Universidade da Beira Interior
Faculdade das Ciências Sociais e Humanas

Competitiveness and Strategic Positioning of Seaports: the Case of Iberian Seaports

Maria Rosa Pires da Cruz

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Supervisors: Prof. Dr. João José de Matos Ferreira
Prof. Dra. Susana Maria Palavra Garrido Azevedo

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To my parents, husband
and daughters Neyma and Letícia

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Abstract

The global market, with its extensive business networks and complex logistics systems, poses a high degree of uncertainty to the seaport industry and leaves seaport managers facing questions over just how to effectively respond to the ongoing market dynamics. Over the years, competition among seaports has intensified due to a number of structural changes taking place in seaport systems. Firstly, seaport hinterlands have extended well beyond national boundaries as a result of improvements to logistics and transport infrastructure. Secondly, the seaport industry is becoming increasingly concentrated through mergers and alliances. Thirdly, seaports are no longer mere interface points between land and sea or air. As communication technology advances and trade liberalization facilitates globalization, the role of seaports in the supply chain is changing. Seaports have now become one of the most dynamic links in international transport networks.

There is already a clear consensus in the literature around the sheer importance of seaports to national economies, especially to those heavily dependent on international trade. Taking into account the vital importance of seaports directly or indirectly to the economy of any country, and especially to those of Portugal and Spain, this research seeks to analyse the competitiveness and strategic positioning of Iberian seaports. In accordance with the seaport context set out above, the following four research questions are raised: i) are there different prevailing levels of competitiveness at Iberian seaports? ii) what are the key factors to seaport competitiveness from the stakeholder's perspective? Do perceptions of the importance of these factors differ between users and service providers? iii) how are Iberian seaports strategically positioned within the Iberian range? iv) What is the contribution of logistics resources to the competitiveness and performance of this sector?

To approach the level of competitiveness dimension, we measure seaport efficiency through applying an alternative Data Envelopment Analysis (DEA) methodology for cross sectional data from 2009 and the appropriate DEA methods (contemporaneous and windows analysis) for panel data (2005-2009). The results suggest that levels of Iberian seaport efficiency differ significantly not only from seaport to seaport but also at each seaport over the course of time. The study also identifies both the contribution of inputs/outputs to this seaport efficiency and the causes of inefficiency. Through the Analytic Hierarchy Process (AHP), we study the key factors to seaport competitiveness from the perspectives of stakeholders as well as the strength of their respective preferences. The Delphi approach was deployed for the preliminary stages of factor selection. The results reveal how seaports users and seaport service providers disagree over the importance of the key factors to seaport competitiveness. The results empirically demonstrate that vessel turnaround time is the most important factor to seaport competitiveness from perception of its users. However, from that of the seaport authorities and terminal operators, seaport facilities and equipment is the most important factor. The importance-performance matrix analysis also confirms that the vessel turnaround time that proves most important to users is also the factor on which the seaports do not perform well. Therefore, the service providers of Iberian seaports need to focus on improving its performance in this field.

To study strategic seaport positioning, we apply the BCG (Boston Consulting Group) matrix as a strategic tool generating an evolutionary perspective. The findings reveal a better positioning of Spanish seaports in relation to total traffic. According to the time series analyzed (1992-2009), the strategic positioning of most seaports in the BCG matrix had changed from the first to the third period. Furthermore, in terms of container traffic, the results identify the seaports of Algeciras, Valencia, and Barcelona as having attained a remarkable position of leadership. With the purpose of analyzing the contribution of resource logistics to seaport performance, the linear additive Multi Criterion Analysis (MCA) and the Principal Components Analysis (PCA) model were adopted. The model incorporates the contribution of two different performance indicators, operational performance and physical capacity, measured by several indicators. The physical capacity indicators considered are logistics resources. Study results show operational performance contributed 48.77% whilst physical capacity represented 51.23% of overall performance with the majority of seaports revealing a direct proportionality between their positioning in terms of physical capacity and their overall performance positioning.

Keywords: Competitiveness, Strategic positioning, Seaports, Iberian Peninsula, Logistics resources.

Resumo Alargado

A globalização dos mercados, caracterizada por uma vasta rede de negócios e um sistema logístico complexo, criou um alto grau de incerteza na indústria dos portos e, neste contexto, responder eficientemente às alterações do mercado tornou-se uma questão central para os gestores. Ao longo dos anos, a competição entre os portos intensificou-se devido a uma série de mudanças estruturais que ocorreram no meio envolvente dos portos. Primeiro, o *hinterland* dos portos estendeu-se para além das fronteiras nacionais, como resultado das melhorias nos suportes logísticos e nas infraestruturas de transporte. Em segundo lugar, a indústria dos portos tem vindo a ficar cada vez mais concentrada, através das fusões e das alianças estratégicas efetuadas entre as empresas de navegação. Em terceiro lugar, os portos já não são meros pontos de ligação entre a terra, o mar e o ar. À medida que as tecnologias de comunicações avançam e a liberalização do comércio facilita a globalização, o papel dos portos na cadeia de abastecimento mudou, tornando-se um dos elos mais dinâmicos na rede de transportes internacionais.

A importância dos portos para a economia dos países é já um consenso na literatura, especialmente nas economias que dependem fortemente do comércio internacional. No entanto, a investigação deste sector apresenta algumas lacunas, nomeadamente no que se refere às investigações sobre a competitividade e o posicionamento estratégico. Nesta ótica a importância da formulação de estratégias para alcançar vantagens competitivas com implicações no desempenho está cada vez mais evidente no contexto dos portos. Como o meio envolvente dos portos tem sido caracterizado por grandes incertezas e riscos, a importância de uma análise estratégica também tem aumentado. Estas considerações acentuam, em síntese, que: i) a competitividade dos portos tem-se intensificado, resultante das mudanças estruturais da indústria e, sendo um setor muito importante para o desenvolvimento da economia dos países, constitui uma área de estudo muito importante; ii) é necessário que sejam adotadas estratégias que possam melhorar a competitividade deste sector numa altura em que o conhecimento sobre esta área é relativamente insuficiente.

Tendo em conta a importância dos portos para a economia de qualquer país e especialmente para os países da Península Ibérica, esta investigação pretende analisar a competitividade e o posicionamento estratégico dos portos ibéricos. Face ao presente enquadramento da problemática em estudo, levantam-se as seguintes quatro questões de investigação: i) Existem níveis diferentes de competitividade nos portos ibéricos? ii) Quais são os principais fatores que afetam a competitividade dos portos? A perceção da importância desses fatores é a mesma para os utilizadores e os fornecedores dos serviços dos portos? iii) Como se posicionam, em termos estratégicos, os portos ibéricos dentro do *range* Ibérico? iv) Qual é a contribuição dos recursos logísticos para a competitividade e desempenho dos portos?

Com base nestas questões, são propostos na presente investigação os seguintes objetivos: i) medir a competitividade dos portos através do nível de eficiência; ii) identificar os principais fatores que afetam a competitividade deste sector na perspetiva dos *stakeholders*; iii) analisar o posicionamento estratégico dos portos ibéricos; iv) analisar a contribuição dos recursos logísticos para a competitividade e desempenho dos portos.

O nível de competitividade dos portos foi medido através do grau de eficiência destes com dados de 2009 e durante o período de 2005 a 2009. Para isso, recorreu-se à técnica estatística não paramétrica denominada de *Data Envelopment Analysis* (DEA). Com os dados de 2009, utilizou-se uma abordagem alternativa ao método tradicional DEA, onde a eficiência foi medida em três níveis: produtividade, rentabilidade e total. Com os dados de 2005 a 2009, mediou-se a eficiência, com recurso a duas abordagens de DEA (contemporânea e *Windows analysis*) consideradas como as mais adequadas para dados em painel. Os resultados sugerem que a eficiência dos portos ibéricos difere significativamente de porto para porto e mesmo dentro de cada porto ao longo dos anos considerados na análise. A investigação também identificou a contribuição dos *inputs* e *outputs* para os níveis de eficiência, assim como as causas da ineficiência.

Através do método *Analytic Hierarchy Process* (AHP), investigaram-se os principais fatores que afetam a competitividade dos portos na perspetiva dos *stakeholders*. Este método permitiu, igualmente, determinar a importância relativa de cada fator. Como análise preliminar ao método AHP, foi aplicado o método Delphi para selecionar os fatores a serem incluídos na análise. Os resultados revelaram que a perceção dos utilizadores e dos fornecedores dos serviços dos portos é diferente no que se refere à importância dos fatores que afetam a competitividade dos portos. Enquanto para os fornecedores dos serviços, o fator mais importante são as infraestruturas e os equipamentos dos portos, para os utilizadores o fator mais importante é o denominado na terminologia portuária de *vessel turnaround time,* que inclui os atrasos na atracação e o tempo entre a descarga e o carregamento. Trata-se, de uma forma geral, de um fator relacionado com a eficiência das operações portuárias. Investigou-se, igualmente, o desempenho dos portos ibéricos no que se refere aos principais fatores identificados na investigação, tendo-se concluído que os fornecedores dos serviços dos portos devem-se focalizar no melhoramento do seu desempenho em termos de eficiência das operações.

Para investigar o posicionamento estratégico dos portos, utilizou-se a matriz BCG (*Boston Consulting Group*) como ferramenta estratégica, numa perspetiva dinâmica, durante o período de 1992 a 2009. Os resultados revelaram que os portos espanhóis estão melhor posicionados em relação ao tráfego total. Verificou-se também que o posicionamento dos portos sofreu alterações ao longo do período considerado. Dentro dos vários tipos de carga, destacou-se, a carga contentorizada, pela importância que a mesma tem atualmente nos

portos a nível mundial e, especialmente, nos portos ibéricos. A análise deste tipo de carga revelou uma posição de liderança dos portos de Algeciras, Valencia e Barcelona. Com o objetivo de analisar a contribuição dos recursos logísticos para o desempenho dos portos, propôs-se uma metodologia onde o desempenho é analisado em duas dimensões: com variáveis operacionais e com variáveis relacionadas com a capacidade física. As variáveis da capacidade física representam os recursos logísticos. Propôs-se o uso da técnica *Linear Additive*, que faz parte das técnicas de análise de decisão de múltiplos critérios (*Multi-criteria decision analysis*), conjugada com a análise paramétrica dos componentes principais. A análise revelou que os indicadores de desempenho operacional contribuem em 48,77% para o desempenho total, enquanto os indicadores de capacidade física contribuem em 51,23%. A maioria dos portos em análise revelou uma direta proporcionalidade entre o seu posicionamento em termos de capacidade física e o posicionamento em termos de desempenho geral.

Palavras – chave: Competitividade, Posicionamento estratégico, Portos, Península Ibérica, Recursos logísticos.

Contents

Part I

1. Introduction

1.1 Background

Trade is recognized as one of the oldest and most important of bonds among nations. An efficient and competitive seaport is vital to the smooth flow of trade and forms the backbone of an economy's prosperity (Irwin and Tervio, 2002; Hu and Zhu, 2009). According to UNCTAD (2009), despite the global economic downturn and the sharp decline in overall world trade in the last quarter of 2008, international seaborne trade still continued to grow, albeit at the slower rate of 3.6 per cent in 2008 when compared with the 4.5 per cent registered in 2007. UNCTAD estimates 2009 international seaborne trade at 7.84 billion tons of loaded goods, with dry cargo continuing to account for the largest share (66.3 per cent). According to Drewry Shipping Consultants, by value, over 70 per cent of world international seaborne trade is shipped in containers (UNCTAD, 2010).

In recognition of how seaport development boosts economic progress, governments and seaport authorities pump huge investments into seaport expansion and upgrading both the hardware and software underpinning these infrastructures while simultaneously implementing customs simplification and cost cutting (Song, 2003; Parola and Musso, 2007; Tongzon, 2007). Whilst these efforts have helped in attracting users and stimulating seaport traffic, they also triggered inter-port competition defined by Slack (1985) as the process of fighting to ensure customers, market share or control of hinterland, over which a seaport may have exclusive or partial control.

In accordance with Voorde and Winkelmans (2002), the term "seaport" for the purposes of this present study may be understood as an area of land and water subject to the improvement works and equipment installation necessary to enable primarily the reception of ships, their loading and unloading, the storage of goods, the receipt and delivery of these goods by inland transport whilst potentially also the location for other shipping related business activities. Winkelmans (1991) reported that the notion of seaport is now difficult to define because the content of the word largely depends on level of terminal diversification and its role as an intersection in the transport and the supply chain. To Notteboom (2007), a seaport is one link in a complex logistics system.

The seaports have undergone a process of rationalization since the eighties (Evangelista and Morvillo, 1998, Song, 2003; Parola and Musso, 2007). The concerns of the 1980s focused on reducing costs and streamlining before being followed by quality management in the 1990s driven by a desire to raise efficiency and competitiveness (Panayides and Gray, 1999). Nowadays, environmental management has become an integral component of corporate seaport strategies and implemented through the operation of multimodal transport and logistics hubs (Rondinelli and Berry, 2000). Seaports have been characterized by complex growth patterns driven by the interaction of sets of endogenous and exogenous factors (Evangelista and Morvillo, 1998). Of particular importance among the exogenous factors are corporate globalisation and decentralisation as well as industrial relocation. Standing out among the intra-industry factors are the more intensive use of technologies in turn contributing towards fostering a stream of innovations.

Whilst the environment has become more generally competitive, this dimension has varied between regions and places, depending on the extent and nature of the respective changes. According to Jenssen (2003), three key phenomena, in particular, have taken place in the environments surrounding seaports: i) information technology and communication, ii) globalization and economic growth, and iii) environmental protection. Heaver (1993) states that the role of seaports was first changed by technological innovation given how terminals have been especially designed with regard to the handling of the loads and specifications required by integrated logistics chains. The various changes occurring in seaports in recent decades have had a continuously important and accumulative impact on their activities and management (Hayuth, 1993; Winkelmans, 1991). The management of seaports operations have increasingly been taken over by groups operating seaports globally. This changing business environment has led to a pattern of competition and cooperation between seaports (Song, 2003).

Seaports have always held major importance to the economic development of the Iberian Peninsula (Portugal and Spain). In Portuguese history, seaports have played a visible role ever since the fifteenth and sixteenth centuries of maritime exploration, and primarily determined by their geographical location (MOPTC, 1999). According to this institution (the Ministry of Public Works, Transport and Communication), there is evidence stretching back to the eighteenth century on how this industrial sector was protected because of its sheer importance to broader national economic activities. Despite the modernization and the high public investment undertaken, Portuguese seaports have lost market share to road transport. Whilst in 1980, foreign trade made recourse to the sea for 95% and 80% of imports and exports respectively, by 2000, these percentages had fallen to 69% and 40%, respectively (Matias, 2009). According to this author, this process is similar to trends in effect until quite recently at other European seaports. However, these seaports have since reversed the decline by taking a set of actions that included the establishing of maritime sector clusters. Matias (2009) and Sachetti (2009) referred that Portugal might also be able to attain this goal with lines of action designed to improve seaport competitiveness implemented within an integrated national logistics system framework.

In an increasingly globalized world economy, Portuguese seaports must prove able to leverage full advantage of its privileged geographical location at the risk of otherwise being considered "marginal" seaports within the scope of the Iberian Peninsula (MOPTC, 2006). According to this same institution, Portugal should open take up the ambition to become a logistics hub on the western frontier of Europe, providing services of excellence driving integrated logistics chains able to enhance the competitiveness of the national economy. Portuguese seaports enjoy the natural conditions necessary to adopting this role of sea-land interfaces integrated into intermodal systems. However, these characteristics, whilst still indispensable, are static and do not guarantee success in an industry where celerity and efficiency across different transport modes proves the most important factor (Guy and Urly, 2006; Lirn et al., 2004).

Since the 1990s, the Spanish seaport authorities have also been facing increased competition due to a set of changes impacting on the industry worldwide (Castillo-Manzano et al., 2008). These changes include seaports specializing in specific traffic categories, trends in route selection, the containerization process and the concentration of companies and businesses (Bichou and Gray, 2005). In addition, Spanish seaports have been subject to successive legal reforms (Suarez and Rodriguez, 2002; Castillo-Manzano et al., 2008). As a result, the Spanish seaport system is notable for its new management model based on functional independence and financial autonomy (Castillo-Manzano et al., 2008). To rapidly adapt to this changing environment, Spanish seaports necessarily had to come up with management strategies placing greater emphasis on providing competitive services, mainly because the Spanish seaport system includes 28 seaport authorities sharing and competing for the same hinterlands (Garcia-Alonso and Sanchez-Soriano, 2010).

Taking into account the vital importance of seaports to any country's economy and especially to the Iberian countries, this research seeks to analyse the competitiveness and strategic positioning of Iberian seaports. The research findings represent particular relevance given the current economic crisis afflicting the Portuguese maritime sector and contrasting with the Spanish seaport level of development and despite the better strategic positioning of Portuguese seaports as potential gateways to Western Europe. This research also attains originality given the lack of any studies of the competitiveness and strategic positionings of Iberian Peninsula seaports. The limited extent of research outputs on Spanish and Portuguese seaports have thus far focused on logistical issues (Guerreiro, 1997; Bravo, 2000; Macedo, 2005) or on seaport efficiency levels (Barros and Athanassiou, 2004; Barros, 2005; Barros and Peypoch, 2007, Garcia-Alonso and Martin-Bofarull, 2007, Díaz-Hernández et al., 2008; Castillo-Manzano et al., 2008; Dias et al., 2009). These studies do not encompass either the strategic positioning analysis of these seaports as a "range" or the competitiveness level analysis between these seaports. Hence, these earlier studies contemplate only either Portuguese seaports or Spanish seaports. The word "range" refers to a geographically defined area encompassing a number of seaports with largely overlapping hinterlands and thus serving much the same clients. The only study identified in the literature on Iberian Peninsula seaports sought to comparatively benchmark the main container terminals (Dias et al., 2009).

In this sense, this research contributes to the existing literature by filling this gap in the literature on the competitiveness and strategic positioning of seaports in general and on Iberian Peninsula in particular. This research also identifies for seaport decision-makers: i) the strategic positioning of seaports over a long timeframe and evolutions in these positioning; ii) their level of competitiveness over a long timeframe and its means of improvement; iii) the key factors of competitiveness from the perspective of stakeholders; and iv) the tools appropriate to measuring competitiveness and strategic positions.

1.2 – Research questions and objectives

The term competitiveness has been widely referenced and discussed in the literature and there are many definitions and approaches under the auspices of this term, some of which have raised controversy. The National Competitiveness Council (2004) defines competitiveness as the ability to succeed in key markets and provide better living standards for populations. According to Teece et al. (1997), competitiveness depends essentially on productivity and the economic capacity to mobilize products/services and especially in the more productive sectors of activities. Porter (1990) stated that there is no clear definition of competitiveness: to firms, competitiveness means the ability to compete in world markets with a global strategy; for others, competitiveness means states run positive trade balances; whilst for some economists, competitiveness means lower unit labor costs adjusted by exchange rates. Competitiveness is closely linked to the capacity for strategic management, and specifically for the ability to provide organizational models and decision making capacities that foster and enhance integrated organizational efficiency, innovation capacities, as well as upgrading both human resource skills and internal company technological knowledge (Teece, 1990). Therefore, competitiveness, despite being an extremely complex and broad reaching and sometimes controversial concept, companies have to develop their competitive capacity to ensure their survival.

