conventional RTG cranes. Therefore, the number of slots will also be a multiple of 6.

The fundamental parameter for the calculation of the terminal storage depot and, therefore, its storage capacity, are the slots for 40ft containers¹⁹⁷ (2 TEUs). Each slot is a reserved spot to store a stack of containers. Thus, the total storage capacity will be the total number of these spaces.

Given that these are the largest, the calculation will be based on the capacity of this size of container.

With this input data, a preliminary estimate of the theoretical storage capacity (C_{ts}) can be calculated using equation (2).

$$C_{ts} = S_{40} \times (h_{max} - t) \times \frac{360}{2} \quad (2)$$

$$C_{ts} = 1,360,800 \text{ 40ft cont.}$$

Where:

S_{40} is the number of slots for 40ft containers = 2,148

A_s is the average stay of the containers in the terminal¹⁹⁸ = 2 days

h_{max} is the maximum operative height with an RTG-Transtainer¹⁹⁹ crane = 4 heights

t is the safety factor = 0.5

With the capacity in terms of 40ft containers known, a fixed proportionality needs to be applied to obtain the total number of TEUs the terminal can accommodate. This is because not all the containers arriving at port will be 40ft in size; a certain proportion will be 20ft. This proportion will not affect the net rate of movements per hour but it will affect the terminal capacity (Doerr & Sanchez 2006). Similarly, the storage capacity depends on the traffic the port receives, such that, lacking a demand study, as has been discussed previously, we will assume that 40% of the containers handled by the terminal will be 20ft (1 TEU) and 60%, 40ft (2 TEU). In this way, the greater proportion of the largest will benefit the safety factor in the present calculation.

Thus, equation (3) shows the proportion between 20ft and 40ft containers:

$$\frac{f_{20}}{f_{40}} = \frac{40}{60}; \quad f_{20} = \frac{4}{6}f_{40}; \quad f_{20} = \frac{2}{3}f_{40} \quad (3)$$

¹⁹⁷ In terms of reserved space, only two types of container are considered: 20ft containers (1 TEU) and 40ft containers (2 TEUs). The latter are twice as long as the former and, for the calculation, all other dimensions will be considered identical (obviating other types of containers such as “open-side”, “open-top” and other special measurements and characteristics).

¹⁹⁸ Corresponds to the “rotation” parameter. Given that land on the shorefront is more expensive than that inland ground that could perform the same function, the terminal storage tariffs are high and, therefore, the time the containers spend there is limited. It includes transshipment times between vessels, loading waiting time and waiting time for transport leaving the terminal.

¹⁹⁹ RTG – Transtainers are wheeled gantry cranes used to stack containers in the storage area. Each height they store corresponds to a container.

Where:

f_{20} represents 20ft containers

f_{40} represents 40ft containers

Next, knowing the value $C_{ts} = 1,353,240$ from equation (2), we will calculate the values for f_{20} and f_{40} as follows. Firstly, equation (4) expresses the equality of the system.

$$f_{40} + \frac{f_{20}}{2} = C_{ts} \quad (4)$$

Then, the value for f_{20} is substituted by that obtained in equation (3), such that equation (5) allows the value for f_{40} to be determined and, therefore, the value for

$$f_{20} \cdot f_{40} + \frac{(\frac{2}{3}f_{40})}{2} \quad (5)$$

$$f_{40} = 1,014,930 \text{ TEU}$$

$$f_{20} = 676,620 \text{ TEU}$$

Lastly, the total terminal capacity is calculated from equation (6).

$$C_t = f_{20} + (2 \times f_{40}) \quad (6)$$

$$C_t = 2,706,480 \text{ TEU}$$

This value of C_t exceeds the 2,670,797 TEUs the terminal can handle in the scenario of 2 berth points and 3 cranes per berth. The terminal will, therefore, be capable of storing a greater number of containers than its dock is able to handle.

In conclusion, the terminal can handle the number of containers it is designed for, both on its dock and esplanade.

The terminal capacity and the calculated number of slots affect the terminal area. Many studies on the sizes and proportions of terminal storage depots and intermodal change areas have been carried out, including those by (Chen 1999), (Linn & Zhang 2003), (Ng 2005) and (Petering 2009).

The most frequent restriction is due to the width of the RTG cranes used to stack containers, which are usually stacked in rows 6 containers wide. Given that the calculated slots are for containers of 2 TEUs (40ft), each container has a reserved space of 12m^{200} .

If stacks measure 6 x 10 containers, stacked to 4 heights as previously established, each block of containers would be able to store 240 units of 2 TEUs (40ft). Given that $C_{ts} = 1,353,240$ and that there are 360 workdays, the daily requirement rises to 3,759 containers.

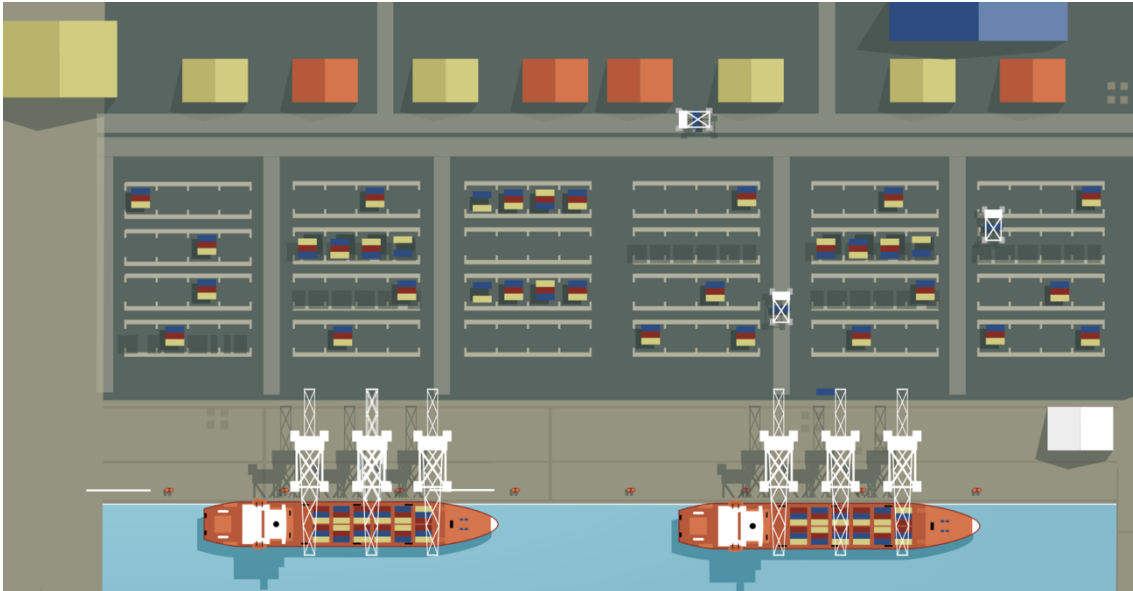
However, we have previously established that containers stay in the terminal for an average of 2 days. Therefore, space is required to handle the cargo of the present day and that of the previous day. Thus, a total of 32 blocks of containers measuring 120m x 14 m each are required.

²⁰⁰ Conversion factor: 1 foot = 0.3048 m

It is also usual to provide an area for refrigerated containers (reefers). As this is conditioned by the characteristics of the terminal traffic, this current study will only provide a small area for refrigerated cargo.

Similarly, space will be provided for IMO containers. Figure 18 shows the type and spaces of the designed terminal.

Figure 18. Type and areas of the terminal.



Source: Author

Figure 18 shows the following zones: 1) IMO container area, 2) General container storage depot, 3) Access control, 4) administrative and services buildings, 5) gantry cranes and 6) berths for vessels.

8.4. Terminal dimensions

As can be seen in Figure 18, the terminal dimensions correspond to the calculated length of the dock and the esplanade, which measures 250m inland.

This esplanade houses the cranes, the manoeuvres yard for the internal transport machinery, the storage area corresponding to the internal transport subsystem, which will be equipped with the previously mentioned 32 blocks and space reserved for reefers. It also includes the services and terminal access control buildings.

The terminal we have designed here is, therefore, small, since its total area reaches 24 hectares (240,000m²) and is only 24% of the size of the *Martiport* terminal.

This difference is due to the scenarios that have been assumed throughout the calculation and possibly to the differences in the type of traffic the two terminals are designed for. Specifically, the size of the container storage depot depends on the nature of the traffic, since import/export containers do not spend the same amount of time in a terminal as transshipment cargo.

8.5. General characteristics of the internal port water

The characterisation of the investments in the terminal would not be complete without a definition of the internal port water. These internal waters condition to a great extent the amount invested, since the most expensive works are those that take place at sea.

The internal port water is protected by seawalls (breakwater and harbour wall), whose type depends on the sea conditions; their location should allow the vessels to manoeuvre normally within the port.

The internal port water also determines one of the most costly investments, both in the initial amount and subsequently maintenance, namely dredging. The draught of the ships that can be handled by the port is determined by the natural depth of the seabed and that achieved through dredging, which tends to be investment-heavy due to its nature.

Table 49 shows the general characteristics of the internal port water or water sheltered by the seawalls, the value of the variable and its description.

Table 49. General characteristics of the internal port water

Variable	Value	Description
Draught	17.5m	<p>The terminal is designed to handle Triple E ships. According to Table 46, these vessels have a draught of 15.5m.</p> <p>The seabed should be between 1.5 and 2m deeper than the draught of the largest ship that can enter the port, both in the approach channel and the manoeuvre and operation areas.</p> <p>The region's maritime conditions and the transport of coastal sediments will determine dredging works, which must be carried out periodically according to these factors.</p>
Size of the internal port water ²⁰¹	100Ha	<p>In terms of the size of the internal port water, this area should allow vessels to come to a complete stop, turn around and start moving (Puertos del Estado 2000).</p> <p>From a financial point of view, the manoeuvres area is important as it determines the total size of the terminal internal water and, with it, the total amount of dredging.</p>

Source: Author

The manoeuvre areas should allow a ship to turn 180° on its centre of gravity.

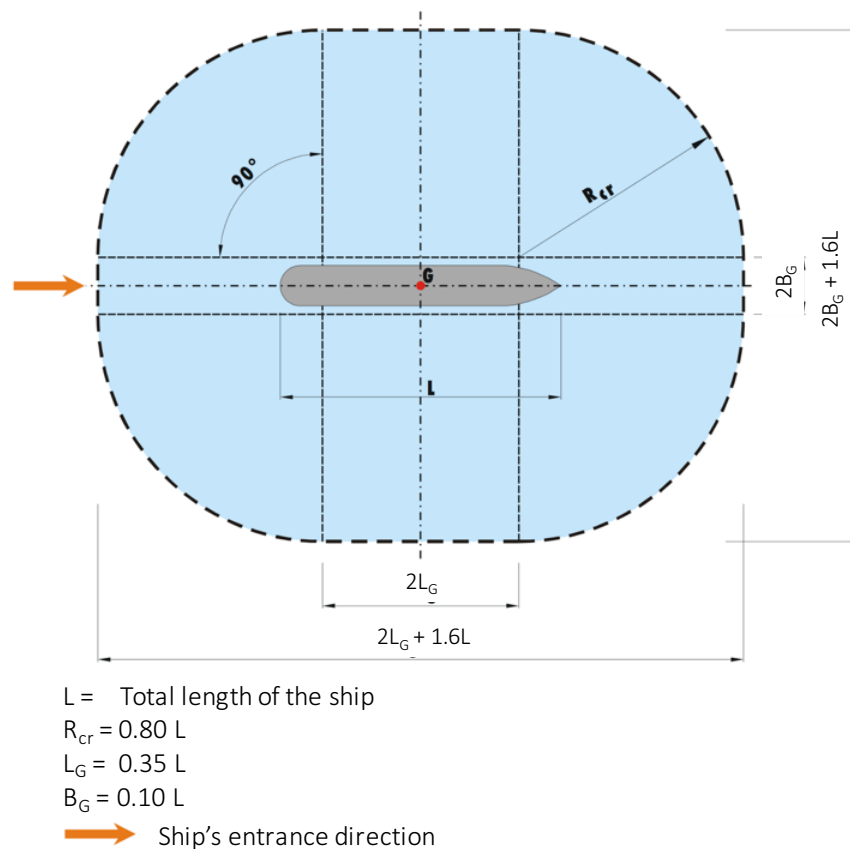
According to ROM 3.1-99, the calculation of the total manoeuvring area is based on a deterministic method in which the space occupied by the ship is defined by a rectangle of the following characteristics:

- Width: $2B_g$
- Length: $2L_g$
- Restriction₁. Access to the manoeuvres area at a speed no greater than 0.2 m/s in the centre of the rectangle.
- Restriction₂. Manoeuvring should take place with the help of tugs.
- Restriction₃. The operation-limiting conditions must not exceed the following values: wind speed ≤ 10 m/s, current speed ≤ 0.1 m/s and wave height ≤ 2 m.

Figure 19 shows a diagram for calculating the manoeuvres area.

²⁰¹ Area protected by the seawalls (breakwater and harbour wall), also known as the "internal waters". Entry of ships into the port, manoeuvres and shipping operations all take place within this area.

Figure 19. Size of manoeuvres area.



Source: ROM 3.1-99

The calculation of the manoeuvres area is based on Triple E vessels. According to Table 46, these ships are 400m in length. Therefore, equation (8) defines the radius described by the sides of a rectangle delimiting the manoeuvres area. Similarly, equations (11) and (12) define the area's width and total length.

$$L = 400m \quad (7)$$

$$R_{cr} = 0.80L = 320m \quad (8)$$

$$L_g = 0.35L = 140m; 2L_g = 280m \quad (9)$$

$$B_g = 0.10L = 40m; 2B_g = 80m \quad (10)$$

$$2L_g + 1.6L = 920m \quad (11)$$

$$2B_g + 1.6L = 720m \quad (12)$$

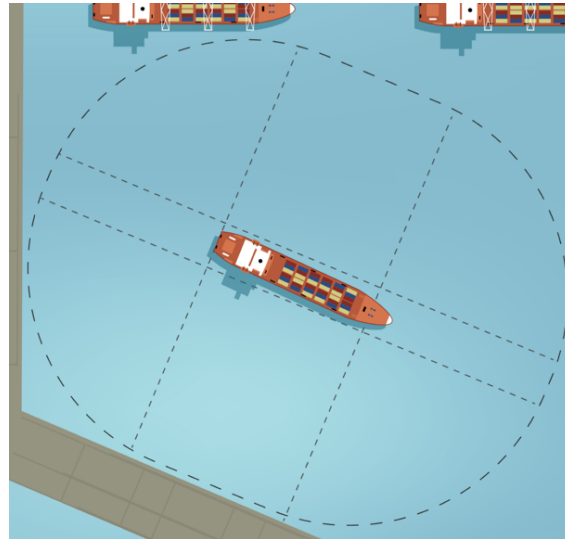
Where:

R_{cr} : Radius of the manoeuvres area

In conclusion, the manoeuvres area should measure 720 x 920m with a radius of 320m, which conditions the size of the terminal's inner water. This includes a safety margin of 0.1L throughout the whole perimeter of the manoeuvres area. The length of the dock established in previous sections is the same as the longest side of the manoeuvres area. Consequently, the dock length will remain as calculated, with both values corresponding to 920m in length. As

shown in Figure 20, the manoeuvres area should not overlap with either the terminal seawalls or moored ships.

Figure 20. Effect of manoeuvres area on terminal inner waters.



Source: Author

The width of the approach or navigation channel is the sum of the terms shown in equation (13).

$$B_t = B_n + B_r \quad (13)$$

Where

B_t is the total width of the navigation channel

B_n is the nominal width of the navigation channel, including the ship and tugs assisting in manoeuvres, and which should be free of obstacles

B_r is the additional safety margin which should be allowed for in the case of, for example, the levelling of the banks on either side of the approach channel

To calculate B_n , weather conditions should be taken in account in addition to whether sailing takes place in a straight line or in a curve. Given that the current study lacks climate data for the area in particular, and that the reason for carrying out this calculation is to determine the amount of investment needed for dredging, only the size of the manoeuvres area will be considered plus an additional 20% for the navigation channels.

8.6. Execution phases

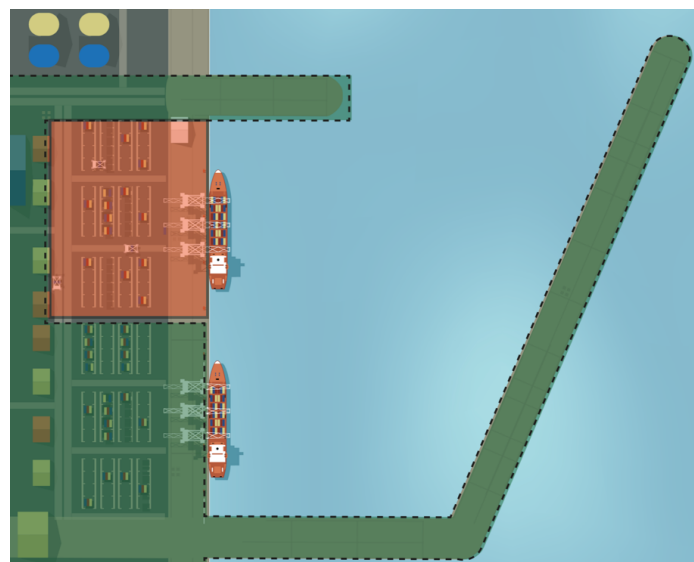
The project will be carried out in two phases that are identical in terms of their type but not in the amounts invested. This separation into two phases will not affect the variables discussed previously nor the general characteristics of the terminal, since they have been designed such that, by completing the first, the minimum investment is reached to ensure the operation of the terminal. However, this separation into phases does affect the terminal capacity and the way in which investments are dealt with from a financial point of view. The terminal will be capable of reaching its maximum capacity as it secures its operations and acquires shipping lines without compromising the total amount invested.

The first phase of the project will consist of the construction of the first berth and the installation of its corresponding cranes. However, it requires a higher volume of investment

than the second, since it will entail building all the seawalls, the containment wall²⁰² and most of the platform filling. Certain engineering projects have been carried out in which the breakwater is lengthened as the terminal phases are completed. However, for this study in particular, the breakwater and the harbour wall, together with the dredging of the access channel and the manoeuvre and operations areas should be carried out from the outset, given the total size of the completed project.

Thus, the second phase will require a smaller volume of investment than the first and will consist of doubling the terminal capacity, which will involve building the second berth and equipping the terminal with all the necessary equipment. Figure 21 shows the final terminal and its stages of execution.

Figure 21. Execution phases of terminal.



Source: Author

It also shows how the manoeuvre area is distributed and how this determines the size of the terminal's inner waters.

9. INVESTMENTS

From the details described in the previous sections, it is possible to characterise the main investments that must be made to build the port. The main investment blocks are:

- Dredging: This is the extraction and transport of material lying below water (Ortega 2003), specifically on the seabed (sand, rock, etc.). The aim is to reach the depth necessary to allow the passage of ships the terminal is designed for. According to Table 46, Triple E vessels have a draught of 15.5m and, as such, the dredging should be carried out to a depth of 17.5m, as discussed before.
- Container dock: This involves the works necessary to construct the area in which the cranes handle containers. The dock consists of slabs of concrete supported by piles²⁰³ and lies at between 2.5 and 3m above the average sea level.

²⁰² A perimeter enclosure of the terminal area that allows subsequent filling of the esplanade (Puertos del Estado 2008).

²⁰³ Reinforced concrete structures between 1.5 and 2m in diameter and whose length depends on the nature of the ground on which they sit (they normally exceed 12m). A dock is built from various blocks of concrete similar to slabs which sit on the heads of the piles.

- Breakwater. This is a structure in the form of an arm that extends out into the sea and protects the port (Puertos del Estado 2008) and whose length and angle to the port depends fundamentally on the type of terminal, its size and the nature of the sea conditions in the area. It is a protective barrier against the outer waters and is more than 50% longer than the length of the dock.
- Harbour wall. This is a second breakwater that closes the terminal obliquely and that leaves only an access channel open. Its typology is the same as that described for the main breakwater.
- Fillings and esplanades. These are landfills that provide a flat surface on which to build the terminal. They are then paved with 30cm of concrete. The filling will be 3m deep, since the terminal described here will not be built on land reclaimed from the sea but on a platform of elevated mainland ground 1m above sea level. If the terminal is to be built on land reclaimed from the sea, the landfills should be of a greater quantity.
- Containment wall. This consists of the layer of quarry run material, dressed on the seaward side by a protective layer of rockfill with a slope of 1:2.
- General equipment. This basically includes the fenders and bollards that prevent ships colliding with the sensitive areas of the seawalls.
- Cranes. With the measurements established previously, the mobile machinery depot will be built to a size necessary to carry out the exploitation of the terminal and service ships.
- Buildings and services. These include all the buildings detailed previously that provide services for the various activities that take place in the port.
- Electrical installations. These include all the lighting towers necessary to illuminate the whole terminal and two electricity substations, one for each terminal.
- Service networks. These are the networks to drain rainwater from the port and to supply basic services (water and electricity). It also includes the fire-prevention system.
- Berth-side installations. This is the auxiliary equipment needed to carry out terminal activities (ship entry control system, waste management facilities, backup fire-prevention system, etc.)
- Health and safety. 1% of the cost of the works should be destined to guaranteeing the health and safety of the construction workers. The total cost of the works should not affect the studies, projects and project management portion.
- Studies, projects and project management. This is an allocation of funds for all the studies that should be carried out before the terminal is designed. It is normally approximately 2% of the total amount to be invested and is destined for the project management board of works.

Table 50 shows the details of the investments divided into project phases. However, it does not show who is responsible for providing the funds, since this will be described in the characterisation of the economic-financial model of the construction and exploitation of the terminal (Chapter 9).

Table 50. Investments in the terminal, by project phase

Description	Unit	Quantity	Unit price [US\$]	Partial [US\$]	Phase I [US\$]	Phase II [US\$]
Dredging				124,200,000	124,200,000	0
Estimate of dredging rock or coral (5m)	m ³	4,968,000	25	124,200,000	124,200,000	0
Container dock				86,400,000	43,200,000	43,200,000
Capping layer to +2.5m	m	960	90,000	86,400,000	43,200,000	43,200,000
Breakwater				68,000,000	68,000,000	0
Breakwater	m	1,700	40,000	68,000,000	68,000,000	0
Harbour wall				6,000,000	6,000,000	0
Harbour wall	m	150	40,000	6,000,000	6,000,000	0
Fillings and esplanades				22,500,000	16,875,000	5,625,000
Esplanade landfill	m ³	900,000	5	4,500,000	3,375,000	1,125,000
Concrete paving	m ³	90,000	200	18,000,000	13,500,000	4,500,000
Containment wall				1,800,000	1,800,000	0
Quarry run	m ³	100,000	15	1,500,000	1,500,000	0
Breakwater 0.5 Tons	m ³	15,000	20	300,000	300,000	0
General equipment				1,695,000	847,500	847,500
SUC -1700 H fenders	S/U	30	50,000	1,500,000	750,000	750,000
150 t bollards	S/U	30	6,000	180,000	90,000	90,000
Metal ladders	S/U	15	1,000	15,000	7,500	7,500
Cranes				117,600,000	58,800,000	58,800,000
SPPX	S/U	6	11,000,000	66,000,000	33,000,000	33,000,000
RTG	S/U	18	1,200,000	21,600,000	10,800,000	10,800,000
Reach Stacker	S/U	6	800,000	4,800,000	2,400,000	2,400,000
Straddle Carrier	S/U	18	1,400,000	25,200,000	12,600,000	12,600,000
Buildings and services				2,165,000	2,165,000	0
Wash station	S/U	1	30,000	30,000	30,000	0
Fuel station	S/U	1	75,000	75,000	75,000	0
Emergence IMO container storage area	S/U	1	100,000	100,000	100,000	0
Admin offices and areas	m ²	500	1,800	900,000	900,000	0
Access Control (gate)	S/U	1	1,000,000	1,000,000	1,000,000	0
Maintenance workshop	S/U	1	60,000	60,000	60,000	0
Electrical installations				4,814,000	3,500,400	1,313,600
Low and medium tension network	TBD	1	4,000,000	4,000,000	3,000,000	1,000,000
Telephone network	TBD	1	200,000	200,000	150,000	50,000
Lighting towers	S/U	20	21,700	434,000	260,400	173,600
Electricity substation	S/U	2	90,000	180,000	90,000	90,000
Services networks				3,580,000	2,685,000	895,000
Drainage	ha	24	50,000	1,200,000	900,000	300,000
Sewage	TBD	1	1,000,000	1,000,000	750,000	250,000
Drinking water supply	TBD	1	1,100,000	1,100,000	825,000	275,000
Painting	TBD	1	80,000	80,000	60,000	20,000
Completion costs	TBD	1	100,000	100,000	75,000	25,000
Fire-prevention circuit	TBD	1	100,000	100,000	75,000	25,000
Health and safety				4,821,473	3,375,031	1,446,442
Health and safety study (1%)	TBD	1	4,821,473	4,821,473	3,375,031	1,446,442
Mitigation measures				38,571,780	27,000,246	11,571,534
General mitigation measures (8%)	TBD	1	38,571,780	38,571,780	27,000,246	11,571,534
Studies, projects and project management				15,530,327	9,540,196	5,990,131
Seabed bathymetry	S/U	1	150,000	150,000	150,000	0
Topography of inland area	S/U	1	90,000	90,000	72,000	18,000
Geotechnical study	S/U	1	300,000	300,000	300,000	0
Sea conditions and transport of coastal sediment	S/U	1	60,000	60,000	60,000	0
Project management	S/U	1	14,930,327	14,930,327	8,958,196	5,972,131

Total	Phase 1 [USD]	Phase 2 [USD]
497,677,580	367,988,373	129,689,207

Source: Author

The difference between the investments in each phase is notable. As has been discussed previously, the two phases are not identical. This is due to the fact that the first requires the greatest number of resources, as most of the landfill works and construction of the seawalls needs to be carried out for the terminal to be able to start operating. This explains why the investments in the first phase represent 74% of the total investment in the project.

With regard to road and rail connections that provide access to the terminal, it is assumed that the project developer will fund part of it, although this is usually negotiated with the local administration. Table 51 shows the investment taken into account in the design of the terminal in the chapter on rail and road infrastructure.

Table 51. Investments in rail and road connections

Connection	Quantity	Unit cost (US\$)	Total
Road (m)	3,500	4,000	14,000,000
Rail (m)	4,000	6,000	24,000,000
			38,000,000

Source: Author

It is often the local municipal or the Government who funds rail and road infrastructures. However, as will be seen in chapter 11, the amount to be invested in rail and road connections is calculated in order to determine whether the model will function when they are factored into the equation and, consequently, whether public aid can be dispensed with when it comes to covering these investments.

10. CONCLUSIONS

This chapter presents a proposal for determining the size of a terminal that can be found in a port, in this case a container terminal, using the *Martiport* terminal as a model.

Despite the similarity between the *Martiport* terminal and the terminal described here, there are considerable differences in their size and facilities. This is due to the fact that both the type of traffic the terminal serves and the arrival distribution of vessels at the port and factors such as the waiting and occupation times generate large differences in the final result.

For the terminal designed here, the areas have been defined and, based on the study of the evolution of the size of container carrier ships, we have established that the terminal must be able to service the largest vessels currently existing — Triple E ships. These are container carriers with a capacity of 18,000 TEUs and whose beam can accommodate up to 23 containers, something that conditions on the one hand the output of the cranes and, on the other, the type of crane used. In terms of output, twin lift cranes capable of handling more than one container at a time will need to be used and with regard to type, they will need to be gantry cranes of an outreach equal to the vessel's beam.

After carrying out the calculations and establishing the scenarios apropos the waiting times in the terminal and the occupation factor, it has been concluded that the terminal should have two berths and three STS cranes per berth. Consequently, the rest of the necessary facilities are sized proportionally and a sketch of the terminal has been presented. With respect to the inner port water, an estimate of its area has been carried out based on the size of the manoeuvres area.

This allowed us to determine the amount of investment necessary for the construction and exploitation of the terminal. The volumes calculated here are approximate as both the measurements and the unit price of each item have been considered from the perspective of a viability study and not an executive project. Nevertheless, our aim has been to design a terminal in order to provide a figure for the total investment, leaving the discussion of who should bear each investment portion and how this affects their business model. An analysis of the phases in which the terminal should be built and the effect of the construction of each phase on the total investment made has also been carried out.

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8

Shipping: Management of import and export processes. Case study: The Port of Barcelona

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1. AIM

The rationale for a port is to serve as a hub for the transfer of cargo between maritime and land transport (road or rail). The traffic can be generated by transshipments if the shipping merchant only uses the port as an exchange hub, **or** from imports and exports if the port serves as a gateway for the entry or departure of the goods into and out of the country. Goods that provide value to the territory are those arising from imports and exports, as are those that require proportionately more resources and that, consequently, generate greater revenues in taxes and port charges.

The volume of imports, exports and transshipment activities are specific to each port and, as such, should be studied in detail.

One of the goals of this study is to design a new business model in which the initiative of developing a port does not begin with a public entity but the private sector. Therefore, activities managed by a port authority in import and export processes are important, as it must be determined whether these activities could be carried out by an entirely private operator with no involvement of any public administrative body.

In this sense, the Port of Barcelona, which is governed by the Spanish port system as discussed in chapter 4, is an example of a port with little involvement in import and export processes due to the organisation of this Spanish port system. Its study is relevant because several interesting conclusions can be drawn from its operating model and it would be interesting to determine whether the activities carried out by the Port Authority of Barcelona (PAB) —which are the minimum that a PA, under the Spanish law, can carry out in this area— could be managed by a private port authority.

At the end of this chapter, we discuss whether it is possible to determine whether the import and export process activities carried out by PAB could be performed by private entities. It will also be possible to determine whether other second-order activities, whose management does not have to be strictly public, could also be carried out by the private entity developing the port.

2. CHAPTER ORGANIZATION

This chapter is based on the article *“Shipping: Management of import and export processes and transition from public to private”*, presented at the XXI International Conference on Industrial Engineering and Operations Management. Aveiro, Portugal. July 6-8, 2015.

3. INTRODUCTION

Of the Eurozone countries, Spain has the longest coastline, reaching about 8,000km. Its port management model implies that the port authority provides only the land on which the port lies, infrastructure and signalling (Nuñez-Sanchez & Coto-Millan 2012). This organizational model is known as the Landlord model, as the port manager owns the land on which it sits. This is also the most widespread port operations model in Europe (Huybrechts et al. 2002). Moreover, other authors have observed similar findings in many other countries around the world ((Van Niekerk 2005), (Ramos-real & Tovar 2010) and (Notteboom 2007)), possibly because it allows competition between different service providers within the same port (Notteboom & Merckx 2006).

This Landlord model is based on a public administrator whose duty is to manage, develop and coordinate port activities (Notteboom & Verhoeven 2009). Services tend to be provided by private entities and port regulation is carried out by a public entity (Martin-Bofarull 2010). Typically, port authorities usually concede terminal spaces to private entities (Roa-Perera et al. 2013). The private entity, which is more efficient (Guasch 2004), then begins to manage

everything specific to its activity (cranes, warehouses, equipment, etc.). Under this model, contractors are responsible for commercially running the terminal. However, port authorities are also interested in procuring the highest possible volume of cargo (Cruz & Marques 2012).

Maritime business is constantly growing. Since 2000, both the accumulated supply and accumulated demand have experienced sustained annual growth of 9.9% and 10.4%, respectively (CEPAL 2012).

The Port of Barcelona currently the third largest port in Spanish after Algeciras and Valencia (Lloyds 2013), which move more transshipment cargo. However, Barcelona handles an important volume of import and export traffic and manages many different types of load (Nuñez-Sanchez et al. 2011). It therefore has to provide many services for users, as port services generate multiple entries and departures according to the characteristics of the goods being moved and/or the way they are packed (Jara-Díaz et al. 2006). Barcelona and Valencia are also among the largest Mediterranean ports, combining an important gateway function (Notteboom 2008) with significant transshipment flows, with transshipment rates of 38.8% and 43.9% respectively in 2008 (Notteboom 2010).

It is no surprise then, that more than 70% of the ships going through Spanish ports come under the control of nine Spanish port authorities, including Barcelona, which is considered one of the most efficient in Spain (González & Trujillo 2008) and indeed the Mediterranean (Liu 2010). Like other ports such as Valencia and Bilbao, Barcelona has tried to develop itself as a hub for container traffic with feeder lines for other Spanish ports (Castillo-Manzano et al. 2008). Moreover, having become a modern port, like Amsterdam, Singapore, Antwerp, and New York, it is considered a “fourth generation port” (Varzilio 2007). It is for this reason that, in addition to providing cargo services, it also provides other value added services.

This has led to the generation of a cluster of certain Mediterranean ports, specifically those of Valencia, Castellon, Barcelona, La Spezia and Genoa (Freire Seoane et al. 2013). Barcelona has become, therefore, a gateway to the regional and national entry and exit of products (Fernández 2009). This benefits not only the port itself, but also its hinterland. With a good management strategy for upgrading the hinterland, the Port of Barcelona has achieved a significant impact on attracting container volumes from distant hinterlands (Van den Berga & De Langen 2011).

We have therefore chosen Barcelona as a case study since it is a port that, unlike other Spanish ports, manages many different types of load and also handles transshipment and import/export traffic.

As a public port authority, PAB is involved in all processes necessary to allow trade between the entities involved in the port business. It therefore participates in the key processes of the import and export of goods. In this chapter we focus on these import and export processes, specifically those flows related to transport processes and/or administration, and evaluate the role of PAB in all of them. The final aim is to determine whether these activities, which are carried out by a public authority, could be managed by a privately owned entity.

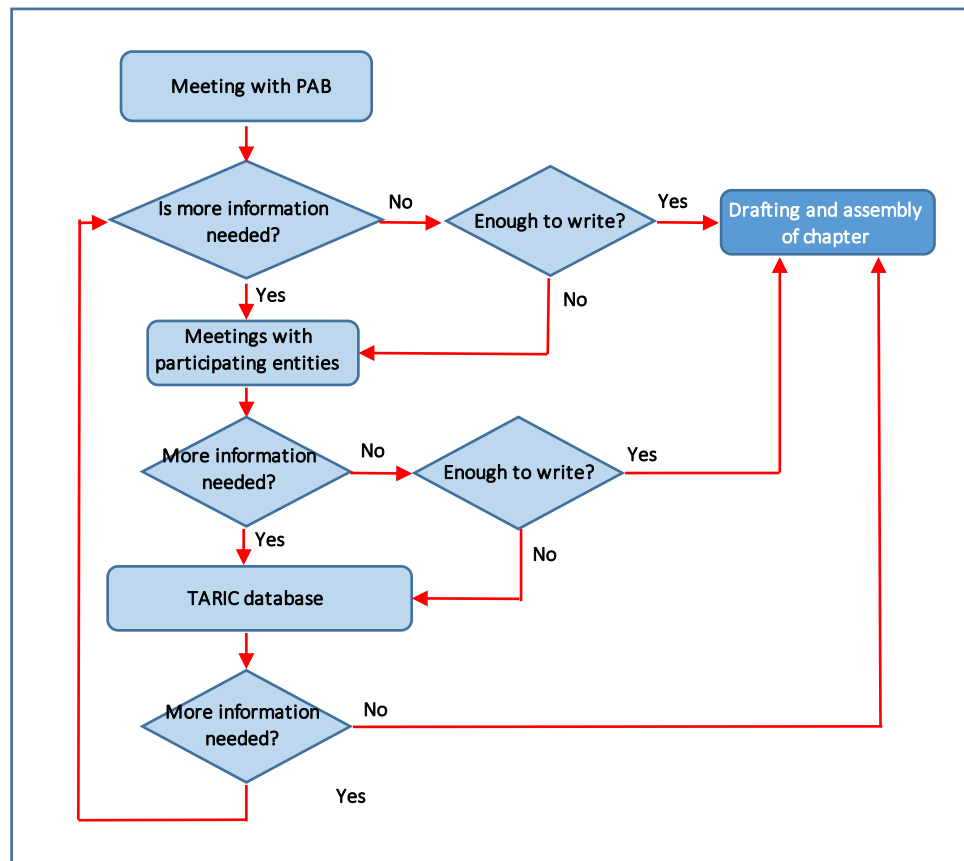
4. METHODOLOGY

This chapter aims to gather information regarding certain aspects relating to the activities carried out in the Port of Barcelona in which PAB is involved in some way or another.