In the seaport context, competitiveness derives from the seaport capacity to create added value, generate a core of regular business and enable productive or industrial activities in surrounding areas (Yeo and Song, 2006; Castillo-Manzano et al., 2009). Thus, the most competitive seaports are able to develop and apply a differentiated strategy and thereby attracting more customers and traffic than its competitors. Regarding seaport competitiveness, reference is often made to Verhoeff (1981) who argued that seaport competition unfolds across four distinct levels: i) competition between the activities ongoing at seaports, ii) competition between seaports, iii) competition between seaport clusters (i.e., a group of seaports in close vicinity with common geographical characteristics) and iv) competition between ranges (seaports located along the same coastline or with a largely identical hinterland). According to the same researcher, the factors influencing competition vary from level to level. Competition among the individual activities ongoing within seaports is determined mainly by factors of production (labour, capital, technology and power). Moreover, competition between seaport clusters and seaport range is affected by regional factors such as geographic location, the infrastructures available, the degree of industrialization, government policies and standards of seaport performance. However, according to Voorde and Winkelmans (2002), competition between seaports is influenced by other factors such as the type of managers, the knowhow in place at seaport authorities and managers, the well-designed application of EDI (Electronic Data Interchange), government intervention (particularly when providing subsidies), the existence of niche markets and the generation of added value.

According to Fleming and Baird (1999), there are clearly some specific influences interfering in the relative competitiveness of any seaport. These researchers propose six factors of influence that, when combined, help explain why certain seaports inevitably develop and gain an advantage over their opponents: the organization and traditions of the respective seaports; land and sea access to seaports; the state of resources and the influence of their costs on seaports; seaport productivity; navigator preferences and comparative advantage in terms of location. This view is also shared by Tongzon (2007) who, in turn, identifies eight factors determining seaport competitiveness: i) the seaport operational efficiency level; ii) seaport cargo handling charges; iii) reliability; iv) the seaport selection preferences of carriers and shippers; v) channel depths; vi) the adaptability to the changing market environment; vii) landside accessibility; and viii) product differentiation.

In their study, Low et al. (2009) identify seaport connectivity as a key determinant to seaport competitiveness. The geography and more specifically the proximity of the origins or destinations of a shipment is a strong factor in the choice of seaport for handling a certain container (Cullinane et al., 2005). Furthermore, greater competition leads to greater service consumer choice (Panayides, 2003). A variety of factors need taking into consideration when identifying the inputs into overall seaport competitiveness because decision-makers are rarely able to select a course of action based only on a single factor (Guy and Urly, 2006). Therefore, seaport managers must identify the needs and changes in consumer preferences and respond appropriately. Strategies incorporating service consumer interests are essential in the highly competitive environment faced by the seaport industry. In this context, the question of which are the most important factors to seaport competitiveness from the perspective of stakeholders represents an important issue for all stakeholders whether for seaport managers, shipping lines or for policy makers (Magala and Sammons, 2008).

The idea that organizations have stakeholders is now common throughout the management literature. Since the 1984 publication of Freeman's book "Strategic Management: a stakeholder approach," there has been a steady stream of books and scientific articles emphasizing the stakeholder concept. Various stakeholder related studies have focused on the analysis of the impact of stakeholders on organizational strategies and performance (Nakamura et al., 2001; Murillo-Luna et al., 2008).The stakeholder approach (Freeman, 1984) was built on this premise: organizations seeking to be efficient should pay attention to all those who affect or are affected by the organization's goals. Thus, it is important to identify the key factors to competitiveness from the stakeholder's perspective. An assessment of these factors proves furthermore useful in providing insights into how best to design an effective seaport strategy.

The importance of strategies formulated with the intent of gaining competitive advantage and higher standards of performance is becoming increasingly evident in the seaport context (Evangelista and Morvillo, 1998; Sletmo, 1999; Jenssen, 2003; Panayides, 2003; Song, 2003; Casaca and Marlow, 2005; Cullinane et al., 2005; Parola and Musso, 2007). According to Panayides (2003), there is a positive relationship between the pursuit of competitive advantage by seaport management and performance. As seaport environments have been characterized by major uncertainties and risks, the importance of strategic planning has also increased (Haezendonck, 2001). In this context, the concepts and practices integral to strategic planning have generated interest in organizations located all around the world as well as across many industries. However, strategic positioning is often not obvious and may be based on customer needs, customer accessibility or a variety of company products/services (Porter, 1996). When engaging in strategic decision-making, seaport authorities, terminal operators and seaport users must build upon a conceptual understanding of the dynamics of international seaport competition and undertake strategic positioning analyses (Haezendonck et al., 2006).

Seaport management have been characterized by fierce competition resulting from structural changes in the industry within the scope of which large companies take over and merge with others in efforts to remain competitive (Panayides, 2003). According to Evangelista and Morvillo (1998), the implementation of strategies based on acquisition stems from several reasons, including: i) the protection of specialized transport activities in a particular market segment in order to maintain and increase service management and production, ii) the running of large scale operations with flexibility and the ability to adapt quickly to changes in specific market segments, iii) the optimization of the experience curve, and iv) the wide reaching adoption of corporate profit controls. However, the merger and acquisition options available are not always ideal or reliable for all seaports seeking to raise market share and competitiveness. Competitiveness may also be achieved through the formulation and implementation of competitive business strategies able to increase performance (Panayides, 2003). In fact, in response to these competitive movements, other seaports try to differentiate themselves through marketing strategies or specializing in delivering services to a specific geographic area or industry. According to Haezendonck (2001), several seaport authorities and operators are aware that the static approach of cost leadership, focusing only on the advantages bestowed by hereditary factors and depending on new infrastructures to attract and retain customers, are no longer sufficient to ensuring the competitive success of seaports. Several authors (Lipman and Rumelt, 1982; Barney, 1991; Grant, 1991; Gordon et al., 2005) refer to how the source of sustainable organizational competitive advantage lies in their resources and capabilities.

Grant (1991) proposes that independently of how the strategic management literature tends to emphasize issues related to strategic positioning in terms of choice of cost advantages and differentiation between segments and broad or narrow markets, the fundamental factor in these choices is the deployment of company resources. In the seaport industry, Sletmo and Holste (1993) accept that maritime organizations cannot achieve competitiveness based only on the three generic strategies. They need also to involve intangible assets (human resources with tacit knowledge and specific seaport related skills).This is in line with the resource-based theoretical view (RBV). The idea of viewing the organization as a collection of resources comes from the work of Penrose (1959). Penrose (1959) indeed characterizes the firm as a collection of resources rather than as a set of product-market positions. However, it was only in the late 1980s and throughout the 1990s, that the resource based view gained momentum as a credible school of thought in the strategic management literature (Barney, 1991; Grant, 1991; Peteraf, 1993; Prahalad and Hamel, 1990). Many of the researchers that refer to resource theory (Grant, 1991; Barney, 1991; Amit and Schoemaker, 1993) do so within a more strategic context, presenting resources and capacities as the inputs needed to obtain the sustainable competitive advantage of a company, and thus obtaining higher rates of return.

The resource based perspective focuses on the internal organization of firms and may therefore be viewed as complementing the traditional strategic emphasis in the seaport industry (Haezendock, 2001). As previously noted, this theory sharply contrasts with the conventional view of company strategic positioning, which focuses almost exclusively on the exogenous variables to a firm's competitive environment and examines how these forces influence firm performance (Foss, 1997; Grant, 1991; Zubac et al., 2010; Perez-Arostegui and Benitez-Amado, 2010). Indeed several researchers (Coeck et al., 1996; Rugman and Verbeke, 1998; Panayides and Gray, 1999; Haezendock et al., 2000; Haezendonck, 2001; Avezedo and Ferreira, 2009) report that the research based theory may prove very valuable to planning and managing seaports. Seaport resources may prove difficult to imitate by their inherent nature (such as geographic location) or processes (technology) (Haezendonck, 2001). In terms of sustainability, seaport competences should be durable and therefore not subject to short term fluctuations.

Among the many resources seaports can focus on in within the scope of attaining competitive advantages, this research highlights physical logistical resources, specifically facilities and equipments. In the seaport context, due to the sheer complexity of the entire logistics process, efficient management resources become a very important facet to achieving competitive advantages. Several researchers (Tongzon, 2007; Pettit and Beresford, 2009; Sohn and Jung, 2009) have suggested that seaport success is closely related to integrating logistics into their strategies. From the perspective of logistics, seaports may thus be characterized and defined in terms of the flows of goods, services, related information and finance passing through any particular seaport interface. As seaports are characterized by a multiplicity of ties, competitors with different roles, supported by commercial relationships between various partners, the integration of logistics and their efficient management is a precondition for the development of this sector (Notteboom and Winkelmans, 2001). With economic globalization, one of the greatest challenges that organizations have to face is to produce and deliver goods/services in large quantities and at low cost (Buckley and Ghauri, 2004; Fawcett and Closs, 1993; Mussa, 2003) and, in this context, logistics represent an essential basis of support to organizations. When competition intensifies, decisions become more global and logistics become a key area and a source of competitive advantage (Buckley and Ghauri, 2004; Bagchi and Virum, 1998; Mussa, 2003). The intensive use of containers, intermodal and information and communication technologies have increased the spatial and functional reconfigurations of the logistics interconnections in seaports (Notteboom and Rodrigue, 2005), which have enabled seaports to obtain competitive advantages.

The importance of seaports to national economies has already gained consensus in the literature and especially to economies heavily dependent on international trade (Song and Panayides, 2008). However, research of this sector has some gaps, notably as regard to competitiveness and strategic positioning of seaports. Some researchers (Tongzon, 2001; Cullinane et al., 2006, Wang and Cullinane, 2006) had attempted to contribute towards seaports studies by trying to associate the strategies of increasing size adopted by some seaports with their respective levels of efficiency. However, according to Sohn and Jung (2009), several studies have also shown that the bigger and larger scale seaports do not necessarily turn in the best efficiency levels. Hence, identifying the factors that really do influence in the competitiveness of seaports still remains necessary.

In summary, these considerations emphasize that: i) seaport sector competition has intensified resulting from structural changes in the industry; ii) this industry is a very important sector for the country's economic development and hence an critical field of study iii) strategies focusing on consumers are essential within the highly competitive environment faced by the seaport industry and thus identifying and knowing customer needs represents a very important strategic dimension; iv) strategic positioning analysis is necessary in this sector and knowledge on the ground on this area is relatively poor; and v) strategies based on resources and capabilities (mainly on logistical resources) are likely to influence overall seaport performance and, therefore, also need taking into consideration.

In this context, this research seeks to analyse the competitiveness and strategic positioning of seaports in general and of Iberian Peninsula seaports in particular.
In accordance with the background set out above, the following four research questions are proposed:

1. Are there different levels of competitiveness among Iberian seaports?
2. What are the key factors of seaport competitiveness from the stakeholder perspective? Do perceptions of the importance of these factors differ between users and service providers?
3. How are Iberian seaports strategically positioned within the Iberian range?
4. What contribution do logistics resources make to the competitiveness and performance of this sector?

Based upon these four research questions, this thesis correspondingly presents the following objectives:

1. To measure the competitiveness of Iberian seaports through efficiency indicators.
2. To investigate the key factors of seaport competitiveness from the stakeholder perspective.
3. To analyse the strategic positioning of Iberian seaports.
4. To analyse the contribution of logistics resources to the Iberian seaport performances.

1.3 Thesis Model Design

This thesis is structured into three core sections. This first consists of the introduction, which provides a brief overview of the research framework and scope. This introduction also provides a short review of the literature transversal to the set of articles making up the body of the thesis to justify the objectives and research questions. This also features a description of the thesis structure.

The second section is made up of four chapters containing four empirical studies. Chapter 1 evaluates the competitiveness of Iberian seaports through the efficiency level applying i) an alternative Data Envelopment Analysis (DEA) approach for cross section data from 2009 and ii) appropriate DEA approaches (contemporaneous and windows analysis) for panel data (2005-2009). Using the Analytic Hierarchy Process (AHP), chapter 2 empirically studies the key factors of seaports competitiveness from the stakeholder perspective and the strengths of their preferences. The Delphi approach was deployed in the preliminary stages of factor selection. This chapter also identifies the performance of Iberian seaports based on factors of competitiveness. Chapter 3 analyses the strategic positioning of Iberian seaports in accordance with the Boston Consulting Group (BCG) matrix as a strategic tool for an evolutionary perspective. Beside static analysis for the 1992 to 2009 period, this chapter also incorporates a dynamic analysis of Iberian seaport strategic positioning. This research allows us to compare and analyse different levels of performance and identify just which seaports have improved their strategic positioning over the period under consideration. With the intent of analysing the contribution made by logistics resources to seaport performances, chapter 4 uses linear additive Multi Criteria Analysis (MCA) and the Principal Components Analysis (PCA) model. The model incorporates the contribution of two different performance indicators, operational performance and physical capacity, respectively measured by several indicators.

The third and final section provides the final thesis considerations and puts forward the core conclusions and contributions generated by the research. A summary of the issues analysed in this thesis and susceptible to conditioning and affecting seaport competitiveness is provided in Figure 1.

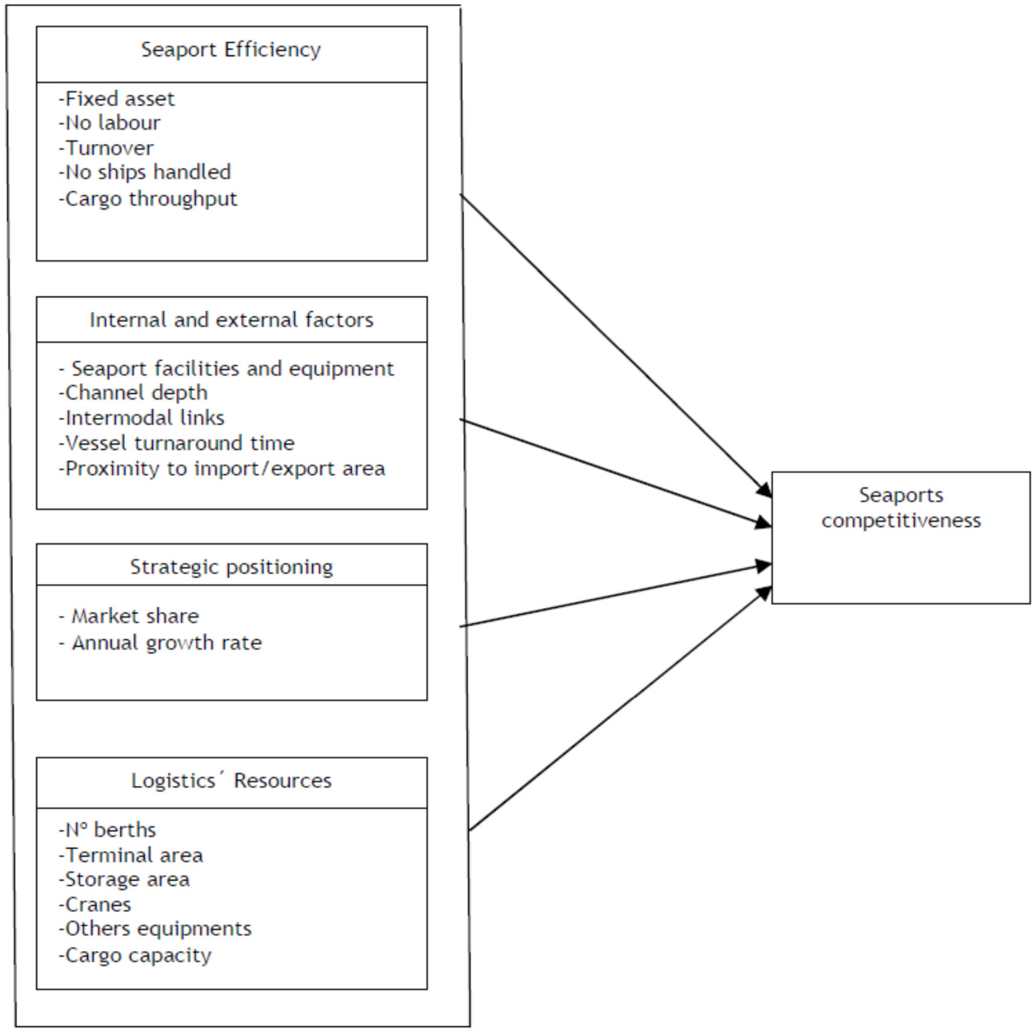

Figure 1 – Doctoral Thesis model

When researchers engage in their respective fields, many questions may be raised and there is often little information for answer them. In such situations, the approach may adopt quantitative and/or qualitative methodologies. This decision depends on several factors, including the aim of the study and the nature of the variables, among others (Perez et al., 2006). The design and conception of this research develops throughout the different methodological procedures summarized in Table 1.

Table 1 - Thesis Design

Papers	Title	Purposes	Research method	Statistics Tools	Contributions
Paper 1	Evaluating Iberian seaport competitiveness through efficiency using DEA panel data Approaches	To evaluate the Iberian seaports competitiveness through efficiency.	Quantitative (secondary data)	-DEA (Data Envelopment Analysis) panel data approaches (contemporaneous and window analyses).	It allows the decision makers to know: i) its efficiency during a long time period ii) the input and output that contribute to it and iii) how they can improve it.
Paper 2	Key Factors of Seaports Competitiveness based on Stakeholders´ Perspective: Analytic Hierarchy (AHP) Model	To Identify the key factors of seaports competitiveness from the Iberian stakeholders´ perspective.	Quantitative (primary data)	-AHP (Analytic Hierarchy Process) -Delphi method	It allows the seaports service providers to know the key factors that shippers deem important in seaport selection decisions and the strength of their preferences.
Paper 3	A Strategic Diagnostic Tool Applied to Iberian Seaports: An Evolutionary Perspective	To Analyze the strategic positioning of Iberian Seaports	Quantitative (secondary data)	-Dynamic BCG (Boston Consulting Group) matrix	It allows the decision makers to know its strategic position during a long time period and the evolution of these positions.
Paper 4	Logistics Resources in Seaport Performance: Multi-criteria Analysis	To validate the importance of the logistics resources to the overall performance of Iberian seaports	Quantitative (secondary data)	-Linear additive Multi Criterion Analysis model; -Principal Component Analysis (PCA)	It Proposes another methodology for analyzing seaport performance for both decision makers and scholars

The four empirical papers in this thesis have all been submitted to international journals (Table 2), in accordance with the content of each article and the core interests of the respective journal, with two studies already published and two currently undergoing peer reviews.

Table 2 – Thesis empirical papers

Papers	Reference	Status of the paper
Paper 1	Cruz, R., Ferreira, J. and Azevedo, S. Evaluating Iberian seaport competitiveness through efficiency using DEA panel data Approaches. *European Journal of operational research*.	Undergoing peer review
Paper 2	Cruz, R., Ferreira, J. and Azevedo, S. Key Factors of Seaports Competitiveness based on Stakeholders´ Perspective: Analytic Hierarchy (AHP) Model. *Maritime Economics and Logistics*.	Undergoing peer review
Paper 3	Cruz, R., Ferreira, J. and Azevedo, S. (2012). A Strategic Diagnostic Tool Applied to Iberian Seaports: An Evolutionary Perspective, *Transport Reviews*, 32(3). Available online: 24Jan2012.DOI:10.1080/01441647.2011.647837	Published
Paper 4	Cruz, R., Azevedo, S. and Ferreira, J. (2012). Operational Performance and Physical capacity of Iberian seaport: a multi-criteria analysis. In A. Gil-Lafuente, J. Gil-Lafuente, and J. Merigó-Lindahl (Eds). Soft Computing in Management and Business Economics, Vol. 1, 449-463, Springer.	Published

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Part II

Chapter 1 - Evaluating Iberian Seaport Competitiveness through Efficiency Using DEA Panel Data Approaches

Evaluating Iberian Seaport Competitiveness through Efficiency Using DEA Panel Data Approaches

Abstract

Seaport competition has become fierce over time because of the rise of international trade, concentration in the shipping industry and liberalization of transport markets. One of the most important tools to measure seaport competitiveness is the efficiency. This paper aims to evaluate the competitiveness of Iberian seaports through the efficiency applying i) an alternative DEA (Data Envelopment Analysis) approach for cross section data and ii) an appropriate DEA panel data approaches (contemporaneous and window analyses). In order to advance the knowledge in seaport efficiency measure, seaport panel data might be more suitable for long term efficiency analysis and yet the literature on this facet is scarce and demands further research. The results suggest that the efficiency of Iberian seaport differ significantly from seaport to seaport and within each seaport over time. The study also provides contributions towards assessing competitiveness in the seaport industry and identifies explicit causes of inefficiency.

Keywords: Competitiveness, efficiency, panel data, DEA, window analysis, Iberian seaports.

1. Introduction

The globalization of the world economy has led to an increasingly important role for transportation industry (Cullinane et al, 2005). The seaport industry that carried 80% of world international trade has been affected by this global change. In order to support trade oriented economic development, seaport authorities have increasingly been under pressure to improve seaport efficiency by ensuring that seaport services are provided on an internationally competitive basis (Tongzon, 2001). Seaports form a vital link in the overall trading chain and consequently, seaport efficiency is an important contributor to a nation´s international competitiveness.

In this context it becomes very important to assessing the Iberian seaport competitiveness through efficiency. The Iberian seaports represent an important role in the world maritime transportation acts as gateway for Europa and Asia. Looking at containerized cargo consideration, Spain took 22nd place in the 2007 rankings, while Portugal came in 53rd among 60 countries (Degerlund, 2009). The Iberian seaports are also important to the national economies (Portuguese and Spanish) because in 2009, 32% of the goods in Portugal and 20% of goods in Spain were carried through seaports (INE 2009a; INE 2009b).

In order to evaluate the seaport competitiveness, measure the efficiency is perceived as an important tool (Park and De, 2004; Cullinane et al., 2005; Cullinane and Wang, 2007; Sharma and Yu, 2010). Knowing the efficiency score is important because it could influence the decision-making strategies, helping to identify areas requiring improvement and training, determining whether a particular seaport is under-utilized or otherwise (Sharma and Yu, 2010). It also provides insights into setting the direction or the scope of the seaport's activities.

In recent years several approaches has emerged to analyze the seaports ´efficiency as Stochastic Frontier Analysis (SFA) and Data Envelopment Analysis (DEA). In this study the DEA analysis was been used because of the practical advantage of this approach in relation to the others. The DEA analysis is a mathematical programming based method that converts multiple input and output measures into a single summary measure of productive efficiency. According Song et al. (2011), DEA is a method for benchmarking production units' productivity, profitability or any other criteria that could be assessed based on the available input and output variables.

This methodology has been applied in many seaports but few compare the efficiency of Iberian seaports. Only one works are known. Dias et al. (2009) applied DEA to Iberian seaports but focused on container terminals using cross-sectional data. There are also some other studies (Bonnila et al., 2002; Barros, 2003a; Barros, 2003b; Barros and Athanassiou, 2004; Dias et al., 2009; Garcia-Alonso and Martin- Bofarull, 2007; Martinez et al., 1999; Serrano and Castellano, 2003) dealing with Portuguese and Spanish seaports efficiency but separately or in conjunction with other European seaports.

On the other hand, however, some of these studies used panel data whilst in the ensuing analysis, the standard DEA model for cross section data was used (e.g., Martinez-Budria et al., 1999). Hence, dynamic time-based changes in relative efficiency levels have not been explicitly investigated or isolated. As referred by Cullinane et al. (2004) when time is not considered, the efficiency results derived using this approach can be biased. UNCTAD, in its 1997 review of maritime transport refer that in many cases, it is more appropriate to monitor seaport efficiency on a time-series basis, comparing it to others seaports over two or more time periods.Thus, beside the lack of Iberian seaports efficiency studies, there is a lack in using appropriate panel data methodology. In this context and filling this gap in the literature, this paper aims to evaluate the competitiveness of Iberian seaport through the efficiency applying i) an alternative DEA approach for cross section data, and ii) an appropriate DEA panel data approaches (contemporaneous and window analyses). The most representative Iberian seaports of each country were selected for this study.

The remainder of the paper is organized as follows. Section 2 provides a brief literature review on seaport competitiveness and efficiency. Section 3 explains the methodological research with a special emphasis on the model specification and selection. Section 4 examines the Iberian seaport competitiveness using a set of 2009 cross-sectional data through the alternative 'three-stages' DEA approach. Furthermore, the study considers a set of panel data from 2005 to 2009 using contemporaneous and window analysis. Finally, section 5 sets out the article's conclusions.

2. Seaport competitiveness and efficiency

The term competitiveness has been very referenced and discussed in the literature and many are the definitions and approaches made about this term, some of them raised controversy. The National Competitiveness Council (2004), define competitiveness as the ability to succeed in key markets to provide better living standards for populations. According to Teece et al. (1997), competitiveness depends essentially on productivity and economic capacity to mobilize the products / services and the more productive activities. Porter (1990) stated that there is no clear definition of competitiveness: to firms, competitiveness means the ability to compete in world markets with a global strategy; for others, competitiveness meant that the nation had a positive trade balance; and for some economists, competitiveness means lower unit labor costs adjusted for exchange rates. Porter is considered the author that most contributed to the clarification and conceptual understanding of competitiveness highlighting the competitive advantages concept instead of comparative advantage of the neoclassical model. Currently, globalization defines a new background of competitiveness, where the capacity for innovation, the service development and the qualification of human resources have become extremely important (Camagni, 2002).

Although there are some studies of seaport competitiveness, the concept of competitiveness in seaport industry have been few discussed. Notteboom (2009) refer that seaport competitiveness is a complex phenomenon, which cannot always be fully explained in terms of easily identifiable and quantifiable elements. According Yeo and Song (2006) competitiveness in seaport industry consist in the ability of seaports to offer services that meet the quality standards of the local and world markets at competitive prices and provide adequate returns. Using related seaports studies as a point of reference (Yeo and Song, 2006; Castillo-Manzano et al., 2009), the definition of competitiveness used in this study is "the capacity of a seaport to create added value, generate a nucleus of business, and produce productive or industrial activity in the surrounding area". Thus, the most competitive seaport will be able to develop and apply a differentiated strategy, attracting more customers and traffic than its competitors. Cruz et al. (2012) propose seaports should consider which factors affect their competitiveness in order to develop strategies aligned with these factors, combining resources and capabilities whenever seeking to achieve higher performance standards.

The seaport managers are often under great pressure to improve the competitiveness of their seaports (Cullinane et al., 2006; Fleming and Baird, 1999). Traditionally, the indicators to measure seaport competitiveness are based on cost and technical efficiency in handling ships and cargo (Cullinane et al., 2006). According to these authors, the scope of a seaport to increase its level of competitiveness is enhance when it can offer technical efficiency and lower costs, and capitalize on its strategic advantages and core competencies in delivering efficient, cost-competitive services to its users. Thus, measure efficiency is fundamental to seaport management planning and control activities, and accordingly, has received considerable attention by both management practitioners and theorist. Lovell (1993) suggests that there are two fundamental reasons why it is important to measure efficiency: firstly, they are indicators of the success achieved by production units and thus provides a basis for their evaluation. Secondly, they enable us to explore hypotheses concerning the sources of efficiency and productivity differentials. Identifying these sources is essential to instituting both public policy and private business strategies that are designed to enhance overall performance. Seaport efficiency is not only a powerful management tool for seaport operators, but also constitutes a most important input for informing regional and national seaport planning and operations (Cullinane et al., 2005; Park and De, 2004). An efficient seaport raises the productivity of prime facto.rs of production (labour and capital) and profitability of the producing units thereby permitting higher levels of output, income, and employment (Dowd and Leschine, 1990).

In Europe, the context with this study is inserting, seaport efficiency is a major issue in economics debates due to the intense pressure that competition exerts on prices (Barros and Peypoch, 2007). Competition between European seaports focuses mainly upon their capacities to attract maximum cargo volumes in order to justify direct calls (ESPO, 2004). This competitive pressure derives from two evolutionary processes: firstly, the deregulation of former national markets fostering competition between domestic seaports and, secondly, the adoption of the EU's Single Market Program and developments in overland infrastructures boosts competition between domestic and international seaports (Haralambides et al., 2001).

In recent years, a growing body of literature deploying a variety of approaches has emerged dealing with efficiency issues in seaports (Barros, 2003a; Barros and Athanassiou, 2004; Bonnila et al., 2002; Cullinane et al., 2004; Cullinane and Wang, 2007; Dias et al., 2009; Garcia-Alonso and Martin-Bofarull, 2007; Martinez-Budria et al., 1999; Park and De, 2004; Roll and Hayuth, 1993). Some of these studies were applied in Portuguese and Spanish seaports but not at the same time, comparing the efficiency between the seaports of each country (appendix A). Martinez-Budria et al. (1999) conclude that Spanish seaports of high complexity are associated with high efficiency, compared with the medium and low efficiency found in others groups of seaports. When compare the traffics with the available equipment of the different seaports of the Spanish system, Bonilla et al. (2002) found that the efficiency score presents high contrasts. Barros (2003a) concludes that an organisational governance environment, with accountability, transparency and efficiency incentives, is needed to overcome the deficits in technical and allocative efficiencies observed in the Portuguese seaports analysed. Barros and Athanassiou (2004) conclude that the majority of Greece and Portuguese seaports are efficient with the sole exception of Thessaloniki. Garcia-Alonso and Martin-Bofarull (2007) concludes that Spanish seaport authorities should not base their success in competing with other seaports for maritime traffic on the volume of their expenditure on infrastructure. Although the resulting gains in efficiency are essential, these do not necessarily derive from the size of the investment because they do not always depend on the increase in the size of the seaport's installations.

3. Research methodology

3.1 Model selection

The basic premise underlying the concept of efficiency is that no output can be produced without resources (inputs) and that these resources are scarce. Consequently, it also follows that there is a limit to the volume of output (commodities) susceptible to production. Until recently, the traditional methodology for measuring efficiency in economics has been the production frontier approach based on principles from statistics and econometrics (Charnes et al., 1994). These functions, which are estimated to determine efficiency, are also known as stochastic frontier approach (SFA). During the last few decades, however, an alternative methodology to the SFA knows as the DEA has been developed with its application growing rapidly in popularity in recent times (Cullinane and Wang, 2007; Dias et al., 2009; Garcia-Alonso and Martin- Bofarull, 2007; Wu, 2011). Both the DEA and the SFA approaches have been applied to study seaport productive efficiency due to the sheer importance of improving their productivity levels. Cullinane et al. (2006) put forward a detailed synthesis on the application of these techniques in seaports and apply them to the world's largest container seaports and demonstrating that the technical efficiency indexed rankings obtained using DEA and SFA do coincide.

However, DEA offers several compelling methodological and practical advantages over the stochastic frontier models. DEA accommodates more multiple inputs and multiple outputs within a single measurement of efficiency than the SFA and has now become the dominant approach to efficiency measurement. DEA does not impose a specified functional form to modelling and calculating the efficiency of a decision making unit (DMU). Unlike the parametric frontier models therefore, DEA does not suffer from the problem of model misspecification, which has the potential of generating misleading results (Charnes et al., 1994; Donthu et al., 2005; Haugland et al., 2007; Luo, 2003). In addition, unlike SFA, DEA does not suffer from multicollinearity and heteroscedasticity problems. DEA manages to measure the level of efficiency empirically obtainable in a particular given scenario (in accordance with the available resources, institutional set-up, etc).

On the other hand, since DEA is a non-parametric technique, statistical hypothesis testing is difficult to obtain. Another limitation or disadvantage is that DEA estimations only inform on how well a DMU or a seaport (in our case) is doing compared to its peers but not compared to a "theoretical maximum". In other words, as DEA gives a relative measurement of efficiency it has the potential of justifying inefficiency, i.e. even those that appear to be efficient in the sample might actually be inefficient in absolute terms. This problem may, however, be minimized by using a large sample data set. To overcome this limitation in this paper, we adopt panel data. Unlike the practice of cross-sectional data analysis, which compares one firm with all other firms in the data set feasible, the analysis of a set of panel data involves choosing only alternative subsets, termed *reference observations subsets* rather than the full data set, in order to evaluate the efficiency of an individual firm (Cullinane and Wang, 2007). Panel data prevails over cross-sectional data because they enable a firm to be compared with its counterparts and evolutions in a firm's efficiency over a certain time period is deductible.

3.2 Models specification

For assessing differences in the efficiency of Iberian seaports, we made recourse to DEA, a multi-factor productivity analysis for measuring the relative efficiencies on decision making units (DMUs). DEA tool enables us to evaluate performances vis-à-vis its peers. DEA is based on the relative efficiency concepts proposed by Farrell, but Charnes et al. (1978) extended and developed Farrell's approach. In effect, DEA utilizes an extended version of Pareto's efficiency concept (Charnes et al., 1994).

According to Sharma and Yu (2010), DEA models are classifiable according to the type of envelopment surface and the orientation (input or output). There are two basic types of envelopment surfaces in DEA known as constant returns-to-scale and variable returns- to-scale surfaces. The first DEA model, DEA-CCR (Charnes, Cooper and Rhodes) was introduced by Charnes et al. (1978) and assumes constant returns to scale so that a change in the input level leads to an equi-proportionate change in the output level. On the other hand, the DEA-BCC (Banker, Charnes and Cooper) model introduced by Banker et al. (1984) assumes variable returns to scale where performance is bounded by a piecewise linear frontier.

According to Gollani and Roll (1989), the CCR model identifies overall technical efficiency (pure technical efficiency and scale efficiencies), while the BCC, pure technical efficiency only. This differentiation is based on the definition of technical efficiency by Fare et al. (1994). In the perspective of these authors, technical efficiency has been decomposed into the product of measures of scale efficiency and pure technical efficiency. Barros (2006) interpreting pure technical efficiency as managerial skills, assuming overall technical efficiency is due to managerial skills and scale effects. A ratio of the overall technical efficiency scores to pure technical efficiency scores provides a scale efficiency measurement. Therefore, when a DMU is inefficient in CCR models and turns out to be efficient in BCC models, signifying that the dominant source of inefficiency is due to scale efficiency. The concept of scale efficiency was first introduced by Farrell (1957), which can be simply defined as the relationship between a seaport´s per unit average production cost and volume. Without precise information on the return-to-scale of the seaport production function and for greater scope of comparison, the CCR and BCC models are applied to analyse seaport efficiency.

DEA models are also classified as input oriented, output oriented, or additive (both inputs and outputs are optimized) based upon the direction of inefficient unit projections into the frontier (Sharma and Yu, 2010). The input-oriented model focuses on how much inputs can be reduced while maintaining the same level of output, while the output-oriented model focuses on how much can output(s) increase while keeping the level of inputs constant. The difference between the two orientations is the projection path to the production frontier. For input-oriented models the projection path is horizontal while for output-oriented models, the projection path is vertical. The orientation of the model mainly depends on the nature of the production and the given constraints.

With regards to model orientation, the input-oriented models in measure seaport efficiency were used by Barros (2003a), Barros and Athanassiou (2004) Park and De (2004) and Cullinane et al. (2005), while Cullinane et al. (2004) and Dias et al (2009) used the output-oriented model. According Cullinane et al. (2004), the input-oriented model is closely related to operational and managerial issues, whilst the output-oriented model is more related to planning and strategies. The choice of an input or output-oriented DEA is based on the market conditions of the DMUs (Barros, 2006). As a general rule of thumb, in competitive markets, DMUs are output-oriented, assuming that inputs are under the control of the DMU, which aims to maximize its output, subject to market demand; something that is outside the control of the DMU. In monopolistic markets, the units analyzed (DMU) are input-oriented, while output is endogenous. In this perspective, in regulated sectors would be more appropriate to use the input orientation. However, Coelli and Perelman (1999) observed that there are arguments for applied both orientation in these sectors and in their study, they obtained similar results applying both.

In this study, the input oriented-based approach is adopted because in our point of view the seaports have better control over inputs than outputs. Given that productive output is fairly predictable in the short and medium term, all this suggests that an input-oriented model is most appropriate to the analysis of seaport production. According to Barros and Athanassiou (2004), the choice in favour of an input oriented approach corresponds to the public nature of seaports, required to accept traffic as and when offered. Wang and Cullinane (2006) maintain that, as an important link in the global supply chain, the seaport ability to efficiently utilize their infrastructures and facilities ultimately most benefits seaport clients in terms of a reduction in costs.

The mathematic formulation of DEA is: Consider *n* DMUs, when each DMU j $(j=1,...,n)$ uses *m* inputs $X_j=(X_{1j}, X_{2j},...X_{mj}) > 0$ for producing *s* outputs $Yj=(Y_{1j},Y_{2j},...Y_{sj}) > 0$. The DEA efficiency score h_{jo} in CCR model can be obtained by solving the following fractional program:

Maximize $h_{jo} = \sum_{r=1}^{s} u_r y_{rjo} \;/ \sum_{i=1}^{m} v_i x_{ijo}$

Subject to $\sum_{r=1}^{s} u_r y_{rj} \;/ \sum_{i=1}^{m} v_i x_{ij} \leq 1$, j=1….,n, (1)

u_r, v_i ≥0 for r = 1,…..,s and i = 1,.....,m.

Where y_{rj} = amount of output *r* from unit *j*, x_{ij} = amount of input *i* from unit *j*, u_r = weight given to output *r*, v_i = weight given to input *i*, *n* = total number of units, *s* = total number of outputs, *m* = total number of inputs.

The weights are all positive and the ratios are bounded by 100%. If a DMU reaches the max possible value of 100% it is considered efficient, otherwise it is inefficient. The formulation of (1) can be translated into a linear program, which can be solving relatively easily, and a DEA solves n linear program, one for each unit:

Maximize $h_{jo} = \sum_{r=1}^{s} u_r y_{rjo}$

Subject to: $\sum_{i=1}^{m} v_i x_{ijo} = 1$,

$\sum_{r=1}^{s} u_r y_{rj} - \sum_{i=1}^{m} v_i x_{ij} \leq 0$, j=1….,n, (2)

u_r, v_i ≥Ɛ for r = 1,…..,s and i = 1,.....,m.