The study therefore focuses on PAB and includes interviews carried out with freight forwarders²⁰⁴, shipping companies and other entities involved in these activities.

As in Chapter 5, Figure 22 shows a flowchart detailing the steps taken to obtain the information presented here.

Figure 22. Flowchart of steps taken to gather information.



Source: Author

As shown in Figure 22, three steps were carried out to gather this information:

- Meeting with PAB: In this meeting, we asked for access to documents relating to port activities and the PAB Quality Plan. Since not all of the information gathered is public, other sources were used to define certain activities and processes.
- Meetings with participating entities: Figure 23 shows the main types of entities that were consulted in order to gather the information presented in this study.
- TARIC²⁰⁵ Database: This is a database used to gain information about certain processes involving the Spanish Inland Revenue and other agencies such as Customs and Excise.

²⁰⁴ A freight forwarder is a company responsible for the administrative and logistical management necessary for the transport of goods, especially in ports and airports (Ateia-Oltra 2016).

²⁰⁵ TARIC is a company, headquartered in Madrid and founded in 1987, that specializes in customs activities. It maintains a customs guideline database and management software used by shipping companies in Spain.

Figure 23. Type of information collected from each participating entity.

Freight forwarders	<ul style="list-style-type: none"> • Their role in transport process administration has been fundamental in characterizing the processes and determining the order of activities. Companies consulted include Ibercondor, Feteia (Federation of Freight Forwarders), Icontainers and Tiba Group, among others.
Shipping agents	<ul style="list-style-type: none"> • Shipping agents act in the name of the ship owner and carry out land transport activities. • They are key to defining the processes, since they are responsible for managing essential customs activities. Companies consulted include Condeminas Shipping Agency and China Shipping.
Terminal operators	<ul style="list-style-type: none"> • Port operators also play an important role, since they channel information and fulfil a range of requirements. Operators consulted include BEST and TCB.
GBMP	<ul style="list-style-type: none"> • The General Board of Merchant Ports, upon which the Harbour Master depends, provided information on dangerous goods.
Platform Portic	<ul style="list-style-type: none"> • Portic is a document management platform used to manage documentation between the various parties involved in the Port of Barcelona.

Source: Author

As can be seen in Figure 23, meetings with five entities related to the shipping of goods and imports/exports processes were carried out.

Once all the information had been gathered, it was graphically processed to better understand it.

5. CHARACTERIZATION OF ACTIVITIES

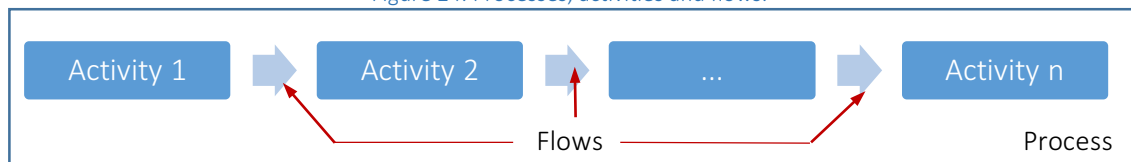
First, a distinction between the meanings of “processes”, “flow” and “activities” should be established. We use the term “process” to refer to a defined sequence of steps or activities that transform inputs into higher value outputs (Suñé et al. 2004). We therefore consider import and export processes because they consist of complex sets of activities.

These “activities” are individual actions that can be grouped or not into processes. The level of performance or the time taken to carry out the activities can be measured and compared with the performance or speed considered “normal” (Suñé et al. 2004).

As such, these activities are the smallest units into which processes can be broken down and condition the execution of larger activity units.

Finally, we use the term “flows” to refer to the movements of goods or any documentation that changes physical or digital location in order to allow the activities to be carried out. Figure 24 shows a representation of processes, activities and flows.

Figure 24. Processes, activities and flows.



Source: Author

In this chapter, we address:

- Processes: Import / Export of goods
- Activities: Inspection, customs declaration, location request, etc.
- Flows: physical movement of goods to be inspected, documentary flows, etc.

It is important to consider the fact that import and export processes can be studied and analysed from different perspectives. Here, we analyse the processes from an administrative perspective and from the point of view of their impact on transport.

The administrative perspective is essential as it defines what documentary steps the processes of importation or exportation of goods should follow and serves to guide the construction process of a private port authority.

Taking into account the impact of these processes on transportation is critical as they determine the movement of cargo in the port area.

This last point is related to the specific activities being studied here. For example, an import process involves many activities that could be broken down into simpler activities. Moreover, a number of flows, ranging from very large to smaller, less important ones, are also generated, so there is a plethora of activities and flows within the import process. The same applies to export processes.

Therefore, we only take into account those activities in which the PAB has some responsibility. Moreover, we also consider the most important, obligatory activities carried out by PAB to ensure the import or export process.

Regardless of the type of cargo (bulk, containerized cargo, general cargo, etc.), we will determine, through process diagrams, which activities are carried out by the Port Authority of Barcelona.

Table 52 shows a general map of the processes defined by the Port of Barcelona Quality Plan²⁰⁶. The columns show who is responsible for each activity, which can be a company or an institution. Their respective responsibilities are indicated by the grey boxes.

As can be seen, a total of 48 activities are highlighted (42 in grey and 6 in yellow), 6 of which involve PAB (marked in yellow). As mentioned previously, activities can be broken down into simpler activities.

Since the activities studied here are only those in which PAB is involved, we will only look at the corresponding column.

²⁰⁶ The new Port of Barcelona Quality Plan for the efficient execution of port logistics processes. April 28th, 2010.

Table 52. General map of processes.

		Business													Institutions				
		Exporter / Impo	Financial institut	Shipper / Shipping com	Rail logistics oper	Rail compa	Freight forwarder / Customs	Transport comp	Port rail termi	Container de	Inner termi	Basic port servi	Port Authority (P	ADIF (Rail infrastructure ma	Maritime Capital	Custom	Border Inspection Service		
Good	Commercial	Commercial recruitment																	
	Transportation	Shipping recruitment																	
		Rail transport recruitment																	
		Terrestrial transport												1					
		Operation of maritime terminal																	
		Operation of rail terminal																	
	Management	Customs clearance												2					
		Border inspection services (BIS)												3					
		Permission to enter dangerous goods												4					
Transportati	Ship-related transport processes	Administrative management of port of call											5						
		Ship services																	
	Rail	Circulations management												6					
		Rail services																	
																			Goods importer / exporter
																		Shipping company	
																		Rail company	

Source: PAB (adapted)

The numbered boxes highlighted in yellow correspond to the following activities undertaken by PAB:

1. Land transport (transportation/goods). This involves managing land transport and the movement of goods entering and leaving the port facilities.
2. Customs clearance (management/goods). This involves communicating data relating to the load being carried on board to the Inland Revenue so that the customs clearance of the goods can be successfully carried out.
3. Border inspection services (BIS) (management/goods): PAB is responsible for validating the checking of goods being managed inside the port, regardless of origin or destination.
4. Permission to enter dangerous goods (management/goods). PAB is the only authority that can, after certain checks, give permission for the entry or exit of certain goods into or out of the port. It is an essential activity that ensures safety at the port facilities.
5. Administrative management of port of call (related to the vessel/transportation). This involves allocating a loading or unloading dock to each vessel arriving at the port. This activity, in most cases, is delegated to the concessionaires of the terminals.
6. Circulation management (rail/transportation). This involves the control and management of the internal movements of goods by rail. PAB also has the power to permit the loads to enter or leave the port facilities.

These six general activities are spread differently throughout the import and export process diagrams and their location and preceding and following tasks also depend on the perspective from which each process is studied.

Therefore, it is necessary to create four process diagrams in order to determine what happens to these activities when studied from different perspectives. These diagrams and the order in which they are analysed are detailed in Table 53.

Table 53. Diagrams and order.

		Perspective	
		Administrative	Transport
Processes	Import	Section 5.1	Section 5.3
	Export	Section 5.2	Section 5.4

Source: Author

Table 54 shows the areas into which the diagrams are divided. As can be seen, there are three areas common to them all (transport processes, administrative controls and vessel processes). Notably, two more areas —commercial processes and rail processes— are included when import and export processes are studied from the point of view of transport. This is because in transport processes, PAB is also responsible for a part of the distribution of transport services.

Table 54. Areas in the process diagrams.

	Transport processes	Administration controls	Vessel processes	Commercial processes	Rail processes
Import / Administrative					
Export / Administrative					
Import / Transport					
Export / Transport					

Source: Author

To finish defining the diagrams, Figure 25 and Figure 26 show the stages in the arrival and departure of a ship and the entry and exit of goods that occur in the import and export processes.

Figure 25. Stages in import processes.



Source: Author

Figure 26. Stages in export processes.



Source: Author

Figure 25 shows the stages corresponding to the import process. The first step is the ship's arrival and the last corresponds to the goods leaving the port after the ship has sailed. Figure 26 shows the stages in the export process. In this case, the first stage is the arrival of the goods at the port followed by the arrival and departure of the ship, which constitutes the maritime portion of the transportation of these goods.

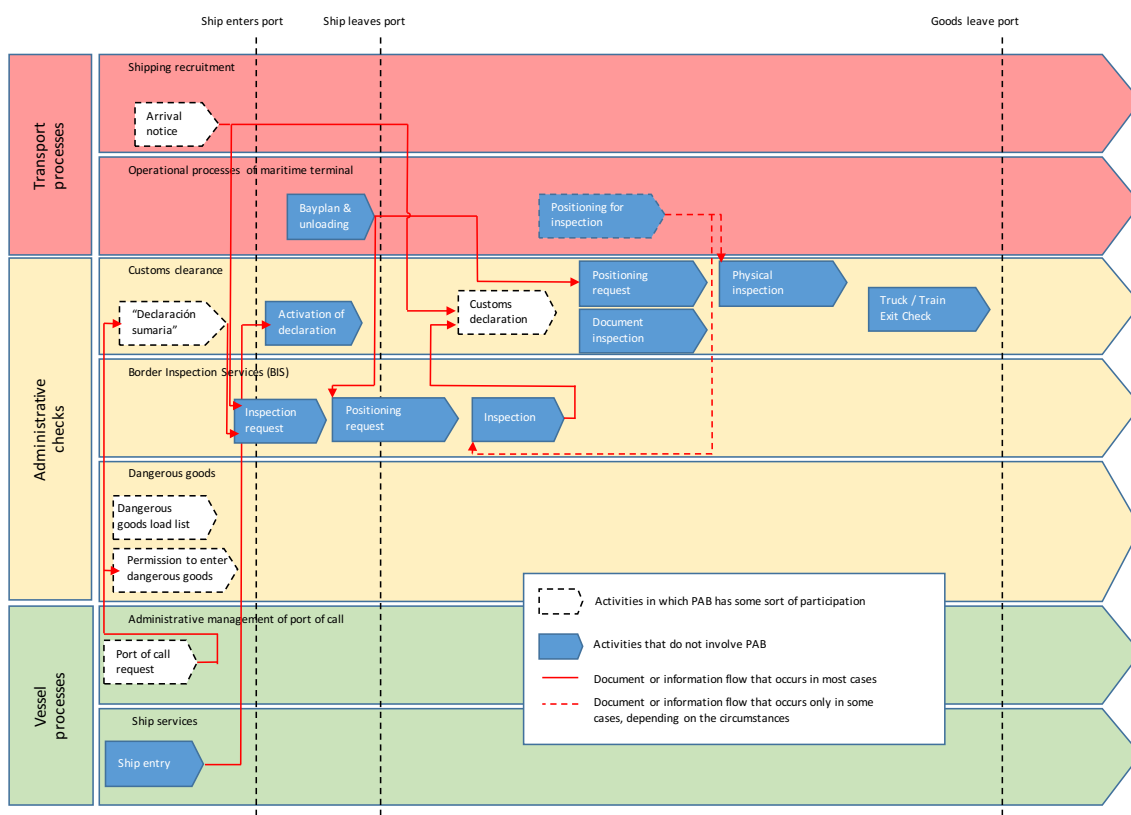
In the diagrams, areas are represented horizontally and in colours. Stages, however, are represented vertically and only with lines marking their position; the stage legend is at the top of the diagram.

5.1. Process: Import. Perspective: Administrative

The first process diagram to be studied is that related to the import process evaluated from an administrative perspective. Figure 27 shows the process diagram, which is composed of three areas (transport processes, administrative checks and vessel processes) and conditioned by three stages: ship enters port, ship leaves port and goods leave port.

The activities in which PAB has some involvement are shown with a white background and dotted line.

Figure 27. Import process from an administrative perspective.



Source: PAB (adapted)

Being a process of importing goods, the first stage is the ship's arrival in port. For this arrival to occur, two other processes need to be set in motion:

- **Port of call request:** When a ship is planning its call at the Port of Barcelona, the owner must request permission to dock at the PAB facilities and perform the tasks of loading and unloading containers. The ship is assigned a port of call number, which is essential for the "declaración sumaria"²⁰⁷. This declaration, which must be made prior to entry of the ship into the port, is necessary to assign the goods a customs destination. The document must be submitted to the Inland Revenue, who is responsible for assigning

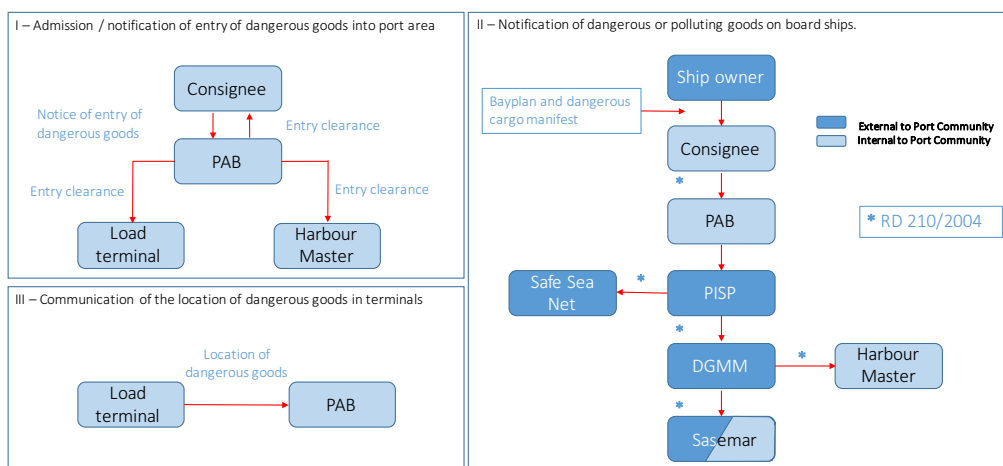
²⁰⁷ As defined by the Spanish Inland Revenue, the "Declaración sumaria" is a prerequisite for assigning customs destination to any load entering the Community Customs Territory. This is enshrined in EEC Regulation 2913/92 of the European Council of 12 October 1992 establishing the Community Customs Code and EEC Commission Regulation 2454/1993, of July 2, 1993.

that destination. It is an essential step as it sets in motion the next stage, which is an inspection request made to the Border Inspection Services²⁰⁸.

The “Public Institute of State Ports” (PISP), which is the institute that controls and monitors all Spanish PAs, currently has a “one stop shop”²⁰⁹ agreement with the Inland Revenue. This allows the procedures for the submission of the “declaración sumaria” to be streamlined. One of the advantages of the system is that the documentation is presented in digital format²¹⁰. According to this agreement, the documentation may be submitted directly to the Inland Revenue by an individual or a company. PAB therefore simply acts as a bridge facilitating the transmission of data but having no power of decision. The path this documentation follows is: Consignee²¹¹ - Customs broker - PAB - Maritime Customs.

- Dangerous goods load list²¹².** The vessel is obliged to declare the origin and nature of any dangerous goods on board²¹³. The consignee of the ship informs the Harbour Master of all dangerous goods being carried on board the vessel, regardless of whether these are to be unloaded in Barcelona or in a later port of call. This process affects port security and sets in motion certain control and management processes and, if necessary, can also bring about the activation of emergency procedures. PAB receives the document, but the responsibility of managing this procedure lies with the State Security Forces. Figure 28 shows the three different processes involving dangerous goods: entry request, notification of goods on board the ship and the communication of dangerous goods location within the terminal. It also shows who is responsible for each activity and the influence of RD 210/2004²¹⁴.

Figure 28. Different processes related to dangerous goods.



Source: PAB (adapted)

²⁰⁸ This inspection may be a) veterinary (animal or vegetable); b) foreign health; or c) SOIVRE (Special Official Service of Inspection, Monitoring and Regulation of Foreign Trade), which is carried out by the Secretary of State and Trade.

²⁰⁹ Royal Decree 1334/2012, article 4.1

²¹⁰ Directive of the European Parliament, Article 4 stating that Member States must complete this process in electronic form before June 1, 2015.

²¹¹ Independent intermediary acting on behalf of the ship owner. Runs land shipping phases, including delivery and receiving of loads.

²¹² Goods classified in the International Maritime Dangerous Goods Code.

²¹³ Royal Decree 145/1989, of 20 January, by which the “National Regulation of Admission, Handling and Storage of Dangerous Goods in Ports” is approved.

²¹⁴ Directive 2002/59/CE, superseded in Spanish law by Royal Decree 210/2004, of 6 February, establishes a system of monitoring and information system for maritime traffic.

In process I, the consignee, following the guidelines set out in RD145/1989, notifies PAB of its intention to enter dangerous goods. PAB is responsible for granting this authorization and thus has a decisive role in this process.

Process II sees the participation of three new entities, DGMM²¹⁵, Sasemar²¹⁶ and Safe Sea Net²¹⁷, and involves communication between all entities. In this case, both PAB and PISP are required to work together to maintain communication systems operational. Process III involves communicating the location of dangerous goods and movements out of the cargo terminals.

- **Permission to enter dangerous goods.** Based on the information sent by the consignee, PAB authorizes the entry of dangerous goods into the port. Containers that are not unloaded do not have to be authorized, but the PAB must know of their existence on board the ship. The path followed by this document is: Consignee - PAB - Terminal - Harbour Master. Again, PAB has some responsibility in this process.

The last activity in which PAB is involved before the ship arrives in port is the allocation of berths.

- **Arrival notice:** Just before arriving and having obtained the port of call permission, the ship informs PAB (or the terminal directly) of its imminent arrival. That is when the berthing dock is assigned, setting in motion customs control procedures. In this process, the consignee reports to the entity in charge of notifying the bill of lading²¹⁸ of the ship's arrival. This entity can prepare for clearance any formalities and expense settlements and, if necessary, can request the Border Inspection Services to start their inspection of the goods. Thanks to the "Portic"²¹⁹ platform, PAB receives a digital report of the vessel with the necessary data and passes it on to Customs. Once again, PAB acts as a bridge to transmit data to its final receiver. The information flow is: Consignee - Importer - Customs (or freight forwarder).

As can be seen in Figure 27, PAB is not involved in any activities between the ship's entry and departure. Just after the departure of the ship (although it is not necessary for it to have left entirely), PAB is involved in one last process:

- **Customs declaration:** This is set in motion after the arrival notice has been issued. Having received the data from the vessel, Customs reports the results to PAB. An inspection of the unloaded cargo may then be necessary. PAB is not responsible for either making this decision or carrying out the inspection. The responsibility lies with the Inland Revenue.

To summarize, as can be seen in this first process diagram (shown in Figure 27), five activities in which PAB has some sort of involvement have been identified.

In some cases, PAB serves only as a bridge to facilitate document management and enables certain processes to be expedited. This occurs in the customs procedures where the responsibility lies with the Inland Revenue. PAB is, however, responsible for the communication of the arrival of dangerous goods and the management of entry permits.

Further on, we define how this is managed and a proposed alternative system.

²¹⁵ "Dirección General de la Marina Mercante" – General Directorate of Merchant Navy.

²¹⁶ "Sociedad de Salvamento y Seguridad Marítima" - Maritime Security and Rescue Society.

²¹⁷ Vessel traffic monitoring and information system, connecting maritime authorities from across Europe.

²¹⁸ A document issued by a an agent, to the shipper as a contract of carriage of goods.

²¹⁹ Creation in 1994 of the Telematics Forum, under the Port of Barcelona Quality Plan and the implementation of electronic data interchange (EDI) to complete the "paperless port" project.

The notice of arrival and the customs declaration follow a similar process. PAB only channels the information and has no direct responsibility for the management of these processes. The notice of arrival and berthing assignment are processes that could be carried out and controlled by PAB, but nowadays these processes are delegated to port concessionaires.

Thus, three types of activities have been defined following a review of this first diagram: Those in which PAB has no involvement, others in which it does but is dispensable and a third group related to the management of dangerous goods where its involvement is legally binding. Therefore, from a legal perspective, the mentioned laws give PAB power over the management of certain activities. The introduction of a private management agency therefore requires a modification of the regulatory framework, since from an operational point of view, these activities could possibly be carried out by a private entity.

5.2. Process: Export. Perspective: Administrative

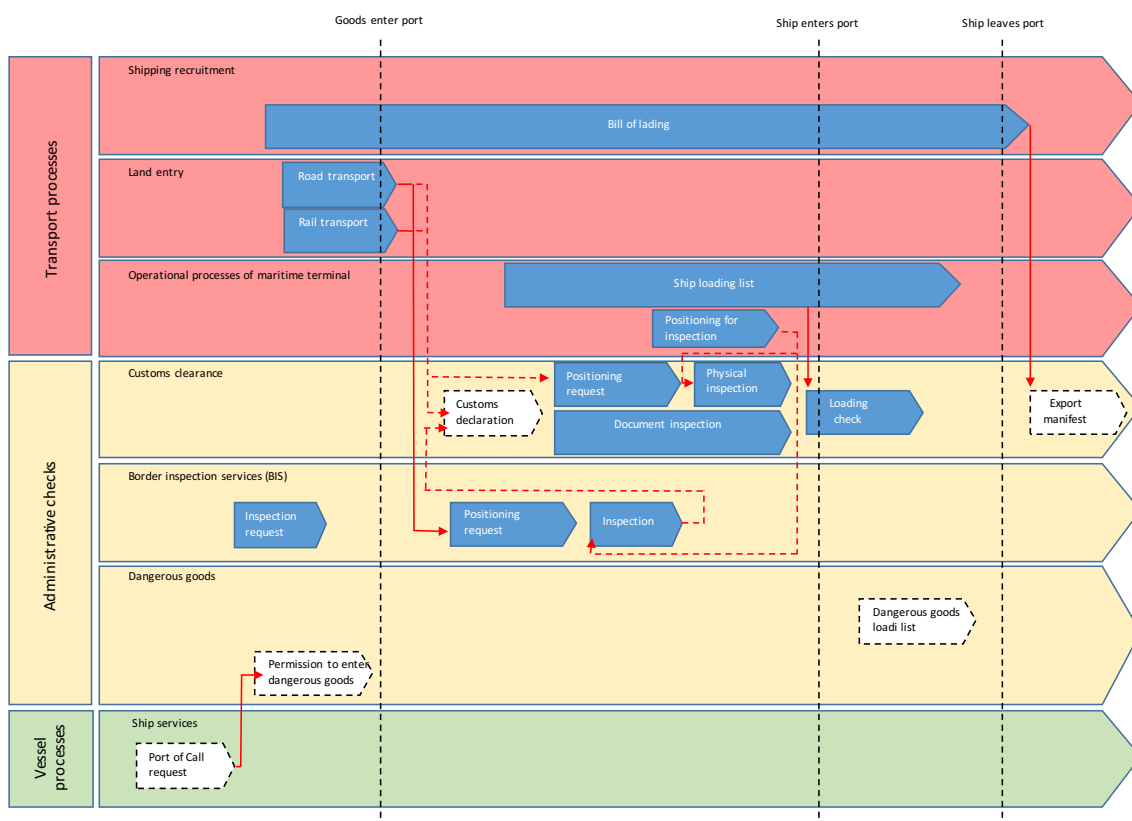
In this process diagram, we define the process of exporting goods from an administrative point of view. In particular, we analyse how PAB is involved in activities defined here. The diagram has been created using the same areas as the diagram shown in Figure 27. However, as an export process, the stages are different and there are differences in the internal distribution of the areas, which is the result of the perspective from which this process is being studied.

In essence, the diagram is very similar but differs from the one shown in Figure 27 in two ways. The first is that, being a process of export, the activities are arranged differently due to the fact that this process is the reverse of the import process. The second is that the three main areas into which the diagram is divided are not exactly the same as those shown in Figure 27. In the case of export processes, there is a new line, corresponding to land entry, in the area of “transport processes”.

This line takes into account what happens when the goods enter the port by road or rail. In the area “vessel processes”, the line “administrative management of port of call” disappears since this process is executed when the ship arrives in port and is therefore set in motion when the goods to be exported arrive at the port.

As can be seen from the top part of the diagram shown in Figure 29, there are three stages. The first corresponds to the arrival of the goods at the port facilities (goods enter port). These goods are stored for an indefinite period until they reach their transport. Therefore, the second stage is “ship enters port” and in the last, “ship leaves port”, the goods are exported by sea, after having been loaded on board.

Figure 29. Export process from an administrative perspective.



Source: PAB (adapted)

There is only one new activity, Export Manifest²²⁰, which is described below. As we are analysing the role of PAB in these activities, the order is not too important if the activity is essentially the same.

- **Export manifest (or waybill):** This report is issued twice a week and details the maritime exports a country has made during, for example, a single year. This document is issued once the goods have left the Community customs territory and not before. It must be presented to the Inland Revenue. This document can be presented directly to the Inland Revenue or through the “one-stop-shop” system, either by a company or an individual. With all the data collected in a given period of time, the National Statistics Institute is able to create a statistics report of the exports carried out by the country. It is, therefore, a vital document for the control of exports.

To summarize, from this process diagram, we can see that there are five activities in which PAB has some degree of participation. Four of these activities had already been characterized in the previous section and essentially are the same.

The only difference is the order in which they are executed. As we are analysing an export process, it can be considered virtually the reverse of the import process. We can also establish the same considerations and conclude that PAB acts merely as a bridge to pass on information or as an entity that should be reported to but that has no responsibility for the activity.

²²⁰ As defined by the Spanish Inland Revenue, the export manifest (or waybill) aims to verify the effective removal of the goods. The manifest must be unique to each vessel and include all goods that have been loaded in the same port (EEC Regulation 2913/92 and EEC Commission Regulation 2454/1993).

Nevertheless, one activity does not appear in Figure 27 and therefore has required a detailed analysis. This activity maintains the same consideration as the four carried out before, as the waybill can be presented directly to the Inland Revenue. However, as in the previous section, for the export manifest, it can be seen that Spanish legislation and the Community to a certain degree require the involvement of the Port Authority in this activity.

Therefore, a private entity could not carry out this activity in Spain without prior modification to the regulatory framework.

5.3. Process: Import. Perspective: Transport

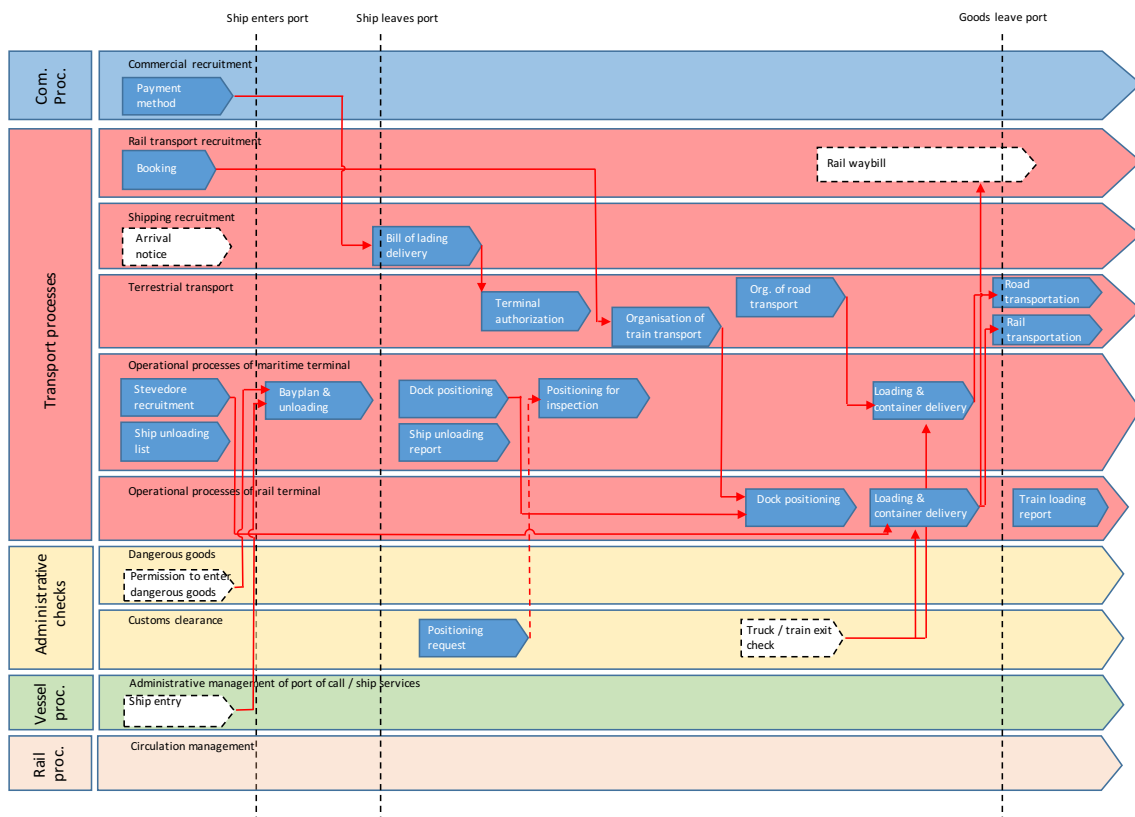
In this section, we analyse the processes from the perspective of the use and management of transport. As shown in Table 54, these process diagrams involve a fundamental change in the distribution of the areas. Two new areas are:

- Commercial processes: PAB is involved in the transport entering or using the port. It is, therefore, also responsible for the marketing of those services.
- Rail processes: This refers to the control and management of domestic rail traffic from the perspective of interference with road traffic.

Accordingly, this diagram is more complex than previous ones as it consists of a total of five areas. However, the methodology for allocating the stages is analogous to that carried out above for the import process from an administrative perspective. First, we consider the arrival of the ship in the port, then the ship's departure and finally the removal of the goods from the port after having been checked.

Given the complexity of the diagrams, no legend box has been included detailing those activities carried out by PAB and those in which it does not have any involvement. Since the methodology is the same for all the process diagrams, how each type of activity is represented can be seen in Figure 27.

Figure 30. Import processes from a transport perspective.



Source: PAB (adapted)

As can be seen in Figure 30, PAB is involved to a certain degree in five activities. In this diagram, we analyse the import process from a transport perspective.

Therefore, although the activities have the same name and are essentially similar to those presented in the previous diagrams, there are some differences:

- **Arrival notice:** This particular activity is exactly the same as in other processes as it generates the same type of documents in terms of administration and transport. It only consists of a notification to the port detailing the arrival time and conditions of the ship. The cargo or its danger are not detailed as this is carried out in another activity. The role of PAB in this activity is as described before.
- **Permission to enter dangerous goods:** As this involves PAB, which is being analysed in this study, this process can be considered analogous to that defined for the administrative process. However, from a transport perspective, this process is not exactly the same. The essential difference is that this activity can set in motion the physical movement of the control systems responsible for checking the cargo. Since PAB is not directly responsible for this process and only notifies the State Security Forces, its role is the same as previously described.

Having defined those activities considered similar or identical to those characterized previously, we will now analyse the new activities. These do not appear in the previous diagrams or, if they do, are considered substantially different:

- **Vessel entry:** To start the operation of unloading the containers, the ship needs to be docked at a pier. The port concessionaire is responsible for this activity as it is responsible for confirming that the ship is actually moored at the berth assigned to it.

- **Rail waybill:** This document is referred to as the “Carte de Porte, or CIM”²²¹. Essentially, it communicates what is being transported by rail (Rodrigo de Larrucea et al. 2012). It is similar to the Export Manifest discussed above. From the point of view of imported goods, the idea is to check the goods leaving the port by rail and to keep track of the volumes of each good in order to generate import statistics. In terms of the transport contracts, it is an essential document for international trade dealings. This document is created by the rail-transport operator and serves all parties involved in rail transport. It is only sent when the rail operator has been able to validate the cargo transported by the train. In Spain, this document is sent to the rail terminal, RENFE²²², ADIF²²³ and the destination terminal. Again, the only function of PAB in this activity is to channel information.
- **Truck/Train Exit Check:** The container cannot leave the terminal without the Spanish Inland Revenue being satisfied that the goods being transported have a corresponding release document²²⁴. The Spanish Inland Revenue is responsible for giving permission for the container to leave the terminal. We believe that PAB has no direct involvement in this step. As defined in the Port of Barcelona Quality Plan, this activity sets in motion the actual removal of containers from the terminal, but authorization is given by the Civil Guard²²⁵, not PAB.

In conclusion, this process consists of activities in which PAB is not involved or simply acts as a bridge. As for previous processes, there are other activities that require a detailed study since PAB itself has a direct and obligatory involvement in accordance with Spanish legislation.

5.4. Process: Export. Perspective: Transport

Finally, we now take a look at the process diagram detailing the export process in terms of the use and management of transport.

As in the previous process diagram, the legend has been removed to facilitate understanding. The diagrams shown in Figure 27 and in Figure 29 contain the same legend, which is applicable to the one shown below in Figure 31.

As shown in Figure 31, this process includes five activities in which PAB is involved.

²²¹ Document proving the contract of rail transport. It is defined in Articles 11, 12 and 13 of Appendix B of COTIF (Convention Concerning International Carriage by Rail). It applies to Europe, the Maghreb and the Middle East as of July 1, 2006.

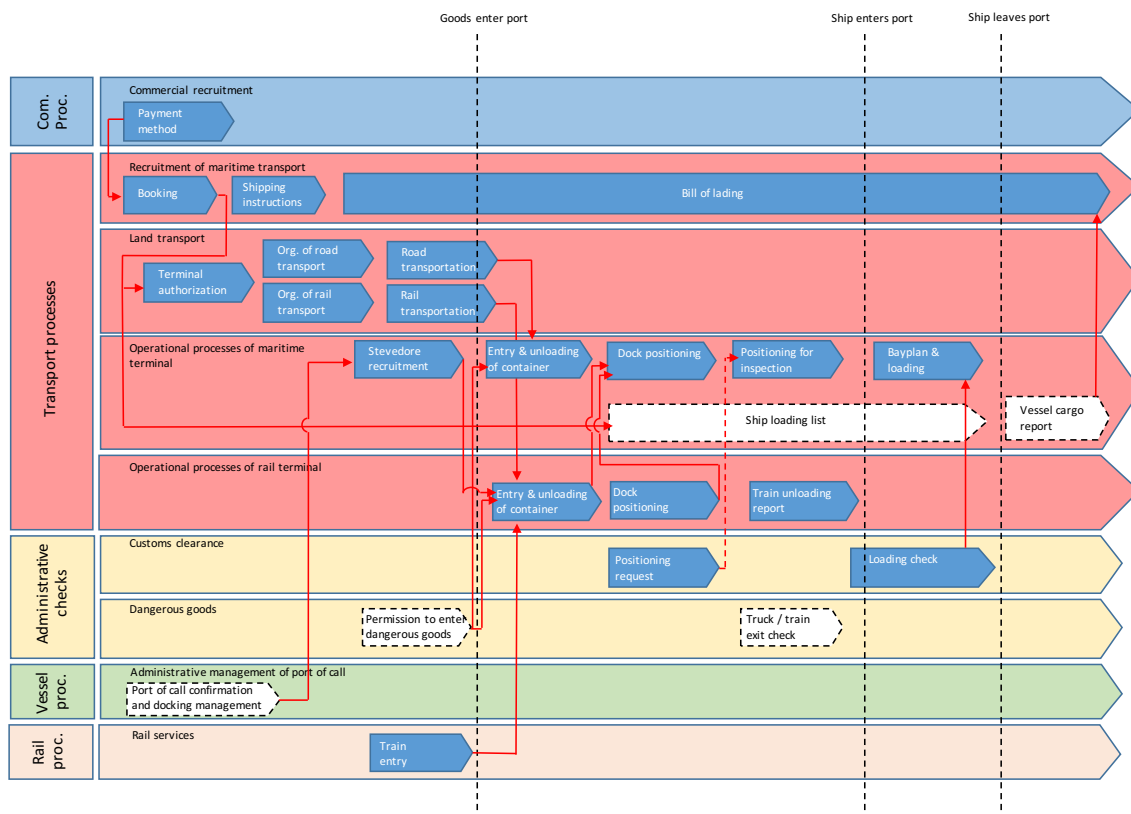
²²² RENFE is the acronym for “*Red Nacional de Ferrocarriles Españoles*” and is the state-owned company which operates freight and passenger trains.