Where Ɛ is defined as an infinitesimal constant (a non-Archimedean quantity).

The BCC model can be defined by adding the constraint $z_{j_0} = 1 - \sum_{r=1}^{m} v_i x_{ij_0}$ as show in model 3.

Maximize $h_{jo} = \sum_{r=1}^{s} u_r y_{rjo} + z_{j_0}$

Subject to: $\sum_{i=1}^{m} v_i x_{ijo} + z_{j_0}$

$\sum_{r=1}^{s} u_r y_{rj} - \sum_{i=1}^{m} v_i x_{ij} + z_{j_0} \leq 0$, j=1….,n, (3)

u_r, v_i ≥Ɛ for r = 1,…..,s and i = 1,.....,m.

Since its advent in 1978, DEA approach has been widely utilised to analyse relative efficiency and has covered a wide area of applications and theoretical extensions. One of these theoretical extensions of general DEA was proposed by Park and De (2004). Park and De (2004) develop an alternative approach to efficiency measurement of seaports using DEA, what they refer to as a "Four-Stage DEA Method": i) Productivity; ii) Profitability; iii) Marketability, and iv) Overall Efficiency. This involves the disaggregation of the overall efficiency model into its constituent components thereby generating better insights into the real sources of efficiency. This methodology represents as an extension of general DEA. According to Park and De (2004), there are, however, certain basic differences between general DEA and this proposed alternative DEA. Firstly, conventional DEA methods usually measure overall efficiency by using specific input and output variables but the proposed alternative DEA divides up overall efficiency into several stages by breaking down the inputs and outputs into stages. Secondly, the four-stage DEA method also portrays the role of the DEA analysis is to select a set of inputs and outputs that are relevant to the inputs and outputs differently in accordance with the respective stages. Thirdly, policy planners can analyse a situation correctly, and suggest solutions for enhancing the efficiency of each individual DMU. Due to the difficulties in obtaining data measuring the Marketability stage, namely customer satisfaction, this is not incorporated into our study. To measuring the Marketability stage Park and De (2004) only suggest as input “revenue” and output “customer satisfaction”. Although there are other proxy to measure marketability in business service, as perceived value by the customer and customer expectations (West *et al.*, 2006), these have not been applied to seaports, yet. Probably, the reason for this lack lies in the nature of the complex activity of this sector which difficult the measurement of those proxies.

Where limited only to cross-sectional data analysis, DEA involves the comparison of one firm with all other firms simultaneously in production and, consequently, the role of time is ignored (Cullinane et al., 2005). As such, panel data prevails over cross-sectional data not only because they enable a firm to be compared with its counterparts but also because evolutions in a firm’s efficiency over a certain time period is deductible. In doing this, panel data is more likely to reflect the real efficiency of a firm. Evaluating the efficiency of an individual DMU on the basis of a set of panel data involves the selection of alternative subsets, termed *reference observations subsets* rather than the full data set (Tulkens and Van den Eeckaut, 1995).

Tulkens and Van den Eeckaut (1995) suggest that each observation in a panel can be characterized in efficiency terms vis-à-vis three different kinds of frontiers, namely i) contemporaneous, involving the construction of a reference observations subset at each point in time, with all observations taken at that time only; ii) intertemporal, involving the construction of a single production set from the observations made throughout the whole observation period; and iii) sequential, involving the construction of a reference observations subset at each point in time but utilising all observations made from one point in time up until another. Charnes et al. (1985) propose iv) window analysis for panel data, a time-dependent version of DEA.

In this paper, contemporaneous and window analyses are used. As Tulkens and Van den Eeckaut (1995) argued, several methods are better than only a few and we expect that by analysing a same data set in various ways, one gets a much better understanding of what these data contain and one finally reaches conclusions that more strongly founded. There are few studies where these approaches were used in seaport context. The DEA window analysis approach was not utilized in seaport context until 2002 and was chosen by Itoh (2002), Cullinane et al. (2004), Cullinane and Wang (2007) and Al-Eraqui et al. (2008). The DEA contemporaneous analysis approach was chosen by Cullinane and Wang (2007).

Both of these approaches lend themselves to a study of “trends” of efficiency over time. This is achievable through the adoption of a “row view”. However, while study of “trends” of efficiency in contemporaneous analysis will be analyzed year by year, in windows analysis is carried out according to the window width. In Contemporaneous analysis, over the whole period of analysis, a sequence of n *reference observation subsets* are constructed, such that there exists one for each time period. That is, the DMU efficiency was only compared with each other’s year by year.

Distinct from contemporaneous analysis, windows analysis also lends itself to the examination of the “stability” of efficiency within windows by the adoption of a “column view” (Cullinane and Wang, 2007; Day et al., 2005). The variation in rows reflects simultaneously both the absolute efficiency of a seaport over time and the relative efficiency of that seaport in comparison to the others in the sample. This is the strength of this approach in relation to the contemporaneous analysis. That is, the windows analysis approach treats the same DMU in a different time as “another” unit, and compares the performance of one unit not only against the performance of other organizations in the same time but also against that of the same unit in other time. The basic concept in Windows analysis involves regarding each firm as if it were a different firm on each of the reporting dates. (Charnes et al., 1994).This is a useful approach when different DMU perform differently and at the same time the same DMU performs differently depending on the period of time (Itoh, 2002).

Generally, the windows analysis procedure is: Assume there are N alternatives, $l = 1, . . ., N$, and each alternative has data for period 1 to M, that is, $m = 1, . . ., M$. The window length is fixed to be K, and the data from period $1, 2, . . ., K$ will form the first window row, and the data from period $2,3, . . ., K, K + 1$ will form the second row, and so on. With the addition of one window, one more periods on the right will need to be shifted to, and a total of $M- K + 1$ window rows are existed. Each window is represented by $i = 1,. . . ,M- K + 1$, and the ith window will consist of the data in periods $j = i. . . ,i + K$-1. In the same window, there are K sets of data to be evaluated; therefore, there are a total of $N *K$ DMUs in that window.

To apply window analysis, DEA is used first to evaluate the performance of all DMUs in the same window, and the efficiency, $E_{i,j}$ of each DMU will be entered in the right window position in the table. The procedure will be repeated M-K + 1 times to obtain all the efficiency values in all windows. Then, window analysis used all the efficiency values of an alternative to generate some statistics as the average efficiency and the variance among efficiencies of each alternative. The variance of efficiency reflects the fluctuation of efficiency values for each alternative l. Table 1 show an example of windows application with six evaluation periods and a window length of three periods for one alternative l.

Table 1 – Windows analysis of alternative *l*

Alternative	Period Windows	1	2	3	4	5	6	Mean efficiency	Variance
l	W_1	$E_{1,1}$	$E_{1,2}$	$E_{1,3}$				M_l	V_l
	W_2		$E_{2,2}$	$E_{2,3}$	$E_{2,4}$				
	W_3			$E_{3.3}$	$E_{3.4}$	$E_{3.5}$			
	W_4				$E_{4,4}$	$E_{4,5}$	$E_{4,6}$		

The software Frontier Analyst 4 is employed to derive a solution for the (2) and (3) DEA model and therefore to the all contemporaneous and windows analysis.

3.3 Sample Characteristics and Selection

Portugal has nine commercial seaports, but the most important in terms of total traffic are the seaports of Lisboa, Leixões, Setubal, Sines, and Aveiro. Since 1997, the Portuguese seaport authorities evolved to become more seaport landlords following a political decision contained in the 1997 White Paper for Seaports and Maritime Transport (ESPO, 2004). The main reason was to leave commercial activities to the private sector while reinforcing the role of the seaport authority in coordinating the following activities: safety and environment, law enforcement, promotion of the seaport, maritime and land access. The status of seaport authorities changed from public institutes to private companies with the state as their only shareholder. Seaports in Portugal remain state owned and only the state is responsible for their management, although operational services are carried out by private companies on the basis of concession contracts awarded following public tenders.

In comparison, the Spanish reality is rather different as its 23 major seaports are managed by companies within the scope of the state holding company - *Puertos del Estado, SA.* (State Seaports, SA.), which, in addition to implementing government defined seaport policies, also holds responsibilities in terms of safety. Since 1990, the Spanish seaports authorities have faced increased competition due to a set of changes impacting on the industry worldwide (Castillo-Manzano et al., 2009). These changes include seaports specializing in specific traffic categories, trends in route selection, the containerization process and the concentration of companies and business. The legislation provides the Spanish seaport system the instruments necessary to improving its competitive position in an open, global market with a setting up extended self-management faculties for the Seaport Authorities (ESPO, 2004). Figure 1 set out the locations of the main Iberian (Portugal and Spain) seaports.

Figure 1 –Iberian seaports Location

Source: APA (2006)

The most representative Iberian seaports of each country were selected for this study. Of the Portuguese seaports, the biggest five (Sines, Lisboa, Leixões, Setubal, and Aveiro) were selected for this empirical study. They represented 97.39% of total traffic in 2009 (Table 2). Regarding Spanish seaports, the top five, Algeciras, Valencia, Barcelona, Bilbau, and Tarragona, accounting for 59.61% of total traffic in 2009, were included for study.

Table 2 – Total Traffic in the main Portuguese and Spanish seaports in 2009*

Seaports	Quantity (1000 tons)	Quantity (%)	Accumulative Quantity (%)
Portuguese			
Sines	24377	40.11	40.11
Leixões	14200	23.36	63.47
Lisboa	11709	19.27	82.74
Setubal	5900	9.71	92.45
Aveiro	3007	4.95	**97.39**
Figueira da Foz	1177	1.94	99.33
Viana do Castelo	407	0.67	100.00
Sum	**60777**		
Spanish			
Algeciras	69911	16.88	16.88
Valencia	61980	14.97	31.85
Barcelona	50884	12.29	44.14
Bilbao	32390	7.82	51.96
Tarragona	31703	7.66	**59.61**
Cartagena	20514	4.95	64.57
Las Palmas	19023	4.59	69.16
Huelva	17999	4.35	73.51
Gijon	14600	3.53	77.03
Tenerife	16479	3.98	81.01
Castellón	11073	2.67	83.69
Baleares	11732	2.83	86.52
Ferrol	12233	2.95	89.47
Coruna	11496	2.78	92.25
Alveria	3836	0.93	93.18
Santader	4422	1.07	94.24
Avilés	3950	0.95	95.20
Cadiz	3836	0.93	96.12
Pasajes	3468	0.84	96.96
Málaga	2075	0.50	97.46
Vigo	3526	0.85	98.31
Sevilla	4501	1.09	99.40
Alicante	2485	0.60	100.00
Sum	**414116**		

* The year for which the latest data on seaport traffic are available.

For the purpose of estimating the efficiency of the seaports under study, sets of both cross-section (sample 1) and panel data (sample 2) are analysed according to a number of differing assumptions and model specifications.

Sample 1: this sample underpins the cross-sectional data analysis and is based on the ten leading Iberian seaports in 2009. The methodology suggested by Park and De (2004) is applied in order to achieve the proposed objective.

Sample 2: this sample underpins the panel data analysis and is based upon of the ten leading Iberian seaports from 2005 to 2009. Thus, the sample under analysis comprises a total of 50 observations. To achieve the proposed objective, the contemporaneous analysis proposed by Tulkens and Van den

Eeckaut (1995) and window analysis proposed by Charnes et al. (1985) are applied. The BCC and CCR models are applied to all samples.

4. Iberian seaport competitiveness

4.1 Input and output variables

The chosen variables derived from our review of the DEA literature on seaports. The first step in conducting relative efficiency analysis is to define the characteristics that best describe seaport performance (Roll and Hayuth, 1993). Second, we have to take into account the unit number to define the variables or the number of variables for a determined sample. Norman and Stoker (1991) suggest that the minimum number of firms that should be considered is 20 or, alternatively, that a general guideline for the minimum number of units making up the sample for evaluation is at least twice the sum of the inputs and outputs. In general, the number of test units should be considerably greater than the total number of variables (Sharma and Yu, 2010). As we chose the ten biggest Iberian seaports, to ensure we meet the conditions above we need five variables [$10 \geqslant 2(5)$] for each analytical process.

In relation to inputs, all seaport studies use capital and labour as inputs. The labour input is usually either the number of employees (Barros, 2003a, Barros, 2003b, Barros and Athanassiou, 2004; Dias et al., 2009) or the total of wages paid (Martinez et al., 1999). The most common measures of capital are: the net value of fixed capital (Barros and Athanassiou, 2004); the book value of assets (Barros, 2003a; Barros, 2003b); depreciation expenditure (Martinez-Budria et al., 1999). Others authors include factors such as 'other expenditure' to represent intermediate inputs (Martinez-Budria et al., 1999).

Two variables were selected as inputs introducing the "three-stage DEA model": i) labor (number of employees) and ii) capital (fixed assets), with the following five variables as outputs: i) cargo throughput, ii) net income, iii) turnover, iv) ships handled, and v) market share. With the exception of i) and ii), the role of each variable is changed from input to output and vice versa in each stage. The "three-stage DEA" is measured as follows:

Stage 1 - Productivity: input (number of employees, fixed assets) and output (cargo throughput, number of ships handled),

Stage 2 - Profitability: input (cargo throughput, number of ships handled) and output (turnover, net income, market share),

Stage 3 - Overall efficiency: input (number of employees, fixed assets) and output (cargo throughput, number of ships handled, turnover).

All the data in this study is obtained either from official seaport websites, namely from the annual financial reports, or following email contact from the seaport authorities themselves. Panel data analysis applies the same inputs (number of employees, fixed assets) and outputs (cargo throughput, number of ships handled, turnover) used in stage 3. All the monetary variables were deflated to render the nominal values as real values by using the Consumer Price Index for the Eurozone based on 2005 figures.

In DEA analysis is important that a set of inputs and outputs are relevant to the evaluation of performance and for which a moderate statistical relationships exists. Thus, to validate the variables chosen, we calculate the correlation coefficients and estimate multiple regression. Table 3 shows the Pearson correlations calculated by the two inputs and the three outputs adopted for overall efficiency and for panel data.

Table 3 - Correlation coefficients with inputs and outputs

	Labour (No.)	Fixed Asset	Turnover	Ships Handled (No.)	Cargo Throughput
No. Labour	1.000*				
Fixed Asset	0.182	1.000*			
Turnover	0.281	**0.965***	1.000*		
No. Ships Handled	0.295	**0.930***	**0.958***	1.000*	
Cargo Throughput	**0.565***	**0.740***	**0.779***	**0.672***	1.000*

* Correlation is significant at 0.05 levels.

Multiple regressions are deployed to determine the kind of relationship between inputs and outputs. Table 4 details the Coefficient of determination (R^2) values showing how the proportion of variation in the dependent variables turnover, ships handled and cargo throughput explained by the regression model are 0.943, 0.880, and 0.740 respectively. As the Sig. value is less than 0.05, the variables labour (No) and fixed asset generate a significant and unique contribution towards predicting the dependent variables (turnover, ships handled, and cargo throughput).

Table 4 - Regression results on inputs and outputs

Inputs	**Outputs**		
	Turnover	Ships Handled (No.)	Cargo Throughput
Labour (No.)	54.723	3.467	116.064
Fixed Asset	0.087	0.004	0.031
Constant	-6283.21	-215.529	-16895.3
R^2	**0.943**	0.**880**	**0.740**
P value	0.000	0.001	0.009

4.2 Cross Sectional Data Analysis

This section sets out the research findings of cross-sectional data analysis for the year 2009. Table 5 shows the input and output values of the ten Iberian seaports. Table 6 provides the results from the DEA-CCR and DEA-BCC models across the three stages adopted.

Table 5 – Inputs and outputs values of Iberian seaports research, 2009

	Variables					
	Labour (No.)	Fixed Asset (1000 euro)	Turnover (1000 euro)	Ships Handled (No.)	Cargo Throughput (1000 ton)	Market Share (%)
Sines	210	381989	30293	1479	24378	8
Leixões	218	260393	40886	2610	14143	5
Lisboa	339	370341	49727	3219	11712	4
Setúbal	181	91753	17139	1321	5860	2
Aveiro	113	299810	10679	848	3007	1
Algeciras	347	749348	83882	24852	69911	23
Valencia	386	1320478	104882	6806	62222	20
Barcelona	161	1746508	162197	8418	50884	17
Bilbau	264	776222	59500	3042	32390	11
Tarragona	183	464965	53412	3012	31703	10

Table 6 - Efficiency results of CCR and BCC models in 2009

		CCR			BCC		
Seaports	Country	Productivity (Stage 1) (%)	Profitability (Stage 2) (%)	Overall efficiency (Stage 3) (%)	Productivity (Stage 1) (%)	Profitability (Stage 2) (%)	Overall efficiency (Stage 3) (%)
Sines	Portugal	68.4	100.00	69.19	90.6	100.00	90.6
Leixões	Portugal	58.2	100.00	100.00	84.00	100.00	100.00
Lisboa	Portugal	33.9	100.00	84.41	53.8	100.00	97.5
Setúbal	Portugal	68.5	100.00	100.00	100.00	100.00	100.00
Aveiro	Portugal	12.8	100.00	30.66	100.00	100.00	100.00
Algeciras	Spain	100.0	100.00	100.00	100.00	100.00	100.00
Valencia	Spain	76.3	100.00	84.75	77.2	100.00	89.7
Barcelona	Spain	100.0	100.00	100.00	100.00	100.00	100.00
Bilbau	Spain	57.8	100.00	68.34	68.4	100.00	68.6
Tarragona	Spain	83.9	100.00	100.00	100.00	100.00	100.00
Mean		65.98	100.00	83.74	87.40	100.00	94.64

We would put forward the following observations resulting from the findings in Table 6. Firstly, all seaports in the two models return a 100% profitability score. Hence, when comparing cargo throughput, the number of ships handled with turnover, net income and market share, all seaports are efficient. Secondly, in terms of overall efficiency, the seaports of Leixões, Setúbal, Algeciras, Barcelona and Tarragona attain a 100% efficiency score in the two models, meaning they performed the best amongst this group and represent benchmark reference seaports on the Iberian Peninsula. Thirdly, beyond these seaports, Aveiro seaport turns out efficient when BCC model is applied, indicating that its dominant source of inefficiency is due to scale efficiency. In other words, when analysed the pure technical efficiency, this seaport is efficient but in terms of overall technical efficiency (pure technical efficiency and scale efficiency) this seaport is inefficient. As in Barros and Athanassiou (2004), Barros (2006) and Cullinanne et al. (2005) studies, the dominant source of inefficiency in this seaport could be due to scale economies. That is, Aveiro seaport has been inefficient in exploiting the economies of scale given the scale of operations. Seaports achieve economies of scale when an increase in output is accompanied by a lower unit cost of production. Taking all the ten analysed seaports Aveiro is the smaller and without deepwater, the number of ship calls is lower, so it's more difficult to taking advantage of scale economies.

Fourthly, the seaports of Setubal and Tarragona made good use of their inputs to produce outputs, even though they are small seaports in their respective countries when compared with the biggest five. Fifthly, overall third stage efficiency is high compared to productivity for all the seaports under study. Since overall and productivity efficiency differ in the output "turnover", this may mean that this is a critical output to the seaport efficiency score. Finally, the average efficiency score under CCR and BCC is equal to 83.74 and 94.64% respectively, meaning that, on average, the seaports analysed could operate at 83.74% and 94.64% of their current levels while still returning the same output value.

For more information, we need to analyse the input/output contributions across the three stages (table 7) and the input reductions and or output increases needed to render the individually inefficient seaports efficient (table 8). Table 7 shows that apart from the seaports of Sines and Algeciras, the variable "turnover" is the output which contributes most to the efficiency score of the seaports under study. Table 8 sets out the percentage by which inefficient seaports need to either decrease their inputs or increase their outputs in order to become 100% efficient, when compared with the others seaports. This information might help inefficient seaports improve their efficiency. As can be seen in table 8, Aveiro seaport needs not only to reduce fixed assets and the amount of labour by 69.34% but also increase cargo throughput by 33.30%, while maintaining the same level of turnover and ships handled, in order to become efficient. Sines seaport needs to reduce fixed assets by 60.81%, the amount of labour by 34.91% and increase ship handled by 480.61%, while maintaining the same level of turnover and cargo throughput. Lisboa seaport needs to reduce fixed assets and the amount of labour by 15.59% and increase cargo throughput by 46.73 and ship handled by 0.27%. Valencia and Bilbau seaports needs to reduce fixed assets and the amount of labour by 15.25% and 31.66% respectively, and increase ships handled by 69.86% and 8.94%, while maintaining the same level of turnover and cargo throughput.

Table 7 – Input/output contributions

	Fixed Asset	Labor (No.)	Turnover	Ships Handled (No.)	Cargo Throughput
Sines	100.00	0.00	32.82	0.00	67.18
Leixões	54.09	45.91	100.00	0.00	0.00
Lisboa	84.91	15.09	100.00	0.00	0.00
Setúbal	72.30	27.70	100.00	0.00	0.00
Aveiro	72.04	27.96	96.19	3.81	0.00
Algeciras	0.00	100.00	0.00	67.81	32.19
Valencia	66.74	33.26	77.12	0.00	22.88
Barcelona	91.45	8.55	100.00	0.00	0.00
Bilbau	74.40	25.60	93.07	0.00	6.93
Tarragona	63.65	36.35	77.22	0.00	22.78

Table 8 - Input reductions and/or output increases needed to render the individual inefficient seaports efficient

	Fixed Asset	Labor (No.)	Turnover	Ships Handled (No.)	Cargo Throughput
Sines	-30.81	-34.91	0.00	480.61	0.00
Lisboa	-15.59	-15.59	0.00	0.27	46.73
Aveiro	-69.34	-69.34	0.00	0.00	33.30
Valencia	-15.25	-15.25	0.00	69.86	0.00
Bilbau	-31.66	-31.66	0.00	8.94	0.00

4.3 Panel Data (2005-2009) Analysis

As with the analysis of cross-sectional data applying the DEA model, DEA-CCR and DEA-BCC were chosen from the various DEA models eligible for analysing seaport efficiency. Indeed, several alternative versions of DEA panel data analyses were implemented as part of this process. These included models integral to the contemporaneous and window approaches to estimating efficiency using panel data. These approaches lend themselves to the study of “trends” in efficiency over time. As we stated earlier, in this analysis, all monetary variables were deflated to turn nominal values into real values using the Consumer Price Index for the Eurozone based on 2005.

4.3.1 Contemporaneous analysis

Table 9 shows the contemporaneous analysis efficiency results generated by the CCR and BCC models from 2005 to 2009. This analysis involves constructing a reference observation subset for each point in time, gathering all the observations made only at that time. That is, each seaport is compared with the others in each year, which allows compares the efficiency of one seaport only against the efficiency of the others seaports on an annual basis and not against the same seaport in other time.

Table 9 - Efficiency results of CCR and BCC models from 2005 to 2009 - Contemporaneous analysis

Seaports	Country	CCR					BCC				
		2005	2006	2007	2008	2009	2005	2006	2007	2008	2009
Sines	Portugal	44.74	54.99	53.65	62.13	69.19	74.00	76.30	75.30	81.40	90.6
Leixões	Portugal	98.26	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Lisboa	Portugal	85.51	85.46	87.02	82.41	84.41	86.10	87.60	89.50	89.10	97.5
Setúbal	Portugal	96.07	93.26	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Aveiro	Portugal	18.89	22.95	25.59	29.87	30.66	100.00	100.00	100.00	100.00	100.00
Algeciras	Spain	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Valencia	Spain	71.04	76.12	76.34	79.94	84.75	71.2	76.20	79.00	84.30	89.7
Barcelona	Spain	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Bilbau	Spain	56.88	65.38	68.42	74.44	68.34	63.8	69.2	69.00	75.30	68.6
Tarragona	Spain	86.23	94.78	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Average		75.76	79.29	81.10	82.88	83.73	89.51	90.93	91.28	93.01	94.64
Number of efficient seaports		2	3	5	5	5	6	6	6	6	6

These two analytical processes result in the following observations. The number of efficient seaports in the BCC method is higher than in the CCR. This means that the dominant source of inefficiency is due to scale efficiency in some seaports. For example after 2007, the number of efficient seaport in BCC method is 5 while in CCR models is 6. Aveiro seaport turns out efficient when BCC model is applied, indicating that its dominant source of inefficiency is due to scale efficiency. As mentioned earlier the reason for that could be explained by "economies of scale". While in the BCC method, the efficient seaports remained the same throughout the period, as did their number, in the CCR method, the number of efficient seaports increased progressively.

Considering the Iberian Peninsula as a "range", we would note only two Spanish seaports, Algeciras and Barcelona, attained 100% efficiency level in all years (2005-2009) and standing out as benchmarks for Iberia. From 2005 to 2006, the seaport of Leixões increased its efficiency from 98.26% to 100.00% and remained at this level through to 2009. A significant acceleration in the implementation of activities under the auspices of the Port of Leixões Strategic Plan was recorded in 2006. The opening of the new Coordination and Security Centre was one significant event in that year, which, through the incorporation of the most modern technology, has enabled more efficient seaport management activities ensuring greater fluency in the handling and unloading of cargo.

The Setubal and Tarragona seaports became more efficient after 2007, raising their efficiency from 93.26% and 94.78% respectively to 100.00%. 2007 was marked by significant growth of 10.2% in freight traffic at the Setubal seaport, hitting a record cargo highpoint of 6.8 million tons. It is also noteworthy that refurbishment work improving the railway connection to the terminals over a length of 1.5km, the start of construction on new docks for vessel navigation, the building of the second container gantry and the launch of a new regular container line all took place. These factors collectively meant the seaport would make good use of its inputs to produce outputs. Finally, we would emphasize that as mentioned in the 2009 financial report, the seaport authority has continued with policies designed to reduce both costs and permanent employees (from 198 to 181) with fixed assets decreasing 10.60% between 2005 and 2009. The seaport authority stated that the resource rationalization is undertaken so as to prepare the seaport for new challenges and heightened competitiveness. In relation to Tarragona seaport, 2007 was the year with the largest volume of cargo throughout. The volume of cargo and number of ships docking increased by 13.5% and 9% respectively from 2006 to 2007.

Although not reaching 100.00% efficiency in any year under review, the seaport of Valencia has annually raised its efficiency. This fact should be explained by the increase of 39.5% in the cargo handled from 2005 to 2009 and consequently boosting turnover by 29.5%. In the Valencia case, the impacts of the crisis were moderate with a loyalty strategy from large shipping companies leveraging the international container traffic in transit to ensure market connectivity. The Bilbau seaport increased its efficiency from 2005 through to 2008, but fell back in 2009 due probably to the reductions of 16% in cargo volume and 15% in the number of ships handled.

The Sines seaport efficiency has also improved over the period 2005 to 2009, from 44.74% to 69.19%, mainly due to a 20% increase in ships handled. The focus on container traffic since 2005 has contributed to this performance. Although this cargo type has not gained greater weighting in the total cargo, containerized cargo surged 365% from 2005 to 2009, while bulk liquids decreased 14%. This increase stems fundamentally from terminal XXI operating since May 2004, a partnership between the APS (Authority of Sines seaport) and PSA (Authority of Singapore seaport) bringing the arrival of the first MSC (Mediterranean Shipping Company) vessel. In efficiency terms, the Lisboa seaport was consistent over the five years under review, coming in at approximately 85%. The traffic volume stood at around 12 million tones and the number of ship arrivals approximately 3,500. 2007 was the year that the seaport of Lisboa reached its highest efficiency and in this year began and concluded a restructuring process, which has driven a more appropriate and efficient allocation of human and physical resources. Aveiro is the seaport with the lowest CCR model efficiency in the "range" over the 5 years. The number of ship calls and the cargo volume decreased by 10% and 20%, respectively, from 2005 to 2009. Despite being the worst efficiency in the range, its efficiency still increased year on year. It is noteworthy that the Aveiro seaport turns out efficient in the BCC method over the years, meaning that the dominant source of inefficiency could be due to its lack of economies of scale. Furthermore, we would point out this is not a deepwater seaport and cannot cope with large vessels and the main cargo load is agro-business related.

4.3.2 Window analysis

In such a circumstance, DEA window analysis can be adopted to detect a DMU trend over the course of time (Charnes et al., 1994). The procedure considers each DMU represented as if a different DMU in each period under analysis. While it is relatively straightforward to calculate efficiency using contemporaneous analyses, caution needs taking in defining the window width for conducting a window analysis (Cullinane and Wang, 2007). For the size of the windows, as well as for the fact that part of the past is ignored, it seems to be hard to find more than an *ad hoc* justification.As in other studies of this kind, the length of the window used herein has been defined as three periods, also consistent with the original work of Charnes et al. (1985). There is no theoretical underpinning justifying the window size choice. However, the following notation or caution is commonly provided (Itoh, 2002): $p \leq k$, $w = k-p+1$, $n*p$ is the number of DMUs in each windows and $n*p*w$ is the total number of ≠DMUs analysed; where n= number of DMU; k=number of time periods; p=time length of window;

w=number of windows of each alternatives. In our case, k=5, p=3 so: w=5-3+1=3; 10*3=30 is the number of DMU in each window and 10*3*3=90 is the total number of ≠DMUs.

Table 10 and table 11 depict the window analysis in the CCR and BCC models respectively, with each seaport represented as if it were a different DMU at each of the three successive dates noted at the top of each column. Three separate windows are represented as separate rows (w_1, w_2, w_3). Taking Lisboa as an example, in table 10 the efficiency of Lisboa seaport in the first windows is 84.73, 84.99 and 81.45. These figures correspond to the efficiency of Lisboa seaport for 2005, 2006 and 2007 measure at the same time as different DMUs. In the third window, efficiency estimates of 83.26, 82.24 and 81.93 correspond respectively to 2007, 2008 and 2009. The average of the nine DEA efficiency scores and associated standard deviations are presented in the columns denoted “Mean” and “S.D”.

Table 10 - DEA – CCR window analysis for Iberian Seaports efficiency

Seaport		Efficiency Scores					Summary Measures	
		2005	2006	2007	2008	2009	Mean	S.D.
Sines	w_1	44.74	50.78	51.28			53.26	3.93
	w_2		54.99	53.55	56.81			
	w_3			53.65	57.27	56.29		
Leixões	w_1	97.34	99.60	93.11			97.69	2.45
	w_2		100.00	95.49	100.00			
	w_3			96.09	100.00	97.62		
Lisboa	w_1	84.73	84.99	81.45			83.12	1.42
	w_2		84.98	82.57	81.93			
	w_3			83.26	82.24	81.93		
Setúbal	w_1	93.39	90.38	100.00			95.45	5.25
	w_2		85.10	94.55	100.00			
	w_3			95.70	100.00	99.99		
Aveiro	w_1	18.83	21.75	25.32			24.79	3.26
	w_2		22.11	25.59	28.42			
	w_3			25.59	28.42	27.10		
Algeciras	w_1	100.00	94.83	95.37			97.91	2.47
	w_2		100.00	100.00	95.42			
	w_3			100.00	95.63	100.00		
Valencia	w_1	70.62	72.01	75.93			74.07	2.19
	w_2		72.48	76.34	75.30			
	w_3			76.34	75.30	72.32		
Barcelona	w_1	100.00	100.00	100.00			97.20	4.51
	w_2		100.00	100.00	93.51			
	w_3			100.00	93.51	87.79		
Bilbau	w_1	56.62	61.98	68.04			65.32	5.29
	w_2		63.30	68.41	71.09			
	w_3			68.42	71.09	58.95		
Tarragona	w_1	85.77	89.51	100.00			93.72	5.95
	w_2		90.21	100.00	96.06			
	w_3			100.00	96.06	85.92		

Table 11 - DEA – BCC window analysis for Iberian Seaports efficiency

Seaport		Efficiency Scores					Summary Measures	
		2005	2006	2007	2008	2009	Mean	S.D.
Sines	w_1	73.78	74.63	73.64			76.38	2.97
	w_2		76.02	74.99	78.57			
	w_3			74.82	78.26	82.75		
Leixões	w_1	97.61	100.00	97.07			98.37	1.69
	w_2		100.00	96.16	100.00			
	w_3			96.12	100.00	98.39		
Lisboa	w_1	85.04	85.30	81.60			84.86	1.82
	w_2		87.63	84.27	82.84			
	w_3			86.65	85.52	84.88		
Setúbal	w_1	100.00	98.06	100.00			99.57	0.85
	w_2		98.08	100.00	100.00			
	w_3			100.00	100.00	100.00		
Aveiro	w_1	100.00	100.00	100.00			99.83	0.28
	w_2		100.00	99.78	100.00			
	w_3			99.41	99.32	100.00		
Algeciras	w_1	100.00	100.00	100.00			100.00	0.00
	w_2		100.00	100.00	100.00			
	w_3			100.00	100.00	100.00		
Valencia	w_1	71.05	73.51	78.96			76.75	3.37
	w_2		74.70	79.04	80.09			
	w_3			79.04	80.09	74.29		
Barcelona	w_1	100.00	100.00	100.00			99.48	1.55
	w_2		100.00	100.00	100.00			
	w_3			100.00	100.00	95.35		
Bilbau	w_1	63.80	66.27	68.06			67.71	2.76
	w_2		67.23	68.66	71.28			
	w_3			68.99	71.28	63.82		
Tarragona	w_1	100.00	99.30	100.00			99.27	1.87
	w_2		100.00	100.00	100.00			
	w_3			100.00	99.86	94.31		

The approach used in table 10 and 11 evidently lends itself to a study of trends. It can also be used to examine stability of the efficiency evaluations across as well as within windows. Efficiency trends are given in the row window with stability defined in the column of each year enabling control of both through the separate windows. The variation in rows reflects simultaneously both the absolute efficiency of a seaport over time and the relative efficiency of that seaport in comparison to the others in the sample. It is important to recognise that the same seaport observed at different time is treated as being different DMUs. So, still taking Lisboa seaport as an example, its absolute efficiency varies from 84.73% in 2005 to 83.26% in 2007 and 81.93 in 2009. This value is also the relative efficiency of Lisboa seaport in these years compared with the others seaports in the first windows.

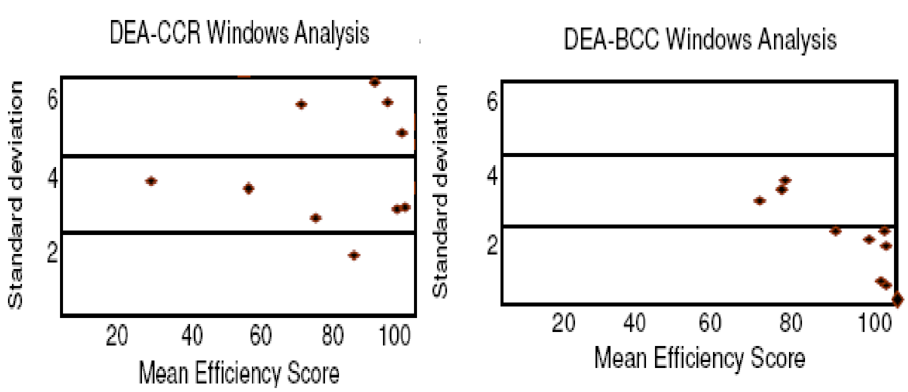
It is interesting to note that in terms of absolute efficiency from 2007 to 2009, while the majority of Portuguese seaports increase their efficiency, the majority of Spanish seaports decrease their efficiency. The seaports of Sines, Leixoes, Lisboa, Setubal and Aveiro increase their efficiency score in 5%, 2%, 2%, 5%, 6% respectively. Valencia, Barcelona, Bilbau and Tarragona decrease their efficiency score in 5%, 12%, 14%, 14% respectively.

In general, analysed the table 10, we concluded that the efficiency differ significantly from seaport to seaport and within each seaport over time. If ranked in terms of total average efficiency, Algeciras is the best performing seaport, followed by Leixões, Barcelona, Setubal, Tarragona, Lisboa, Valencia, Bilbau and Sines. Aveiro are the least efficient seaports among the range. When compared to the others, despite having low efficiency score, the Aveiro and Sines seaports reveals a great improvement in their efficiency from 2005 to 2009 (44% and 26% respectively). When only the pure technical efficiency (BCC model) is measured in table 10, the efficiency of all seaports improves.

In terms of efficiency score mean value all seaports are inefficient under CCR and BCC models, except Algeciras in the BCC model. The standard deviation under CCR model is higher than in BCC models. This means that when only the pure technical efficiency is measure, the seaports efficiency is more stable over time. Therefore, this could mean that the fluctuations of efficiency in these seaports are due the scale efficiency.

The relationship between mean efficiency scores and their standard deviations is depicted in Figure 2, where a low correlation (0.061) and a high correlation (-0.815), respectively corresponding to the CCR and BCC models, between mean efficiency scores and their standard deviations can be seen.

Figure 2- Relationship between mean efficiency and standard deviation



A two-tailed test of significance reveals that the correlation coefficients are not statistically significant at the 5% (sig=0,866) under the CCR models and statistically significant at the 1% (sig= 0,004) under the BCC models. In a practice sense, this implies that only in BCC models there is a linear relationship between these two variables: the higher the efficiency, the lower the variance.

5. Conclusions

In order to support trade oriented economic development, seaport authorities have increasingly been put under pressure to improve efficiency by ensuring that seaport services are provided on an internationally competitive basis. Thus, monitoring and comparing one's seaport with other seaports in terms of overall efficiency has become an essential part of macroeconomic reform programs in many countries. In an internationalized and competitive market, the positioning of seaports, although constrained by some external factors - location, economic development of the hinterland they serve, among others - are increasingly dependent on their ability to adapt and meet the operational conditions arising from the physical and technological means and the strategic choices made by the main players in the market.