²²³ ADIF is the acronym for “*Administrador de Infraestructuras Ferroviarias*” and is a Spanish state-owned company under the responsibility of the Ministry of Public Works and Transport, which is charged with the management of most of Spain’s railway infrastructure.

²²⁴ According to the Valencia Port Community System, the release document is a procedure by which the Civil Guard carries out checks on all transported goods leaving the port customs area by land. No cargo must leave the port without proper customs clearance.

²²⁵ According to the Organic Law 2/1986 of 13 March on Security Forces of the State (Article 12 paragraph b, letter b), the Civil Guard enforces the tax laws and takes actions to prevent and prosecute smuggling.

Figure 31. Export processes from a transport perspective.



Source: PAB (adapted)

We know from the analysis of the above diagrams that PAB should actively participate in activities related to dangerous goods. Therefore, the activity “Permission to enter dangerous goods”, which is executed in exactly the same way as for previous diagrams, will be discussed in a chapter dedicated specifically to this subject.

Only 4 activities will therefore be analysed here. The order of analysis corresponds to the stages of this process, which, as it entails the export of goods, consists of Goods Entering Port, Ship Entering Port (to collect the goods) and Ship Departure, which is when the ship leaves port loaded with the goods.

- Confirmation of Port of Call and Docking Management:** We have spoken before of “Port of Call” when we looked at Figure 27 and “Docking Management” was discussed under the “Arrival Notice” when analysing imports from an administrative perspective. However, this step includes these two additional activities and is significantly different from the processes involved in the Port of Call and Docking Management described previously, as it has no direct involvement with the port of call management or berth allocation. Rather, this step entails checking that the vessel has requested a port of call and has been assigned a berth number, as described in section 5.2, and is required for hiring stevedores. The terminal only hires out stevedores to load/unload vessels that have confirmed their call at the port to the public company Estibarna²²⁶.

²²⁶ Estibarna, founded in 1986, is stevedoring company located in the Port of Barcelona. Stowage Societies provide skilled workers to stevedoring companies. In Spain, by law, the loading and unloading of goods must be carried out by stevedores hired to stevedoring companies. Only companies that manage their own goods can use their own labour for unloading.

The role of PAB in this step is only to channel information, since it has no power of decision.

- **Ship loading list²²⁷:** In this step, the consignee informs the maritime terminal of the cargo it intends to ship. In turn, the maritime terminal notifies PAB in order to compare information and to check whether there are any dangerous goods in the cargo. The step prior to this is referred to as “booking”, as the containers to be loaded onto the vessel need to be confirmed in order to reserve container space, which is issued by the freight forwarders / customs brokers. From the definition of this step, it can be deduced that if the business model changes, it is not strictly necessary for PAB to be involved since it currently only serves to validate information.
- **Vessel cargo report:** The maritime terminal sends the report detailing the actual cargo loaded on board the vessel. This occurs when the ship is fully loaded and all operational processes have completed. This is a fundamental activity that activates the issuing of the bill of lading. The bill of lading is a document issued by the consignor that guarantees that the loading company has delivered the goods on board the ship. With it, the title of such goods is awarded, pursuant to the relevant Incoterm²²⁸.

The fourth activity shown in Figure 31 (Truck/Train Exit Check) is exactly the same as described for the import process transport perspective (Figure 30). In short, once again, the only step executed by PAB is the management of hazardous goods.

All others may be carried out perfectly adequately by a separately managed port authority, since PAB only serves to channel information to its final destination. In these steps, PAB has no real power of decision.

6. ACTIVITIES IN WHICH PAB INVOLVEMENT IS OBLIGATORY

Throughout this thesis, a series of activities in which PAB has some degree of participation in import/export processes have been defined and characterized. It has been shown that, in some of these activities, PAB acts as a bridge to channel information to its final destination. This final destination corresponds to the entity responsible making decisions in these steps.

A series of activities related to the management of dangerous goods has also been defined in which the participation of the PAB is obligatory. In this section, we review Spanish legislation in order to determine who bears the ultimate responsibility for decisions in cases where it is necessary to handle dangerous goods. The aim is to establish whether PAB participation is a legal necessity or is only related to operational issues.

Royal Legislative Decree 2/2011²²⁹ gives Spanish Port Authorities the necessary general powers and competences. In turn, Law 2/2012²³⁰ consolidates the existing rules regarding the State Ports and Merchant Marine Law.

²²⁷ This procedure is defined in the PAB procedure document “Lists of loading / unloading”, version 1.4, April 2013.

²²⁸ Incoterm is the acronym of International Commercial Terms. The latest version dates from 2010. They are rules (not laws) accepted internationally and are intended to contribute to the legal certainty of international transactions of sale of goods.

²²⁹ Royal Legislative Decree 2/2011 of September 5, by which approves the revised Law of State Ports and Merchant Marine.

²³⁰ TRLPEMM – “*Texto refundido de la Ley de Puertos del Estado y de la Marina Mercante*”; Law 2/2012 of 29 June on General State Budget for 2012 that fulfils the mandate of consolidating the laws of ports established by disposition 6 of Law 48/2003 and subsequently by disposition 7 of Law 33/2010.

With regard to the activities described in this chapter and according to the principle of functional autonomy and management²³¹, Port Authorities must carry out, among others, the following functions²³²:

- Manage the common services and maritime signalling, and authorize and control the port and commercial services.
- Coordinate the activities of the administrative bodies conducting business in the port.
- In the port area, ensure compliance with the rules on dangerous goods²³³, security systems and protection against terrorism and antisocial acts²³⁴, and fire and emergency prevention and control.

Activities in which the involvement of PAB is obligatory include those that deal with the management of hazardous goods. The law²³⁵ states that the Harbour Master may admit ships carrying dangerous goods. In turn, the port director has the authority to accept dangerous goods in the port service area.

The same law stipulates that certain prohibitions may be established to prevent the entry into a port of a ship or the confiscation of a cargo on port territory if it is considered unsafe or violates any of the provisions of law.

In short, Spanish legislation gives the Harbour Master and the Port Director certain responsibilities for the management of dangerous goods. In Spain, these two key figures would represent an obstacle to the implementation of a private management model, as “*ports of general interest*” must be publicly owned and, as such, their employees must be in some way be linked to the Public Administration.

However, it should be noted that while both the Port Authority and the Harbour Master are under the same Ministry, they are administered by separate entities. Port authorities depend on the Public Institute of State Ports (PISP), which in turn depends on the Ministry of Public Works and Transport (MPWT). The Harbour Master, however, depends on the Directorate General of Merchant Marine (DGMM)²³⁶, which also in turn depends on the MPWT.

They are, therefore, two different management entities and for the purposes of this investigation will be treated differently. Figure 32 shows relationships between these entities.

²³¹ Article 24.3 of TRLPMM.

²³² Article 26 of TRLPMM.

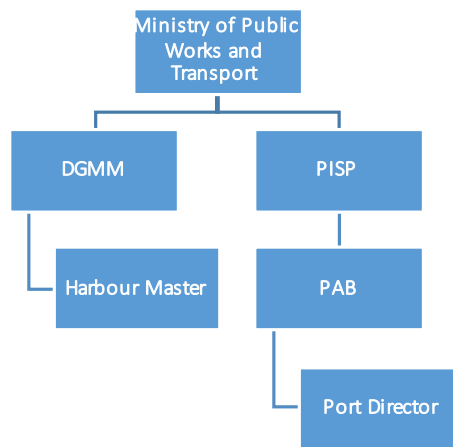
²³³ Royal Decree 145/1989, of 20 January, by which the National Regulation of Admission approves the handling and storage of dangerous goods in ports.

²³⁴ Each Port Authority approves a plan for the protection of ships, passengers and goods as part of the Port Ordinances set out in Article 65.3 of TRLPMM, as established by Royal Decree 1617/2007, of 7 December, establishing measures to improve the security of ports and maritime transport. It also decides on the application area in the port of Regulation (EC) 725/2004 of the Parliament and of the Council of 31 March 2004, on improving the security of ships and port facilities.

²³⁵ Chapter 1.3 (Powers of Port Authorities), Article 4 (Powers for admission and limitations), Royal Decree 145/1989.

²³⁶ Law 27/1992 on State Ports and Merchant Marine designates in Article 88 the Harbour Master as a peripheral body of the Maritime Administration. Royal Decree 638/2007, of 18 May, which amends the Maritime Captainty model set out in Royal Decree 1246/1995, of July 14, maintains the dependence of the Harbour Master on the Directorate General of Merchant Marine. Currently, this figure has exclusive functions dedicated to shipping and vessel monitoring.

Figure 32. Harbour Master and Port Director control hierarchy.



Source: Author

7. CONCLUSIONS

This study has used the Port Authority of Barcelona (PAB) as an example to define import and export processes and to determine those stages in which the involvement of PAB is obligatory. Every Port Authority worldwide is granted different powers and their involvement in port processes vary as a consequence. Therefore, this study cannot be applied generically.

We have been able to confirm that, in contrast to that initial believed, there are indeed activities that must be carried out by PAB and Spanish legislation takes them in account when it determines the power of the Port Director to make decisions regarding dangerous goods. However, the legislation does not state that the Port Director must be a State official. It states that PAB must be a public entity. Therefore, there may be a loophole that would allow the Port Director to be a commercial worker contracted by PAB, as, currently, are other others.

The model presented here would be difficult to implement in Spain as any discussion regarding the powers of the Port Director and his/her recruitment would probably be futile. However, this chapter aims to define the activities involved in the import and export of goods, which are the most important flows of goods that a port handles. Having completed this analysis, it is clear that there are a series of legal factors in Spain that would prevent the implementation of the business model set out in this thesis.

This would only be possible if there were a change in the legislative framework, something that occurs occasionally when countries open their doors to certain actors when experiencing shortages; for example, when there is not enough financial muscle to back investments in infrastructure and the doors are opened to the creation of PPPs with foreign capital.

Nevertheless, our intention in this chapter has been to conduct a more general analysis and to determine what steps should be taken to allow this business model to be implemented in any country.

Beyond the legal determinants specifically identified for the particular activities described in this chapter and previous chapters, it is important to point out that the implementation of the business model described in this thesis would depend, as in any commercial exploitation, on the economic outcomes and the profit forecasts of the various participants.

It is therefore essential to understand the processes described here in order to not only optimise them and to improve their efficiency, but also to analyse how the business itself should addressed, something which is discussed in the following chapter.

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9

Economic and financial analysis of the operation of a port terminal

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1. AIM

The purpose of this chapter is twofold. First, to define the relationships between the various agents involved in the port business model described (developer, concessionaires, builders and end users). Second, to establish the economic flows that exist between them in order to determine the basic parameters that govern the model.

An algorithm is then developed, which may be supplemented by various modules (e.g. the environment), that allows the analysis of participant-generated income and its regulation, based on certain established conditions (traffic, rates, etc.) in order to prevent large inequalities.

2. CHAPTER ORGANIZATION

The introduction to this chapter aims to differentiate the two investments that have to be made in order to build a port: investments in infrastructure and superstructure. We also briefly review the history of the port concession model and how it came about.

In section 4, we define the entities involved in the economic processes necessary for the operation of the business model and the relationships between them.

In Section 5, we consider the prices that concessionaires can charge end consumers. In Section 6, we discuss the influence of demand on the mathematical model and then, in section 7, we analyse the two investment types.

From there, section 8 discusses which rates the PA may charge to concessionaires and, consequently, the revenues and expenses of each participant (section 9).

In section 10, we take a look at the funding needed to undertake these investments. Yields and IRR are discussed in section 11 and finally, the feasibility of the model is evaluated in section 12.

3. INTRODUCTION

During the 19th century, thanks to the introduction of steam as a new system of propulsion for ships, tonnage and load capacity underwent an exponential increase that forced port facilities to modernize. For a time, the specialization of the machinery used in port activities was a general issue (Biere Arenas & Almirall Garcia 2003).

The increase in the size of ships has been more pronounced in the last ten years than at any other time, growing from a capacity of just a few hundred containers to the current vessels capable of housing up to 18,000 or even 22,000 (Fernández 2009).

In this context of growth and improvement in capacities, port business models have also undergone gradual changes that have allowed them to adapt to the new needs. The technological evolution of maritime transport has increased the demand for port facilities able to manage those technologies (Ramos-real & Tovar 2010).

Originally, ports were designed by nations as hubs intended to boost trade and to allow the interchange of marine and land modes of transport. The implementation initiative was usually public, as was the management of the ports as a whole. The investments made were therefore assessed in two ways: through the evaluation of the cash flows generated and, in particular, by measuring the socio-economic impact of the port on its hinterland²²⁶, or area of influence (Brooks 2000), (Cariou 2001), (Haralambides et al. 2002).

²²⁶ According to the Oxford Advanced Learner's Dictionary, Hinterland refers to the remote areas of a country away from the coast or the banks of major rivers.

Over the years, and forced by the constant need to increase the efficiency of port services, public authorities have been replaced by private managers. According to the ESPO²²⁷, international private operators of container terminals²²⁸ are known for their efficiency in the management and operation of terminals (Reeven 2010). Moreover, they seek to establish a consistent cash flow rhythm that allows them to obtain an economic profit in a given period of time.

For those new port operators, the induced economy²²⁹ generated within the port area plays an increasingly minor role.

Nowadays, the implementation of a public initiative port²³⁰ only makes sense if certain socio-economic impacts are pursued. Moreover, an important limitation is that, since the advent of the fifth-generation vessels (Post Panamax²³¹ or older), ports must be deepwater seaports in order to accommodate these types of ships (Roa-Perera et al. 2013).

Therefore, investments suffer greater economic tension since greater investment is required in order to dredge deeper.

From the point of view of a private entity, any initiative follows strictly economic criteria. However, these participants leave the door open to interactions with the public sector. For example, asking the municipality affected by the port activity to manage accesses as compensation for the induced economic impact, because this is considered a strategic element by the port sector (Wan & Zhang 2013).

Figure 33 shows the investments made in the construction of a port and the usual period of maturation of each.

²²⁷ ESPO is the acronym for European Sea Ports Organization. In 1974, the European Commission set up the Port Working Group, consisting of port authority representatives of Europe's major ports. In 1993, the European Sea Ports Organisation was born out of this working group as an independent lobby for seaport interests (<http://www.espo.be/>).

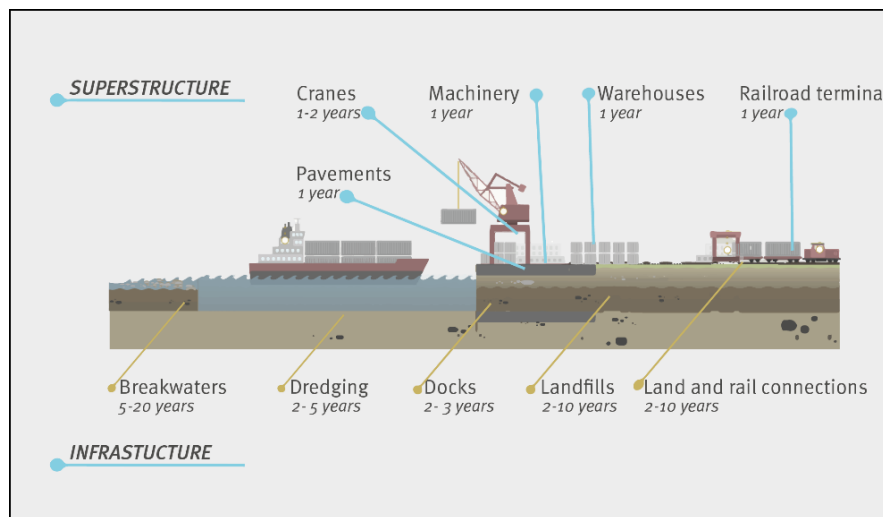
²²⁸ Also named Transnational Operating Companies or TOCs

²²⁹ We define induced economy as the *generation of business that occurs around a node*. In this case, to that which it is generated around a port through other activities and the economic flows that are generated within the shelter of the port itself.

²³⁰ We use the term "port" to refer to the set of terminals that handle loads of the same kind or different and that use the services provided by the port authority managing the site.

²³¹ The Panama Canal began operating in 1914. Vessels using it should not be greater than 294.13 m (965 ft) in length, 32.31 m (106 ft) in width and 12.04 m (39.5 ft) deep. Otherwise, they would not be able to use the Panama Canal facilities. In 2009, the Panama Canal Authority published the dimensions for Post Panamax vessels. The authority began constructing a third lane of locks greater than 427 m (1400 ft) in length, 55m (180 ft) in width and 18.3 m (60 ft) in depth to accommodate larger ships.

Figure 33. Investment in a port and normal maturity time



Source: adapted from (Empresa Portuaria San Antonio 2009)

As can be seen, there are two types of clearly defined investments:

- Infrastructure: Long-term investments in common elements. We also consider infrastructure to be works carried out in the elements that constitute the platform on which will each concession²³² be settled. Without these elements, no activity could be developed in the port. They are usually carried out by the developer.
- Superstructure and machinery: elements of the specific activity of the concessionaire. This is a short-term investment.

Each country, port, or even industrial era determined the allocation of investments made (Montero-Garcia 2007). During the earliest years of an industrial development, the private sector was only responsible for the land operation of the load. Ports were not conceded and berths were allotted according to the needs of each particular moment. As the workload management represents 80% of the cost when a vessel arrives at port (Ramos-real & Tovar 2010), the efficient management of the goods became a fundamental pillar of the business and priority was given to the implementation of certain types of facilities that helped to this end, thus gradually enhancing the economic performance of the developer.

Thus the concession model came about and the private sector, which is more efficient (Guasch 2004), began to take charge of everything specific to its activity (cranes, warehouses, equipment, etc.). In other words, the concessionaire had to plan investments in superstructure. During the third stage, the private sector begins to undertake investments in ports and fillings, with the result that public intervention becomes increasingly less necessary. Although there is no single universal model, the trend is increasingly towards the application of the Landlord, whereby a port authority concedes spaces to private operators (Ramos-real & Tovar 2010).

The forecasts point to growth in the market over the next few years greater than has been seen over the last one hundred (Brooks 2000). There will, therefore, arrive a time in which a wholly private entity specialized in the management of this type of infrastructure will be responsible for all of the necessary investments.

It is a fact that shipping companies view the holding of concessions as one of the key aspects of their business (Notteboom & Merckx 2006). We will therefore attempt to explain this type of wholly-private ownership of all the investments necessary for the creation and exploitation of

²³² A concession is the granting of exploitation rights for a certain period of goods and / or services by a public authority or company to another, usually private.

container terminals, aware that the public sector will adapt to the demands of the market (De Borger & De Bruyne 2011) and, as a result, could allow the situation described.

The reason we focus on the container terminal is that it is a growing market. Evidence of this is that container traffic increased from 36 million TEUs moved in 1980 to 237 million in 2000, increasing to 549 million TEUs in 2010 (Yang et al. 2012). Similarly, since 2000, both the accumulated supply and accumulated demand have experienced sustained growth, with a yearly average increase of 9.9% and 10.4%, respectively (CEPAL 2012). Therefore, it is a market with an upward projection.

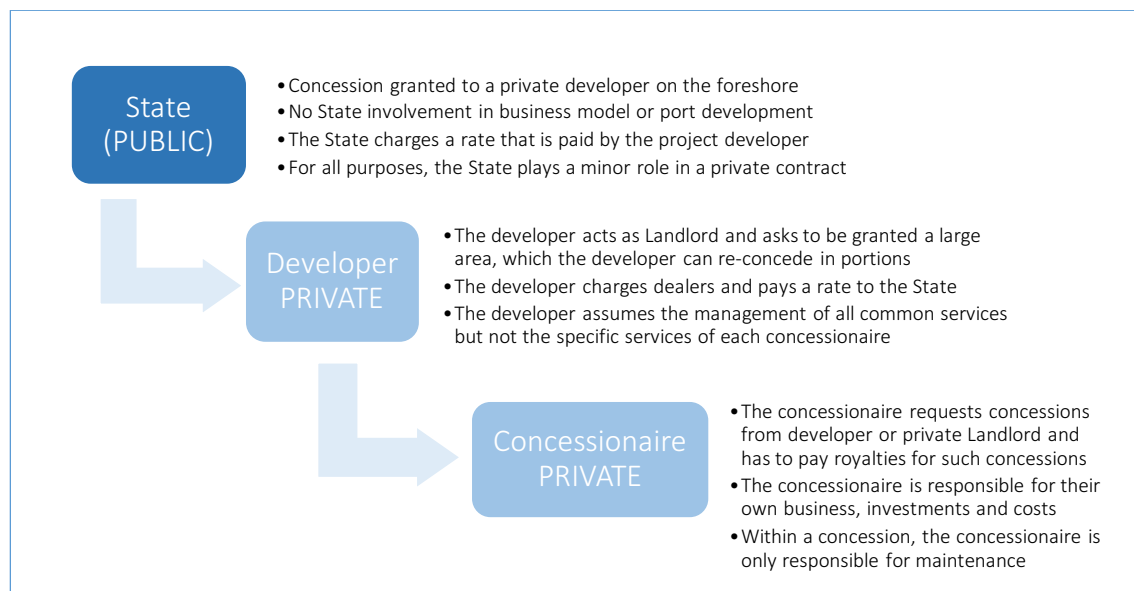
On the other hand, this approach forces us to look at the business from a purely private perspective. This is due to the current support for initiatives that bring capital from non-nation entities, which are more agile and flexible and base their business culture on the advantage of the first to arrive, optimum port planning and the diversification of the roles played by ports (CEPAL 2014).

4. METHODOLOGY

4.1. Characterization of entities and interrelations

Firstly, we must study the underlying relations between the major players in the model and their origin. We will consider the land adjacent the sea to always be public. Therefore, although we intend to study a unique and wholly private participation model, there will always be a public entity that holds title to the land, but that is not involved in the business. Figure 34 shows the role of the public body.

Figure 34. Concession cascade structure



Source: Own analysis

The main players in this model are the developer and the concessionaire. The State and a construction company, who are responsible for financing the execution of the works, will be treated only as secondary players. We will only come back to them when it is strictly necessary to explain the economic flows that affect them. Table 55 shows the interrelationships between the different economic agents²³³, taking into account how revenues²³⁴ and costs of each are

²³³ Economic agents are those involved in the economic flows of this model (end customers of the port, container concessionaire, project developer, construction company, etc.)

related. The cells connected by arrows and whose outline is the same have direct relationships. For example, the table specifies that the container handling service income for the port concessionaire (first row, second column) represents a cost for port end customers (second row, first column).

²³⁴ According to the Oxford Advanced Learner's Dictionary, revenue is an income, especially when of an organization and of a substantial nature.

Table 55. Interrelationship between economic agents in terms of income and costs.

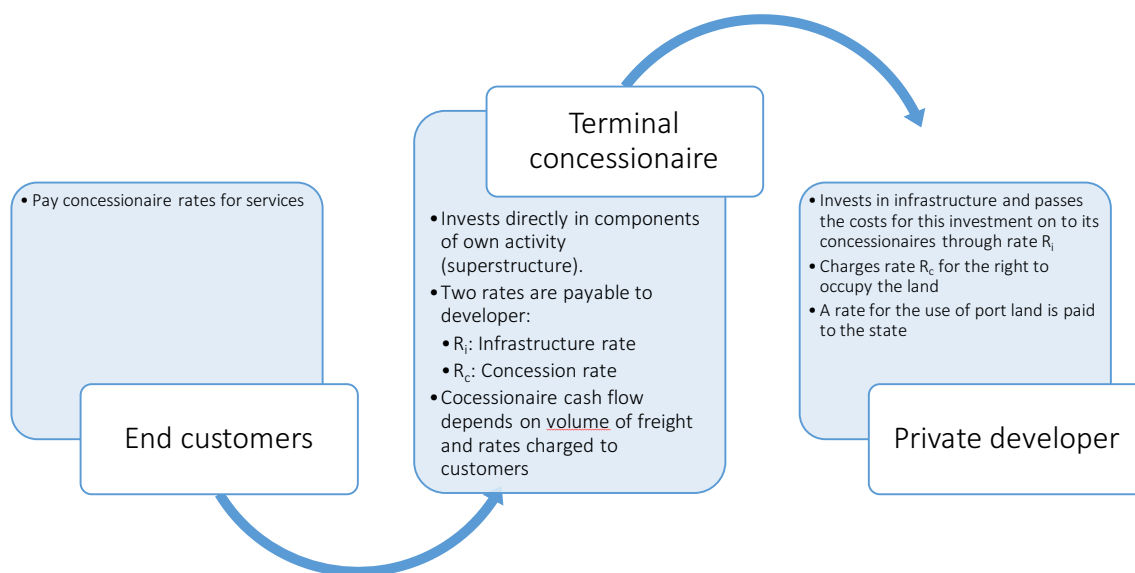
Inter-relations	Port end Customers	Container Terminal Concessionaire	Developer	Construction company	Public Entity PE
Incomes		Container Handling Services Charge – end customers	Developer common investments Rate R Charge – from Concessionaire Use of Concession Rate Charge – from Concessionaire	Developer common investments charge – from Developer (only in the case that the construction company funds the works)	Use of Concession Rate Charge – from Developer
Costs	Containers Handling Services payment to Concessionaire	Developer common investments Rate R Charge – from Developer Developer common investments Rate R Charge – to Developer	Amortization of the common investments done by the Developer and carry-out by the Constructor	Cost of the common investments – to Developer	
			Rate payment to the PE for the use of the concession – to the PE (not R, but a different rate)		
		Own Terminal Costs (Exploitation, maintenance and reposition) Concessionaire own investments Amortization Financing Interests	Financing Interests Workforce and structure costs that belong to the Developer		

Source: Own analysis

From Table 55 Source: [Own analysis](#), it is also possible to note other examples of this detailed relationship as indicated by the arrows. For example, what we consider income for the public entity for the use of the concession represents a cost to the developer. In short, this chart shows graphically the relationships established between the entities involved in the port business model defined.

However, it is also important to define the main economic flow. As in virtually all businesses, the consumer ends up paying, one way or another, for all the costs associated with the operation and exploitation of both the terminal and the port. This is paid to the concessionaire in the form of rates. These rates are used by the concessionaire to pay the PA, to pay for superstructure investments and to generate a profit from the surplus. In turn, the concessionaire must pay rates to the PA. Figure 35 Shows a graphical representation of the defined economic flow.

Figure 35. Main economic flows



Source: Own analysis

4.2. Rates according to movement of containers

Concessionaires charge end customers an amount determined by the workload, management and other services that form part of trade relations with its customers. It is extremely difficult to define a output value for the rate for container movements, since it depends on several factors (United Nations & Korea Maritime Institute 2002) including:

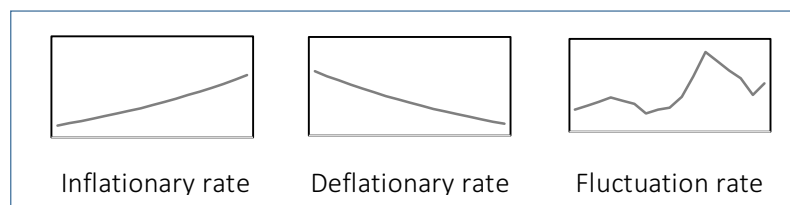
- The size of the ship; the larger the vessel, the lower the cost due to the fact that fixed costs are shared among more container units
- Cost of the route
- Cost of navigation in an specific area
- The navigation itself
- The variability of the freight rate²³⁵, which is subject to the conditions of a changing market and which exceeds demand.

²³⁵ There is an important future market for freight. Agents buy capacity on ships many months in advance. The freight is a very technical market that is governed by the law of supply and demand and has indices that predict future recessions or stoppages of the economy (Baltic Dry Index, for example). At present, there is overcapacity because there are many large container ships. Therefore, the price of freight is currently set.

- The time²³⁶ the container spends in the port, etc.

Therefore, the rates charged by the concessionaire at any moment during the project will be based on the factors listed above and their calculation is beyond the objectives of this thesis. However, three possible scenarios have been taken into account generically: inflationary, deflationary and fluctuating rate. This refers to the trend of the rate projected over a certain number of years. In the first case, the rate increases over the years (inflationary scenario). The opposite occurs in the second case (deflationary scenario) and the latter scenario assumes that the rate will suffer considerable ups and downs throughout the lifetime of the project. Figure 36 shows a graphical representation of the three scenarios of the potential evolution of rates over the years.

Figure 36. Potential scenarios for the rates evolution



Source: Own analysis

For the purposes of mathematical formulation, only a single index, Φ , associated with the rate, will be introduced to represent the correction factor in equation 14. Thus,

$$\varphi_j = \Phi_j \Gamma_j \quad (14)$$

$\varphi_j = \Phi_j \Gamma_j$ Where:

Φ_j : Correction of the rate in year j

Γ_j : Rate in year j

φ_j : Total value of rate in year j

Using this equation, the mathematical model is able to incorporate fluctuations in the rates charged by the concessionaire.

4.3. Determination of demand

Determining demand is the most important of the hypotheses, as it is the measurement that directly affects the concessionaire trading account and, therefore, determines whether the developer can set this rate. Empirical data can be obtained for certain parameters that affect demand. For example, maritime traffic increased during the early years of the 21st century by approximately 3.9% per annum (González-Cancelas 2007). Historical series and projections over a certain number of years, based on estimates of world GDP²³⁷, USA GDP, the advanced economies of the Euro area, the newly industrialized economies in Asia, auto-regressions, etc., can also be obtained (International Monetary Fund 2014). However, determining the demand requires a thorough study of the port environment to be developed by the developer and the competition in the area. Given that costs tend to be reduced in competitive markets, especially for a port that uses the same channels and has the same constraints as other nearby ports (Reeven 2010), it is of vital importance to properly define the stage of competition.

²³⁶ Due to import and export processes and all the activities involved

²³⁷ GDP is the acronym for Gross Domestic Product. It is the most widespread way to measure a nation's total economic activity. It represents the monetary value of all goods and services produced within a nation's geographic borders over a specified period of time.

This characterization is based on the study of demand²³⁸, which goes beyond the objectives of this thesis. This study of demand cannot support a static figure, but generates various scenarios:

- Pessimistic: If only a small portion of the total number forecast by the demand study can be captured
- Realistic: If the calculated demand can be captured exactly.
- Optimistic: If a greater demand than shown by the studies can be captured.

These three scenarios are usually subjected to a reliability study in order to guarantee mathematical rigor and provide reliable data, which is, in any case, always an estimate. In our case, given that we do not have access to a demand study, we will consider this demand (δ) to be an independent variable.

Depending on the value of demand (δ), the terminal will be built for certain capacity (ζ). This will condition the investments necessary to perform the design (ι). Therefore:

$$\iota = f(\zeta, \delta) \quad (15)$$

Equation (15) indicates that investments are based on the capacity of the terminal and its projected demand.

The demand study to be developed to implement a container terminal gives specific figures for each particular situation. The realization of this study is not part of the objectives of this study. However, what happens to demand throughout the first years will be considered. This is conditioned by the Ramp-Up, Δ , of the project.

The Ramp-Up is the speed with which the terminal is able to capture the demand for which it is designed in each phase of the project. Both works on infrastructure and superstructure have a considerable construction period, which can sometimes reach up to 3 to 5 years. During this time, the terminals can begin to manage cargo in designated areas on a provisional basis. These areas become progressively larger and better equipped as the work advances. This progressive advance in the capacity of the terminal to manage the amount of load for which it is designed determines the Ramp-up.

In the present study, the Ramp-up is set between 0 and 1, which will penalize the revenues (μ) of the concessionaire, since it is not possible to manage all the load for which the terminal is designed from time zero.

$$\mu = \sum_{j=1}^n (\delta_j \times \varphi_j \times \Delta_j) \quad (16)$$

Where:

Δ_j : Ramp-up in year j; $0 \leq \Delta_j \leq 1$

n : Number of years

Equation (16) shows the relationship between demand (δ), the value of the rate (φ) and the ramp-up (Δ). The combination of these three factors affects the calculation of the revenues (μ).

²³⁸ A study of demand includes the analysis of the load-sensing ability of a container terminal. To do this, several factors are taken into account, including the competition in the area under study, the need for load flow of the port area of influence, fluctuations in the freight market, the economic conditions of the country, etc. It is therefore a complex study that gives particular values for each specific situation.

4.4. Investments

In the present study, only two types of investment are considered: infrastructure (carried out by the developer) and superstructure (carried out by the concessionaire, because it is specific to the concessionaire activity). Table 56 shows some of the investments divided by group.

Table 56. Investments per stage and execution phases. Source: Own Analysis

Description	Symbol	Type of Investments
Dredging	β	Infrastructure
Container wharf		Infrastructure
Breakwater		Infrastructure
Jetty		Infrastructure
Fillings and esplanades		Infrastructure
Containment wall		Infrastructure
Equipment (Defences, Bollards, etc.)		Infrastructure
Wharf and esplanade auxiliary equipment	ξ	Superstructure
Buildings		Superstructure
Electrical installations		Superstructure
Civil work – net services		Superstructure
Berth		Superstructure
Berth equipment		Superstructure

Source: Own analysis

Total investments in the infrastructure (β) are the sum of all investments in infrastructure. Similarly, total investments in the superstructure (ξ) are the sum of all investments in superstructure, as shown by Equation (17):

$$\beta = \sum_{\alpha=1}^p \beta_{\alpha}; \quad \xi = \sum_{\gamma=1}^q \xi_{\gamma} \quad (17)$$

Where:

β, ξ : Infrastructure or superstructure

α, γ : Year in which the investment is studied

p, q : Limit year for each stage of investments

Therefore, as shown by Equation (18), both investments in infrastructure (β) and those related to superstructure (ξ) are a function of demand (δ) and capacity (ς).

$$\beta, \xi = f(\varsigma, \delta) \quad (18)$$

4.5. Rates

Once the amount of investment is known, who pays for it and how needs to be analysed. The economic flows of the model are based on the rates charged by the port authority for the right to occupy an area or to carry out an activity. A more specific breakdown could be carried out to include more specific rates, but the essence of the model can be explained solely by reference to infrastructure and concession rates. In any case, other rates that a port authority could charge operators follow the same procedure we have developed for calculating the rate for infrastructure, R_i .

To start the project, the developer makes a series of investments in infrastructure. This investment is made in common elements necessary to carry out any activity. Like any private entity, the developer of a port seeks to generate cash flows in the activities taking place in the

port, allowing a return on investments and profits to be obtained. In fact, in this business model the developer assumes the greatest risks and sustains them for longer. As a consequence, the investments made in the infrastructure, which are those to be made first, are passed on entirely to the concessionaire or concessionaires. This will generate a return in the long term, as investments in infrastructure are often very expensive and the return time is necessarily long. However, this is the main difference between a private and a public developer. While a private developer needs to generate a cash flow to obtain a return on their investment, a public developer has access to capital markets under better conditions and does not need to obtain a cash flow because the capital comes from the State.

To sum up, concessionaires pay an annual rate for infrastructure investments. Occasionally, if the operator has sufficient financial means, it provides an initial amount that lowers the annual payment rates. This is good for both the developer and concessionaire. The developer gets a faster return on a portion of the investment made. Although the operator is forced to provide the concessionaire better conditions for the annual payment, it is a beneficial option for them, as they begin to recoup their investment much sooner.

Equation (19) represents the costs that the operator transfers to the concessionaire, in year j. Basically, it establishes which part of the investments will be charged to the concessionaire every year and adds a profit margin.

Equation (20) represents the total rate charged as infrastructure. It consists of the initial contribution (if any) and the rates payable each year

$$\omega_j = \chi_j \times (1 + \psi) \quad (19)$$

$$R_i = \omega_0 + \sum_{j=1}^n \omega_j \quad (20)$$

Where:

ω_j : Entry of the developer per infrastructure in year j

χ_j : Developer infrastructure costs for year j

ψ : Margin that covers management costs of the developer and / or profits

ω_0 : Initial payment (if any)

$\sum_{j=1}^n \omega_j$: Annual payment rates for infrastructure

Superstructure investments are not discussed in this chapter. They are unique to each concessionaire. That is, all investments that the concessionaire undertakes in equipment, cranes, buildings, etc., must be justified by its own cash flows. Thus, the concessionaire pays the developer a rate for the infrastructure and, through its own business activity, will also be faced with investments in superstructure.

As this thesis studies the relationship between the developer and the concessionaire, it makes little sense to establish the rate for the superstructure, since these investments must be fully paid by the concessionaire and do not affect the developer.

The concession rate is charged for surface occupancy. That is, the payment of a rate that entitles the concessionaire to occupy an area of the terminal for a determined period of time.

In this case, a value for the occupation of the terminal is established and negotiated with the concessionaire. Of course, not all port concessions have the same value. This value depends on

the location within the port, access, the value of the land on the real estate market and other factors, such as freight traffic recorded by the port, for example²³⁹.

As was the case with the concession rate, an agreement can be made with the concessionaire to pay an initial amount that reduces subsequent monthly or annual contributions. Equation (21) shows the total value of the concession rate, the sum of initial contribution (if any) and annual contributions.

$$R_c = R_{c0} + \sum_{j=1}^m R_{cj} \quad (21)$$

Where:

R_{c0} : Initial payment (if any)

$\sum_{j=1}^m R_{cj}$: Annual payments per concession rate

As shown above, the business model and management of port concessions is very heterogeneous between countries and even within certain countries. This means that in the review of the implemented concession systems, many systems and rates have been found. There are countries in which rates are levied on certain items while in others they are not. However, other rates are applied.

It is therefore very difficult to establish specific rates applicable to the concessionaire in a worldwide perspective. In this chapter, we have decided to define only two of them: the rates for infrastructure and those for concessions. However, there are many other additional rates that may be charged to the concessionaire, the most important of which is the activity rate R_a .

The activity rate R_a is charged according to the activity carried out by the concessionaire. The concessionaire always requires more business to generate more cash flow. However, occasionally the developer wants to encourage the concessionaire to try to handle more cargo. In such cases, the activity rate varies, decreasing as the load managed increases.

In other cases, the concession agreement sets a minimum and a maximum load that the concessionaire must manage. In these cases, the developer is not interested in increasing the volume and the activity rates can be fixed or variable. Normally, it is this activity rate R_a on which rebates, if any, are applied²⁴⁰.

4.6. Revenues and expenses of each participant

In general, revenues of the developer are the costs of the concessionaire (Martínez Abascal 2012). Table 57 shows a summary of the income and expenses of each of the participants with the variables designed for this model, where it can be seen that this principle is fulfilled.

²³⁹ Sometimes these factors are valued below their real price, so that the concession rate is lower. This is done to attract certain concessionaires to the harbour. This decision is strategic, as perhaps the PA may be interested in the involvement of a particular company in the project, for example, because it can divert business lines it has with other ports.

²⁴⁰ For example, in Spain, rebates can only be applied to rates of activity and / or use, according to RD 2/2011 (Consolidated Ports Act), section six, article 245.

Table 57. Income and expenses of participants

Developer Incomes	Developer Costs
<ul style="list-style-type: none"> ▪ R_i, R_c 	<ul style="list-style-type: none"> ▪ χ ▪ Operating Costs (low) ▪ Common Investments Amortization (high)
Concessionaire Incomes	Concessionaire Costs
<ul style="list-style-type: none"> ▪ $\mu = \sum_{j=1}^n \delta_j \times \varphi_j \times \Delta_j$ 	<ul style="list-style-type: none"> ▪ $\omega_0 + \frac{\sum_{j=1}^n \omega_j}{1+\psi}, R_c$ ▪ Operating expenses ▪ Own investments amortization

Source: Own analysis

In Table 57, we can see for example that the concessionaire's revenues are mainly based on the provisions set out in equation (16). That is, they depend on the demand (δ), the unit price charged for each container (φ) and the ramp-up (Δ).

In turn, costs of the concessionaire depend in part on infrastructure and the concession rate, and the concessionaire's own operating costs and amortization of investments.

But to address investments of this size, it is important not only to quantify their total value and to know who undertakes them, but also to know exactly when they will have to be made.

This allows the strategies to cope with the investments in the best way possible to be defined. In this sense, Table 58 shows the year of initial implementation²⁴¹ of the costs of the concessionaire.

Table 58. Concessionaire costs in years

Concessionaire Costs		
Item	Definition	Year of application (Indicative)
Maintenance	Includes the costs of preventive maintenance and repairs	From year 4
Exploitation	It includes all costs (direct and indirect) of the activity of the concessionaire, investment, personnel, etc.	From year 4
Asset replacement	Basically, this is the replenishment of equipment, maintenance of containers	From year 4
Commercial expenses	Expenses arising from the implementation of the service in the market	From year 1
R_i rate	Payment by the concessionaire of the investments made by the developer	From year 2
R_c rate	Concession rate	From year 1
Financing Interests	Banking interests of amortization of loans requested for investments in asset	From year 1

Source: Own analysis

²⁴¹ These are investments developed over the long term. This value corresponds to the initial year of the implementation of investments, counting from zero, the moment the project begins. This does not mean that they are carried out only in the year indicated in the table, but begin to develop in that year.

As can be seen from this table, most of the concessionaire's costs begin to be addressed in year 4, which is when the terminal starts operating. Other costs start in year 1 (marketing, financing and concession rate (R_c)) and in year 2 (when those investments made by the developer start to be paid via the infrastructure rate (R_c)). Table 59 shows the same information for the developer.

Table 59. Developer costs in years

Developer Costs		
Item	Definition	Year of Application (Indicative)
Payment to the construction company regarding financing investments	This is not a cost in reality, due to the fact that it relates to the amortization of the investments	From year 4
Rate to the PA for the use of land through a concession	Amount paid to the State for the use of land through a concession	From year 4, which is when the concessionaire starts to exploit the business
Rate to the PA for the use of the sea bottom	Amount paid to the State for the use of a portion of the seabed	From year 4, which is when the concessionaire starts to exploit the business
Staff and structure	Costs related to the activity of the developer (land, equipment, etc.). This section includes port maintenance and the infrastructures	From year 1
Developer investments Amortizations	Asset investments amortization	From year 4
Financing Interests	Bank interests related to the amortization of loans in connection to the asset investments	From year 1

Source: Own analysis

Actually, the developer is faced with costs from the very outset of the project. Once the first foundation stone is laid, the developer has to pay the builder for the work being carried. However, in many cases the developer goes to construction companies that finance the work in order to delay the investment repayment period.

This is why in Table 59 the term of payment of most investments starts in year 4. Thus, the only costs that the developer faces from year 1 are those corresponding to staff costs and the interests from the funding required to make the investments.

It is also important to set the period of investment amortization²⁴², since it depends on the type of the asset. Table 60 shows the maximum amortization periods established in the general table of annual depreciation rates in the common European territory²⁴³ and the amortization period that should be taken into account for each type of asset.

Table 60. Amortization periods per type of asset

Amortization periods per type of asset		
Asset	Period of Amortization	Maximum Period by law
Dredging, dams and breakwaters	100 years	100 years
Gantry Cranes	20 years	40 years

²⁴² We use the term "amortization" to refer to the financial process by which a debt is gradually extinguished through periodic payments (Cruz Rambaud & Valls Martínez 2003).

²⁴³ RD1777/2004 of 30 July approving the Corporation Tax Regulations. Annex RIS, grouping 95

Installations	20 years	34 years
General Infrastructure	20 years	40 years
Other maintenance equipment	8 years	20 years
Industrial buildings and warehouses	20 years	68 years
Administration buildings	20 years	100 years
Roads	20 years	40 years
Rail transport infrastructure	20 years	50 years

Source: Own analysis

It can be seen from Table 60 that the maximum time limits are not enough and are, in many cases, half the maximum period allowed by law. This is done to avoid an excessive delay in the return of investments, which could, in some cases, become obsolete if the legal deadline expires. A balance should be sought that allows the return of investments to be achieved comfortably without stifling the developer.

4.7. Financing

Funding²⁴⁴ depends primarily on the debt capacity of both the developer and concessionaire at the beginning of the project. It is important to note that in a private funding model, guarantees are clearly defined and are explicitly linked to the flow of project revenues (Luberoff & Walder 2000). Under this perspective, two types of funding can be considered:

- a) The financing that one of the participants provides the other, (for example the constructor provides finances to the developer).

The financing entity is, in fact, acting as a bank. In the case of a construction company that finances a developer, the construction company requests an amount for the work to be developed and spreads payments over time, which include an amount of interest. The developer benefits by not having to seek financing from a bank or banks. The problem is that tracking the actual amount of interest being paid is lost. For this reason, a “turnkey” contract is signed. This type of contract implies that the constructor delivers a fully completed project. All savings the builder may achieve are often reversed, so that there is a risk that the developer ends up paying more for the asset.

- b) The financing that any of the economic entities can get by their own means has an equivalent in financial interests, the definition of which includes the provision of initial capital, amortization period, interest rate and other factors. In this way, the funds are available at the right time²⁴⁵ and each investment starts being repaid at a time as close as possible to the moment at which financing is sought.

The private sector’s participation in infrastructure funding and management is growing around the world (Albalate & Bel 2009) and governments have found that partnership with the private sector is an attractive alternative to increase and improve the supply of infrastructure services (Quium 2011). It is for this reason that we believe that funding for such projects, which are ultimately financed by a bank or an investment fund and comes, therefore, from the private sector, should be the first option.

²⁴⁴ According to the Oxford Advanced Learner’s Dictionary, financing or funding consists of the management of large amounts of money, especially by Governments or large companies. We also understand financing / funding as the act of getting financial support for an enterprise.

²⁴⁵ This implies that asset financing will be requested as needed, so that the interests of the funding will be paid as the stages of the project finish. Various loans that were requested at different times end up being paid at the same time. Therefore, financing will also have different maturities.

4.8. Yields

Yields²⁴⁶ are a key part of the evaluation of any investment. Nowadays, a sound financial status facilitates the movement of resources to wherever they generate the highest yields (Pallis et al. 2010). Thus, it is extremely important for a private company to obtain these resources and generate a profit.

Yields correspond to the internal rates of return (IRR) of each participating business. The IRR²⁴⁷ compares, for example, the variation of liquid assets with the capital invested. Table 61 shows the behaviour of the IRR depending on the values of the rates.

Table 61. IRR Behaviour

Rate	Rate behaviour	Developer IRR	Concessionaire IRR
Infrastructure, R_i	Increases	Increases	Decreases
	Decreases	Decreases	Increases
Concession, R_c	Increases	Increases	Decreases
	Decreases	Decreases	Increases

Source: Own analysis

As can be seen in Table 61, when the infrastructure rate (R_c) increases, the developer benefits from a higher IRR while, obviously, the concessionaire IRR decreases.

Assuming that the developer penalizes only investments in infrastructure by applying a margin of ψ and assuming its profit is R_c , it can be inferred that the variation of both values will determine the balance of the IRR. The key to the model will therefore be to optimize the values of these two parameters; both participants generate profits and a private model can be established.

For a public entity, both values tend to zero if the induced economy generated by the port business justifies a benefit to the environment. In the case of a private entity, both factors determine the success of the business and, therefore, it is absolutely necessary to optimize their values.

5. CHECKING MODEL VIABILITY

The model of business between the participants involved is viable when a balance is reached, i.e. when all economic entities obtain the expected return on the investments made. In this model, a balance is reached when a “win-win”²⁴⁸ situation is achieved.

The model should prevent one of the participants from generating very high profits at the expense of the other. When this happens, parameters that ensure that the profitability of the second reaches reasonable proportions should be introduced.

Otherwise, the participant generating virtually no profit would experience significant difficulties in managing their business. Figure 37 shows a simplification of the situations that could occur with the IRRs of two opposing participants, where *opposing participants* refers to those

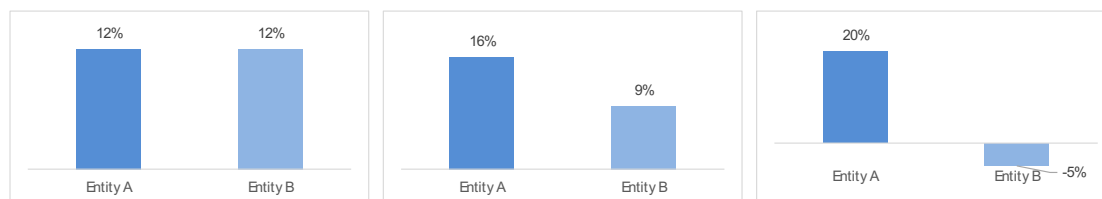
²⁴⁶ We use the term “yield” to refer to the returns obtained from an investment.

²⁴⁷ IRR or Internal Return Rate is a discount rate that makes the Net Present Value (NPV) of all cash flows from project owners equal to zero. In turn, the NPV is the difference between the present values of cash inflows and outflows.

²⁴⁸ When everybody obtains the expected profitability. In other words, when everybody gets the expected profitability, even in different proportions among participants.

participants whose costs form the revenue of the other entity and whose operating accounts are related somehow.

Figure 37. Profitability proportion for the main participants



Source: Own analysis

The first situation would be optimal, with reasonable and balanced values of IRR. The second situation is more real, since one of the actors (either the developer or concessionaire) can reasonably obtain an IRR higher than the other. The third situation, in which one participant generates a significantly high IRR and the other generates a very small IRR or even experiences losses, would not allow the model to hold and would lead to its collapse. The model should, therefore, prevent the third situation from becoming reality. Preventing this situation requires setting limits on profit levels.

If a participant enters an amount of N for its economic activity, they will be able to obtain an expenditure of $N\%$ but the pre-agreed percentage of expenses will never be exceeded. In this way, the participants are guaranteed profits which, of course, will depend on their volume of activity.

However, this does not mean that the profits of the participants are balanced; it only ensures that each participant will not enter losses.

Introducing the factor η into the algorithm ensures that there is balance of profits among the participants. This factor compares the IRR of participants and ensures that there are no disparities. When the IRR percentage difference between two participants exceeds a set value, or when one of the participants obtains an IRR that lies outside the initial limits, η helps to reduce those rates that represent a cost to the disadvantaged participant and an income to the participant obtaining a higher IRR. This happens in the year following the review.

For example, if the developer obtains an IRR of 25% and the concessionaire, one of 3%, η would have a bearing on rate R_c the following year, thereby creating a reduction that would benefit the concessionaire and that would bring about a decrease in profits for the developer, resulting in a more balanced model, thus tending towards the second situation in Figure 37.

It is important to note that, for the application of η , disparity in the IRR of the participants is a necessary but not sufficient condition, since the handicapped participant needs to have an IRR below preset limits.

To ensure that all economic entities participating in the model reach equilibrium, factors detailed in Table 62 are also examined.

Table 62. Revised factors necessary to check the balance of the model

	Definition
Balance	<ul style="list-style-type: none"> Explores the balance of each of the economic entities. All must balance and no excessive profits must occur. In the case of an imbalance, η should be applied.
Internal rate of	<ul style="list-style-type: none"> The internal rate of return or IRR is the profitability of an investment to the discount rate r, which makes its net present value equal to zero (Aguer et al.

	Definition
return (IRR)	<p>2005). It must be studied from two very different perspectives, as the IRR for the project is not the same as the contributions of capital invested by the shareholder to carry out the operation:</p> <ul style="list-style-type: none"> ▪ IRR_p: Project IRR does not consider the necessary funding or financial costs involved in such financing. <p>IRR_a: IRR of participants considers the capital outlays incurred by the participants and those obtained by dividends or capital recovery. IRR_a can be calculated in three different ways: by cash flow, net profit and cash variation. The three calculations should yield the same value.</p> <p>We consider the investment to be viable when profitability, p is greater than the required profitability. It is unviable when profitability is lower and neutral when the values are equal (Aguer et al. 2005). Put another way, it would be advisable to invest when IRR yields a profitability greater than that obtained, for example, by keeping the money in a bank. The IRR is a value whose minimum is set by the investor and reflects the returns expected from putting an amount of capital at risk. In the present study, we consider an IRR between 15 and 25% to be viable.</p>
Net present value (NPV)	<ul style="list-style-type: none"> ▪ The Net Present Value is the difference between the present value of payments and the payments generated by an investment. The investment will be achievable when the NPV is greater than what there is to spend. The investment is neutral when the NPV is equal to the initial outlay required and unviable when the present value of the cash flows is less than the initial outlay (Aguer et al. 2005). It should be studied from two different perspectives: ▪ NPV_p: Project NPV ▪ NPV_a: Shareholder NPV
Maximum borrowing	<p>One of the premises of the model is that the maximum debt can never exceed 100% in any of the stages of investment.</p>

Source: Own analysis

After conducting the review of the balances, the IRR and NPV and verifying that the maximum borrowing is not exceeded, the model can be validated, provided the established premises are fulfilled.

6. CONCLUSIONS

Unlike traditional models of calculation, in this study we are not seeking a method of calculation to obtain the rate of return on the investments made by each participant. What is sought is a mathematical model capable of determining which of the parameters governing the model are the most important in terms of guaranteeing a balance.

In this regard, it has been shown that certain conditions (basically, demand and prices) are crucial in the model. As in any other business, success or failure depends primarily on the sales margin and the amount of sales made. However, this model has allowed us to study how the various rates condition the return of the investments made by each of the entities involved. Consequently, we have been able to assess which rates the model is capable of balancing in order to ensure that all entities see similar returns. We have carried out a breakdown of the charges and found that both the infrastructure and concession rates are those that balance the model.

Having said this, the model will work when developer knows how to optimize the IRR of the investments and enter fair values for the concession rate R_c and ω into the model, which means income according to infrastructure. Based on the premise that all participants in the model must earn and receive reasonable rates of return, the range of possible solutions is infinite but always converges in the optimization of these two parameters, which allows the concessionaire to run their business and provide a service to their customers, in addition to paying rates to the developer, who is thereby able to pay the State the required land rates.

It is also important to note that this mathematical model allows certain modules to be included. For example, we could also create a tool for calculating rebates and / or surcharges based on certain performances achieved by the concessionaire. If so, it would be possible to estimate rebates or surcharges for certain rates. In the next chapter, this model is developed for the environment and a subsequent model validation is carried out by applying it to several real cases.

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10

Environmental monitoring: Rebate calculation algorithm of the activity rate of port terminal concessionaires

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1. AIM

Diverse activities take place in a port that result in different environmental impacts. A port is a place where various modes of transport (usually sea, rail and road) converge and is therefore capable of generating environmental impacts through the various forms of transport and cargo loading and unloading.

Environmental regulations set maximum values for certain environmental parameters such as CO₂ emissions. However, port authorities do not have the means to award concessionaires rebates if their environmental impacts are substantially lower than those established by law. Nor are they in a position to penalize them if they exceed a set value, which must always be less than the maximum allowed by law.

This chapter describes the activities that take place in a container terminal that are the responsibility of the concessionaire. A review of the environmental regulations affecting port operations in Spain is also carried out and finally, an algorithm to establish rebates or surcharges based on rates of activity, from the limits set by the Port Authority, is described.

This algorithm is a module of the one presented in Chapter 9, and aims to complement the calculation of concession rates and activity rates derived from the same formula.

2. ORGANIZATION

This chapter is based on the article: “*Environmental monitoring; Bonus calculation algorithm of the activity rate of port terminal concessionaires*”, presented in the journal “*Environment and Planning A*”, dated January 26, 2016

3. INTRODUCTION

The Spanish port system consists of 46 ports of general interest, managed by 28 Port Authorities (PAs) (Roa-Perera et al. 2015). Public Institute of State Ports (PCSPs) are responsible for coordinating and monitoring the efficiency, as one of their goals as an organization is the constant search for improvements in port performance (Nuñez-Sanchez et al. 2011). In this context, port authorities manage the ports under the PISP since the entry into force of Law 27/1992²⁴⁹ (Nuñez-Sanchez & Coto-Millan 2012).

The port system is governed by a *landlord* business model whereby the infrastructure is concessioned to private operators for exploitation (World Bank 2007). This public-private management ensures that the PA is responsible for some activities, while others, such as facility planning or business tasks, are left to the private sector (Rangel et al. 2012), (Yuen et al. 2013).

In terms of the environment, heightened awareness today has led to an increasingly strict control of port activities and the implementation of stringent regulations to control their impact on the environment (Saz-Salazar et al. 2013). Reforms in public administration of the ports have led to the adoption of new and better technologies in port terminals (Estache et al. 2004). We also know that the size of the terminal is closely related to its efficiency (Cullinane et al. 2002) and that there is a positive relationship between the size, prestige and performance of the operator (Rodríguez-Álvarez et al. 2007). Nevertheless, the fact is that, even today, Spanish PAs have still much to worry about in terms of the management and control of certain activities whose effects can be potentially harmful to the environment.

The vast majority of port areas are concessioned (Ramos-real & Tovar 2010). Knowing that in this management model developer revenues represent the costs of the concessionaire

²⁴⁹ Law 27/1992, of 24 November, of Ports and Merchant Marine

(Martínez Abascal 2012), passing part of the environmental costs to concessionaires based on the result of their environmental activities becomes possible. It is not a way to interfere with the functioning of the market, since economic regulation would originate precisely in the deficiencies that it could present (Coto-Millan et al. 2005). It is to provide a tool for calculating rebates for concessionaires of dedicated terminals when their environmental activities agree with preset standards and, if not, to apply surcharges.

The issue of dedicated terminals has been extensively studied in recent years, good examples of which include the studies by (Brooks 2000) and (Cariou 2001). There are also many lines of research that discuss critical issues related to concession contracts, including those carried out by (Brooks 2004), (Notteboom 2007), (Brooks 2010) and (Ng & Pallis 2010). However, the impact on concessionaire income of the effect their activities have on the environment has not been studied. Thus, this study aims to create a multivariable calculus algorithm whose purpose is to determine whether surcharges or rebates should be applied to terminal concessionaires based on the sustainability of their actions with the aim of improving their environmental performance, ensuring proper management of natural resources and being in strict compliance with current regulations.

4. METHODOLOGY

Environmental activities are subject to a strict legislative control, so first a thorough review of international, European, national and local standards was carried out. Subsequently, the kinds of environmental impacts that may affect the algorithm were studied. Next, a list of the minimum and maximum thresholds were established in order to be used to award rebates or surcharge the concessionaire. It is assumed, therefore, that the goodwill of the concessionaire in providing services need not necessarily be aligned with the interests of the PA (Notteboom 2007) and that there is also a large number of stakeholders involved, with often opposing interests (Cavallo et al. 2015). The control of environmental parameters is, therefore, an important point in the drafting of concession contracts.

A review of the literature of economics that focuses on the design of optimal incentive contracts was also carried, from the earliest authors who proposed theories related to this issue, including (Hölmstrom 1979), (Baron & Besanko 1984), (Dewatripont 1989), (Laffont & Tirole 1993), (Tirole 1999) and (Laffont & Martimort 2002), to more modern studies in this specific field, including works by (Guasch et al. 2008) and (Scandizzo & Ventura 2010).

The next step was to determine which of the rates paid by the concessionaire were susceptible to rebates or surcharges. With all this data, the algorithm was defined and finally conclusions were drawn.

Law 48/2003²⁵⁰, amended by Law 33/2010²⁵¹, stipulates an initial range of rebates and surcharges for activities that are potentially harmful to the environment. Article 19 of this law sets out the activity and lease rate. Paragraph 1 specifies those designed to encourage better environmental practices. Operators following the guidelines set out in the EMAS²⁵² or who have implemented an environmental management system based on standard UNE-EN ISO 14001:

²⁵⁰ Law 48/2003 of 26 November, of financial regulation and the provision of services of general interest ports.

²⁵¹ Law 33/2010, of August 5, amending Law 48/2003.

²⁵² European Eco-Management and Audit Scheme of the European Commission

2004²⁵³ can benefit from this law. However, it only lays down general and non-specific rebates; for example, those based on permissive emission ranges. Precisely for this reason, Law 33/2010 refers to the guidelines for good environmental practices adopted by the PCSP in March 2011. These guidelines do not set out specific recommendations either from an operational perspective or from the point of view of determining the best available techniques to apply these environmental practices (Puertos del Estado 2011). The revised text of the new law on ports by the RD 2/2011²⁵⁴ was approved in the same year. Article 165 specifies that more than one rebate on port rates may be applicable in order to promote competitiveness and economic and environmental sustainability of port activity. However, it also stipulates that these improvements should be introduced in succession and should be multiplicative on the full amount, with a rebate coefficient for reduction factors. However, Article 245, which is devoted to rebates, does not specify any rebate specifically related to environmental activities.

Consequently, the only legislation that sets the standards that this study aims to define and improve is that of the EMAS, which, according to AENOR, promotes better environmental performance of organizations. In this sense, the EMAS includes all the precepts of ISO-14001, and also requires periodic provision of information through an Environmental Statement, whose contents are detailed in Annex IV of Royal Decree 239/2013²⁵⁵, which transposes in Spain's application of European regulation EMAS III.

The loophole described justifies the need to generate an algorithm able to establish rebates for certain port activities, depending on the implementation of good environmental practices as set out in this work. This algorithm allows the Port Authority to select the type of mathematical formula governing the model according to how they want their concessionaires to be rebated. The principle is simple. Given this formula, the Port Authority establishes certain minimum and maximum limits and introduces the observed value for the environmental parameter being controlled. The algorithm determines the value of the environmental index or rebate based on the observed value and its subsequent comparison with the selected formula.

The algorithm then compares other controlled parameters and, based on the overall performance of the concessionaire, establishes a final value for the activity rate rebate. Of course, the regulatory framework of the country in which the algorithm is applied is very important because the limits fixed by the Port Authority must improve the environmental performance of the concessionaire and must be more restrictive than the law itself.

5. CHARACTERIZATION OF ACTIVITIES RELATED TO THE ENVIRONMENT

As an example of application, we will define what we mean by container terminal. The algorithm can be applied to any type of port concession. If other types of concessions were studied, environmental activities and potential sources of environmental impacts would have to be redefined.

²⁵³ Specifies the requirements for an environmental management system. This is an international code applicable to any organization that wishes to establish, implement, maintain and improve an environmental management system.

²⁵⁴ Royal Legislative Decree 2/2011 of 5 September, approving the revised text of the Law on State Ports and Marine Merchants.

²⁵⁵ Royal Decree 239/2013 establishing national standards for the implementation of Regulation (EC) No 1221/2009 of the European Parliament on the voluntary participation by organizations in a Community eco-management and audit scheme known as EMAS III or Global EMAS.

The basic function of a port is to transfer cargo and passengers between ships and land and / or between ships themselves (Goss 1990) and should, therefore, provide different types of facilities (Liu 2010). According to the authors consulted, the activities carried out in a container terminal can be divided into many separate subsystems. One possible classification is a division into four subsystems (González-Cancelas 2007) that interact in the transfer of the cargo to a different form of transport (Holguín-Veras, J; Walton 1996):

- Loading dock subsystem: Terminal berths. It has some ability to transfer cargo through gantry cranes.
- Internal transport subsystem: Transfer of containers between the quay and the storage area.
- Storage subsystem: Areas of collection of containers intended for import, export or storing empty containers. It occupies most of the terminal surface.
- Delivery and reception subsystem: Interface between storage areas and road vehicles delivering or collecting containers from the terminal.

With regard to the environmental implications, it is important to note that in each subsystem includes potentially harmful activities that need to be defined in order to determine the associated potential impacts. Table 63Source: **Own analysis** shows some of the sources of environmental impacts, grouped by subsystem. For example, in the delivery and reception subsystem, the environmental impact of trucks must meet regulation Euro VI. In such a case, the function of the trucks is the delivery and receipt of material, which falls outside the terminal.

Table 63. Sources of environmental impacts

Item	Definition	Subsystem(s)	Regulation
Off-road machinery	Machinery for free movement of containers (reach stacker, straddle carriers, etc.)	Internal transportation, Storage and Delivery and reception	Euro IV ²⁵⁶
Office boilers	Boilers for hot water generation and heating	Delivery and reception ²⁵⁷	Not applicable. No limits
Garage boilers	Boilers for hot water generation and heating	Storage ²⁵⁸	Not applicable. No limits
Trucks	Container transport elements outside the terminal	Delivery and reception	Euro VI ²⁵⁹
Ships	Elements of container transport by sea	Loading dock subsystem ²⁶⁰	Fuel: D33/2012 ²⁶¹ , Motor: TIER III ²⁶² , Emissions: Marpol Annex VI agreement ²⁶³
Office wastewater	Sewage services from offices (bathrooms and toilets) ²⁶⁴	Delivery and reception	If the waters go to the network, the Metropolitan Barcelona Dumping Regulations ²⁶⁵ applies. If the waters go to a septic tank they should be treated before being discharged into the sea ²⁶⁶
Garage wastewater	Discharges from garage activities ²⁶⁷	Storage subsystem	The same rules as for office sewage apply
Potentially contaminated rainwater	Discharges from runoff rainwater ²⁶⁸	Loading dock, Internal transport, Storage and Delivery and reception	The same rules as for office sewage apply

Source: Own analysis

²⁵⁶ European emission standards adopted in January 2005 and applicable from January 2006. Grounded in Directive 2006/96/EC amending Directive 70/220/EEC. This standard applies to machines built after the date of implementation of the law.

²⁵⁷ We place offices in this system, as they are on the main access.

²⁵⁸ We place this in the storage system, as it involves the repair and maintenance of machinery.

²⁵⁹ European emission standards for road vehicles, approved in January 2014 and applicable from January 2015, based on the 692/2008 directive amending Directive 70/220/EEC, apply to machinery constructed after the date implementation of the law.

²⁶⁰ We include ships in the dock subsystem. However, vessels are external customers of the terminal and, therefore, their environmental impacts are not directly borne by the vessel's operator.

²⁶¹ Directive 2012/33/EU of the European Parliament and of the Council of 21 November 2012 amending Directive 1999/32/EC as regards to the sulphur content of marine fuels.

²⁶² The International Association for Catalytic Control of Ship Emissions to Air (IACCSEA) is a global authority associated with the SCR Marine Technology. Adopted in MEPC66 implementing the new Tier III NOx Standard, which requires all vessels made from 1/1/16 to reduce emissions of NOx in order to navigate the NECA (NOx emission Control Area) areas in the United States and the Caribbean from the installation of SCR (Selective Catalytic Reduction).

²⁶³ Marpol is the International Convention for the Prevention of Pollution from Ships.

²⁶⁴ In which, in particular, the BOD5 (Biological Oxygen Demand 5 days), COD (chemical oxygen demand) and SS (Suspended Solids) are controlled.

²⁶⁵ Regulations of Metropolitan Wastewater discharge in Barcelona published in the BOPB on 9 February 2015. No. Exp: 5279/13.

²⁶⁶ Permission to be sought from the Catalan Water Agency (ACA). The "Indicative guide of the conditions of authorizations and discharge permits and vector water environmental licenses and authorizations" applies.

²⁶⁷ Before placing in any medium, a decanted fats and oily sands separator must be installed, which is needed to control in particular SS and hydrocarbons.

²⁶⁸ Since activities in the terminal are likely to generate oil spills onto the pavement, rainwater runoff can wash away these discharges. Therefore, a hydrocarbons and heavy metals separator is required.

For the correct use of the algorithm, the PA is responsible for defining the environmental impacts to be controlled. The PA is also responsible for fixing the control limits for each impact. From the point of view of the container terminal operator, the 8 groups of potential impacts shown are those that generate potential environmental hazards. For the application of the algorithm for calculating rebates, the PA must ensure compliance with the standards set for the ranges of emission and pollution for each of them, since the PA is in charge of monitoring the activities of private operators inside the port (Puertos del Estado 2015).

Normally, PAs apply an administrative regulation in granting concessions, licenses and an operating control. They also conduct monitoring of environmental parameters established by control and validation campaigns. The Port of Barcelona, for example, controls the quality of its waters under the PVMALC²⁶⁹ by taking monthly samples. They also control bottom sediments inside and outside the port (Autoridad Portuaria de Barcelona 2014). Similarly, they control air quality through a network of weather stations (four major units and four complementary) and a HVC System²⁷⁰.

All Spanish PAs have specific protocols for risk operations. For example, activities involving emission sources are included in Annex IV of Law 34/2007²⁷¹ and should have express authorizations (Autoridad Portuaria de Avilés 2014). Activities whose environmental risk is higher will fall outside of the application of the calculation algorithm, since they are one-off actions.

6. APPLICATION OF THE ALGORITHM

The algorithm can control an infinite number of environmental parameters. The first step is to establish how to define the parameters to be controlled and to establish their limits. The algorithm disqualifies any rebate if one parameter exceeds the legal maximum. Each PA can control the number of parameters as necessary. Table 43 shows each parameter associated with the three values that define their limits:

- Minimum (Min_n): This is the minimum value the parameter can have. By reaching this value, the concessionaire will be awarded the maximum possible rebate, so it must be a real and achievable value.
- Maximum Law (Max_n): The maximum is only a control value. Since all environmental parameters are set by law, this value is the maximum that can be achieved without actually exceeding what is established by law.
- Optimal (Opt_n): This is the most important value. The optimal value is the one from which a concessionaire can begin to claim a rebate. Any value between the optimum and minimum will be awarded a rebate, which increases the closer it gets to the minimum value.

²⁶⁹ PVMALC is “Plan de Vigilancia de las Masas de Agua Litorales de Cataluña”, which is a system to monitor Catalan coastal waters and is headed by the Catalan Water Agency (ACA).

²⁷⁰ HVC System is the acronym for High Volume Collectors System.

²⁷¹ Law 34/2007 of 15 November, of Air Quality and Atmospheric Protection.

Table 64. Parameters to control and limits of each

	Minimum (Min _n)	Optimal (Opt _n)	Maximum Law (Max _n)
Parameter 1	Min ₁	Opt ₁	Max ₁
Parameter 2	Min ₂	Opt ₂	Max ₂
...
Parameter n	Min _n	Opt _n	Max _n

Source: Own analysis

The second step is to set the control function, which compares each of the values associated with the parameters.