Within this perspective, this paper presents the efficiency analysis of the top-ten Iberian seaports using a DEA approach. This paper has explored the alternative "Four-stage" DEA method develop by Park and De (2004) in cross-section data and contemporaneous and window analysis in panel data. Using a cross section data of 2009 was possible to conclude that the average efficiency score under CCR and BCC is equal to 83.74 and 94.64% respectively, meaning that, on average, the seaports analysed could operate at 83.74% and 94.64% of their current levels while still returning the same output value. All seaports in the two models return a 100% profitability score. In terms of overall efficiency, the seaports of Leixões, Setúbal, Algeciras, Barcelona and Tarragona attain a 100% efficiency score, meaning they performed the best amongst this group and represent benchmark reference seaports on the Iberian Peninsula.

Unlike the ranking in terms of cargo throughput, the most efficient Portuguese seaports are Leixões and Setubal and their Spanish peers are Algeciras, Barcelona and Tarragona. This has proven what has been reported in other studies: that seaport efficiency is not necessary influenced by its cargo throughput. Setubal seaport, despite being fourth in terms of total cargo throughput, makes good use of its inputs to produce outputs, probably due to being located near both an industrial park and some important companies such as Autoeuropa (automotive industry) and Portucel (paper industry) and the seaport's operators probably adjust their inputs to make better use of cargo carried by these companies. Tarragona seaport, despite being fifth in the Top 5, has benefited from being located near Barcelona seaport and absorbs all the overspill cargo that Barcelona seaport has difficulty in operationally handling. When looking at the input/output contributions to the efficiency level we find that the variable "turnover" is the output which contributes most to the efficiency score of the seaports under study.

Analysed the efficiency evolution of Iberian seaports from 2005 to 2009, we find that Algeciras and Barcelona emerge as best performers in terms of efficiency in all the years when compared to the top-ten. In this analysis, both Sines and Lisboa seaports (the main Portuguese seaports) don't reach 100.00% efficiency in any year under review. It is suggested that these two seaports strengthen co-operation in order to raise their competitive standard. Furthermore, while the Valencia seaport was the second largest Spanish seaport, it also has not reached 100.00% efficiency in any year under review.

From windows analysis, we concluded that the efficiency differ significantly from seaport to seaport and within each seaport over time. This analysis stood out that in terms of absolute efficiency from 2007 to 2009, while the majority of Portuguese seaports increase their efficiency, the majority of Spanish seaports decrease their efficiency. When compared to the others, despite having low efficiency score, the Aveiro and Sines seaports reveals a great improvement in their efficiency from 2005 to 2009. The standard deviation reveals that when only the pure technical efficiency is measure, the seaports efficiency is more stable over time.

The findings of this research are important to seaports authorities because this study allows them to know its efficiency during a long time period, the input and output that contribute to it and how they can improve it.

The main limitation of this study derives from not considering all Iberian seaports in the analysis and hence preventing any conclusions on smaller seaports. Therefore, the conclusions presented here are limited to the selected sample of the most representative Iberian seaports. As DEA analysis calculates the efficiency based on the selected DMU´s, the results probably would be different if the sample was different. In this sense, we would suggest the study be applied to all Iberian seaports. We would also recommend that the study be applied to the same seaports for the period since 2009 to analyse and compare i) the effects of the global financial crisis and the recovery, or otherwise, of seaports, ii) the effect of the latest restructurings, for example, Aveiro seaport's link to the national railway network, operational in 2010, provides for the movement of around 600,000 tons, and iii) the effects of the enlargement of the Panama Canal from 2013 that will impact on the world's shipping routes and the positioning of Iberian seaports.

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Appendix A - Studies on DEA application in the seaports research

Authors	Unit of Analysis	Input	Output
Martinez Budria et al. (1999)	26 Spanish seaports (1993-1997)	Labour expenditure, depreciation charges, other expenditure	Cargo throughput, level service, consumer satisfaction, ship calls
Bonnila et al. (2002)	23 Spanish seaports (1995-1998)	Seaport equipment	Commodities traffic (including the containers)
Barros (2003a)	5 Portuguese seaports (1999-2000)	Number of employees Book value of assets	Ships, movement of freight, gross tonnage, market share, break-bulk cargo, containerised cargo, Ro-Ro traffic, dry bulk, liquid bulk, net income
Barros (2003b)	10 Portuguese seaports 1990-2000	Number of employees Book value of assets	Ships, movement of freight, break-bulk cargo, containerised freight, solid bulk, liquid bulk
Serrano and Castellano (2003)	9 Spanish container terminal (1990-2002)	Berth size, terminal area, number of cranes	TEU handled, total tons throughput
Barros and Athanassiou (2004)	4 Portuguese seaports and 2 Greece seaports 1998-2000	Number of employees Fixed capital	Ships, movement of freight, cargo handled, containers handled.
Garcia-Alonso and Martin-Bofarull (2007)	2 Spanish seaports	Staff and stevedores, materials, metres of quay, metres of stocking areas	Tonnes of solid bulk Tonnes of general cargo
Dias et al. (2009)	10 container terminals of Iberian Peninsula	Number of cranes, Number of employees, terminal area, number of trailers, yard equipment, terminal length	TEU moved Container movement by hour by ship

Chapter 2 – Key Factors of Seaports Competitiveness based on Stakeholders´ Perspective: Analytic Hierarchy (AHP) Model

Key factors of seaport competitiveness based on the stakeholder perspective: an Analytic Hierarchy Process (AHP) model

Abstract

In their decisions, seaport stakeholders internalize various factors that intervene in seaport competitiveness. The literature emphasizes that such seaport characteristics are important in the stakeholder choice of seaports. Given today's competitive environment, it becomes imperative that seaport managers develop the ability to determine which factors stakeholders perceive as critical. This research aims to empirically study the key factors of seaports competitiveness from the perspective of Iberian seaport stakeholders by applying the Analytic Hierarchy Process (AHP) model. The Delphi approach is deployed for the preliminary factor selection stages in an AHP context. Our initial results demonstrate that seaport users and seaport service providers differed in their understandings of the key factors of seaport competitiveness. The results provide empirical evidence that vessel turnaround time is the most important factor to seaport competitiveness. From the perspective of seaport users, Iberian seaport service providers need to focus on improving their performance in this aspect.

Keywords: seaport competitiveness, stakeholders, multi-criteria decision, AHP, Delphi method.

1. Introduction

As from the 1980s, seaport competitiveness has steadily risen, influenced by the growth in international trade and due to deep reaching seaport sector reforms. Nowadays, the ongoing structural changes to the seaport sector reflect the generally increasing complexity of the seaport environment. Representing the interface linking sea and overland transportation, a seaport provides an integral platform that serves as a base for logistics, production, conveying information and international trade, and as a springboard for the economic development of the hinterland (Song and Yeo, 2004). To appropriately carry out these functions, a seaport needs to effectively and efficiently handle and process ships and other transport modes within its terminals.

The importance of seaports to national economies attracts broad consensus in the literature as does the rise in fierce competition between seaports. Iberian seaports are no exceptions to this struggle for market share. 27% of the 2010 Iberian Peninsula flow of goods and trade went through seaports (INE 2010a; INE 2010b). In accordance with this context, it is important to assess the key factors of seaport competitiveness, described in the literature either as those factors that the major seaport users attach significance when choosing seaports or those factors enhancing the attractiveness of seaports. Awareness of the respective importance of these factors enables seaports to define which characteristics they can best compete on.

According to Dooms et al. (2004), seaport competitiveness becomes a matter of points of view because seaport stakeholders themselves hold different goals and, as such, different seaport stakeholders prioritize different features. The factors of seaport competitiveness most commonly identified in the literature include geographical position, infrastructure, service quality, costs, seaport operational efficiency levels, seaport cargo handling charges, reliability, product differentiation (Fleming and Baird, 1999; Guy and Urly, 2006; Tongzon and Heng, 2005) with stakeholders holding influence over these factors including terminal operators, service providers, labour providers, public service providers, seaport authorities, the state and other institutions. Therefore, assessing these factors from the stakeholder's perspective provides valuable insights into how an effective seaport strategy should best be designed. However, a variety of factors need taking into consideration when identifying the factors contributing to overall seaport competitiveness as decision-makers can rarely select a course of action based on a single factor (Guy and Urly, 2006).

Several studies (Fleming and Baird, 1999; Guy and Urly, 2006; Song and Yeo, 2004; Tongzon, 2007; Tongzon and Heng, 2005) have shown that there are many potential factors of seaport competitiveness, which may be either quantitative or qualitative in nature. Ascertaining the most important factors of seaport competitiveness from the stakeholder perspective proves a key priority for all stakeholders, whether seaport managers, shipping lines or for policy makers (Magala and Sammons, 2008). It thus comes as no surprise that research has attempted to shed light on this facet. In effect, a number of studies on seaport attractiveness were undertaken and published in economics and management journals and adopting a number of different methodologies (Guy and Urly, 2006; Lirn et al., 2004; Magala and Sammons, 2008; Tiwari et al., 2003; Tongzon, 2009; Notteboom, 2009, Saeed, 2009; Ugboma et al., 2006). Most of the studies provide useful insights into the determinants of seaport attractiveness in different contexts and with significant implication for policy and practice. However, there has been no study of the Iberian seaport and only one study (Lirn et al., 2004) the perceptions of more than one seaport stakeholder group (seaport users and seaport service providers).

In light of the increased importance of seaport competitiveness and the need to better grasp seaport stakeholder decision-making processes, this paper aims to empirically analyse the key factors of seaport competitiveness from the perspective of Iberian seaport stakeholders according to the Analytic Hierarchy Process (AHP) model. This study contributes to the existing literature by i) deepening our understanding of the factors of seaport competitiveness and their relative importance to stakeholders and ii) shedding some light on the current attractiveness of Iberian seaports through evaluating their performance on the key factors of competitiveness driving the final decisions of shippers.

The application of the AHP model, introduced by Saaty (1977), serves both as a tool for portraying the most important criteria for seaport competitiveness from the perspective of stakeholders, and also as a management technique for seaport selection processes (Lirn et al., 2004). In the context of this research, the model also serves to reveal any discrepancies in perceptions between seaport users and seaport operators and thus enabling, whenever necessary, the latter to re-align their strategies. The AHP represents a multi-objective, multi-criteria theory of measurement addressing the issue of how to structure complex decision making problems, identify their criteria (tangible and intangible), measure their mutual interaction before finally synthesizing all this information to arrive at priorities conveying the preferences in effect (Saaty, 2001). The AHP is able to assist seaport managers in obtaining a detailed understanding not only of the criteria stakeholders attribute most importance in terms of seaport competitiveness but also the respective strengths of these preferences. The Delphi approach has applied in the preliminary stages of factor selection in an AHP context.

Following this introduction, the next section sets out a brief review of the literature on factors influencing the seaport competitiveness and the stakeholder approach. The section thereafter discusses the methodological issues to the model used followed by a description of the key factor identification process using the Delphi approach. The following section is dedicated to the empirical analysis carried out according to the AHP model along with discussion of the findings before the conclusions.

2 Literature review

2.1 Factors influencing seaport competitiveness

Taking related studies as a point of reference (Teng et al., 2004; Yeo and Song, 2006; Castillo-Manzano et al., 2009), this study approaches "competitiveness" as the capacity of a seaport to generate added value and maintain its core business while fostering productive and industrial activities in its surrounding hinterland. Thus, the most competitive seaports are able to develop and implement differentiated strategies, attracting more customers and traffic flows than their competitors (Castillo-Manzano et al., 2009). The complexity of this concept means, however, that various aspects must be taken into account when identifying the factors decisive to seaport competitiveness. As identified by Verhoeff (1981), competition between seaports is framed by regional factors such as geographic location, the infrastructures in place, the level of industrialization, government policies and the respective seaport operational performance standards.

According to Fleming and Baird (1999) there are clearly some specific influences that interfere on the relative competitiveness of any seaport. These researchers propose six factors that, when taken together, help explain why certain seaports inevitably gain and maintain an advantage over their opponents: the organization and traditions of the respective seaports; land and sea access to seaports; the state of the resources available and the influence of their costs on seaports; seaport productivity; shippers preferences and comparative advantage in terms of location. This view is also shared by Tongzon (2007) who, in turn, identifies eight factors determining seaport competitiveness: i) the port operational efficiency level; ii) seaport cargo handling charges; iii) reliability; iv) the seaport selection preferences of carriers and shippers; v) channel depths; vi) the adaptability to the changing market environment; vii) landside accessibility; and viii) product differentiation. In their study, Low et al. (2009) identify seaport connectivity as a key determinant of seaport competitiveness.

It is important to note that research on the actual relevance of the different factors shaping seaport competitiveness remains rather limited. Most seaport competitiveness studies have sought to identify only the seaport selection criteria (Slack, 1985; Murphy and Daley, 1994; Guy and Urly, 2006; Lirn et al., 2004; Magala and Sammons, 2008; Ng, 2006; Tongzon, 2009; Saeed, 2009; Song and Yeo, 2004; Ugboma et al., 2006). Slack (1985) surveys seaport end users and freight forwarders engaged in trans-Atlantic container trade between the American mid-West and Europe to identify seaport selection criteria. His findings point to how, while improvements in seaport facilities were often necessary, they did not always have a direct impact on diverting cargo flows to other seaports because shippers were largely conservative decision-makers and not particularly open to alternatives. Murphy and Daley (1994) surveyed U.S. purchasing managers to reveal shipment information and the loss and damage performance as the most important factors in seaport selection. Meanwhile Lirn et al. (2004) apply the AHP model to portray and analyse seaport selection by global carriers before confirming the importance of handling costs and basic infrastructural facilities to seaport selection. Song and Yeo (2004) empirically investigate the competitiveness of container seaports in China using the AHP model to find that location still plays the most significant role in the seaport competitiveness evaluation process. Guy and Urli (2006) study container seaport selection in the Northeast of North America and depict the key role played by seaport location and intermodal connections. Ng (2006), through researching the role of qualitative factors in the attractiveness of major Northern European seaports, finds that monetary cost is not the only component in explained seaport attractiveness. Other factors, such as time efficiency, geographical location and service quality, also need taking into consideration. This conclusion is also drawn by De Langen (2007) for seaport competition and seaport selection for cargo to/from Austria. Ugboma et al. (2006) analyses the service characteristics shippers identified as important when selecting a Nigerian seaport and provides support for the perspective that seaport efficiency is the single most important factor in seaport selection.

Saeed (2009) presents an analysis of carrier selection criteria for container terminals in Pakistan and concludes that terminal operators should focus on three factors: service level, loading/discharging rate and handling charges. Tongzon (2009), based on a survey of selected freight forwarders located at industrial and logistics centers in Malaysia and Thailand, concludes that in terms of relative importance, seaport efficiency is the most relevant factor to seaport selection.

Table 1 displays the key factors of seaport competitiveness/attractiveness identified by the literature.

Table 1 - Key factors of seaport competitiveness/attractiveness

Factors	Authors										
	Slack (1985)	Murphy and Daley (1994)	Flaming and Baird (1999)	Lirn et al. (2004)	Song and Yeo (2004)	Guy and Urly (2006)	Ng (2006)	Tongzon (2007)	Ugboma et al. (2006)	Saeed (2009)	Tongzon (2009)
1. Geographical advantage	√		√	√	√	√	√	√	√	√	√
2. Accessibility (land and sea)	√		√	√		√	√	√	√	√	
3. Tradition and organization			√					√			
4. Productivity/Efficiency	√	√	√				√	√	√		√
5. Preference of navigation			√					√			
6. Facilities and equipment	√	√	√	√	√	√	√	√	√	√	√
7. Preference of navigators			√					√			
8. Product differentiation								√			
9. Loading and discharging costs	√	√		√		√	√		√	√	√
10. Ownership of seaport				√						√	
11. Privileged carrier terms				√							
12. Government tax and duties				√			√				
13. Customs regulations	√			√			√				
14. Turnaround time				√		√	√			√	
15. Risk management											
16. Security and seaport safety				√							
17. Cargo volume	√				√					√	
18. Service level	√	√			√		√			√	
19. Frequency of ship visit	√	√							√	√	√
20. Port reputation for cargo damage							√		√		√
21. Quick response to user needs							√		√		√
22. Congestion	√										
23. Shipment information		√									
24. Personal contacts										√	

2.2 The stakeholder approach to seaports competitiveness

Stakeholders may be defined as any individual or group of individuals that either is affected by the company or somehow affects the company's goals (Freeman, 1984). This is the underlying concept shaping Stakeholder Theory. Freeman (1984) states that management based on the stakeholder theory must involve the allocation of organizational resources in accordance with the impacts this allocation generates on the respective interest groups both inside and outside of the company. Thus, managers should also make decisions taking into account the interests of all the individuals and groups involved, both the primary stakeholders (owners/shareholders and creditors) and the secondary stakeholders (society, the local community, employees, suppliers, among others) that may affect or be affected by organizational decisions.

Clarkson (1995) argues that the survival and success of an organization depends on its managers' ability to create wealth, value and satisfaction for its stakeholders. Hence, it becomes fundamental for organizations to identify and understand just who their stakeholders are, what their respective interests are and how to correspondingly improve their management (Grundy, 2005; Ferreira and Azevedo, 2010). However, in keeping with this broad vision, it is also important that each organization considers the more specific and characteristic aspects of its activity, which Argenti (1997) termed the *peculiarities* of organizational businesses within the framework of identifying the main stakeholders. One of the main issues under scientific discussion and debate in this research field is precisely this identification of critical organizational stakeholders (or stakeholder categories). One of the most common criticisms of stakeholder theory deals with the fact that aiming to meet the multiple goals of different stakeholders inevitably generates situations of conflict among these goals. Therefore, it is important to identify key-stakeholders. In a broader sense, such an approach stems from the level of recognition attributed the importance that stakeholders bear on an organization's results and thus the rationale for developing mutual cooperation in order to leverage synergies and gain in competitiveness (Donaldson and Preston, 1995; Ferreira and Azevedo, 2010; Sharma and Henriques, 2005).

To our knowledge, there are few stakeholder theory studies applied to the seaport context. Maloni and Jackson (2007) make a contribution to this field in their analysis of stakeholder contributions to container seaport capacity. They find that seaport capacity growth is a complex issue involving many diverse stakeholders. These stakeholders have diverse and complex goals, which in turn often force action by other stakeholders. For example, steamship lines are looking to the economies of scale of larger ship sizes, which in turn require seaports to dredge channel depths and adapt berths and seaport equipment. Furthermore, federal security mandates not only reduce container throughput velocities due to inspections but also cause seaports to redirect funds away from capacity expansion projects.

A lot of different stakeholder categories are identifiable in the seaport context. Notteboom and Winkelmans (2002) differentiate between internal stakeholders (groups within the scope of the seaport's authority) and external stakeholders (groups beyond the scope of the seaport organization). These external stakeholders consist of three groups, i.e. economic/contractual external stakeholders (e.g. shipping companies and their representative bodies), public policy stakeholders (e.g. government bodies) and community stakeholders. According BIC (2009), although the seaport authorities remain important players in seaport management, their role has changed. The different stakeholders involved in the seaport business, such as terminal operators, shipping companies, forwarders, dockers and the customs authorities, have begun cooperating closely both with each other and with the seaport authority within a framework of seeking to optimise internal seaport processes and boosting the seaport's level of efficiency.