This algorithm only allows rebates for values between the minimum and optimum to be awarded, although the PA could easily extend this range of rebates to the maximum legal limit. In the present example, any value between the optimum and maximum will not be considered. The algorithm allows the PA to establish how the rebates are awarded. That is, the port authority can decide whether the rebate is high if the concessionaire keeps their values close to the minimum range. By contrast, very low or no rebates are awarded for values close to the optimum level. Another possibility is that the PA decides that both the minimum and optimum values are awarded a high rebate, in which case only the formula needs to be modified. In this example the form of mathematical functions used are shown in equation (22).

$$Y = A^{-x} \quad (22)$$

Where A takes values between 12 and 1.1. The mathematical principle is this: the PA decides whether to award a rebate for values close to the optimum level, in which case, a value for “A” should be chosen from group 4 in Table 65, or whether it prefers to award rebates for those values close to the optimum in a similar way as for minimum values, in which case it should choose a value for “A” from group 1 in Table 65. Table 65 shows the function that the algorithm assigns to each value selected from the dropdown menu.

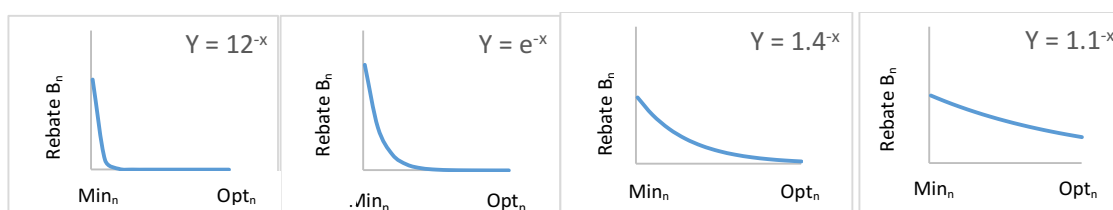
Table 65. Function applied by the algorithm according to the selected value in the dropdown menu

Selected value (dropdown menu)	Function
4	$Y = 12^{-x}$
3	$Y = e^{-x}$
2	$Y = 1.4^{-x}$
1	$Y = 1.1^{-x}$

Source: Own analysis

Similarly, Figure 38 shows the four functions used by the algorithm in the example described here.

Figure 38. Functions used by the algorithm



Source: Own analysis

From Figure 38, we can see that while more or less all of the formulae award rebates for minimum values (Min_n), those whose value for A lie closer to 1 receive higher rebates than those whose values lie between the minimum and optimal (Opt_n) values. Applying the selected function and entering the given value observed for the environmental parameter being studied will give the values to be used to calculate rebates. The algorithm allows for possibility for each environmental parameter to be governed by a different formula, so that an optimal value for some parameters would not allow a rebate to be awarded, while an optimal value for other parameters would allow a rebate to be awarded using the same calculation.

For example, imagine that we have an environmental parameter whose observed value is 6. In this example, the minimum value (Min_n) is 0 and the optimal value (Opt_n) is 10, in which case, the initial value lies within the rebate range. After entering the value in the algorithm, it then asks the user to tell it how the user wishes to study it. In other words, to tell it which of the four formulae it should use to calculate the rebate. Table 66 shows the values for the four functions available. In this example, selecting a value of 1, the function is $Y = 1.1^{-x}$ and the value returned by the algorithm is the highest of the four, so this observed value is awarded a higher rebate because we apply a formula that provides a higher rebate to values approaching the optimum.

Table 66. Y values for the observed X = 6 value

Selected value	Function	Y value for X = 6
4	$Y = 12^{-x}$	0.000
3	$Y = e^{-x}$	0.002
2	$Y = 1.4^{-x}$	0.133
1	$Y = 1.1^{-x}$	0.564

Source: Own analysis

This algorithm recognizes not only an environmental parameter but also all the values of environmental parameters in total, so that the final rebate is a combination of the particular rebate for each parameter. Table 67 shows the “n” controlled parameters and the value of each particular rebate (B_n) and its weight (w_n) or weight allocated by the PA based on the importance attached by the PA to each.

Table 67. Values, rebates and weights of each parameter

	Value	Rebate	Weight
Parameter 1	P_1	B_1	w_1
Parameter 2	P_2	B_2	w_2
Parameter 3	P_3	B_3	w_3
...
Parameter n	P_n	B_n	w_n

Source: Own analysis

The algorithm executes a final control in which the number of parameters that are sub-optimal is validated. The more suboptimal the parameters, the higher final rebate. As shown in equation (23).

$$B_{partial} = B_n \times w_n \quad (23)$$

Where:

B_{partial} : Each particular rebate parameter

B_n : Rebate applied to each parameter, before weighting

w_n : Weighting applied to each parameter

$$B_{\text{total}} = \sum_{B=1}^n B_{\text{partial}} \quad (24)$$

Where:

B_{total} : Sum of partial rebates of all parameters

And finally,

$$B_{\text{final}} = f(B_{\text{total}}) \quad (25)$$

Where:

B_{final} : Function that controls the number of parameters that are within the set limits and reduces B_{total} depending on the number of parameters that are not in the range defined.

The calculation of the final rebate applied to the concessionaire (B_{final}) is also adaptable to the requirements of the PA. Therefore, the PA can select how to avoid supplementing B_{total} depending on the number of parameters that are off limits. In the example shown in Table 47, one of four controlled values lies outside the limits, so the algorithm penalizes the B_{total} by deducting by 25%.

In this example, the final rebate to be awarded to the concessionaire whose four environmental parameters are being monitored can be calculated. The meaning of each column is defined:

- “Observed value” contains the value that has been measured by the PA.
- The columns “Minimum”, “Optimum” and “Legal Maximum” define the rebate range. It should be recalled that only those parameters whose values are between the minimum and optimum are awarded a rebate.
- The column “Formulation” defines which mathematical formulation is used to award a rebate. For this example, a different formulation is applied for each parameter.
- “Unitary rebate” is obtained by applying the “observed value” in the “formulation” chosen.
- The “Weight” column shows the weight that the PA attributes to each parameter, depending on the importance accorded to it. In this case, parameter 4 is the most important, followed by 3, 2, then 1.
- The “Partial rebate” is obtained using the “weighting” on the “special rebate”.

These calculations give the “total rebate”, which is the sum of the partial rebates. The “final rebate” to be awarded to the concessionaire takes into account how many of the observed parameters are within the limits.

Table 68. Example of calculation of the final rebate

	Observed value	Rebate application range			Formulation	Rebate and weighting		Partial rebate (B_{partial})
		Minimum (Min_n)	Optimum (Opt_n)	Legal maximum		Unitary rebate (B_n)	Weight (w_n)	
P_1	6.00	0.00	10.00	14.00	4 ($Y = 12-x$)	0.000	5%	1.67E-08
P_2	31.00	12.00	50.00	120.00	3 ($Y = e-x$)	0.002	15%	0.0004
P_3	0.90	0.00	0.80	1.30	2 ($Y = 1.4-x$)	0	30%	0
P_4	122.60	100.00	140.00	185.00	1 ($Y = 1.1-x$)	0.564	50%	0.2822

Total rebate (B_{total})	0.2826
Final rebate (B_{final})	0.2120

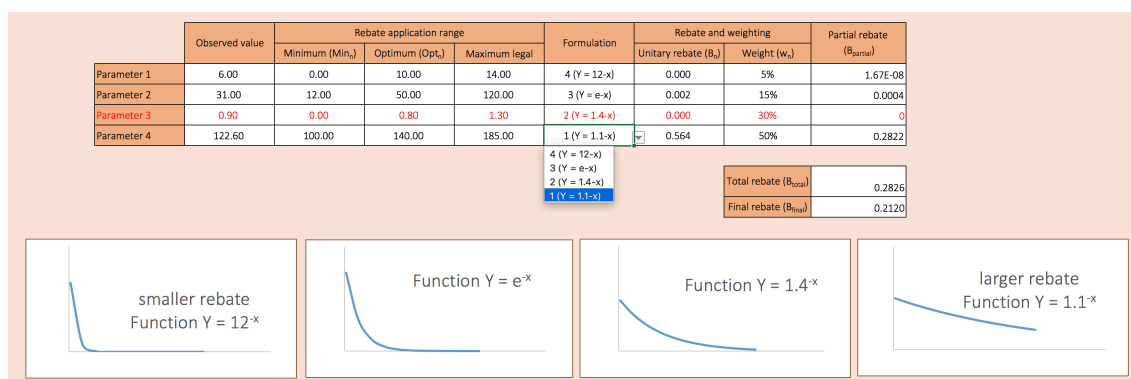
Source: Own analysis

In this case, parameter 3 has a value of 0.90. The value is, then, outside the minimum-optimal range. In doing so, the algorithm automatically gives a value of zero to the “Unitary rebate”. In this way, two effects are generated:

- The first is direct, as the “total rebate” (B_{total}) will be lower, since parameter 3 sets a value of 0 for the unitary rebate.
- The second is indirect, but important because the algorithm detects that one of the four controlled parameters lies outside the set range. Consequently, it reduces the total rebate by 25%, leaving a final rebate corresponding to 75% of the total rebate.

In short, having a parameter outside the limits penalises the concessionaire in terms of the final rebate it is awarded. Figure 39 shows the Microsoft Excel environment used to implement the algorithm for calculating the above example, in which comparison functions are of the form $Y = A^{-x}$.

Figure 39. Sample of Excel environment calculation algorithm



Source: Own analysis

7. APPLICATION TO THE RATE

A good part of the income of PAs comes from the rates charged for concessions. Specifically in Italy, this reaches 30% (Parola et al. 2012). The issue of port concessions has, therefore, become an important focus of study (Notteboom et al. 2012). This phenomenon stems from the fact that one of the major controversies for PAs is in the management of relations between the growing power of the shipping companies and terminal operators. The only tool available to PAs to address this issue is the concession contract (Aronietis et al. 2010), (Theys et al. 2010).

The algorithm developed here aims to promote activities by enabling concessionaires to increase their returns if they meet the environmental criteria defined by the PA, as the guarantee of concessionaires obtaining returns plays an instrumental role in the development of concession contracts (Pallis et al. 2010). In Spain, Article 5 of the first section of Chapter 3, Section Two of Law 33/2010 states that the Spanish PAs can charge 4 kinds of rates:

- Occupancy rate for the private use of public port domain.
- Activity rate, through the exercise of commercial, industrial and service activities in the public port domain.
- Utilization rates for the special use of port facilities.
- Navigation aid rates for maritime signalling service.

The occupancy rate can be divided into two rates: R_i (or infrastructure charge destined to pay those investments in public infrastructure undertaken by the developer or the PA) and R_c (or occupancy rate per unit of occupied surface). Both rates would be comparable to the “occupancy rate” established by Spanish Law but do not seem to be applicable rebates calculated by the algorithm, as it is the payment of investments made by the PA for the concessionaire to develop activity.

Since utilization rates only apply when using certain special equipment (Rua 2006) and navigation aids are in a completely different field, the calculated rebates are applied on activity rates.

In this regard, Law 33/2010 states in Article 7, paragraph c that “the amount of the participation rate is fixed by reference to the value derived from the use of the public domain for the user”. Paragraph f supports the application of successive rebates by reduction coefficients and maximum limits set by law, so both arguments back the appliance of the algorithm on activity rates.

8. CONCLUSIONS

In this study, we have developed an algorithm able to define rebates for the concessionaire of a port terminal, depending on the fulfilment of environmental standards set by law, but improved by the limits set by the Port Authority, termed “optimal”. These optimal values are below the limits set by law.

The general idea is that the Port Authority can set the “optimum value” it considers appropriate for each parameter, awarding rebates to concessionaires if they obtain values that fall between the minimum and optimal. It is thus a system adaptable to any situation, as it not only allows an infinite number of values to be controlled but also offers the possibility that each parameter is controlled in a different way, adapting them to the different characteristics and control mechanisms.

The algorithm allows the Port Authority to define certain elements, such as the number of parameters to be controlled, the minimum and optimum values for each parameter (since the maximum is defined by law), the mathematical formulas that control each of the parameters (among those provided), their distance from the axis of coordinates, etc.

This calculation also opens up the possibility of controlling other parameters that are not strictly environmental and could apply, for example, to controlling the load sensing ability of a concessionaire or adequacy of preventing occupational hazards, for example.

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11

Validation of the mathematical model. Its application to the *Martiport Container Terminal*

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1. AIM

The aim of this chapter is to validate the mathematical model generated in the last two chapters and to determine what happens to the profits of the developer and concessionaire as a function of the various variables that govern the model. As a sensitivity analysis has been carried out, it will also be determined whether the model is stable and robust and whether it remains constant when the variables undergo sudden changes.

Therefore, several numerical values will be applied to the previous formulae with the aim of studying how the model should be executed and what economic flows should exist for the business to be feasible for all parties, since this will allow the model's fundamental parameters to be determined.

In order to validate the model, the example of a real container terminal will be used. Due to reasons of confidentiality, neither its geographical location or real name be revealed and, as such, we will refer to it as "*Martiport*".

2. CHAPTER ORGANIZATION

In order to be able to analyse how the rates behave and how fluctuations in these rates affect the economic-financial model of the developer and concessionaire, real data from the studies of the viability of *Martiport* terminal, which is a private initiative, will be used. This data includes, among others, the demand hypothesis and construction costs that enable us to determine the total amount of investments and how cash flows are generated. In this way, the expected profits for the developer and concessionaire can be determined.

An analysis of their forecast financial states affecting the profit and loss account, the balance sheet and liquid assets is then carried out.

A sensitivity analysis is carried out on thirteen of the parameters governing the behaviour of the economic-financial model with the aim of determining which of the parameters are more sensitive and make the model fluctuate. We analyse and assess which parameters the corrections should be applied to. We apply the example of a model of rebates for environment performance (chapter 10) and establish how the calculated rebate affects the model. Finally, the conclusions are drawn.

3. INTRODUCTION

As has been seen in previous chapters, there is great variation on the management of a port and its terminals as a function of the country in which they are located or even between the regions of the same country. Port terminals may be dedicated to different types of goods and traffic, which means that the volumes of investment vary considerably in function of a wide variety of parameters.

Private operators provide shipping companies in China more space in a terminal to compensate them for the poor connectivity with the hinterland and the resulting costs to them of this situation in comparison to the use of a public terminal (Yeo 2015). This exemplifies that the sizes of two container terminals with the same traffic can differ between countries.

As we have already discussed in previous chapters, it is not clear who between the developer and concessionaire is responsible for investments. For example, in the case of natural disasters, the probability of their occurrence and the lack of knowledge regarding the volume of these investments means there is a gap in the definition of who assumes them (Xiao et al. 2015).

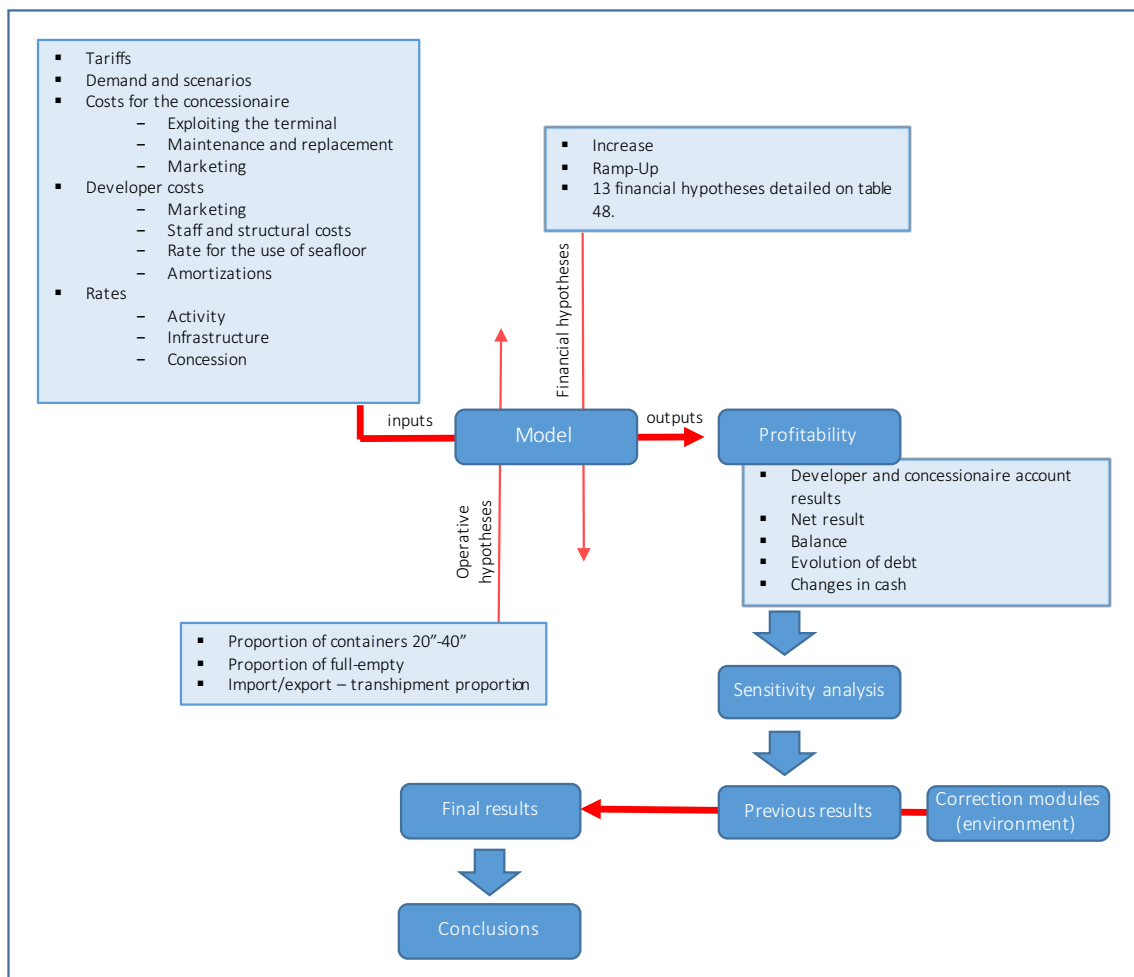
As a consequence, the definition of the mathematical model that governs the developer-concessionaire relationship should take into account the wide variety of parameters and should

start from many superimposed hypotheses. Regardless, it is essential to analyse the profits from the investments made by the participants in the business and how these profits fluctuate when the contextual conditions, which are variables in the model, undergo changes. For this, it is important to carry out a sensitivity analysis, a technique widely used in studies of the port sector. Evidence of this is provided by the sensitivity analyses of the transit times of containers (Notteboom 2012), of the benefits of the decentralisation of a port for the business (Zheng & Negenborn 2014), the impact of empty containers (Shintani et al. 2007), the expansion of the port (Dekker et al. 2011), etc. This technique is useful to assess the various scenarios of the parameters that govern the model and to establish their influence on the global model.

4. METHODOLOGY

The methodology used in this chapter to validate the mathematical model and obtain analysable results is described in Figure 40.

Figure 40. The validation methodology



Source: Author

As Figure 40 shows, the inputs and the operative and financial variables are introduced into the model. The expected profits of the developer and concessionaire are then obtained. The results are then subjected to a sensitivity analysis and, in this example, a correction module that awards a rebate for the environmental performance is applied to these results. After this process, the definitive results are obtained, which are analysed in the conclusions.

5. APPLICATION OF THE MODEL

The mathematical model is applied to the previously mentioned container terminal *Martiport*, whose sizing is described in chapter 7.

5.1. Hypothesis

As defined in chapter 9, the model's fundamental hypothesis is the developer-concessionaire relationship. In this model, the developer purchases the land on which the port is to be built and only pays the State a rate for the right to use the waters affected by it. The concessionaire, for its part, pays the developer various rates that give it the right to exploit the terminal.

However, the model is influenced enormously by the contextual conditions of the operation of the terminal and by a series of financial parameters which, in this chapter, are described in detail when they are used. Some of the fixed hypotheses are set out in Table 69.

Table 69. Financial parameters of the model

Parameters	Values
Year of start of concession rate payments	Year 2
Percentage of investments in infrastructure assumed by the developer ²⁷²	100%
Discount rate for the calculation of net present value	10.5%
Discount rate for the updating of the infrastructure investments	4.0%
Concession payment period	30 years
Interest rate investment loans	9.0%
Interest rate credit facilities	12.0%
Available interest rate	0.5%
Period of amortization of loans	10 years
Period of grace	0 years
Business tax rate (% of profits)	25.0%
Value Added Tax (VAT)	12.0%
Euro € / US\$ exchange rate	1.35

Source: Author

5.2. Concessionaire revenues

The concessionaire's revenues come from the rates it charges for the management of containers and the number of containers it is able to move. In this model, the rates proposed for the first year of the exploitation of the terminal are shown in Table 70 and come from an estimation carried out of the rates charged by the *Martiport* terminal and the competition in its area of influence.

Table 70. Rates, by movement of containers

Transshipment	60.8 US\$/TEU
Import / Exports	100.6 US\$/TEU

Source: Author

²⁷² A situation may arise in which part of the investments are assumed by the State in which the port is located as compensation for the generation of an economic activity hub. This compensation may be in the form of access to the port, whose value in this model is 38 million US\$.

The modelling carried out requires the value of the tariffs in successive years to be established. To determine this value, we use equation (26) defined in chapter 9, in which the rates are characterised as a function of the year of application and three scenarios are defined: the inflationary rate, deflationary rate and variable rate.

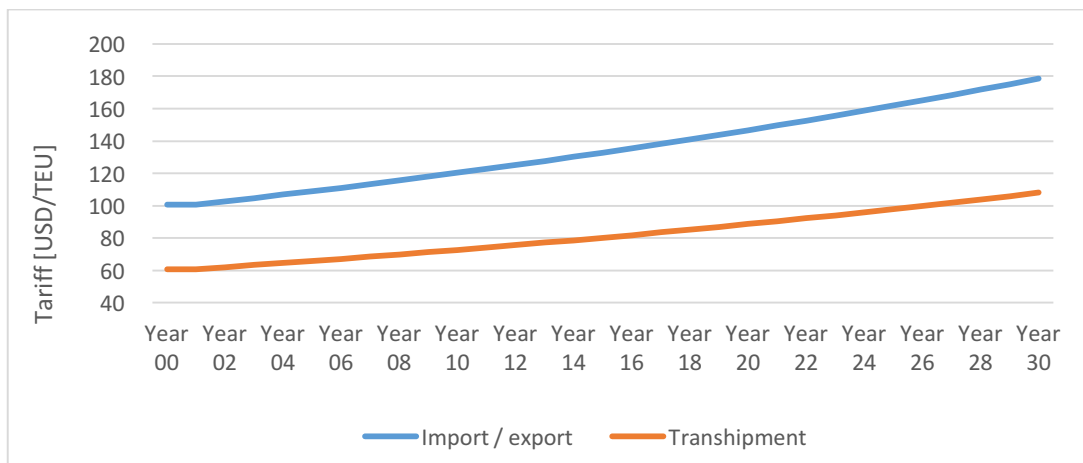
$$\varphi_j = \Phi_j \Gamma_j \tag{ 26 }$$

Where:

- Φ_j : Is the correction factor in year j. In this example, we apply a constant positive inflation rate corresponding to 2% annual growth. This means that we are working with a scenario in which the demand is inflationary.
- Γ_j : Base rate of the initial year j. For transhipments, this is 60.8US\$/TEU and for imports/exports, 100.6 US\$/TEU
- φ_j : Total value of the rate in year j.

Figure 41 shows the evolution of the total value of rates φ_j over the first thirty years, which corresponds to the concession period.

Figure 41. Evolution of the rates over the first 30 years



Source: Author, from the mathematical model

Figure 41 shows that the annual increase of 2% occurs over the entire period.

Now that the rates have been determined, it is necessary to determine the number and type of containers the terminal can handle. In other words, it is necessary to define the demand for the successive years of the terminal’s operation. *Martiport* is designed to handle 2.65 million TEUs per annum. However, this capacity is achieved only when the terminal’s two phases are completely operative. To calculate the number of TEUs handled each year, we fix the assumptions defined in Table 71. The proposed values can be modified in the model to dynamically obtain various results for the profits of each entity.

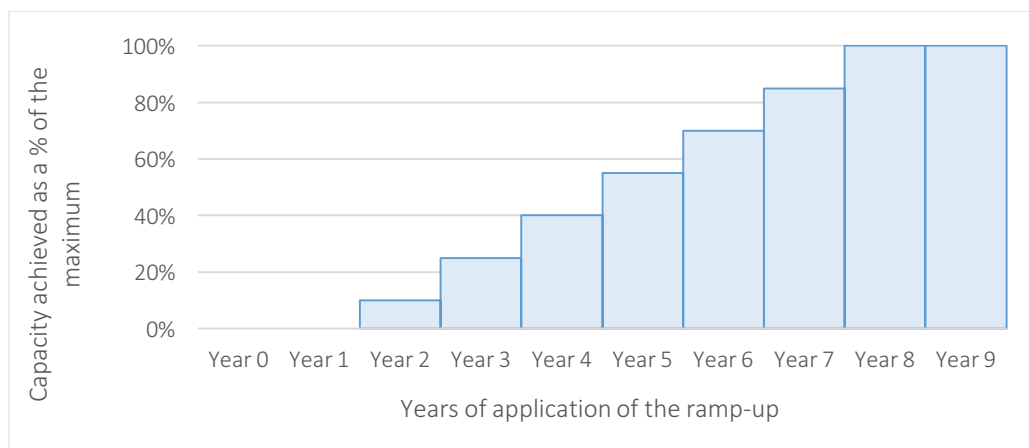
Table 71. Assumptions for the calculation of true demand

Assumptions	Values
Ramp-up	The ramp-up is defined in chapter 7 as the time that a terminal takes to be capable of handling the amount it is designed for. In this example, the terminal has two phases and the ramp-up is considered to affect each of the phases separately. In phase I, construction begins in year 0 and is completed by year 2, reaching its maximum capacity in year 8. With exactly the same gradation but starting later, phase II reaches its maximum capacity in year 13. Figure 42 shows the evolution of ramp-up of phase I.
Proportion of	60% of the containers handled by the terminal are 40ft (2TEU), while the remaining 40% are

20ft/40ft containers	20ft (1TEU)
Proportion of full empty containers	The forecast traffic for the terminal means that 40% of the containers handled will be empty and 60%, full.
Import/export – transshipment proportion	75% of the containers handled are transshipment, and 25%, import/export.
Demand scenarios	Three demand scenarios have been created for each type of traffic (transshipment and import/export). In the scenario of maximum demand (optimistic), the terminal's maximum capacity (2.65 million TEUs/year) is achieved. In the scenario of intermediate demand (moderate), 85% of its maximum capacity is reached and in the scenario of minimum demand (pessimistic), 75% of the maximum capacity is achieved. The calculation has been carried out for the minimum demand scenario.

Source: Author

Figure 42. Evolution of the ramp-up over the years años



Source: Author, from the mathematical model

There is a technical limitation brought about by the capacity of the cranes. These are capable of moving a certain number of containers per unit of time. To determine the quantity of TEUs being moved in each of these movements, a hypothesis needs to be established that takes into account the proportion of 20ft and 40ft containers detailed in Table 71. Equation (27) shows the way in which the proportion of TEUs per movement is calculated.

$$P_{TEU/mov} = \frac{2 \times \left(\frac{M_{40}}{M_{20}} + 1 \right)}{\left(\frac{M_{40}}{M_{20}} + 1 \right)} = 1.6 \quad (27)$$

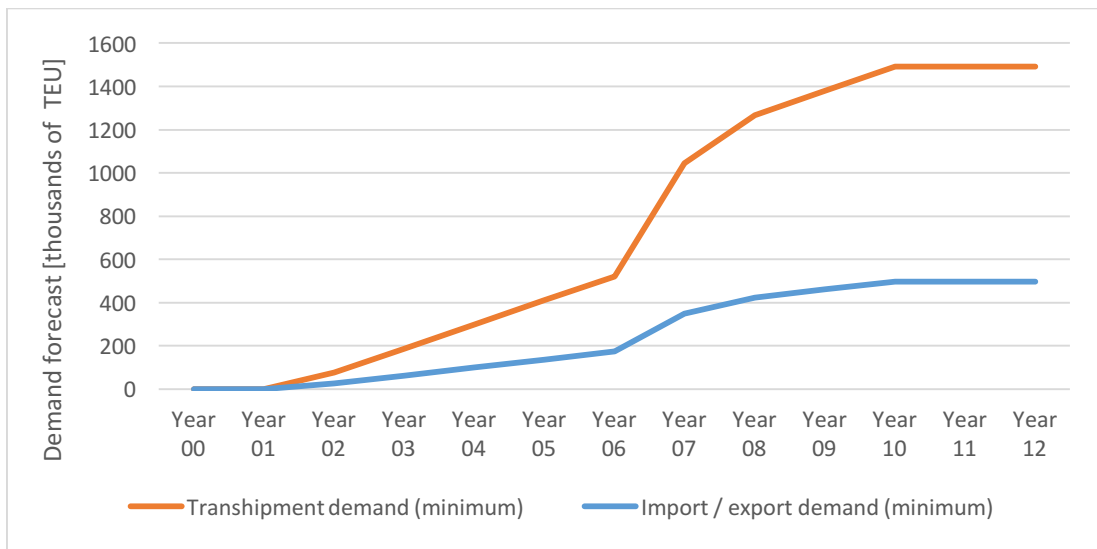
Where:

M_{40} : Movement of 40ft containers

M_{20} : Movement of 20ft containers

Therefore, if 60% of the containers handled in the terminal are 40ft, the cranes will be moving 1.6 TEU per movement. Figure 43 shows the demand, in thousands of TEU, the terminal will be able to handle over the years. As can be seen in Figure 43 and on the basis of the hypotheses established, from year 11 the values of the forecast demand tend to stabilise and become stationary, reaching its maximum capacities. Consequently, values beyond 13 years are not shown.

Figure 43. The demand the terminal will be able to handle

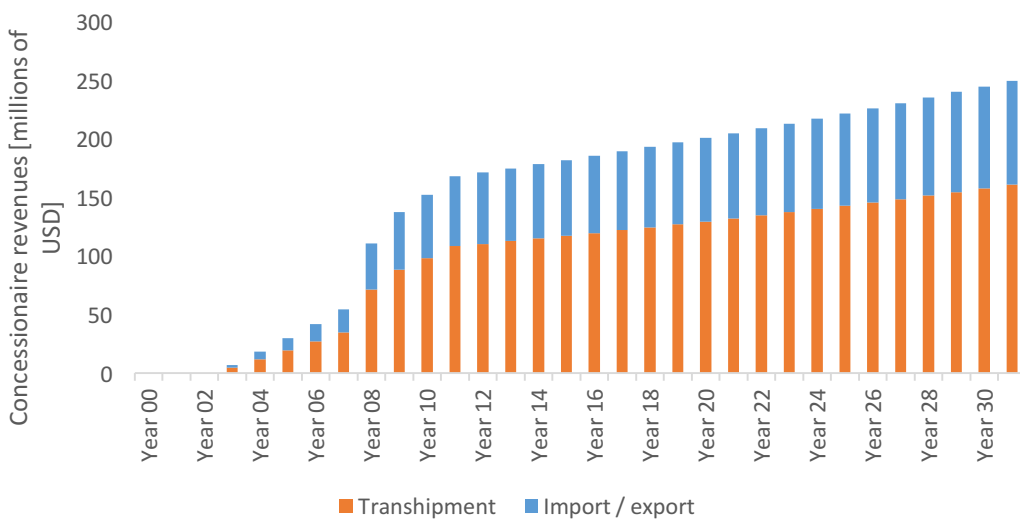


Source: Author, from the mathematical model

The model also allows us to operate on the demand for containers similarly to that done with the rates. That is, the demand could be, for example, inflationary year on year or for successive periods such that the terminal’s maximum capacity is exceeded in a target year, in which case, expansion of the terminal may be considered. However, this tool has not been used in this analysis and the cargo handling capacity is only affected by the phasing of the terminal and by the ramp-up.

Standardising the rates by movement of TEUs and the demand forecast, the graph shown in Figure 44 is obtained in which the concessionaire revenues, in millions of US\$ for each type of traffic, can be seen.

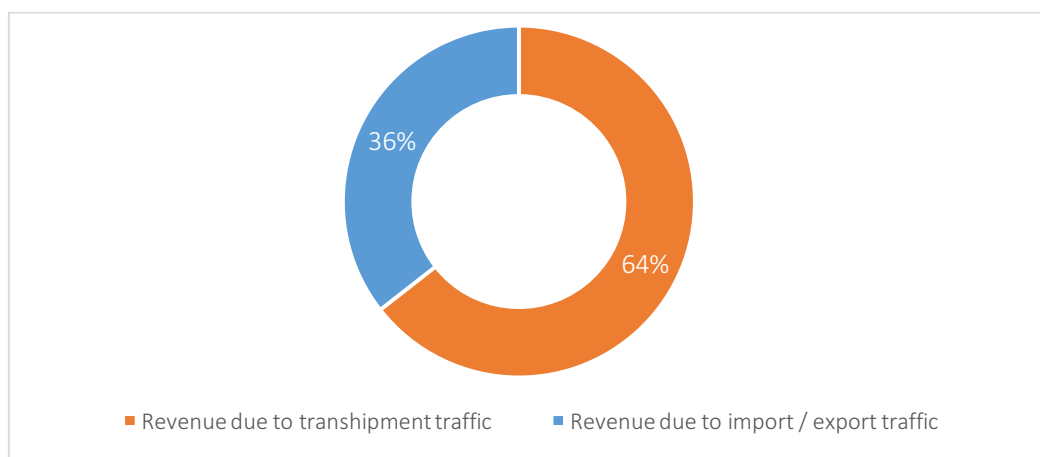
Figure 44. Concessionaire revenues, by movement of containers



Source: Author, from the mathematical model

In turn, Figure 45 shows the distribution of the concessionaire revenues as a function of the type of traffic.

Figure 45. Proportion of concessionaire revenues, by type of traffic



Source: Author, from the mathematical model

As can be seen, despite the fact that only 25% of the traffic handled by terminal is import/export, the volume of revenues forecast by from this is 36%. This is due to the fact that the rate for import/export traffic is higher than for transshipment traffic.

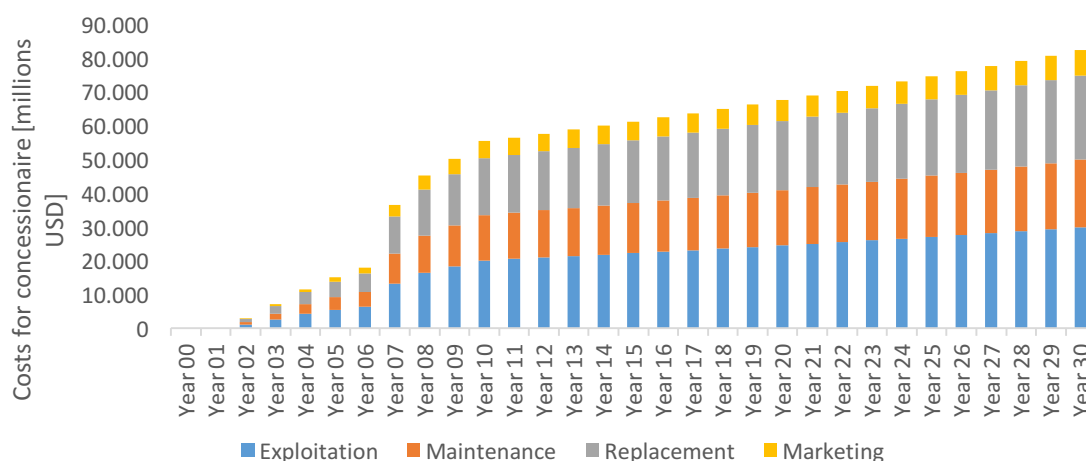
5.3. Costs for the concessionaire

The costs for the concessionaire of the container terminal *Martiport* are divided into two blocks:

- Block 1: The costs of exploiting the terminal, maintenance and replacement of the equipment. They are costs the concessionaire must assume in order to operate the terminal.
- Block 2: Activity rate (R_a), infrastructure rate (R_i) and concession rate (R_c)

We have included the costs associated with port services together with any marketing expenses in block 1, as it is understood that they form a part of the volume of costs the concessionaire has to take on in order to operate the terminal. Figure 46 shows the structure of the costs for the concessionaire.