However, as described by Dooms et al. (2004), the extent of seaports is in most cases dispersed over an extensive geographical area, and the characteristics, interests and criteria of stakeholders may change and adapt according to the characteristics prevailing in the different geographic areas, it becomes difficult to come out with any clear definition of the respective different stakeholders. To overcome this limitation, these investigators propose dividing the seaport area into separate geographical areas or port 'zones' as best appropriate. For this research, in addition to separating the seaport stakeholders by geographical area (the stakeholders common to both Iberian countries), we also need to identify the categories of stakeholder wielding greatest decision making influence over the seaport's level of competitiveness.

There is broad consensus in the literature that the decision to route cargo through a seaport ultimately lies with the shippers (Tongzon, 2009). Thus, shippers represent the key-stakeholders in studying seaport competitiveness. Shippers are business firms that utilize carriers for the transportation of goods from origin to destination locations (Talley, 2009). Shippers choose those seaports, which act as transshipment seaports for their cargoes or as origin/destination seaports, where their cargoes are most reliably, efficiently and economically handled (Tiwari et al., 2003) and in their decision making shippers internalize various seaport competitiveness criteria. Shippers may be grouped into three types (Tongzon, 2009; Ugboma et al., 2006): i) those holding long-term contracts with shipping lines and in this case those shipping lines choose the seaports; ii) those turning to freight forwarders and; iii) independent shippers. Seaport competitiveness is assessed here according to the opinions of shipping lines that are the major and direct users of seaports. We correspondingly selected those shipping lines with scale and working in both Iberian countries (i.e., operating at one or more seaports in Portugal and Spain). In light of the importance of revealing any discrepancies in the perceptions held by seaport users (shippers) and seaport operators (seaport authorities and seaport terminal operators), we also incorporated the latter dimension into this study.

3. Research methodology

3.1 Model selection and specification

The Analytic Hierarchy Process (AHP) is one of the most popular and powerful methods for decision making, which has also been applied to various areas of decisions such as economic analysis, strategic planning, forecasting, etc. (Xu, 2000). The methodology falls into the category of Multi-Criteria Decision Making (MCDM) approaches. The AHP concept was introduced by Saaty (1977), who defined it as combining either subjective or objective assessments or perceptions into an integrative framework based on simple pairwise comparison ratio scales. Two of the main approach characteristics are: i) the existence of an analytical measurement to evaluate decision maker inconsistencies when eliciting judgments, and ii) the scope of opportunity for applying AHP to group decision making processes (Escobar et al., 2004).

Thanks of its applicability to business decision making, resource allocation, priority rating and/or performance evaluation problems, AHP has been deployed across a variety of industries (Chwolka and Raith, 2001; Beynon, 2002; Tzeng et al., 2002). The research success of the AHP model in a number of areas confirms its robustness and appropriateness for solve seaport problems, as concluded by Lirn et al. (2003) and Song and Yeo (2004). The AHP's advantages as a decision making tool have been extensively reviewed. Saaty (2001) lists ten benefits to applying AHP as a decision making tool: unity; complexity; interdependence; hierarchy structure; measurement; consistency; synthesis; tradeoffs; judgment and consensus; and process repetition. As argued by Forgionne et al. (2002), the AHP methodology as a decision support system mechanism easily incorporates model modifications and simulations through sensitivity analysis. One of the major criticisms of AHP, however, is that it allows ''rank reversals'', where the ordering of the alternatives changes when factors added or removed (Lirn et al., 2003). One of the problems AHP has had to contend with concerned the reliability of values attributed to pairwise comparisons by survey participants (Beynon, 2002).

The AHP methodology for decision making problems involves four distinct steps (Forgionne et al. (2002): i) structuring the decision hierarchy by breaking down the decision problem into a hierarchy of interrelated decision factors (criteria, alternative decisions); ii) collecting input data, depicted by matrices of pairwise comparisons, of decision factors; iii) applying the eigenvalue method to estimate the relative weightings of the decision factors; and iv) aggregating the relative weights of the decision factors to arrive at a set of ratings for decision alternatives.

When employing the AHP methodology, the input data for the decision problem consists of decision factor pairwise comparison matrices. Thus, where there are n elements a total of n (n-1)/2 comparisons are required. This results in an n*n matrix. Deploying the 1 to 9 Saaty scale (see survey in Appendix A), the respondent´ judgments were first obtained. With these input data, the pairwise comparison matrix is generated. For example, when a respondent compares two factors, channel depth (F_1) and seaport facilities (F_2) and indicates that F_1 is more important than F_2 and the relative importance is 6, then a value of $f_{12}=6$ is assigned to this pairwise comparison. The principal diagonal matrix elements all report unity because when compared with itself, each factor bears equal importance (figure 1).

Figure 1 – The input matrix of respondent judgments

	F_1	F_2	…	…	F_n
F_1	1	β	…	…	k
F_2	1/ β	1	…	…	…
…	…	…	1	…	…
…	…	…	…	1	…
F_n	1/k	...	…	…	1

The eigenvalue method of the AHP incorporates the respondent pairwise comparisons as inputs and produces the relative weights or priorities (ω) of each factor. According to Saaty (1980) the priorities ω_i, i=1,……,n are obtained by solving the eigenvector problem:

$$A_* \omega = \lambda_{max*}\, \omega \qquad (1)$$

Subject to $\sum_{i=1}^{n} \omega i = 1$; where A is a positive pairwise comparison matrix of order n; λ_{max} is the principal eigenvalue of A and ω is the priority vector.

When groups such as stakeholders take individual decisions, it is necessary to aggregate the individual preferences into a consensus rating. As regards group decision making, the AHP model sets out two different approaches to aggregating individual judgments to form a judgment for the group: the aggregation of individual judgments (AIJ) and the aggregation of individual priorities (AIP) (Escobar et al., 2004). The AIJ implies a synergistic aggregation of individual preferences in such a way that the group becomes a new individual and behaves as such. The AIP in turn requires the aggregation of individual priorities and thus the individual preferences remain under analysis. For this reason, the AIP was chosen for this study and the geometric means adopted for calculating the priorities of the group (ω_G) were:

$$\omega_G = \left(\prod_{i=1}^{n} \omega i\right)^{1/n} \qquad (2)$$

Another important facet to the AHP is its notion of consistency (Saaty, 1980). Consistency is the degree to which the relationship perceived between factors in the pairwise comparison is maintained. This proves important because comparisons lacking consistency may indicate a respondent failure to understand differences in the choices presented or an inability to accurately assess the relative importance of the factors under comparison. Furthermore, a lack of information on the criteria under comparison or a lack of concentration during the judgment process may also lead to inconsistency. Thus, the matrix should report an acceptable level of consistency, which can be assessed by the Consistency Ratio (CR) (Saaty, 1980).

$$CR = \frac{(\lambda\max - n)/(n-1)}{RI\ (n)} \qquad (3)$$

Where:

λ_{max} is the principal eigenvalue of the judgment matrix

n is the number of factors

RI (*n*) is the Random Index for matrices of order *n*.

The Ri value varies with the size of the pairwise comparison matrix (table 2).

Table 2 – The Random Index

n	1	2	3	4	5	6	7	8	9	10	11	12
RI	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49	1.51	1.53

A CR of 0.10 or less is evidence of informed judgments. According to Saaty (1980), the value of the consistency ratio should be 10 per cent or less. Where greater than than 10 per cent, the judgments may be somewhat random and should perhaps be subject to revision.

3.2 Key factors for the AHP survey

The first step in this research design involves identifying the relevant factors of seaports competitiveness through a literature review. The literature review on seaport competitiveness/attractiveness generated an extensive list of factors (see table 1). From the list, it was found that several factors are common to all studies and grouped into four dimensions: cost perspective, seaport management, geographical location, and physical and technical characteristics. Based on the literature review, a total of twelve factors grouped

into the four dimensions mentioned above were identified for study. They are: seaport charges; government tax and duties; privileged carrier terms; vessel turnaround time (berthing delay and loading/discharging rate); seaport security and safety; seaport reputation for cargo damage and delays; proximity to import/export area, proximity to alternative loading centre; proximity to main navigation routes; channel depth; seaport facilities and equipment (including IT); and intermodal links (including seaport access: rail, road, barge).
However, as the number of factors involved in the AHP survey are critical to the successful application of AHP (Lai et al., 2002), clearly structuring and defining the number of factors is a critical preliminary stage. It has been observed that when five or more items are involved in the survey questionnaire, decision-maker statements regarding pairwise comparisons tend to become increasingly inconsistent in terms of transitivity (Bodin and Gass, 2003; Gass, 1998). Thus, the expectation of using the twelve factors in an AHP survey (66 pairwise comparisons) would be extremely unrealistic. The literature proposes limiting the numbers of factors through applying factor analysis (Park and Han, 2002; Sohn et al., 2001), the Delphi technique (Lirn et al., 2004; Schmidt, 1997) or brainstorming (Lirn et al., 2004; Song and Yeo, 2004).

The adoption of factor analysis is not appropriate to this study because this technique not only requires a large sample, commonly five times larger than the number of factors included (Hair et al., 1995) but also there must be no overlap between respondents involved in factor analysis and those surveyed for the AHP (Lirn et al., 2004). Thus, the size of the population target prohibitive it. As there are no minimum limits on expert numbers involved in the Delphi technique, the non-overlap rule was easy to follow. The Delphi technique was applied in this study to limit the number of factors to a level acceptable for utilisation in the final AHP survey (with a maximum of five factors).

The classical Delphi method, first developed by the RAND Corporation in the 1950s, was originally developed to assess variables that are intangible and/or shrouded in uncertainty by drawing on the knowledge and abilities of a diverse group of experts through a form of anonymous and iterative consultation (Linstone and Turoff, 2011). Forecasting has been a major area of method application across many different fields, such as public administration, medicine and the diffusion of technology (Frewer et al., 2011; Landeta and Barrutia, 2011).

A primary reason for the sustained popularity of Delphi is its very unique strength as a planning, forecasting and decision-making tool (Gupta and Clark, 1996). It relies on a structured, yet indirect, approach to quickly and efficiently eliciting responses from experts who bring knowledge, authority, and insight to the problem. However, Delphi also contains some limitations, some of which include conceptual and methodological inadequacies, unreliable analysis of results and the limited value of feedback and consensus (Gupta and Clark, 1996). To overcome some of these limitations, this technique has been modified with some alternative variations, such as Ethical Delphi and Policy Delphi, appearing in addition to

Schmidt's (1997) proposal that the non-parametric statistical technique be applied to managing Delphi surveys. This study adopts this suggestion.

According to Rowe and Wright (1999), four key features may be regarded as necessary for defining a procedure as a "Delphi": anonymity, iteration, controlled feedback and the statistical aggregation of group responses. This study follows all of these features. Twenty-two international experts from industry and academia were identified and recruited. The expert profiles are detailed in table 3. The shared selection feature for choosing these participants were: professionals from the industry with more than five years of shipping experience and academic experts with works published in the leading shipping journals. The twelve factors were presented to these experts in November 2011 through an anonymous Internet survey adopting a five-point Likert scale.

Table 3 –Expert panel profile of Delphi survey participants

Institutional affiliation	Citizenship		Work experience		International publication (no.)	
	European (EU)	International non-EU	5-10 years	More than 10 years	10-15	More than 15
Academics	6	7	n.a.	n.a.*	5	8
Professionals from industry	7	2	2	7	n.a.	n.a.
Sum	13	9				

*n.a – not aplicable

As consensus between the experts is necessary, various rounds are needed. According to Green et al. (1999), two or three rounds are preferable and an 80% consensus rate is deemed good. In this study, the consensus, and thus the number of rounds, is measured using Kendall´s coefficient of concordance (W), as suggested by Schmidt (1997). Kendall´s method measures current agreement (the list ordered by mean ranks) with a least squares solution. With this non-parametric statistic, realistic determinations of whether any consensus has been reached become feasible in addition to gauging the relative strength of consensus (appendix 2) (Schmidt, 1997). After analysing the survey results, median, average, standard deviation and Kendall´s coefficient (w=0.3) of the first Delphi survey, we identify the need to carry out another round. Therefore, a second round was undertaken when the average for each factor was sent and the panel members were asked to reassess their first round of questions. The second round Kendall´s coefficient was 0.6, meaning that the group consensus was between moderate and strong and thus the rounds came to a close. Table 4 presents the results of the two Delphi method rounds.

Table 4 - The Delphi method results

Dimension	Variables	1st Round		2nd Round	
		Mean	σ	Mean	σ
Cost perspective	Seaport charges Government tax and duties Privileged terms to carriers	3.90 3.76 3.67	0.69 0.68 0.71	3.82 3.77 3.82	0.29 0.35 0.45
Seaport management	**Vessel turnaround time** Seaport security and safety Seaport reputation for cargo damage and delays	4.19 3.52 3.57	0.49 0.56 0.67	4.09 3.23 3.23	0.39 0.39 0.50
Geographical location	**Proximity to import/export area** Proximity to alternative loading centre Proximity to main navigation routes	4.10 3.57 3.95	0.56 0.73 0.84	4.14 3.77 3.82	0.35 0.50 0.48
Physical and technical infrastructure	**Channel Depth** **Seaport facilities and equipment** **Intermodal links**	4.00 4.00 4.29	0.61 0.50 0.49	4.05 4.00 4.95	0.21 0.00 0.21
	Coefficient of Kendall (W)	0.30		0.61	

Following analysis, the second and final round reported moderate consensus with the five most important factors then selected for the AHP survey: intermodal links; proximity to import/export area; vessel turnaround time; channel depth and; seaport facilities and equipment. It is interesting to note that not one of the cost perspective variables was identified as top five. This is, however, consistent with earlier studies by Malchow and Kanafani (2001), Ugboma et al. (2006) and Tongzon (2009) who all find seaport charges relative to other factors are not in the top five factors of seaport competitiveness. However, this factor was nevertheless considered in the top five of competitiveness factors in the studies of Lirn et al. (2004) and Saeed (2009).

3.3 Data collection: AHP model

As detailed above, out of the range of different seaport stakeholders, this study focuses on shippers as the key stakeholders for the study of seaport competitiveness. Within the three shipper's categories defined by Tongzon (2009), the shipping lines referred to as major and direct seaport users were chosen. Shipping lines are companies operating vessels whether or not actually owning them and that handle all the movements of goods from seaport to seaport as well as all traffic navigation in seaports (Talley, 2009). Thus, based on the regular lines operating at the most representative seaports of Portugal and Spain, thirty-one liner shipping companies simultaneously serving seaports across the Iberian Peninsula were identified. The most representative Portuguese seaports (Sines, Lisboa, Leixoes, Setubal and Aveiro) covered 96.67 % of total traffic in 2010 while the most representative Spanish seaports (Algeciras, Barcelona, Valencia, Tarragona and Bilbau) accounted for 59.06 % of total traffic.

The questionnaire (appendix A) was distributed by Internet to the liner shipping companies in December 2011, followed up by a telephone call. Twenty-four completed questionnaires were returned by February 2012, corresponding to a seventy seven percent response rate.

In parallel to the survey of liner shipping companies, a related questionnaire was distributed not only to the seaport authorities (10) but also to the terminal operators (28) of the aforementioned seaports. The liner shipping companies and the terminal operators were identified using the respective seaport websites, with recourse to the Degerlund (2009) database in addition to information requested from the seaport authorities by email. All the seaport authorities and twenty terminal operators, a total of thirty seaport service providers, replied to the survey, corresponding to a 79 per cent response rate.

The survey contains two sections. In the first, respondents complete pairwise comparisons of the importance of the five key factors of seaport competitiveness. The fundamental AHP nine-point scale was applied for the pairwise comparisons. In the second, respondents scored the performance of the leading Iberian seaports according to these factors. The scale ranged from 1 “poor” to 5 “excellent”. The second section was only included in the liner shipping company questionnaire. Detailed instructions on how to complete a pairwise comparison factor scale with an explanation of the factors provided on the introductory page of the questionnaire. This proved important in order to familiarize respondents with AHP survey pairwise comparisons and minimize the number of inconsistent replies.

4. AHP model results

As the starting point for empirical analysis, the factor weights are computed based on the pairwise comparison of the five factors. Table 5 reports the outcomes of the calculations based on the two steps described above in equation (1) and (2) in accordance with the Expert Choice Software. The consistency ratios are 0.091 and 0.095 for the liner shipping companies group and the seaport service providers group respectively. These values are within the acceptable range of 0.10 and the survey’s results are, consequently deemed consistent.

Table 5 - Key factors of seaport competitiveness as perceived by liner shipping companies (seaport users) and seaport service providers.

Factors	Liner shipping Companies (%)	Rank of importance	Seaport service providers (%)	Rank of importance
Seaport facilities and equipment	20.86	3	26.24	1
Channel depth	14.57	5	23.39	2
Intermodal links	21.11	2	17.87	3
Vessel turnaround time	25.75	1	16.77	4
Proximity to import/export area	17.71	4	15.72	5
Standard deviations of weights	4.17		4.57	
CR (Consistency ratio)	9.19%		9.59%	

The initial results from the surveys of liner shipping companies and seaport service providers (seaport authorities and terminal operators) revealed that the two groups were in open disagreement on the importance of the key factors of seaport competitiveness. However, the variability between the weighted factors in both groups is low and does not particularly differ as is reflected in the standard weighting deviation. This result supporting the findings of Lirn et al. (2004) who find that the global carriers and seaport operators disagreed on the relative importance of the top five criteria. From Table 5, we may conclude that vessel turnaround time (time delays, loading/discharging rate) is considered by the liner shipping companies as the most influential factor to competitiveness, followed by intermodal links, seaport facilities and equipment, proximity to import/export area and channel depth. From the seaport authorities and terminal operators perspective, seaport facilities and equipment is the most important factor followed by channel depth, intermodal links, vessel turnaround time and proximity to import/export area. This result implies the competitive cutting edge of the seaport industry is perceived differently by the users and the service providers.

From our perspective, these results accurately portray the current seaport situation: liner shipping companies are more concerned with time delays, loading/discharging rates and intermodal links because these factors impact and affect their company efficiency level, its reputation as well as the cost of transport. Meanwhile, the seaport authorities and terminal operators are more concerned with the infrastructure, equipment and principally with the channel depth in order to handle more and larger ships. This situation is reflected in the substantial investments made at seaports on these facilities and capacity and, as referred to by Lirn et al. (2004), seaport authorities and terminal operators also seem to accredit their efforts to provide appropriate basic seaport infrastructures with more impact on seaport selection than their customers do.

The results from the liner shipping company surveys are consistent with those from the earlier studies of Machow and Kanafani (2001), Ugboma et al. (2006), Ng (2006), Tongzon (2009) and Saeed (2009). In their studies of different seaport context, these authors found vessel turnaround time to be the most important factor of seaport competitiveness/attractiveness from the shippers' perspective. The greater emphasis on qualitative service factors seems consistent with the global trend attributed to changes in commodity patterns involving a greater proportion of high added value products and the adoption of logistics approaches to freight management in response to greater competition between producers (D´Este and Meyrick, 1992).