Figure 46. Costs for the concessionaire (block 1)



Source: Author, from the mathematical model

These costs are proportional to the revenues, such that the costs of exploitation correspond to 12% of the revenues. Similarly, the costs of maintenance represent 8%, replacement of equipment, 10% and marketing, 3%.

As higher costs will have to be assumed during the first few years of operating the terminal — due to the need to purchase certain equipment, invest in marketing campaigns etc.—, a forecast of the increase in costs was carried out and, during the first 4 years of operation, a growth rate of the costs, corresponding to 30%, 20%, 10% and 10%, respectively, was determined.

The costs in block 2 are those agreed with the developer and represent the developer-concessionaire economic flows. The model built for this terminal includes three types of rates:

- Activity rate (R_a): This is the percentage paid to the developer for the rights to activities. It corresponds to a percentage of the revenues and has been established at 5%. This is the rate that can be awarded a rebate by the developer as long as the established conditions are met.
- Infrastructure rate (R_i): In chapter 9, we defined the amount paid by the concessionaire to the developer such that the developer is able to manage the investments made in infrastructure. According to this definition, the rate R_i is broken down into an initial payment ω_0 , if there is one, and annual payments, ω_j , whose value corresponds to the payment of investments by the developer χ_j and their operating margin ψ . Equations (28) and (29) show how the infrastructure rate is calculated.

$$\omega_j = \chi_j \times (1 + \psi) \quad (28)$$

$$R_i = \omega_0 + \sum_{j=1}^n \omega_j \quad (29)$$

In the proposed model, the value ψ (the operating margin of the developer) has been established at 2.5% and the initial payment of the rate ω_0 at 5%. The value of ω_0 of 5% has been taken into account in the model not as a percentage but as a total monetary volume of the initial payment.

Both values are calculated from the net present value of the investments, to which the discount rate (specified in Table 69) is applied. The initial payment is paid in year 5 and the remaining infrastructure rate is paid over the successive years for the whole of the concession period.

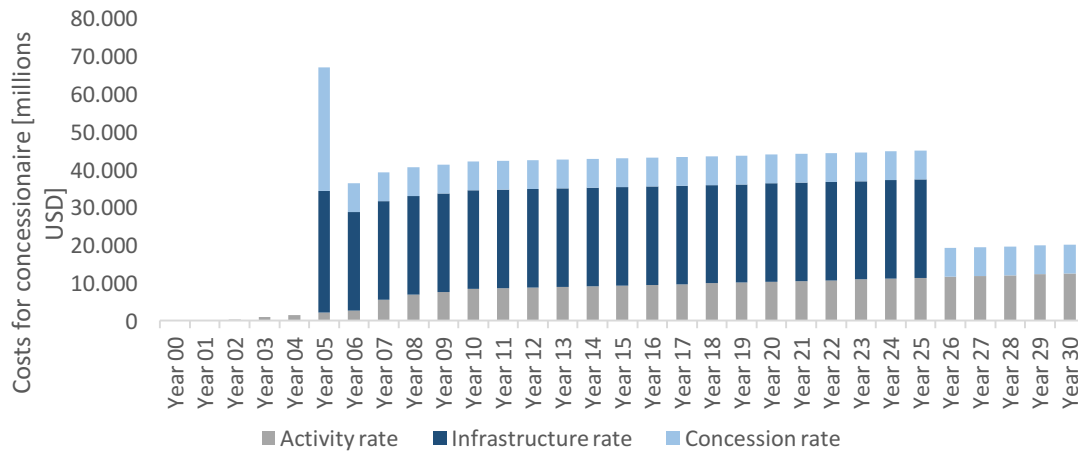
- Concession rate (R_c): This is defined in chapter 9 as the payment paid by the concessionaire for the right to use the concessioned land. As shown in expression (30), it can also be broken down into an initial payment R_{c0} , if there is one, and additional annual payments, R_{cj} .

$$R_c = R_{c0} + \sum_{j=1}^m R_{cj} \quad (30)$$

We have fixed a value for the total concession at an amount of 150 million US\$, divided into the 30 years of the concession period. From this amount, the net present value is calculated with a discount rate of 4% and an initial payment R_{c0} of 12.5% is made in year 5. The remaining rate, R_{cj} , is divided annually until the end of the concession.

Figure 47 shows the structure of the concessionaire costs for block 2 over the 30 years of the concession period.

Figure 47. Costs for the concessionaire (block 2) – rates



Source: Author, from the mathematical model

As can be seen in Figure 47, the activity rate does not start to be paid until year 2, which corresponds to the moment when the terminal starts operating. This rate increases over the first 10 years due to the fact that the phases of the terminal construction are being completed and the fact that the established ramp-up is increasing gradually. From year 10, it continues to increase due to the inflation applied to rates.

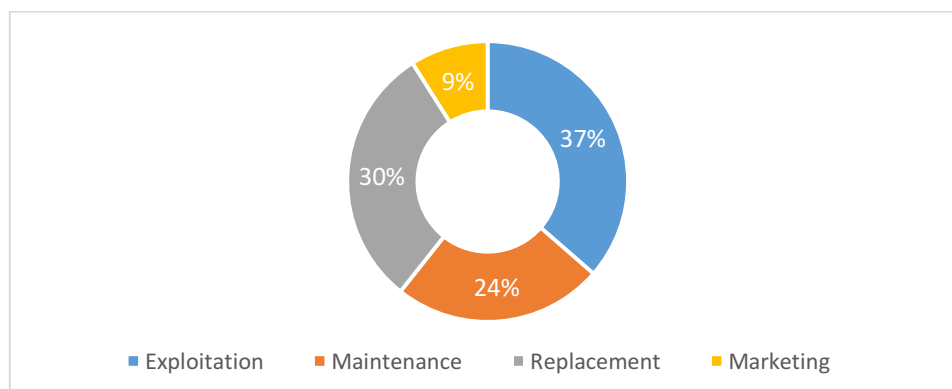
Figure 47 also shows that both the infrastructure rate and the concession rate have an advanced payment in year 5, which corresponds to 5% and 12.5%, respectively.

Due to this initial payment, the column corresponding to year 5 is larger than the others. This advanced payment allows the concessionaire to obtain better payment conditions for these rates over the following years, which assures the developer a quick return of part of the investments it has made.

With regard to the durability of the rates over time, we see that both the activity rate and the concession rate are paid over the total concession period (fixed at 30 years), while the infrastructure rate stops being paid the moment the investments have been fully paid off.

Figure 48 shows the proportion of the concessionaire costs for the Martiport terminal that correspond to block 1.

Figure 48. Proportion of the concessionaire costs (block 1)



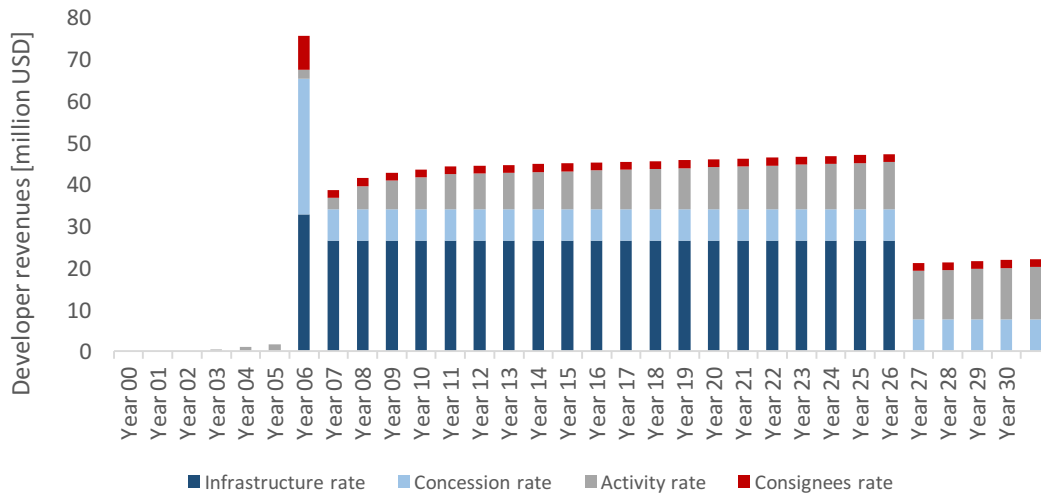
Source: Author, from the mathematical model

The most important costs to be paid by the concessionaire, without taking into account the rates to be paid to the developer, are the exploitation and equipment replacement costs, followed by maintenance costs and lastly, marketing costs.

5.4. Developer revenues

Part of the developer's revenues corresponds exactly to the concessionaire's costs. These are the revenues derived from the application of rates. Figure 49 shows the distribution of the developer revenues over the first 30 years.

Figure 49. Developer revenues



Source: Author, from the mathematical model

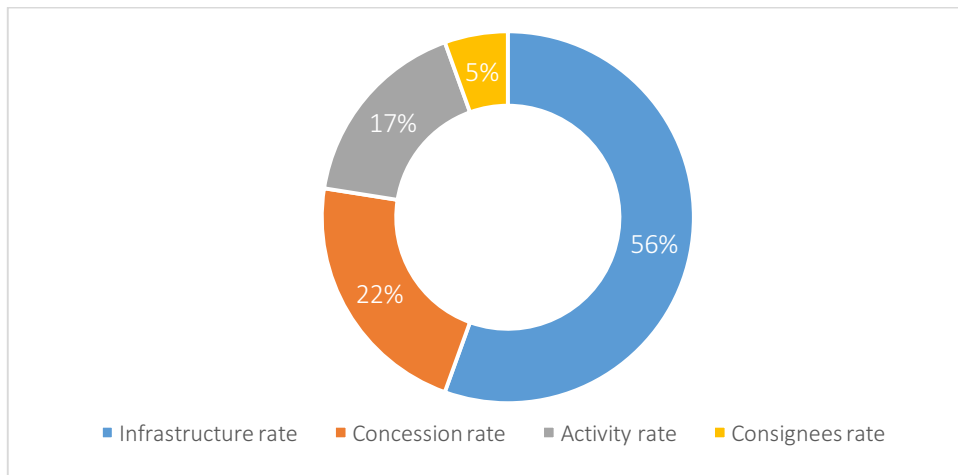
Figure 49 shows the previously mentioned effect of the advanced payment of the infrastructure and concession rates and the repercussion this effect has on the concessionaire's revenues in year 6.

This effect is vital to the developer's business structure, since as we will see further on, during the first three years it has to take on the greatest volume of investment in the project and the payment of a part of the rates in advance allows it to quickly reduce its level of funding and debt levels.

The developer, who is also the Port Authority in our model, may also charge third parties for other services. Figure 49 takes into consideration the charging of a rate to consignees. This rate is proportional to the concession rate, R_{cj} , charged to concessionaires and in this model, this has been established to rise to 25% of the concession rate. Thus, the developer charges the consignees 25% of the sum charged annually to the concessionaires for the right to operate its port.

However, this is not the only rate the developer could charge. In this model, extra revenues have not been included, as we want to determine the core business model. However, developers usually charge for services such as crew, tugs and dangerous waste management services and for the use of wastewater treatment systems, etc. Figure 50 shows the distribution of the revenues for the developer.

Figure 50. Proportion of developer revenues



Source: Author, from the mathematical model

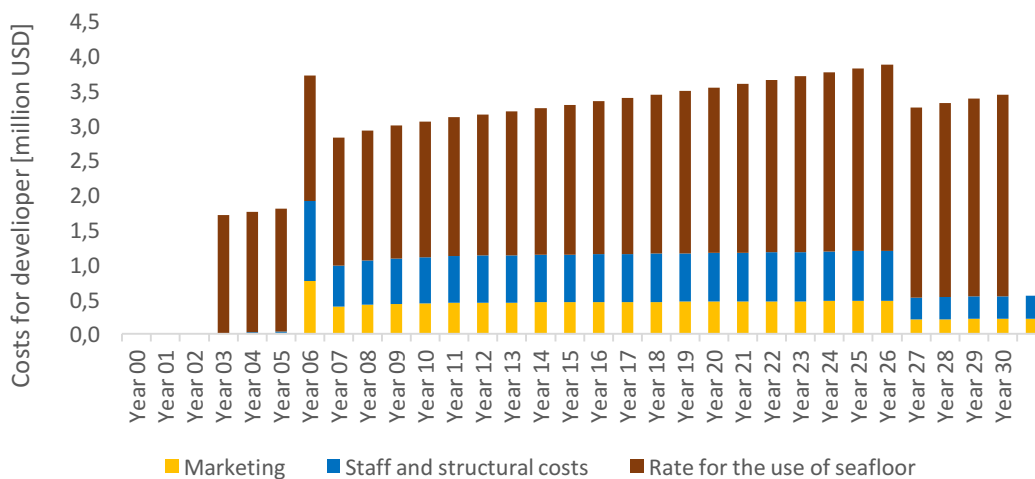
5.5. Costs for the developer

To explain the business costs for the developer, a structure analogous to that developed for the concessionaire will be used. Thus, we will divide the developer’s cost into two blocks:

- Block 1: This consists of the exploitation costs, which include marketing (1% of the developer’s total revenues), staff and structural costs (1.5%), and the rate paid to the State for the use of the seafloor. This rate is paid independently of whether the land has been purchased by the developer (whether inland territory or land occupying the seabed). This payment gives the right for the use of the coastal areas for the navigation of the ships that use the port. In the model, as value of 2 US\$/m² has been used, with an area of occupied seafloor (waters sheltered within the port and seawalls) of 80 Ha.
- Block 2: Amortizations of common investments generated by the infrastructure rate (R_i) that the developer receives as income.

Figure 51 shows the costs for the developer making up block 1.

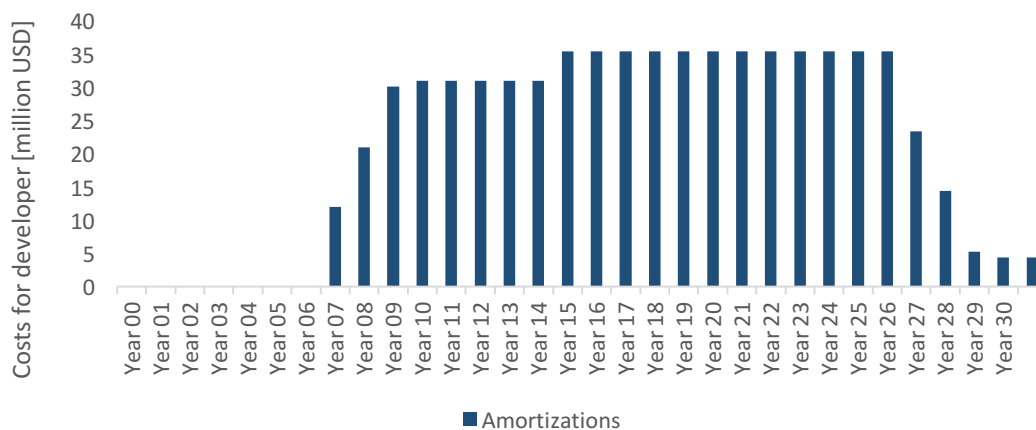
Figure 51. Costs for developer (block 1)



Source: Author, from the mathematical model

As can be seen in Figure 51, the most important costs in block 1 are those incurred for the use of the seafloor, which starts to be paid back to the State after the seawalls in phase I have been completed. The costs of marketing and staff/structure start to be paid from year 2, although their amount is proportional to the revenues generated in the first years and are not noticed until year 6, one year after the first phase of the terminal becomes operational. Figure 52 shows the costs for the developer in block 2 that correspond to the amortization of common investments or those in infrastructure.

Figure 52. Costs for the developer (block 2)

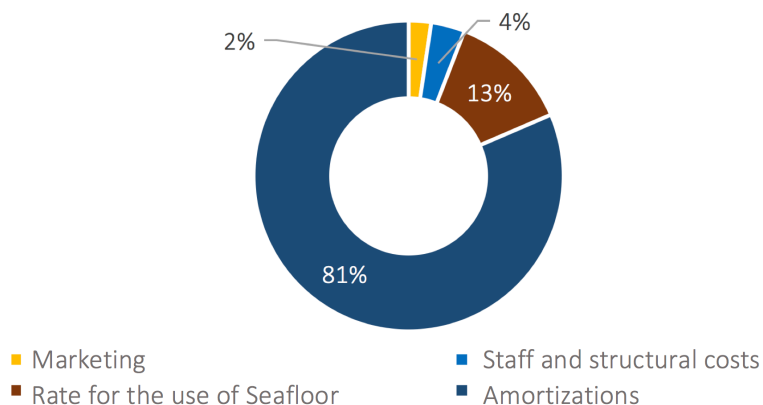


Source: Author, from the mathematical model

The amortizations begin to affect the concessionaire as an infrastructure rate from year 5, which is when the first phase of the terminal becomes operational. For the period it takes to complete the construction of the rest of the terminal, the developer gradually assumes the costs of the largest amortization, which reach a stationary maximum from year 13 and start to reduce from year 25, falling to zero at the end of the concession.

Lastly, Figure 53 shows the proportion of the developer costs. As can be seen, the most important costs correspond to the amortization of the investments in infrastructure, at 81% of the total. This is understandable, as one of the main components of the developer’s business is to receive a return on its investments in infrastructure.

Figure 53. Proportion of the developer costs



Source: Author, from the mathematical model

Of the remaining costs, the most important is the rate paid to the State for the right to use the shelter waters inside the seawalls. Staff and structure correspond to 4% of its costs, while marketing expenses reach 2% of the total.

5.6. Developer and concessionaire investments

In general and as has been described in previous chapters, the investments made by the developer correspond to those made in common elements (infrastructure) and those of the concessionaire correspond to those for its own activity (superstructure). Equation (31) shows the composition of each of these volumes of investment. The investments in infrastructure are represented by β , while ξ represents those corresponding to superstructure.

$$\beta = \sum_{\alpha=1}^p \beta_{\alpha}; \quad \xi = \sum_{\gamma=1}^q \xi_{\gamma} \quad (31)$$

Where:

β, ξ : Infrastructure or superstructure

α, γ : Year in which the investment is studied

p, q : Limit year for each stage of investments

In expression (31) we see that the rates p , for infrastructure and q , for superstructure, mark the limit year for the payment of these types of investment. In the case of infrastructure investments, this rate corresponds to 25, as can be deduced from a study of Figure 47.

Investments are made during the first years of construction project and the exploitation of the terminal. It should be remembered that in chapter 7, which described the characterisation of the terminal, the construction works were divided into two phases. These phases directly affect the distribution of the investments over the years. Tables 50 and 51 in chapter 7 detail the investments and their measurements. Table 72 shows a summary of the investments, distinguishing whether the investments are undertaken by the developer or by the concessionaire in the *Martiport* terminal for each execution phase.

Table 72. Summary of total investments

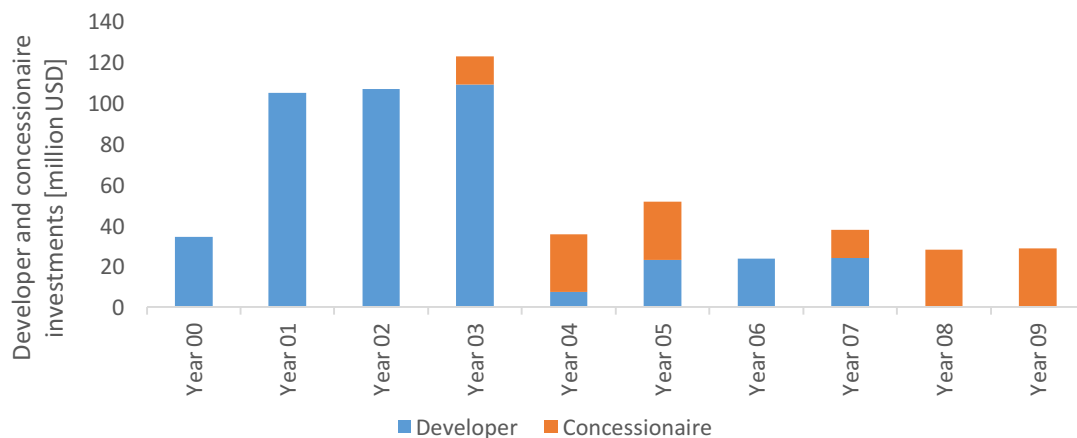
INVESTMENT SUMMARY (millions US\$)	Phase 1	Phase 2	TOTAL
TOTAL = (D) + (O)	406.0	129.7	535.7
Developer (D) = (A) + (C) + (E) + (F)	341.5	69.6	411.1
Developer works (A)	301.6	50.6	352.2
Rail infrastructure	38.0	0.0	38.0
Dredging	124.2	0.0	124.2
Breakwater	68.0	0.0	68.0
Outer harbour wall	6.0	0.0	6.0
Landfills and esplanades	16.9	5.6	22.5
Container dock	43.2	43.2	86.4
Containment wall	1.8	0.0	1.8
General equipment	0.8	0.8	1.7
Service networks	2.7	0.9	3.6
Mitigation measures (C)	27.0	11.6	38.6
Studies, projects and project management (E)	9.5	6.0	15.5
Health and safety (F)	3.4	1.4	4.8
Terminal operators (O)	64.5	60.1	124.6
Container terminal	64.5	60.1	124.6
Cranes	58.8	58.8	117.6
Buildings and services	2.2	0.0	2.2
Electrical installations	3.5	1.3	4.8

Source: Author, from the mathematical model

As can be seen in Table 72, the total investment made by the developer is 411.1 million US\$ and by the concessionaire, 124.6 million US\$. It can be seen that the mitigation measures (C), studies, projects and project management (E) and health and safety (F) are the responsibility of the developer. For its part, the concessionaire only invests in cranes, buildings and services and electrical installations, all representing superstructure investments in elements required for its activity.

However, to schedule the investments, it should be borne in mind that the construction works and installation of operation elements take place over several years. Figure 54 takes into account the total investment in each year and shows the proportion of investments of the developer and concessionaire.

Figure 54. Scheduling of the developer and concessionaire investments



Source: Author, from the mathematical model

Figure 54 shows that until year 3, the developer has to undertake the greatest volume of investments. This is due to the fact that during the execution of phase I, all the breakwaters have to be built and the landfills and containment wall must be completed (see figure 21 in chapter 7). The amount invested by the developer in phase II is considerably less.

For its part, the concessionaire does not start to invest in superstructure until year 3, when the developer has completed building the infrastructure, at which point the equipment can start to be installed. From this moment, corresponding to years 4 and 5, its investment levels are similar. In year 6, the concessionaire makes no investments, as it is waiting for the developer to equip the infrastructures necessary in phase II and from year 7, it follows an investment structure identical to that in the first phase. Therefore, it could be considered that the concessionaire investments are identical in both phases, while those of the developer are considerably higher in the first years of phase I. As will be seen in later sections, this point is important from a financial point of view.

6. PROFITS AND SENSITIVITY ANALYSIS

To determine whether the business is viable or not for each of the participants, a profitability analysis needs to be carried out. Profitability can be understood as the profit that the investor

receives for taking on the risk of using its capital in a business. This profitability is assessed through an IRR²⁷³ analysis.

However, in the business model described here, two different perspectives have been defined: the perspective of the developer and that of the concessionaire, both of which are, in theory, inversely related. We then carry out a sensitivity analysis of the IRRs of the developer and the concessionaire, modifying within certain ranges the fundamental parameters that govern the business. The detailed sensitivity analysis carried out for each variable is described in the following sections. Table 73 shows a summary of the ranges used in the analysis of each variable.

Table 73. Variables included in the sensitivity analysis

Variable analysed	Pivot value original model	Minimum range	Minimum value	Maximum range	Maximum value
Value of the rates charges per container handled	-5.0%	-15.0%	-20.0%	+15.0%	10.0%
Inflation scenarios	2.0%	-5.0%	-3.0%	+5.0%	7.0%
Variation in demand	0.0%	-15.0%	-15.0%	+15.0%	15.0%
Import – export / transshipment proportion	75.0% trans.	-25.0%	50.0% trans.	+25.0%	100.0% trans.
Proportion 40ft / 20ft containers	60.0% 40ft	-20.0%	40% 40ft	+20.0%	80.0% 40ft
Proportion full/empty containers	40.0% empty	-40.0%	0.0% empty	+60.0%	100.0% empty
Activity rate R_a	5.0%	-5.0%	0.0%	+5.0%	10.0%
Infrastructure rate R_i	V_{inv}^{274}	-15.0%	$0.85 V_{inv}$	+15.0%	$1.15V_{inv}$
Advanced payment of the infrastructure rate R_i	5.0%	-5.0%	0.0%	+5.0%	10.0%
Variations in the value of the management fee charged by the developer over the value of the infrastructure investments	2.5%	-2.5%	0.0%	+17.5%	20%
Concession rate R_c	150MUS\$	-14.0%	129MUS\$	+20.0%	180MUS\$
Advanced payment of the concession rate R_c	12.5%	-12.5%	0.0%	+12.5%	25.0%
Rate charged by the developer to consignees R_k	25.0%	-25.0%	0.0%	+32.5%	57.5%
Rate for the use of the seabed R_m	2US\$/m ² /year	-100.0%	0	+300.0%	8US\$/m ² /year

Source: Author, from the mathematical model

The definitions of the headings in Table 73 are as follows:

- The “Pivot value original model” corresponds to the base value used in the model and from which the various scenarios proposed in the analysis vary.
- Minimum range: The percentage value of the analysis that establishes the lower limit of the analysis range.

²⁷³ IRR is the Internal Rate of Return. It is a method for evaluating investments that measures the profitability of current charges and payments generated through an investment in relative terms, i.e. as a percentage.

²⁷⁴ Value of the investments

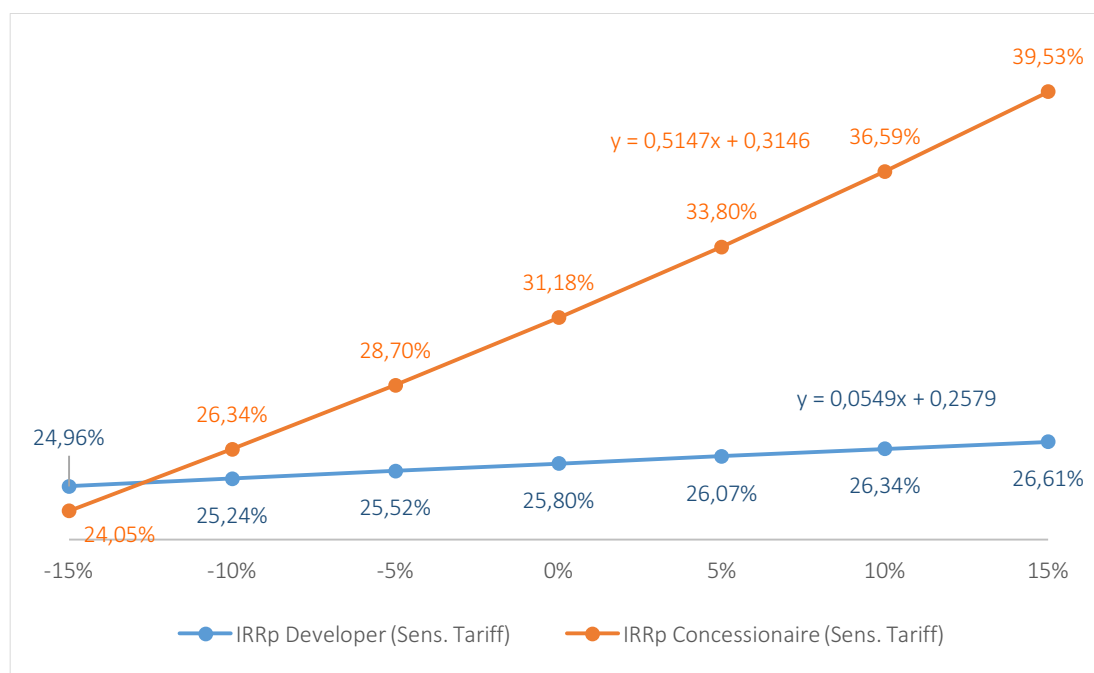
- Minimum value: The minimum absolute value of the variable.
- Maximum range: The percentage value of the analysis that establishes the upper limit of the analysis range.
- Maximum value: The maximum absolute value of the variable.

Next, we carry out a sensitivity analysis for each of the 13 parameters.

6.1. Sensitivity analysis of the value of the rates

Taking as a base the value of the rates by movement of containers, which is initially fixed at 60.8US\$/TEU for transshipment traffic and 100.6US\$/TEU for import/export traffic, an fluctuation range of these values lies between -15% and +15%. We analyse how the profits for the developer and concessionaire are modified. Figure 55 shows the results of this analysis.

Figure 55. Sensitivity analysis of the value of the rates, by container movement



Source: Author, from the mathematical model

Given that we have created a range from -15% to +15%, the total value of the interval studied is 30 units. Moving the rate value by 30 percentage units, we can see that the profitability value ranges from 24.05% to 39.53%, moving for its part by 15.48 units. Therefore, by modifying the rate by 30 percentage units, the profitability is modified by 15.48 units. We can therefore confirm that for each percentage point the rate is modified by, the profitability is modified by 0.52%. We see that the effect is more pronounced for the concessionaire than for the developer (a ratio of approximately 1 to 10). Consequently, increases or decreases in the rate affect the concessionaire considerably and only affect the developer a little, since the rate implies direct exploitation revenues for the concessionaire, while for the developer it is a source of secondary revenues to be received by it as a proportion of the concessionaire activity rate.

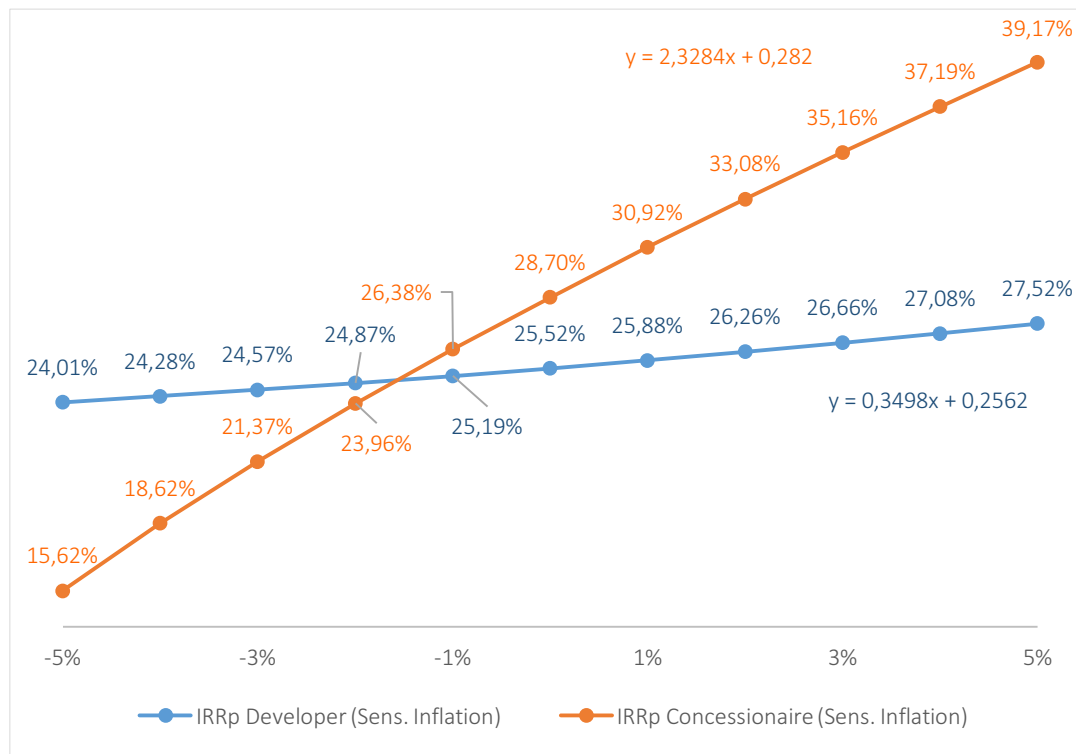
Therefore, we consider the variation of 0.52% of the profitability for each percentage point modifying the rate to be high, since the proportion exceeds 50%.

6.2. Sensitivity analysis of inflation

In the calculation model, the base value for inflation has been fixed at 2%, which is applicable to the value of the rates per container movement. To carry out the sensitivity analysis, a range of

inflation values of $\pm 5\%$ of this value was established, with the range of values being a minimum of -3% per annum and a maximum of 7% per annum. It is important to emphasise that one of the hypotheses of the economic-financial model defined in chapter 9 established a constant inflationary demand with a correction factor Φ_j , to which the variation from -3% to $+7\%$ per annum corresponds. Figure 56 shows the evolution of the IRRs for the developer and the concessionaire.

Figure 56. Sensitivity analysis of inflation



Source: Author, from the mathematical model

It can be seen that the gradient of the line defined by the concessionaire's IRR values achieves a value of 2.3284, while that of the developer achieves a value of 0.3498. This means that the increase in inflation improves the profits of the developer and the concessionaire, but affects the concessionaire much more and the value of the gradient means that the effect is very high. Inflation is applied to the rates received by the concessionaire for handling containers. This is its activity and, consequently, its only source of income. In the case of the developer, it has more sources of income and inflation only affects it in the calculation of the activity rate.

6.3. Sensitivity analysis of the variation in demand

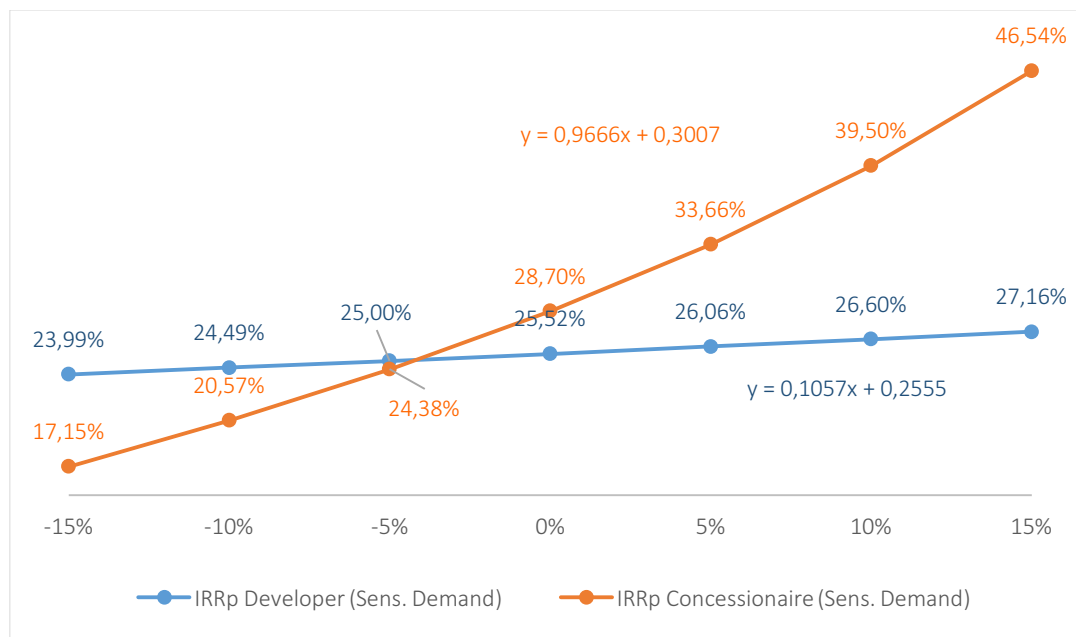
To calculate the demand, three scenarios have been created. The optimistic scenario is one in which the demand corresponds to the maximum capacity of the terminal (2.65 million TEUs per annum). In the moderate scenario, the demand corresponds to only 85% of its maximum capacity, while in the pessimistic scenario, it corresponds to 75%.

Using the pessimistic scenario, we assess whether the profits of the business participants are adequate and, if so, whether the business can be considered profitable for all parties, since this has been assessed using the worst of the scenarios possible and, consequently, any other demand scenario will always improve the profits of the developer and concessionaire.

However, a sensitivity analysis has been applied to the minimum demand scenario in order to determine what happens for demand levels lower than 75%. For this, a range was established using as a base the scenario of 75%, reducing the demand by 15% and, symmetrically,

increasing it by 15%. Therefore, Figure 57 shows the sensitivity analysis carried out for this demand scenario when demand lies between 60% and 90% of the terminal's maximum capacity (2.65 million TEUs).

Figure 57. Sensitivity analysis of the demand in the pessimistic scenario



Source: Author, from the mathematical model matemático

As can be seen from Figure 57, small changes in demand appreciably affect the concessionaire. In fact, by obtaining the equation of the gradient for the concessionaire's IRR, it can be seen that it is close to 1 (0.9666), while for the developer, the slope reaches a value approximately 10 times lower (0.1057).

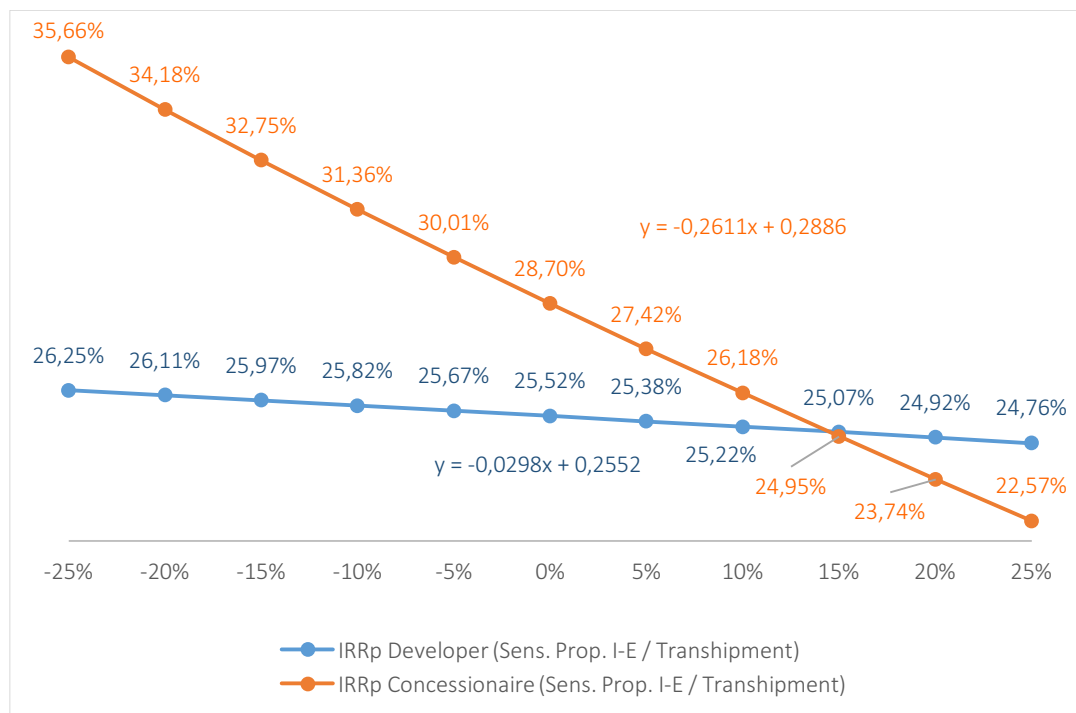
The conclusion is that the demand affects the concessionaire, as it is the concessionaire's only source of income, while for the developer, as can be seen from Figure 50, the activity rate represents 17% of its income and is calculated as a proportion of the concessionaire's revenues.

6.4. Sensitivity analysis of the proportion of import-export / transshipment traffic

The traffic that uses the terminal is composed of a proportion of containers that belong to the flow of the import and export of goods, while the other part corresponds to those that use the port for transshipment purposes. The model presented here establishes that 25% of the containers handled by the terminal are import-export and 75%, transshipment. To carry out the sensitivity analysis, a range of +/-25% was established such that the minimum proportion of transshipment containers is 50% and the maximum, 100%.

We have not considered it appropriate to reduce the proportion of transshipment containers to below 50%, since this model aims to be potentially implementable in any country and all countries that require infrastructure for the import and export flows already have ports that serve these flows. Consequently, this model is considered applicable to that port with the greatest transshipment traffic (similar to the case of Algeciras, in Spain). Moreover, containers of import/export traffic generate more profits than transshipment flows, as their rates are higher and require more services. Therefore, minimising this flow in the modelling guarantees working with more adverse economic scenarios and generates a more robust economic model. Figure 58 shows the evolution of the IRRs in the sensitivity analysis for the proportion of import-export / transshipment traffic.

Figure 58. Sensitivity analysis of the proportion of import-export and transshipment traffic



Source: Author, from the mathematical model

It can be seen that in this example, the gradients are both negative. In the case of the developer, the decrease is moderate and the value of the slope reaches -0.0298 . By contrast, for the concessionaire, the value is greater and reaches -0.2611 .

This effect means that when the quantity of transshipment containers increases, the profits of the developer and concessionaire decrease. In the case of the developer, this is moderate, since once again this only affects part of its revenues through the activity rate. On the other hand, the concessionaire is more interested in having more import-export containers, as when this proportion increases, its results considerably improve, representing a direct increase in its main source of revenues – the rates for container movement ($64\text{US}\$/\text{TEU}$ for transshipment traffic and $105.9\text{US}\$/\text{TEU}$ for import-export).

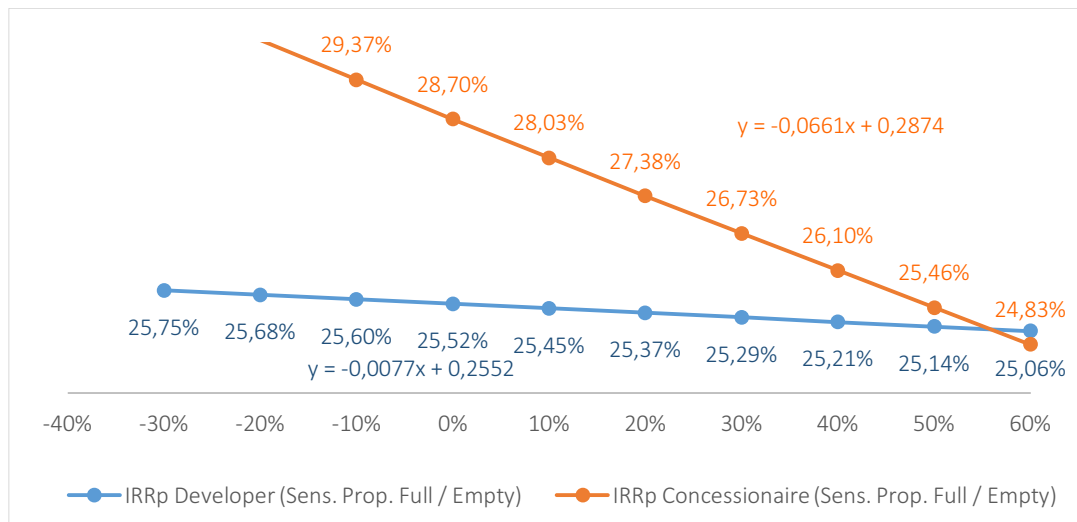
6.5. Sensitivity analysis of the proportion of full and empty containers

In any shipping line there is a proportion of full containers and the traffic usually circulates in reverse direction, with the containers returning after having left their cargo at its destination. This has been widely studied, evidence of which is provided by the analyses carried out by (Shintani et al. 2007) and (Xu et al. 2015). Due to the asymmetry of the market in this sector, some ports accumulate a large number of empty containers, while others have very few (Dang et al. 2012), (Di Francesco et al. 2013), (Wong et al. 2015).

The rates charged for handling these two types of containers are not the same, with rates for empty containers ($131\text{US}\$/\text{TEU}$) lower than those for full ($200\text{US}\$/\text{TEU}$) in the import/export flow, while for transshipment traffic, they are equal.

In the base model, we establish that 40% of the containers handled by the terminal are empty and, for the sensitivity analysis shown in Figure 59, this value varies between 0 and 100% (generating a range from -40% to $+60\%$).

Figure 59. Sensitivity analysis of the proportion of full and empty containers



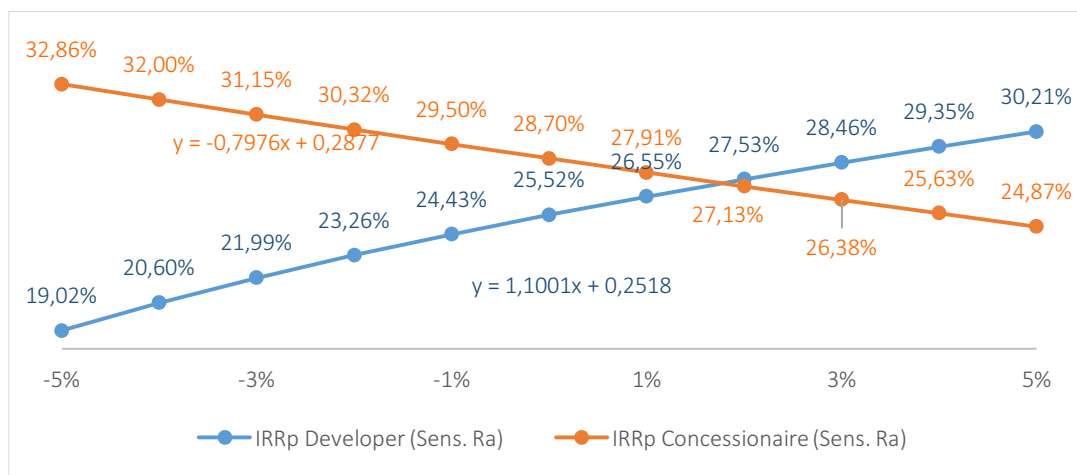
Source: Author, from the mathematical model

As can be seen, the profits of the developer and concessionaire decrease. Therefore, the increase in the proportion of empty containers negatively affects the profits of both parties. However, once again we can see that, while the developer is not affected very much, with its gradient reaching -0.0077 units, the concessionaire is considerably affected, with its slope reaching a value of -0.0661 units. This effect is analogous to that characterised previously and is due to the fact that the proportion of empty containers directly affects the main source of revenues of the concessionaire, while only the developer's activity is affected, with its remaining sources of income being unaffected.

6.6. Sensitivity analysis of the activity rate R_a

As has been previously defined, the activity rate R_a is calculated from the concessionaire revenues through the movement of containers. In this base model, the value of this rate has been set at 5%. To carry out the sensitivity analysis, a range of +/-5% was fixed such that the rate varies between 0 and +10%. Figure 60 shows the evolution of the profits for the developer and concessionaire, modifying the activity rate.

Figure 60. Sensitivity analysis of the activity rate



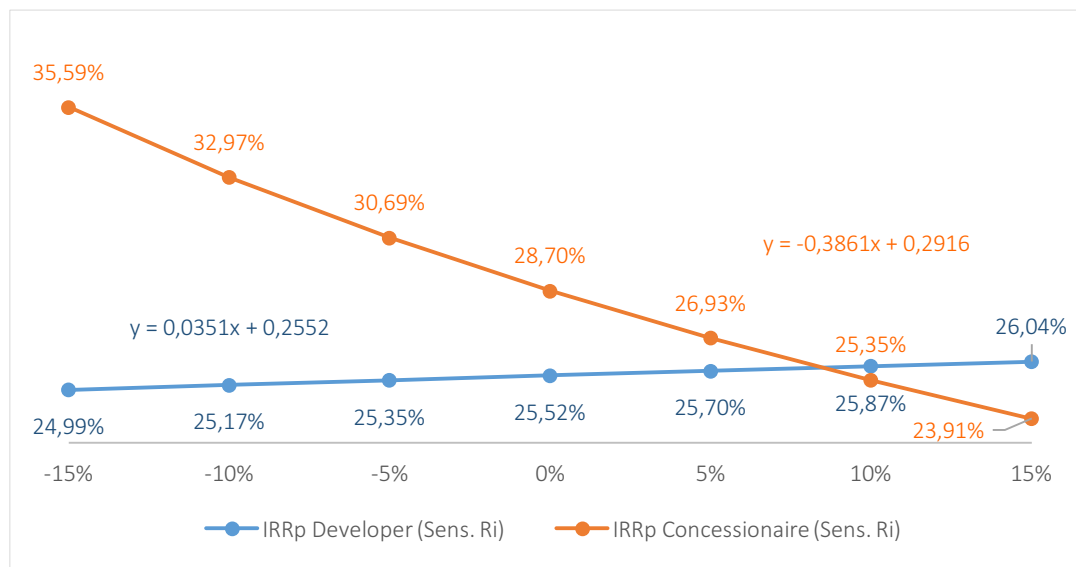
Source: Author, from the mathematical model

In this example, it can be seen that the evolution of the profits is inversely related. In the case of the developer, the slope is positive and is greater than 1. For the concessionaire, the gradient is negative and reaches a value of -0.7976, such that for each point the activity rate increases, the developer's profits increase by 1.1%, while those of the concessionaire decrease by approximately 0.8%.

6.7. Sensitivity analysis of the infrastructure rate R_i

Similarly to the sensitivity analysis carried out for the rates, the total value of the investments in both infrastructure and superstructure are varied between -15% and +15%. Figure 61 shows the result of the sensitivity analysis of the investments.

Figure 61. Sensitivity analysis of the infrastructure rate R_i



Source: Author, from the mathematical model

In this case, we see that for every percentage point in the variation of the volume of investment, the concessionaire's profits change by 0.39%. As happens with the rates, the effect on the developer is ten times lower. This is due to the fact that the volume of investment only affects the developer through the financing required to undertake it, since at the end of the concession period, the concessionaire is responsible for paying for all the investments in infrastructure, independently of the volume of investments. However, for the concessionaire this is important, since it must be capable of paying for all these investments taken on by the developer and its own investments in superstructure. Consequently, the affect on its profits is considerable.

It should be pointed out that the developer is barely affected by the variation in the cost of the investments in infrastructure, since this cost is completely recovered through the rate. However, the concessionaire is considerably affected, since it pays through the same rate all the investments, independently of the amount.

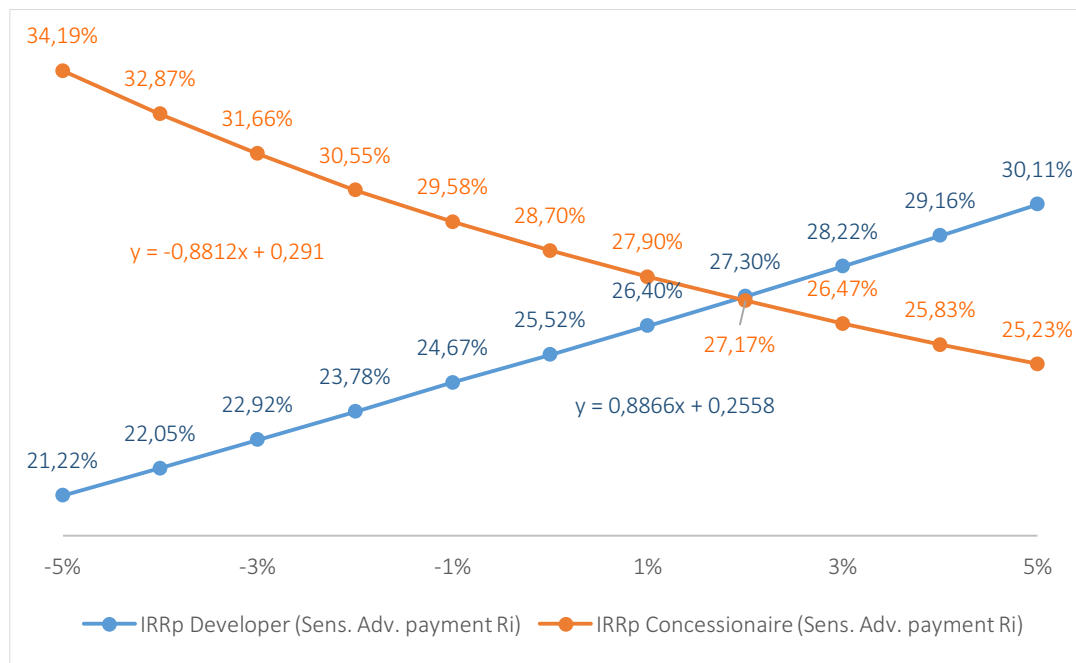
6.8. Sensitivity analysis of the advanced payment of the infrastructure rate R_i

The model built here offers the possibility of carrying out a sensitivity analysis of the advanced payment of part of the infrastructure rate R_i . By paying a quantity at the beginning of the concession period, the concessionaire obtains advantageous conditions and is assured of a series of annual payments whose value corresponds to the remaining infrastructure rate divided into 29 instalments.

The developer, on the other hand, is interested in this advanced payment, as it quickly recovers a part of the investments it has made and can reduce its debt levels.

In the base model, a value of the advanced payment of the infrastructure rate has been fixed at 5% of the total amount requested by the developer. To carry out the sensitivity analysis, the result of which is shown in Figure 62, a range between -5% and +5% was established such that the advanced payment varies between 0 and 10% of the total infrastructure rate.

Figure 62. Sensitivity analysis of the advanced payment of the infrastructure rate R_i



Source: Author, from the mathematical model

As can be seen, the slopes of both are practically identical, with only their signs changing. Consequently, it can be concluded that the advanced payment of the concession rate by the concessionaire affects both parties with an identical, but inverse, variation in profits, in that while the concessionaire suffers a worsening of its profits, the developer's increase by the same amount.

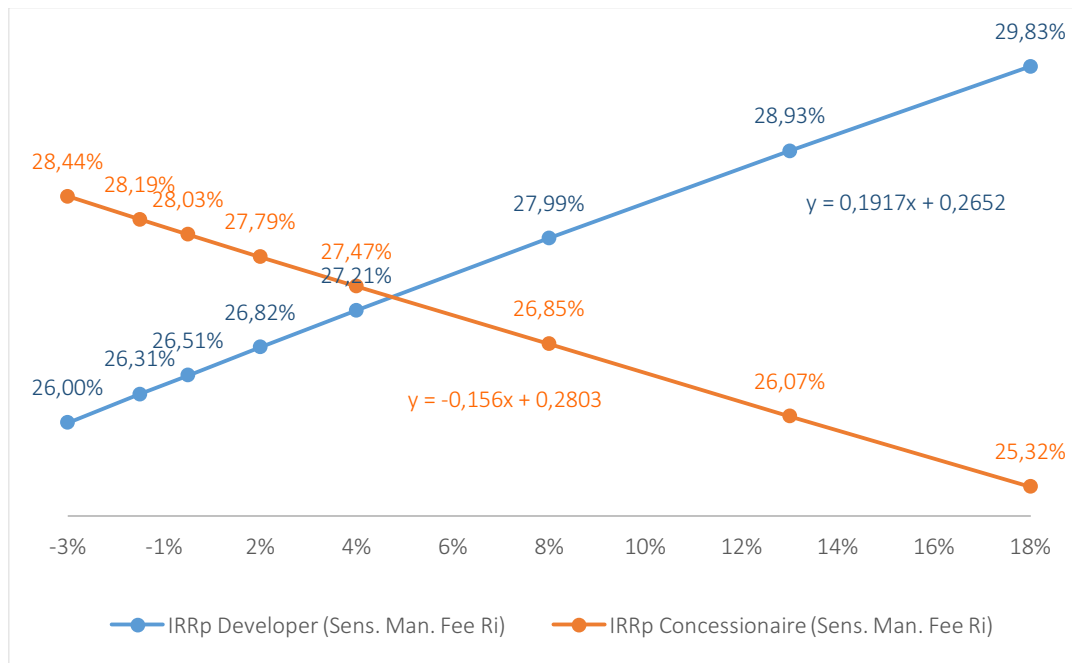
It can be confirmed, therefore, that the advanced payment of part of the infrastructure rate is of interest to the developer, but may not be so attractive for the concessionaire.

6.9. Sensitivity analysis of the management fee charged by the developer as a proportion of the volume of infrastructure investment

The developer has to undertake the investments necessary to execute the investments in infrastructure. In the model presented here, the total investments made by the developer for infrastructure affect the concessionaire, which it pays over a certain number of years.

In the description of the economic-financial model presented in chapter 9, the value of the rate ψ was defined, which exists to cover the developer's management costs and to eventually generate a profit. This rate is applied to the total volume of investments made in infrastructure and its base value has been fixed at 2.5%. To carry out the sensitivity analysis, shown in Figure 63, a range was established such that this value varies between 0 and 20% of the total volume of investments.

Figure 63. Sensitivity analysis of the management fee applied by the developer to the volume of infrastructure investment



Source: Author, from the mathematical model

As can be seen in Figure 63, once again there is an inverse evolution in the variability of the profits, such that while the developer sees an increase in its profits by 0.19% for each point increase in the management fee, the concessionaire experiences a decrease of 0.16% in its profits.

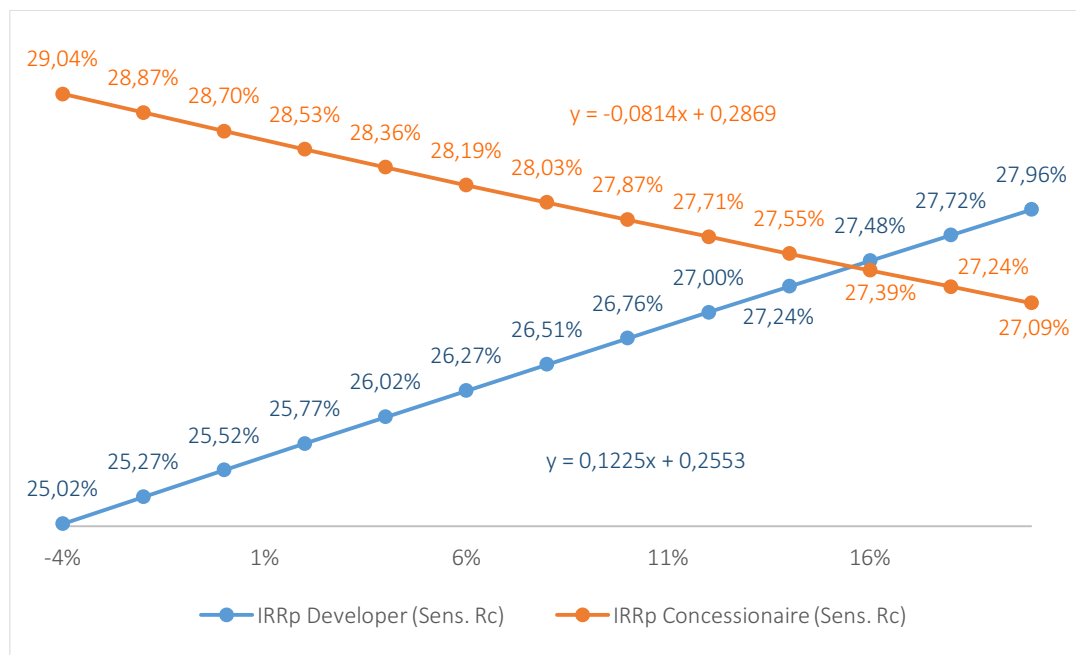
6.10. Sensitivity analysis of the concession rate R_c

The concession rate is an independent variable in this model. This is due to the fact that the value established for this rate is the result of the agreement between the developer and concessionaire. The developer offers the concession for a specific amount, which in this model reaches 150 million US\$. The concessionaire bids for this concession if it is of interest to it. In other words, if it believes that even with paying this rate, it will still be able to make a profit from its investments.

In this way, the concession rate only depends on this agreement and its value is usually established as a function of the relative value of the port. Normally, this is proportional to the real-estate value of the land, but it also includes a strategic component. Its total value is divided into the 30 years of the concession period.

To carry out the sensitivity analysis, the results of which are shown in Figure 64, a range of values was set to vary between -4% the value of the pivot value and +20%. The asymmetry of the analysis is due to the fact that the equilibrium point lies at approximately +16% with regard to the pivot value (150 million US\$).

Figure 64. Sensitivity analysis of the concession rate



Source: Author, from the mathematical model

We can see that the concession rate follows an inverse structure in which, for each point it increases, the profits of the developer increase by 0.12% (positive slope of +0.1225), while the profits of the concessionaire fall by 0.08%. Consequently, the decrease in the concessionaire's profits is less than the increase in the developer's profits. As such, it could be considered that the percentage variations in the concession rate affect the developer more than the concessionaire.

If the developer were a public entity, the value of the concession rate would not be the result of a commercial agreement but a process of public bidding.

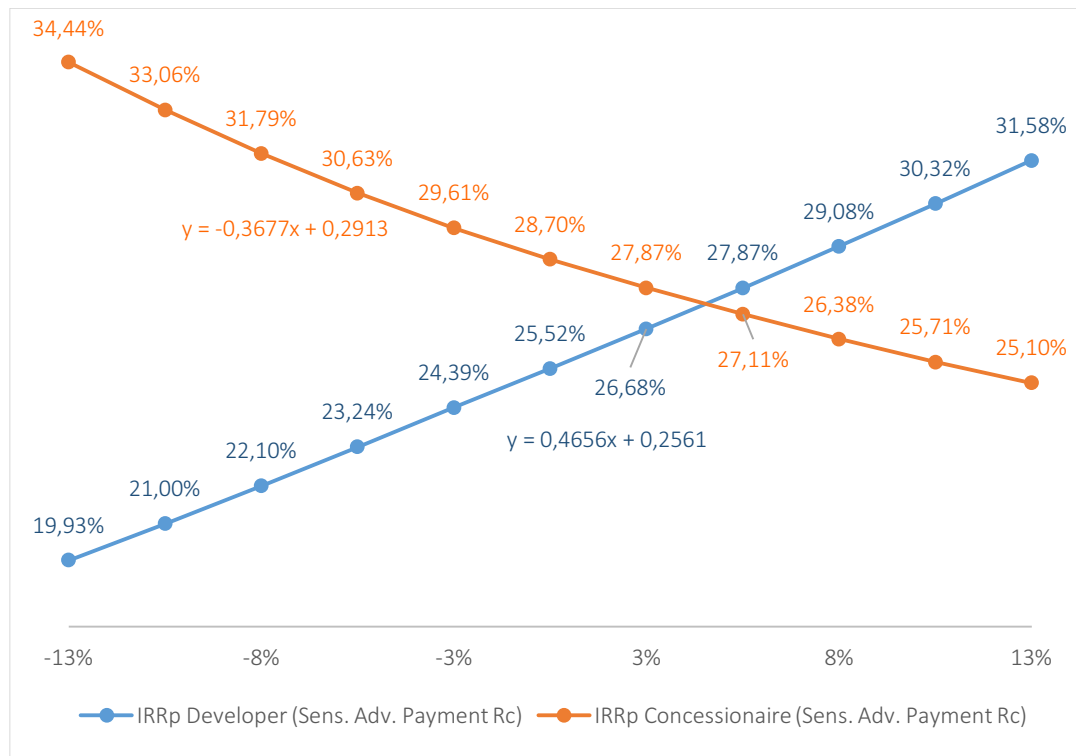
6.11. Sensitivity analysis of the advanced payment of the concession rate

As for the infrastructure rate, the concession rate allows for an advanced payment that allows the concessionaire to achieve better conditions, while the developer gets a quick return on part of its investment.

In the base model, a value for the advanced payment of the concession rate has been set at 12.5% of the total amount of this rate. Bearing in mind that in the base model the concession rate is of a value of 150 million US\$, the advanced payment has a pivot value of 18.75 million US\$. This figure is not too high, bearing in mind examples such as that for OLP-Cosco in a concession for 35 years in the Port of Piraeus, whose value for the advanced payment of the concession rate was fixed at 50 million Euros (Psaraftis & Pallis 2012).

To carry out the sensitivity analysis, whose results are shown in Figure 65, a range was set that generated values that vary from no payment of this rate to 25%.

Figure 65. Sensitivity analysis of the advanced payment of the concession rate



Source: Author, from the mathematical model

For each point increase in the percentage of the advanced payment of this rate, the developer's profits increase by approximately 0.47%. For the concessionaire, the profits calculated for the various scenarios form a parabola to which, if the trend line is calculated, produces a slope value of -0.3677 such that, assuming a certain error range, would mean that for every point the advanced payment increases, the concessionaire's profit decreases by 0.36%.

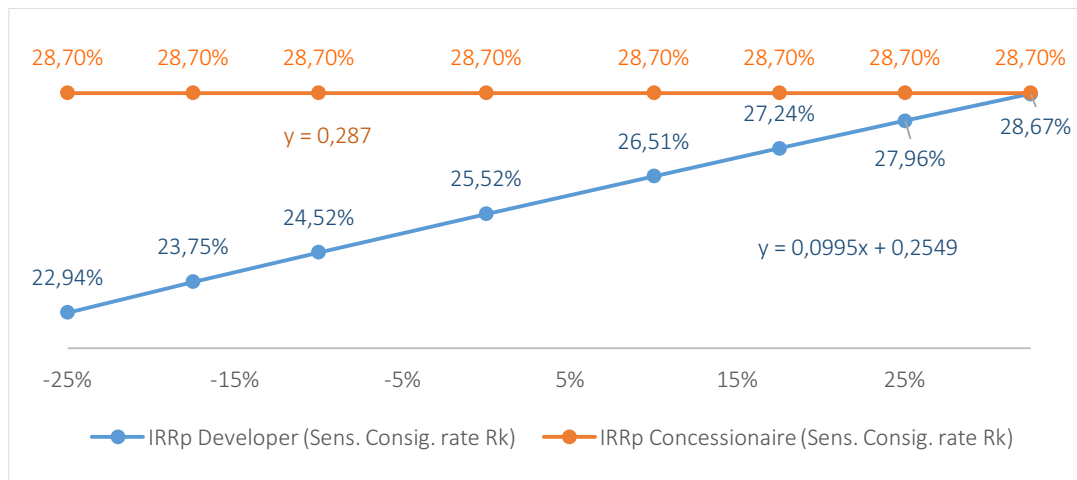
This inverse effect is similar to the one described for the advanced payment of the infrastructure rate, since an advanced payment interests considerably the developer (not only because it improves its profits but also because it receives a quick return on its investments), while the concessionaire's economic model decreases and should, on the basis of these results, negotiate for compensatory measures.

6.12. Sensitivity analysis of the rate charged by the developer to consignees R_k

The developer charges consignees a rate for the right to be positioned and operate in its terminal. In this model, the consignees' rate corresponds to 25% of the value of the concession rate for each year (except in the year in which the advanced payment of this rate is paid).

To carry out this sensitivity analysis, whose results are shown in Figure 66, an asymmetric range has been set from -25% to +32.5%, such that the rate varies between the minimum established at point 0 (consignees are not charged a rate) and +57.5%.

Figure 66. Sensitivity analysis of the consignee rate



Source: Author, from the mathematical model

Figure 66 highlights the fact that this rate does not affect in any way the forecast profits of the concessionaire (the gradient is asymptotic at $b = 0.287$), while the developer experiences a variation of 0.1% in its profits for each point the percentage charged to the consignees rises. This effect is understandable when it is recalled that this is a developer-consignee relationship in which the concessionaire takes no part. Consequently, variations in this rate do not affect it.

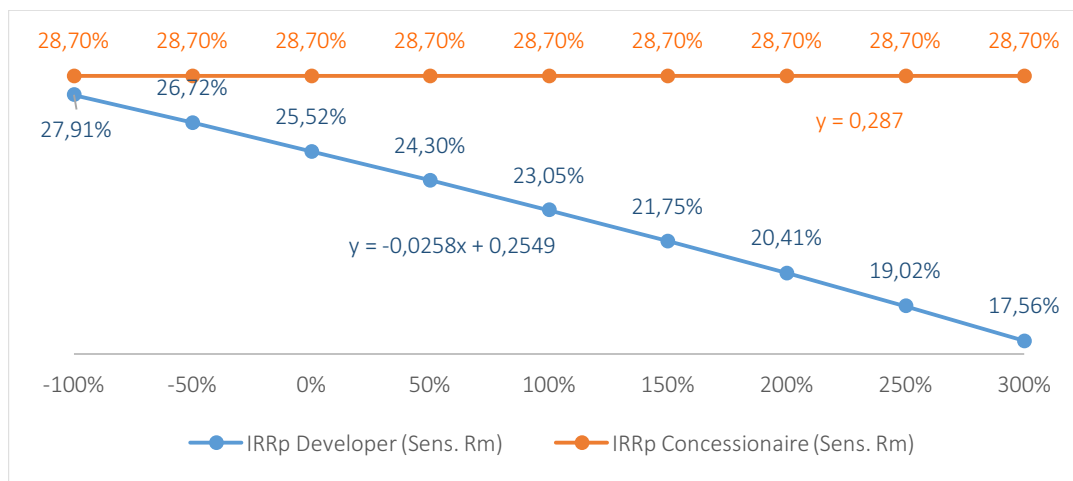
6.13. Sensitivity analysis of the rate for the use of the seafloor

The rate for the use of the seafloor is the amount charged by the State in which the port is located for the use of the waters sheltered by the port and the coastal areas. This amount is paid to the State independently of whether the developer has purchased the land or not.

The calculation of this rate is carried out as a function of the area of the waters sheltered within the port, including the area required to build the breakwalls. The size of this area in this model is 80Ha and the model's pivot value, 2US\$/m²/year.

The sensitivity analysis carried out models scenarios in which the value of the rate of the use of the seafloor ranges from 0 (no rate charged) to a value of 8US\$/m²/year. Figure 67 shows the results of this analysis.

Figure 67. Sensitivity analysis of the rate for the use of the seafloor



Source: Author, from the mathematical model

As can be seen, in this case the concessionaire's profits are not affected very much, since the line described by its profits is asymptotic ($b = 0.287$). In contrast, the developer experiences a decrease in its profits by 0.03% for each dollar increase in the value of the rate for the use of the seafloor.

This effect is understandable, as the rate for the use of the seabed does not affect the concessionaire, as it is paid directly to the State by the developer.

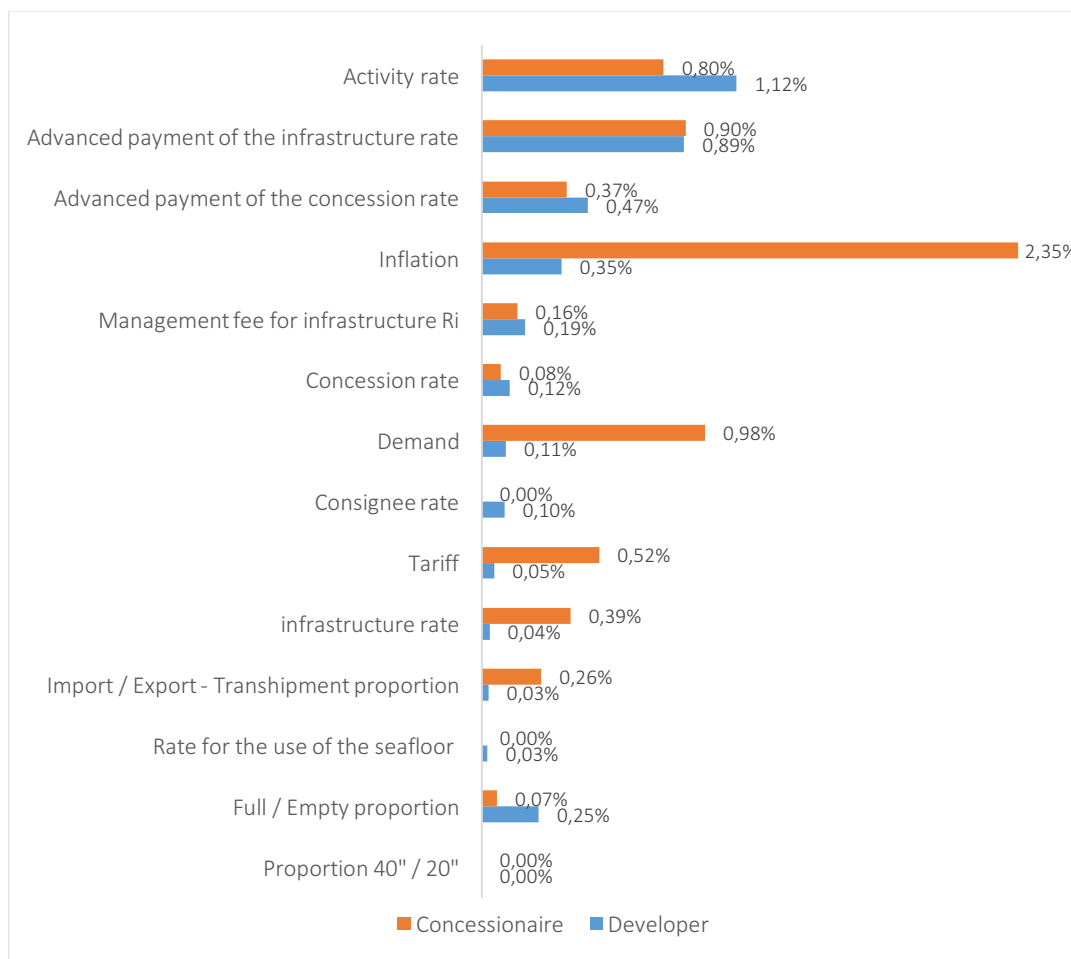
6.14. Conclusions about the profits and the sensitivity analysis

Having carried out the sensitivity analysis of thirteen of the variables that govern the mathematical model, we have been able to confirm that, in general, the profits of the developer and concessionaire have an inverse relationship. In other words, when one experiences an increase in profits, the other suffers a decrease due to the fact that many of the variables represent a cost for one of the parties and an income for the other.

However, we have also been able to confirm that the effects are not proportional and, as a consequence, how each variable affects the global profits of the party should be studied. For this, for each variable, we have assessed how the profits change as a function of the variability of the parameter tested in the sensitivity analysis.

Figure 68 shows the thirteen variables, in decreasing order as a function of their relative importance in the economic-financial model of the developer.

Figure 68. The relative influence of the variables on developer profits



Source: Author, from the mathematical model

Figure 68 highlights the fact that the activity rate is the rate that most affects the developer, followed by the advanced payment of the infrastructure rate, the advanced payment of the concession rate, inflation, the management fee of the infrastructure rate, etc.

If we focus solely on the rates and disregard the other variables, we can confirm that for the developer, the most important rate is the activity rate (R_a), followed by the concession rate (R_c) and the infrastructure rate (R_i). The developer charges this rate to consignees, which has a greater importance in its business model than the infrastructure rate and pays the rate for the use of the seafloor to the State without any intervention by the concessionaire.

If we were to carry out the same exercise and ordered them from the point of view of the concessionaire, we would see that the most important variables are inflation and demand (which, along with the rate, represents its direct exploitation revenue), the advanced payment of the infrastructure rate and the activity rate. If we focus only on the rate the concessionaire pays the developer, we can see that the most important rate for its business model is the activity rate, followed by the infrastructure rate and, lastly, the concession rate. Table 74 summarises this and shows the rates ordered by their importance to the developer and concessionaire.

Table 74. Importance of the rates to the developer and concessionaire business model

Developer		Concessionaire	
Rate	Importance	Rate	Importance
Activity (R_a)	1.12%	Activity (R_a)	0.80%
Concession (R_c)	0.12%	Infrastructure (R_i)	0.39%
Infrastructure (R_i)	0.04%	Concession (R_c)	0.08%

Source: Author, from the mathematical model

As can be seen, for both the most important rate is the activity rate (R_a). The two parties only coincide in this aspect, since the other two rates are not ordered in the same way.

Given that the activity rate (R_a) is the most important for both parties and that it is precisely this rate that can be awarded a rebate, it is necessary to next ask how a rebate is applied to this rate, by how much and what happens to the developer and concessionaire models when this rebate is applied.

7. CORRECTION MODULES: THE ENVIRONMENT

In Chapter 2, a global characterisation of the mathematical model was carried out in which the structure of the calculation applicable to each concessionaire (independently of terminal type) was defined, together with the possibility of applying an application of the activity rate, in the form of a calculation module.

In the model, n modules can be applied to a container concessionaire and the rebate of the activity rate (R_a) is then calculated. In chapter 10, a control module of the environmental parameters was described. The correction module was then applied to the activity rate (R_a), setting out how this can be carried out with another series of additional modules that control aspects such as the concessionaire's performance in customer services, documentation management, the adequacy of the work health and safety regulations, etc.

7.1. Hypothesis

Spanish legislation²⁷⁵ establishes that a rebate applied to the activity rate as an incentive to improve environmental practices has a value, in general, of 15% of the total activity rate.

In the proposed model, a rebate of 15% of the activity rate R_a means that, if the activity rate is set at 5% of the concessionaire's total revenues, applying a rebate of 15% of this 5% would result in a maximum rebate of 0.75%. According to the sensitivity analysis carried out for the activity rate R_a , for each point this rate decreases, the profits of the developer falls by 1.12%, while the concessionaire's profits rise by 0.8%. These are, therefore, very low correction coefficients that do not result in significant variations in the profits and consequently, are not attractive enough for the concessionaire to invest in adequate measures to improve its environmental performance.

In other countries, various rebate schemes are being considering as a function of the final objective of the entity that sets them. In this model, we only apply a correction module and, therefore, a rebate is awarded only for environmental performance. We shall pursue, therefore, the creation of a port in which both the developer and concessionaire obtain the forecast profits from their investments. However, this port is exemplary in its environmental performance and, as such, no limits to the rebates for activity rates have been established. We start from the hypothesis that if the concessionaire's environmental performance is near perfect (in terms of the requirements established by the developer), the rebate for this rate may be close to the full amount and, as a consequence, the concessionaire does not pay the activity rate.

For the purpose of sensitivity, we have confirmed that if the activity rate is zero (we reduce the pivot value, fixed at 5%, by 5%), the developer's profits decrease from 25.52% to 19.02% (a reduction of 6.5%), while the concessionaire's profits increase from 28.7% to 32.86% (an increase of 4.16%). Therefore, in the hypothesis in which the concessionaire's environmental performance approaches excellence, it would obtain a better profit for its investments. Moreover, the developer would not be affected to the extent that it would doubt the viability of the business. As such, the operation is assured of an environmentally sustainable port that, moreover, generates value added and would probably obtain additional profits as a result of the improvement in public image, greater operating attractiveness, etc.

7.2. Controlled environmental parameters

In this model, a total of 9 parameters relating to environmental performance of the *Martiport* terminal are controlled, using as a model:

- CO₂ emissions: The emissions controlled are only those generated by the machinery used for handling containers. Emissions from lorries that enter or leave the terminal are not taken into consideration, as these do not come under the control of the concessionaire.
- Accidental spills: Accidental spills are those resulting from the rupture of a machinery diesel tank, the fracture of a container tank, etc. In this example, the optimal situation is no recorded incident during the control period.
- Ground pollution: This is the result of the spillage of liquids onto the paving that filter through to the subsoil and even certain polluting solid material. For this parameter, the optimal situation is that no accident occurs during the control period.

²⁷⁵ Law 33/2010, BOE of August 2010, section 5 "The awarding of bonuses to the activity and use rates", article 19, paragraph 1 b)

- Noise: The proximity of urban populations may lead this parameter to becoming decisive. A container terminal is not the most harmful in this respect, since the most polluting in terms of noise is solid bulk (scrap).
- Garage wastewater: Garage wastewater can potentially be very polluting, since it may contain oil, paint, solvents and even metals from the maintenance of terminal machinery.
- Office wastewater: Office wastewaters must be treated before being released into the network. The quality of treatment received determines the observed value of this parameter. Thus, the better it is treated before discharging, the lower the parameter value.
- Emission of greenhouse gases: It is difficult for a container terminal concessionaire to control the emission of these types of gases into the atmosphere. It can bring about a reduction in this parameter by basically ensuring that its purchase policy limits itself to products whose manufacture generates low levels of emissions.
- Generation of terminal waste. The concessionaire can adopt the terminal's waste recycling policies, aimed at minimising the final amount of waste. The greater the amount recycled, the lower the waste and, consequently, a greater value for the parameter.
- Treatment of rainwater: As occurs with office wastewater, rainwater must be treated before being discharged into the network due to the fact that the activities that take place in the terminal usually generate small spillages onto the paving and rainwater is susceptible to becoming polluted by hydrocarbons. The better the treatment the rainwater receives prior to being discharged into the system, the lower the pollution and the greater the value of the parameter.

Other parameters that may be important for other types of terminals have not been considered as they have very little impact on a container terminal. Some of these parameters include airborne dust (important in solid bulk terminals), CO₂ emissions from road vehicles (important in Ro-Ro²⁷⁶ terminals) or the emission of certain substances into the environment (important in solid bulk terminals).

7.3. Calculation of the rebate

To calculate the rebate, it is firstly necessary to establish the minimum, the optimal and the maximum for each parameter and its observed value. The *Martiport* container terminal does not currently have a rebate calculation model for the activity rate. Therefore, fixing the minimum and optimal thresholds has been carried out on the discretion of the author of this thesis and not that of the developer, which would be the desirable situation if this rebate calculation model were applied. Table 75 shows the rebate range for each of the nine controlled environmental parameters.

Table 75. Control values for each parameter

	Observed value	Rebate application range			
		Minimum (Min _n)	Optimum (Opt _n)	Legal maximum	
1	CO ₂ emissions	8.00%	7.00%	10.00%	14.50%
2	Accidental spills	0.00%	-	0.00%	-
3	Ground pollution	0.00%	0.00%	0.00%	2.00%
4	Noise	2.85%	0.00%	3.00%	5.00%

²⁷⁶ Ro-Ro refers to the term *Roll on – Roll off*, and represents here a vehicle terminal

5	Garage wastewater	10.00%	0.00%	16.00%	20.00%
6	Office wastewater	6.00%	1.25%	5.00%	20.00%
7	Greenhouse gas emissions	1.30%	1.00%	4.00%	7.25%
8	Generation of terminal waste	7.00%	2.20%	5.00%	8.30%
9	Rainwater treatment	9.50%	6.00%	10.00%	16.00%

Source: Author, from the mathematical model

To facilitate the comprehension of the impact of each parameter in the model, the table above shows the parameters in the form of a percentage. Thus, it can be seen that the value of the CO₂ emissions has a legal maximum of 14.5%, an optimal level of 10% (fixed by the developer) and a minimum of 7%. The observed value is 8%, which lies between the minimum and optimal value and the parameter therefore can receive a rebate.

The “accidental spills” does not have a maximum or minimum value and its optimal value is simply that there are no spillages. Finally, there are two parameters, 6 and 8, that are not awarded a rebate, as their values exceed the optimal.

We now address the calculation of the partial rebate for each parameter and the total applicable to the activity rate. Table 76 shows how this calculation is carried out. Firstly, the equation that governs the mathematical model of each parameter is selected, as described in chapter 10 (column headed “Formulation”). The observed value is introduced into the equation; the resulting values are shown in the column headed “Unitary rebate B_n ”. A weight is applied to each parameter as a function of its relative importance and the unitary rebates are calculated for each, the results of which are shown in the column headed “Partial rebate B_{partial} ”.

Table 76. Formulation and calculation of the rebate

		Formulation	Rebate and weighting		Partial rebate (B_{partial})
			Unitary rebate (B_n)	Weight (w_n)	
1	CO ₂ emissions	1) $Y = 1.1^{-x}$	0.728	30%	2.18E-01
2	Accidental spills	3) $Y = e^{-x}$	1.000	20%	2.00E-01
3	Ground pollution	4) $Y = 12^{-x}$	1.000	15%	1.50E-01
4	Noise	2) $Y = 1.4^{-x}$	0.041	10%	4.09E-03
5	Garage wastewater	3) $Y = e^{-x}$	0.002	5%	9.65E-05
6	Office wastewater	1) $Y = 1.1^{-x}$	-	5%	0.00E+00
7	Greenhouse gas emissions	4) $Y = 12^{-x}$	0.083	5%	4.17E-03
8	Generation of terminal waste	1) $Y = 1.1^{-x}$	-	5%	0.00E+00
9	Rainwater treatment	2) $Y = 1.4^{-x}$	0.061	5%	3.03E-03

Total rebate (B_{total})	57.97%
Final rebate (B_{final})	52.18%

Source: Author, from the mathematical model

All the rebates for each parameter are then added up, obtaining the total rebate value, shown in the row “Total rebate B_{total} ”.

However, two parameters are not rebatable: 6 and 8, whose combined weights as a function of their relative importance adds up to 10% of the total controlled rebate. The final value, shown in the row “Final rebate B_{final} ”, which is the rebate awarded to the concession rate, corresponds to the total rebate (“Total rebate B_{total} ”) minus 10% for the failure to comply with these two parameters.

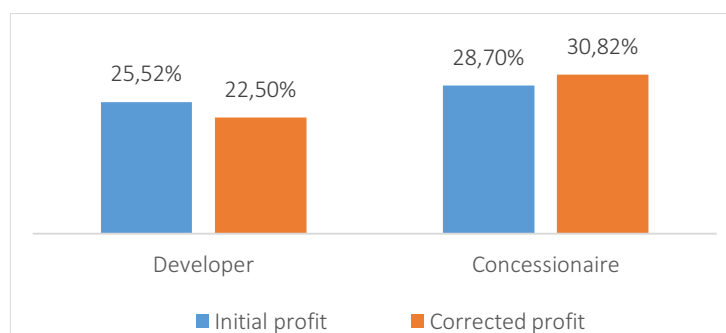
The method followed ensures that the rebate is penalised when the concessionaire fails to comply with those parameters considered the most important. Thus, for example, if the concessionaire of the *Martiport* terminal failed to satisfy parameter 1, an additional 30% would be deducted from the rebate rate applied to the activity rate R_a , as the relative weight of parameter 1 is 30%.

In conclusion, the rebate awarded to the concessionaire of *Martiport* for its current activity rate would be 52.18%.

8. A COMPARISON OF THE ORIGINAL AND CORRECTED MODELS

For the concessionaire of the *Martiport* terminal, obtaining a rebate of 52.18% of the value of the activity rate R_a means that, of the 5% it pays to the developer in the base model, it will obtain a discount that will result in this rate falling to 2.391%. Let's see then what happens to the profits of the developer and concessionaire from this corrected value of the rate. Figure 69 shows the evolution of the profits before and after applying the correction of the activity rate R_a .

Figure 69. Initial and corrected profits



Source: Author, from the mathematical model

As can be seen, the developer experiences a decrease in its profits of 3.02%, while those of the concessionaire increase by 2.1% due to the fact that the effect of this factor on the concessionaire is less than its effect on the developer. In terms of an absolute value, the improvement in the concessionaire's profits represents a saving of 4.25 million US\$/year. As such, with the proposed rebate scheme, this is the amount the concessionaire can dedicate to investing in improving its environmental performance for the first year. Given that this calculation is carried out year on year, the incremental improvements achieved in the environmental performance of the *Martiport* terminal as a result of the reinvestment of the rebates would mean that in n years the terminal will no longer have to pay the activity rate R_a . Having carried out the sensitivity analysis of this rate, we can see that this is not critical for the developer's exploitation balance, which would suffer a slight decrease in its profits but would obtain other commercial advantages as a result of making sure the port fulfils the most exacting environmental criteria.

9. CONCLUSIONS

For most of the variables analysed in this economic-financial model, it can be seen that the profits of the developer and concessionaire are inversely related. In other words, when the profit of one party increases, the profits of the other decrease. It can also be seen that for most of the thirteen cases studied, the variations are not proportional and the decrease in profits of one party is not equal to the increase in the profits of the other.

The fundamental variables in the developer's economic-financial model are firstly the activity rate R_a , followed by the advanced payment of the infrastructure rate R_i , the advanced payment

of the concession rate R_c , inflation, the management fee for the investments in infrastructure R_i , the concession rate R_c and demand. The developer, therefore, is affected to quite an extent by the advanced payments of the rates, since it achieves a quick return on its investments. It also has a fairly diversified business, as although the concessionaire's activity affects it and, as a result, should ensure the stability of the business, most of the variables that affect it are related to the return on its investments and not so much on the port business itself.

The concessionaire, on the other hand, is affected most by inflation followed by demand (which is understandable, as they are two of the variables that make up its main source of income), the advanced payment of part of the infrastructure investments R_i , the activity rate R_a , the tariffs for the movement of containers and the infrastructure R_i , among others. The concessionaire's business depends entirely on its handling capacity and the number of containers the port can handle in a year. Consequently, it is a business that is much more diversified than the developer's and depends on its performance and efficiency.

Focusing only on the activity rate R_a , the concession rate R_c and the infrastructure rate R_i , which generate the economic flows between the developer and concessionaire, we can see that for both the developer and concessionaire, the most important is the activity rate R_a . However, although for the developer the order is $R_a - R_c - R_i$, for the concessionaire the order is $R_a - R_i - R_c$. Therefore, for the developer the least important rate is the infrastructure rate, as the total amount of investments in infrastructure, which generate this rate, are recovered from the concessionaire(s) over the concession period. The concession rate R_c is the only independent variable in the model, as its value does not correspond to the calculation carried out with the other variables but to the market price agreed between the developer and concessionaire, or tendered by the former and won by the latter.

Having carried out the sensitivity analysis and in line with what has been proposed in previous chapters, a correction module, corresponding to the environmental performance of the concessionaire, has been applied to the activity rate. By applying this module and on the basis of the analysis of nine parameters, we have been able to determine that there are significant variations in the profits of the developer and concessionaire if the model allows the activity rate to be fully rebated. However, the profits of the developer, who is responsible for awarding the rebate, are still correct and justify the application of the rebates, making it possible for the concessionaire to make savings that it could reinvest into improving its environmental performance.

Finally, it can be concluded that with the hypotheses made for the development of the economic-financial model and on the basis of the established contextual conditions, both the developer and concessionaire obtain the right profits for their investments and thus the viability of the port is guaranteed.

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12

Conclusions

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1. CONCLUSIONS

Having presented the main part of this thesis, we now present the main conclusions drawn from this investigation, which are broken down into three aspects: accomplishment of aims, responses to research questions and conclusions.

1.1. Accomplishment of aims

In this investigation, both the main and secondary aims set out at the start of this thesis have been accomplished.

From the point of view of the main aims, the rates that govern the developer (private)-concessionaire (private) relationship and that generate the economic flows of the business have been studied. A practical application has been conducted that has enabled us to confirm that the economic flows allow both to obtain the desired profits. Moreover, we have looked in detail at the parameters that govern the business model by carrying out a sensitivity analysis.

With regard to the secondary aims, it was necessary to generate a mathematical model that allows all the contextual conditions and the variables of the port business to be introduced in order to study the rates. An additional module was also created that corrects the value of the activity rate to be paid by the concessionaire, awarding it a discount on the basis of its environmental performance.

1.2. Responses to research questions

Answers to all the research questions have been obtained. These are as follows:

Question 1: What type of relationship should there be between the participants such that a discussion of the rates as described here can take place?

The private developer purchases the land and the only relationship it has with the state in which the port facilities are located lies in the rates for the use of the seabed, in the use of national waters for the transit of ships handled by the port and for the right to build the port itself on the seafloor.

With respect to the developer-concessionaire relationship, the latter pays the former three rates: an infrastructure rate, which helps the developer pay for the investments made in infrastructure; an activity rate, as a proportion of revenues made through the handling of containers; and a concession rate for the right to occupy the terminal for a certain number of years. Moreover, the developer may discount the total amount of the activity rate if the concessionaire's environmental performance is above the optimum established as the control level.

Regardless, it is absolutely necessary that both achieve sufficient profits for their businesses. If the developer believes that it will not obtain the desired profit, the business will not prosper. If the concessionaire does not believe it will make a profit, any bid for a concession in the port will be void. Therefore, the mechanisms that ensure that there is no great difference in the profits must be established.

Question 2: How are investments in infrastructure to be undertaken?

The developer is responsible for the investments in the first instance, but owing to the infrastructure rate, it receives a return for these from the concessionaire. This return is generated over the period of the contract and, as built into the mathematical model, the developer recovers the entire amount of the investments plus a management fee. In the research question, the analysis of how this concession rate affects the concessionaire was implicit. We have been able to confirm that this rate does not affect it much and that its profitability is affected more by the activity rate.

The possibility that the concessionaire provides an initial contribution that allows the concessionaire itself to negotiate better conditions and the developer to obtain a quicker return on its investments has also been explored.

Question 3: In the business model derived from the study of the rates, is the participation of the public sector necessary for infrastructure investments?

In contrast to the traditional business model and the so-called “privatisation” process, the business model presented in this thesis does not require the participation of the public sector.

The difference between the management model presented here and privatisation processes is the treatment of the infrastructure investments. In traditional ports, infrastructure investments are carried out by the state and, for various reasons, when the government decides to privatise it, asks a private concessionaire to develop the port business and pay it certain rates. However, this private entity does not pay for the infrastructure investments and, as a consequence, does not have the same economic tension as the developer of the business presented here, who does have to obtain economic flows sufficient to cover these investments. Therefore, in answer to the research question, in the economic model described, the participation of the public sector is not necessary so long as the described contextual conditions exist and that the developer-concessionaire relationships are fulfilled as detailed.

Question 4: Is the private management of a port possible from its design stage, addressing investments in infrastructure?

Yes, if the contextual conditions exist necessary to enable the concessionaire to develop its business and pay the rates charged by the developer. From this point, the management of the port may follow a similar pattern to the management of a private port.

Question 5: What type of port can the business model be applied to?

This business model is applicable to medium-sized seaports. Only in these ports do the contextual conditions and the volume of investment necessary exist for the business model to function.

It is not applicable to isolated specialised terminals. In other words, it would not be applicable if there were only one container terminal. It must be a multi-activity port in which there are several terminals; the infrastructure investments may be paid by several concessionaires such that the total volume assumed by each one is proportional to the use they make of the infrastructure.

Question 6: Are there similar business models to the one described here?

No. There are specialised terminals and privatised ports, but no multi-activity ports whose initiative is private and in which the developer is responsible for investments in infrastructure without having a greater relationship with the state that charges it the rate for the use of the seabed.

Question 7: Are there any calculation models similar to the one presented in this thesis?

The general calculation model comprises various methods that have been combined to obtain a tool that enables the user to determine the economic flows and which of the model variables are fundamental. Each of the methods existed beforehand, but the model is a unique tool. Similarly, the activity correction module, applied to environmental performance, is a unique tool designed in the investigation, as we felt it was necessary from the interviews carried out with port authorities.

Question 8: Are there any legal determinants for the implementation of the business model derived from the discussion about rates?

Yes. In fact, the most important restrictions to the application of the models are legal. In this investigation, a universally applied business model has been designed that enables developer-concessionaire rates to be analysed. However, the application to a specific country requires a detailed legal study that affects the rates and determines whether the model needs to be modified in order for the port to be implemented in a specific country. The study of countries carried out here has yielded discouraging results since the ideal hypothesis was that there were international regulations for the implementation of this type of model. However, even within the same country there may be marked differences in port policy and port management. As such, broad checklists were drawn up to guide the potential developer in the stages and items that it should take into account when conducting the in-depth legal study.

Finally, it should be pointed out that following the study of potential host countries of the business model described here, a range of countries were found in which the business model could presumably be implemented while others, with their current national regulations in force, present insuperable barriers to the implementation of this type of business.

1.3. Conclusions

Following the analysis of the developer-concessionaire rates, the main conclusion differs from the idea held at the beginning of the investigation in which we believed that the concession rate was the rate governing the economic model and determines whether the business is viable or not. This is due to the fact that it is the model's only independent variable, as its value is fixed and does not depend on any other variable. However, after having carried out the analysis set out in chapter 11, we have determined that the rate that most affects the business model — both of the developer and the concessionaire— is the activity rate.

In the case of the developer and if we focus only on the rates that generate the developer-concessionaire economic flows, the most important rate is the activity rate, followed by the concession rate and finally the infrastructure rate ($R_a - R_c - R_i$). For the concessionaire, the order is different, being ($R_a - R_i - R_c$), due to the fact that it is affected more by the infrastructure rate.

This effect is logical since for the developer the infrastructure rate is not the most important, as all the investments that generate it are passed on to the concessionaire during the period of the concession. However, for the concessionaire it is important, as it must generate sufficient liquidity to pay this rate.

With respect to the activity rate, we have been able to confirm that the application of the bonus calculation module, which corrects the basic model and which in this case has materialized in an application that measures the environmental performance of the concessionaire, is correct, since it can improve the concessionaire's profitability. Moreover, it explains that the concessionaire makes investments to improve its environmental performance, so long as the concessionaire's profitability does not worsen and, consequently, allows for the possibility that the bonus calculation is applied.

Regardless, we have been able to determine that the businesses of both the developer and concessionaire are at variance with each other, as the improvement in the profitability of one usually means a decrease in the profitability of the other. However, there are variables that have a direct decisive influence on the increase or decrease of the profitability of the participants, while others hardly affect the counterparty.

With regard to the solidity of the developer and concessionaire business models, it should be pointed out that the developer has a diversified business, since it charges rates that enable it to gain a return on its investments in infrastructure. It also charges others that affect the activity of the concessionaire and that, therefore, explains why the developer encourages this activity. It

also charges a concession rate that is independent of the others and that represents an annual fixed income. Moreover, in the basic model, the developer charges consignees for the right to locate themselves in the terminal. These sources of revenue are extendable, since if the developer acts as the port authority, it can additionally charge for labour services, ship services or any other activity that generates business. Therefore, the business of the developer can be considered diversified.

From the perspective of the concessionaire, this diversification is practically non-existent, since, as defined in the model, its only source of revenue comes from the handling of containers. Consequently, its model is highly dependent on demand, the tariffs and inflation, as these are variables that directly affect its only source of income. However, as happens with the developer, the concessionaire's business is diversifiable in that it can offer cargo services and activities that add value and generate extra sources of revenue.

In the model, only a single container terminal has been characterised and, on the basis of the developer-concessionaire relationships and the established contextual conditions, we have been able to determine how the model should function and which rates should be applied so that the profitability of both participants are correct. However, the port as it is conceived here should be equipped with infrastructures that can serve several terminals, such that all are responsible for proportionally paying for the infrastructure investments through the infrastructure rate. This means that the container terminal's economic tension decreases and, as a consequence, the concessionaire's economic model improves. Moreover, it makes it possible that the developer applies a greater management fee on the infrastructure investments. Consequently, its profitability will also be greater.

2. RECOMMENDATIONS

To ensure the robustness of the business model, it is vital that adequate contextual conditions prevail (demand, inflation, etc.). However, it is also important that the developer-state agreement is carried out using clear rules that prevent the state boycotting the development of the port. In other words, the state allows private investment, as without its involvement the state is capable of generating a hub of economic activity that benefits the territory and creates an entry and exit point for its imports and exports. However, many countries have ports and national policy should allow the development of the business model of a port without negatively interfering it. For example, the developer-state agreement should ensure that the national tariff policy benefits the development of the port, that there will be no interference in the hinterland and that no action shall be carried out that could reduce the port's competitiveness. If these and other considerations that are in line with ensuring the long-term viability of the port are not correctly framed by clear and specific collaboration agreements, the business model may fail to develop.

3. FUTURE LINES OF RESEARCH

This investigation has fulfilled its main aim, as we have been able to study the developer-concessionaire rates through the design of a mathematical model that includes corrector modules that enable us to determine whether the concessionaire will obtain bonuses as a function of its environmental performance. This should serve as a starting point for future investigations that broaden the study conducted in this thesis. For this, we propose the following lines of future research: 1.- The study of the efficiency of a port of this type and a comparison with actual ports; 2.- To put the model into practice and optimize it, to see its strong and weak points, 3.- An analysis of the incentive variables of the choice of a port to boost the development of a new one, 4.- An analysis of port organization and the study of feasibility models in the sector, 5.- The study of the treatment of genders in this sector.

Experience and academic curriculum

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1. WORK EXPERIENCE IN LOGISTICS

This section sets out the author's work experience in logistics and ports, demonstrating an extensive knowledge of the subject and the possibility of putting into practice the knowledge acquired throughout this investigation.

1.1. ILI Logística Internacional

Since 2011 until the present day, the author has been Director of Projects at ILI Logística Internacional. As part of his responsibilities, he has participated, among others, in the following projects:

- A private initiative for the PPP participation in a container terminal in Chimbote, Peru, 2015.
- Strategic consultant for the implementation of logistics software for a private client (Grupo Gutiérrez Logistics) in Honduras, 2014.
- Drafting of the Río Loge Special Economic Zone Master Plan, Ambriz, Angola, 2014.
- Drafting of the Barra do Dande Special Economic Zone Master Plan, Bengo Province, Angola, 2014.
- Design of the modification of a 1000m² warehouse in the Viana Special Economic Zone, Angola, 2014.
- Drafting of the Luanda-Bengo Special Economic Zone Master Plan, Angola, 2013.
- Executive project of an access road to the first quadrant of the Luanda-Bengo Special Economic Zone, Angola, 2013.
- Development of a business model for the implementation of a multimodal logistics hub in Sepetiba, Rio de Janeiro, Brazil, 2013.
- The Ecuadorian National Logistics Plan, Ecuador, 2012.
- A viability study of the Guatemalan Interoceanic Corridor, Guatemala, 2012.
- Pre-feasibility studies for the construction of a new port on the Atlantic coast of Colón, Panama, 2012.

The author is also the Director of Education of the same entity and has designed and coordinated the following logistics training courses:

- A master's in Logistics and International Commerce. 5 courses since 2011. Programme taught in collaboration with the Universitat Abat Oliba – CEU.
- Integral Training in Customs Management. 3 courses since 2014. Programme taught in collaboration with Taric, S.A., a company specialised in customs training.
- Various training courses designed, coordinated and taught for the Anahuac University, Mexico South (Mexico City).
- International Marketing Seminar. 2 courses since 2015. In collaboration with several participating universities.
- Tailored projects conducted for companies or in collaboration with other universities in other countries, including ITAG Mexico (Veracruz) and I.A.E Bordeaux (France).

1.2. CILSA

From 2006 to the end of 2010, the author worked for the public company CILSA (Centro Intermodal de Logística, S.A.) as Director of Planning and Projects. Some of the activities in

which he participated while in this post in the area of logistics, planning and strategic development of the Logistics Activity Zone of the Port of Barcelona include:

- The design, development and control of construction projects of logistics buildings (feasibility studies, preliminary designs, basic projects, executive projects, management of primary occupation licences, environmental licences, etc.).
- Director of Projects for the remodelling of logistics warehouses in accordance with changes in legal regulations.
- Planning of territorial development. The design of new logistics software for the Port of Barcelona LAZ in countries such as Morocco and France and Project Leader in the development and expansion of LAZ in Catalonia.

2. EDUCATION

- Master's in Logistics and International Commerce, from the Universitat Abat Oliba-CEU, 2012.
- Life Mos Numina Course, from the Short Sea Shipping European School, 2012.
- Graduate in Industrial Organisation, from the Polytechnic University of Catalonia, 2011.
- Postgraduate in Advance Design and Structural Analysis, from the Polytechnic University of Catalonia, 2006.
- Graduate, Industrial Technician, Specialised in Mechanics, from the Polytechnic University of Catalonia, 2005.

3. PUBLISHED PAPERS

Title: "Aviación comercial: Evolución hacia las alianzas de bajo coste y repercusión en las infraestructuras aeroportuarias" – "Commercial Aviation: Evolution toward low cost alliances and impact on airport infrastructure"

- Scope: Paper and presentation made for "CIO 2012, 6th International Conference on Industrial Engineering and Industrial Management" (18-20/07/12), organized by the Industrial Engineering School of the University of Vigo. ISBN 978-84-938642-4-8
- Abstract: Commercial aviation as it stands today is undergoing an evolutionary shift towards new management models. Companies able to reduce operating costs, and thus the prices offered to customers, dominate the market. The industry is evolving towards a new model of airline company. Axioms that have bedevilled these airline companies, which had been fully justified until a few years ago, are now beginning to disappear and with them, the differences between traditional carriers and those offering services at very low costs. This article attempts to review the current airline market, dismantle the myths surrounding the management of low cost airlines, and warns of the impact of such changes on airport infrastructure.

Title: "Ports: Definition and study of types, sizes and business models".

- Scope: Paper published in "Journal of Industrial Engineering and Management". ISSN: 2013-8423 (print); ISSN: 2013-0953 (Online). Scopus SJR 0.302
- Abstract: In the world today, thousands of port facilities of different types and sizes compete to capture a portion of the market share of sea freight. This article aims to determine the type of port and the most common size in order to establish which business model is applied in the sector and the legal status of companies of such infrastructure.

Title “Shipping: Management of Import and Export Processes and Transition from Public to Private. Case study: The Port of Barcelona”

- Scope: Paper and presentation made for “ICIEOM 2015 - International Conference on Industrial Engineering and Operations Management” (06-08/07/15), organised by the University of Aveiro, Portugal, in collaboration with ABEPRO (Associação brasileira de engenharia de produção). ISBN. 978-972-789-453-6
- Abstract: The Port Authority of Barcelona (PAB) manages one of the 46 general interest ports in Spain, all of which are public. Therefore all activities in which PAB participates are developed from a public point of view. In this study, the possibility of performing these tasks from a private point of view is considered. The flows of imports and exports, focusing on administrative and transport processes, are analysed.

The author has also written various articles for specialised logistics journals or financial newspapers:

Title: “Importancia y complejidad de la logística internacional”. Revista Logistec, Chile. Published 06/01/14. Impact factor: 58.062. (c)2015 303 Publishers: Santa Marta de Huechuraba 7242 – Huechuraba. Available at: <http://www.revistalogistec.com/index.php/logistica/94-logisticaglobal/1459-importancia-y-complejidad-de-la-logistica-internacional>

Title: “¿El sector logístico invita al optimismo?” Cinco Días, Spain. Published 10/03/16. Impact factor: 108.920. Available at: http://cincodias.com/cincodias/2016/03/09/economia/1457546295_243401.html

4. TEACHING ACTIVITY

Universitat Abat Oliba-CEU.

- Coordinator of the Master’s in Logistics and International Commerce
- Director of Master’s Final Projects
- Practical tutor for the Master’s in Logistics and International Commerce
- Course: The Context of the Logistics Chain (Associate Teacher)
- Course: Anthropological Research Project (Associate Teacher)
- Course: Law and Financial Instruments in International Commerce (Associate Teacher)
- Course: Logistics Management (Associate Teacher)
- Course: Logistics and Operations Planning (Associate Teacher)
- Course: Treatment of Commercial Information (Associate Teacher)
- Course: The Context of Trade and International Businesses (Associate Teacher)

Anahuac University, South Mexico.

- Teacher of module “Inventory Management and Warehouse Design” (Nov. 2014 and May 2016)
- Teacher of module “Physical Distribution and Supply Chain Management” (June 2015)

ICIEM Business School

- Course: Distribution Management. International operations: Logistics Management and Transport. Customs (Associate Teacher).

5. OTHER PROJECTS AND COLLABORATIONS

- Collaborator: Demonstrative and participative project of the design of suitable technologies for the purification of water in semi-arid areas through the use of natural coagulants based on the Drumstick tree *moringa oleifera*. Project ARZAN TIIGA-2. Competitive project financed by Terrassa City Council (code 20150617_logalty_relev. Value: 18,332€). Start date: 15/05/15. Finish date: 30/05/16.
- Publication "Empresa familiar responsable". Chapter "RSC en la gestión responsable de la cadena de suministro". Publishers: Huygens (in press).
- Award: "Estudio de implantación de metodología de evaluación para evitar la component subjetiva en la calificación del alumnado". Universitat Abat Oliba – CEU. 07/03/16