Whilst both groups disagree over their ranking, there are two factors that appear to be roughly in agreement: proximity to import/export area and intermodality links. The first is adjudged one of the least important while the latter is considered in the top three. Unlike the studies of Tiwari et al. (2003), Song and Yeo (2004), and Guy and Urly (2006), which reported seaport location as the most important factor of seaport competitiveness, in this study the proximity to import/export area appears as one of the least important. Tiwari et al. (2003) identifies the distance from the seaport of origin (for imports) or destination (for exports) as an important variable and acting as a proxy for shipping costs. However, as mentioned by Guy and Urly (2006), whilst access to cargo appears an obvious dimension this does not prove so important in situations where alternative seaports provide access to a similar hinterland as in the Iberian Peninsula context. In the Lirn et al. (2004) study, the proximity of the import/export area also emerges as one of the least important factors from the perspective of both global carriers and seaport authorities and terminal operators.

The weights of intermodal links in both group (ranking second and third respectively) is hardly surprising when taking into account the current seaport operational environment. In a context of fierce competition between seaports, intermodal links have increasingly proven a factor prevailing in the survival of seaports. This finding was also returned by Guy and Urly (2006) and Tongzon and Heng (2005). Originally, ships loaded and discharged their cargoes in towns or cities where the producers and consumers were located (Tongzon and Heng, 2005). The expansion and consolidation of land transport systems have since altered transport patterns somewhat. The days when ships were forced to call in at city terminals blocked in landside by congested city street are long since gone. The efficiency of inland transport to serve an increasing and most often competitively disputed hinterland has become a critical factor to the potential future of seaports as well as to their prospects of registering an overall growth in cargo flows. According to Fleming and Baird (1999), new remote coastal terminals with good landside connections, and with seaports strategically located close to the main global trade lanes, increasingly provide carriers and shippers with a preferred alternative option. Since seaports have become a prominent node in integrated logistics chains, quick and safe access to seaport facilities from an inland transport system becomes a basic requirement for seaport users when evaluating their seaport selection options (Tongzon and Heng, 2005).

The important of this factor has been discussed both in the literature and at the institutional level. As stated in the transport white paper "European Transport Policy to 2010: time to decide," published by the European Commission (EC) in 2001, intermodality is of fundamental importance for developing competitive alternatives to road transport. Action must therefore be taken to ensure an integration of all the transport modes in an efficiently managed transport chain joining up all the individual services (EC, 2001). Therefore, it is correspondingly important that seaports are integrated into intermodal links enabling efficient door-to-door cargo transportation, integrating two or more modes of transport between the origin and the destination of goods.

5. Main Iberian seaport performance

In the second part of the liner company survey, respondents awarded scores to evaluate the performance of the leading Iberian seaports according to the five factors discussed above. The scale ranged from 1 "poor" to 5 "excellent". Table 6 presents the average scores for the five factors at eight Iberian seaports. At first glance, respondents have significantly different opinions on the different factors of seaport competitiveness. However, to confirm this objectively, statistical testing is needed. The analysis of variance (ANOVA) proves relevant for testing such differences through calculating their F-values. Before applying this technique, the prior verification of its premises was carried out and verified.

The results of the normality test (appendix 3), an important assumption when the sample size is below 30, demonstrate that the level of the P-value (*Sig*) for all variables is less than 0.05, which rejects a normal distribution for each group have. Recourse to '*One Way*' Anova is thus rendered impossible. Hence, according to Hair et al. (1995), the non-parametric Kruskal-Wallis test, represents an alternative test to '*One-Way*' Anova, and was duly applied. With this test (table 7), the P-value (*Sig*) result is equal to 0.000 and hence, at a significance level of 5%, we conclude that significant differences do exist among all the five factors applied to the eight seaports.

Table 6 - Average Iberian seaport performance score based on five factors of competitiveness

Factors	Average Score							
	Algeciras	Valencia	Barcelona	Lisboa	Leixoes	Sines	Tarragona	Bilbau
SFE	4.250	4.250	4.500	3.125	3.875	3.875	3.125	3.875
CD	4.625	4.375	4.500	3.750	3.250	4.625	4.375	4.500
IL	4.000	4.625	4.625	3.125	3.375	3.875	4.458	4.000
VTAT	4.500	4.125	4.250	3.625	3.875	4.000	4.250	3.583
PIEA	3.750	4.375	4.250	3.500	3.375	3.250	4.250	3.500

Note: SFE (seaports facilities and equipment); CD (channel depth); IL (intermodal links); VTAT (vessel turnaround time) and PIEA (proximity to import/export area).

Table 7 – Chi-square of the different Kruskal-Wallis test factors

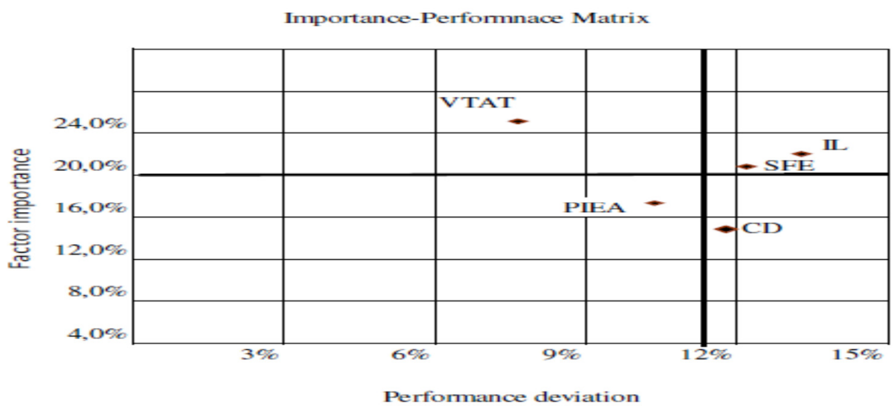
Factors	Chi-Square	Sig.
SFE	80.617	0.000
CD	82.113	0.000
IL	80.617	0.000
VTAT	33.446	0.000
PIEA	55.091	0.000

Table 6 demonstrates that no seaport is considered the best across all five factors. Barcelona seaport has the best seaport facilities and equipment performance (with an average score of 4.5). This score could be attributed to the specialized and multipurpose terminals of the seaports of Barcelona that suit different traffic types. Furthermore, beside the commercial seaport, Barcelona has a logistics seaport. Meanwhile, the seaports of Algeciras and Sines attain the best channel depth performance (with average scores of 4.625). This classification might be explained by the excellent natural conditions of the Bay of Algeciras with a channel depth of 18.5 meters. Furthermore, Sines seaport is a deepwater seaport with 17.5 meters of depth and equipped with specialized terminals catering for different cargo types. In addition to its position as the main Atlantic coast seaport of Portugal, due to its geophysical characteristics, Sines is also the main gateway for the country's energy supply including, natural gas, coal, oil and its derivatives.

The seaports of Valencia and Barcelona receive the highest intermodal links evaluations (with average scores of 4.625). The interconnection of all transport modes (seaport, airport, highways and rail) within a five kilometre radius and with an environment favourable to the provision of good transport sector services and logistics make Barcelona one of the main logistic 'hubs' in the Mediterranean region. Valencia seaport has excellent road and rail connections to the centre of Spain, making it the natural seaport for Madrid (the Spanish capital). These good connections to the centre of Spain also make this seaport the best in terms of proximity to import/export area (with an average score of 4.375). Indeed, this seaport is considered the gateway for both production and consumption across the entire Iberian Peninsula. Meanwhile, Algeciras seaport was acknowledged as the best performing in terms of vessel turnaround time (average score of 4.5). The experience of this seaport in transshipment (85% of total traffic) perhaps makes this seaport the most efficient in terms of delay times and loading/discharging rates.

In order to distinguish between determinant and non-determinant factors of seaport competitiveness, the Martilla and James (1977) tool was applied. Importance and performance have been used to highlight potential areas for improving customer satisfaction through traditional Importance-Performance Analysis (IPA). As detailed by Lirn et al. (2004), combining the dispersion of evaluation scores for alternatives (seaports) with the AHP weightings calculated through the liner companies survey will produce a meaningful guide to the scope for competition among the leading Iberian seaports. Martilla and James (1977) were the firsts to propose the IPA as a tool to develop company management strategies. In its essence, the IPA combines measures of attributed importance and performance into a two-dimensional grid. The mean or median values of importance and performance scores then serve as the crossing point in constructing the IPA grid. The IPA effectively provides an attractive snapshot of how well the company meets important customer concerns on selected attributes and, at the same time, generates guidelines for future company resource allocation decisions (Oh, 2001). Thus, the five factors were plotted as competitiveness determinants in two dimensions (figure 2): (1) the factor's importance in terms of its AHP weights (vertical axis); and (2) the seaport performance standard deviation scores for each factor.

Figure 2 – Importance-Performance Matrix



As shown in Figure 2, the IPA generates four different suggestions based on importance-performance measures. The first quadrant, 'keep up the good work', captures the attributes (seaport facilities and equipment and intermodal links) that users think are important to their decisions and where users also perceive the seaports perform well. Likewise, the 'possible overkill' in Quadrant 2 indicates that channel depth is relatively less important but that seaports nevertheless perform well on this attribute. Because both importance and performance ratings of proximity to import/export area are lower than the average, this attribute falls into the third quadrant, 'low priority´. Thus, this factor may be expected to receive low priority in resource allocation decisions. However, in the seaport context this is the factor that seaport service providers do not control. The factor (vessel turnaround time) that is important to client purchase decisions but where the seaports do not perform well is classified into Quadrant 4, 'concentrate here'. Thus, seaports need to focus on improving their performances on this factor, particularly as already seen in the results above, this is also the most important factor from the perspective of seaports users.

5. Conclusion

To improve seaport competitiveness, the providers of seaport services need to thoroughly understand the user's seaport experience, determine the antecedents of competitiveness, identify performance gaps and ascertain where a seaport may best concentrate improvement efforts. Whether as independent operators or as seaport-operating companies, seaport/terminal operators need to be able to assess the customer criteria applied in evaluating seaport alternatives for cargo transportation. The stakeholders approach argues that the survival and success of an organisation depends on its management's ability to create wealth, value and satisfaction for its stakeholders. Thus, it becomes fundamental that organisations identify, consider and understand their own respective stakeholders, their interests and correspondingly how to improve their management performance.

This paper studies the importance of different factors affecting seaport competitiveness from the perspective of Iberian seaport stakeholders using the Analytic Hierarchy Process model. The perceptions of both seaport users and seaport service providers are analysed to reveal whether there are any discrepancies between these two stakeholder groups. The liner shipping companies and seaport service providers AHP surveys results revealed the two groups were in disagreement on the respective importance of the key factors of seaport competitiveness. Vessel turnaround time (time delays, loading/discharging rate) is deemed the most influential factor to competitiveness by liner shipping companies. However, from the seaport authorities and terminal operator's perspective, seaport facilities and equipment is the most important factor. However, both agree that intermodal links should also be taken into consideration. Nowadays, it is important that seaports should be integrated into intermodal links enabling efficient door-to-door cargo transportation integrating two or more modes of transport from the origin to the destination of the goods. As the variability between the factor weightings is so low in both groups, the study results support the idea that seaport competitiveness is a mixture of different factors with no one particular factor enough to decide overall seaport competitiveness.

In relation to the performance of the most representative Iberian seaports across the five key factors of seaport competitiveness, we may conclude that significant differences exist in all five factors across the eight seaports and no seaport is considered the best in all five factors. In terms of seaport facilities and equipment, respondent opinions suggest that Barcelona is the ideal seaport. Considering only channel depth, the seaports of Algeciras and Sines were ranked as returning an excellent performance. However, the seaports of Valencia and Barcelona are identified as equipped with the best intermodal links. Taking the proximity to import/export area into consideration, Valencia seaport is the first choice shipping line option. Finally, Algeciras seaport is attributed the best performer in terms of vessel turnaround time. It would also seem that shipping line opinions on seaport performance are consistent with their actual decisions in choosing Iberian Peninsula seaports.

To distinguish between determinant and non-determinant factors for seaport competitiveness, the importance-performance matrix was deployed. This analysis confirms vessel turnaround time as the most important factor to customer purchase decisions and is also the factor on which seaports do not perform well. It is, therefore, essential that seaport operators and policy makers award top priority to improving their overall level of vessel turnaround time relative to other factors in order to attract more shippers to their seaports.
These findings are important because in an increasingly competitive seaport environment, knowing the key factors at play in the decision making processes of seaport users is essential. The findings of this study are similarly of interest to seaport managers since seaport strengths and weaknesses are identified. With this understanding, seaports may therefore better position themselves and formulate strategies able to gain competitive advantages. Thus, where a seaport aims to overtake their competitors, they must strive to generate greater competences in the most important criteria.

To conclude, this research is the first analysis of the key factors of seaport competitiveness through recourse to the perceptions of two different groups of stakeholders and applied to Iberian Peninsula seaports. Although the results of this study derive from stakeholder perceptions within a specific geographic area, they provide relevant information for seaport authorities and terminal operators and especially in terms of understanding and fulfilling the requirements of shippers.

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Appendix 1 – The AHP survey

QUESTIONNAIRE SURVEY FORM

The purpose of this survey is to assess your opinion towards the relative importance of five factors related to the competitiveness of seaports in a pair-comparison approach. The five factors include *vessel turnaround time, proximity to import/export area, port equipment and facility, channel depth and intermodal links,* whose details are described below. In respect of the pair-comparison, you are requested to express which factor is more important and how important the factor is compared with its counterparts. It is just two questions and will take at most 7 minutes to complete it. The answers are treated confidentially. Thank you!

PART I. GENERAL INFORMATION

The five factors are extracted from the previous studies as the vital attributes to seaport competitiveness. The definition of each factor is given below for your reference before going through the questions.

Seaport facilities and equipment: infrastructure and equipment including information technology
Channel depth: depth of water access
Intermodal links: port accessibility by land and sea including port access by rail, road and barge.
Vessel turnaround time: berthing delay and loading/discharging rate
Proximity to import/export area: proximity to cargo origin or destination

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In making pair-comparison of the relative importance between any two factors above, the following nine scales are used.

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(1) *Equal importance* in case of both factors having the same weight
(3) *Fair importance* in case of a factor having slightly more weight than the other factor
(5) *Strong importance* in case of a factor having more weight than the other factor
(7) *Very Strong importance* in case of a factor having much more weight than the other
(9) *Absolute importance* in case of a factor having the absolute weight over the other factor

Note: (2), (4) (6) and (8) are in the middle of each relevant scale (e.g. (2) is between (1) and (3)).

PART II. PAIR COMPARISON

Question 1- Which factor is more important and how important is it?

1.1. Which factor is the more important? Seaport facilities and equipment ( ) or Channel depth ( )
How important is it? (1) (2) (3) (4) (5) (6) (7) (8) (9)

1.2. Which factor is the more important? Seaport facilities and equipment ( ) or Intermodal links ( )
How important is it? (1) (2) (3) (4) (5) (6) (7) (8) (9)

1.3. Which factor is the more important? Seaport facilities and equipment ( ) or Vessel turnaround time ( )
How important is it? (1) (2) (3) (4) (5) (6) (7) (8) (9)

1.4. Which factor is the more important? Seaport facilities and equipment ( ) or Proximity to import/export area ( )
How important is it? (1) (2) (3) (4) (5) (6) (7) (8) (9)

1.5. Which factor is the more important? Channel depth ( ) or Intermodal links ( )
How important is it? (1) (2) (3) (4) (5) (6) (7) (8) (9)

1.6. Which factor is the more important? Channel depth ( ) or Vessel turnaround time ( )
How important is it? (1) (2) (3) (4) (5) (6) (7) (8) (9)

1.7. Which factor is the more important? Channel depth ( ) or Proximity to import/export area ( )
How important is it? (1) (2) (3) (4) (5) (6) (7) (8) (9)

1.8. Which factor is the more important Intermodal links ( ) or Vessel turnaround time ( )
How important is it? (1) (2) (3) (4) (5) (6) (7) (8) (9)

1.9. Which factor is the more important? Intermodal links ( ) or Proximity to import/export area ( )
How important is it? (1) (2) (3) (4) (5) (6) (7) (8) (9)

1.10. Which factor is the more important? Vessel turnaround time ( ) or Proximity to import/export area ( )
How important is it? (1) (2) (3) (4) (5) (6) (7) (8) (9)

Question 2 – Based on the five factors above, evaluate the performance of the following seaports using a 5-point Likert scale: 1 "poor"; 2 "fair"; 3" average"; 4 "good" and 5 "excellent".

	Port facilities and equipment	Channel Depth	Intermodal Links	Vessel turnaround time	Proximity to import/export area
Algeciras					
Valencia					
Barcelona					
Tarragona					
Bilbao					
Lisboa					
Leixões					
Sines					

THANK YOU FOR YOUR COOPERATION AND TRUST

Appendix 2 – Interpretation of Kendall´s W

W	Interpretation	Confidence in Rank
0.1	very weak agreement	None
0.3	weak agreement	Low
0.5	moderate agreement	Fair
0.7	strong agreement	High
0.9	unusually strong agreement	Very high

Appendix 3 – Test of normality of the five factors

Tests of Normality							
		Kolmogorov-Smirnov			Shapiro-Wilk		
Factors	Seaports	Statistic	df	Sig.	Statistic	df	Sig.
PFE	AL	.250	24	.000	.813	24	.000
	VA	.401	24	.000	.616	24	.000
	BA	.401	24	.000	.616	24	.000
	LX	.331	24	.000	.770	24	.000
	LE	.310	24	.000	.761	24	.000
	SI	.331	24	.000	.770	24	.000
	TA	.358	24	.000	.637	24	.000
	BI	.250	24	.000	.813	24	.000
CD	AL	.401	24	.000	.616	24	.000
	VA	.401	24	.000	.616	24	.000
	BA	.336	24	.000	.640	24	.000
	LX	.464	24	.000	.542	24	.000
	LE	.464	24	.000	.542	24	.000
	SI	.401	24	.000	.616	24	.000
	TA	.401	24	.000	.616	24	.000
	BI	.336	24	.000	.640	24	.000
IL	AL	.250	24	.000	.813	24	.000
	VA	.401	24	.000	.616	24	.000
	BA	.401	24	.000	.616	24	.000
	LX	.331	24	.000	.770	24	.000
	LE	.310	24	.000	.761	24	.000
	SI	.331	24	.000	.770	24	.000
	TA	.358	24	.000	.637	24	.000
	BI	.250	24	.000	.813	24	.000
VTAT	AL	.381	24	.000	.690	24	.000
	VA	.239	24	.001	.802	24	.000
	BA	.269	24	.000	.789	24	.000
	LX	.401	24	.000	.616	24	.000
	LE	.331	24	.000	.770	24	.000
	SI	.250	24	.000	.813	24	.000
	TA	.269	24	.000	.789	24	.000
	BI	.304	24	.000	.733	24	.000
PIEA	AL	.269	24	.000	.789	24	.000
	VA	.310	24	.000	.761	24	.000
	BA	.269	24	.000	.789	24	.000
	LX	.336	24	.000	.640	24	.000
	LE	.401	24	.000	.616	24	.000
	SI	.312	24	.000	.751	24	.000
	TA	.269	24	.000	.789	24	.000
	BI	.336	24	.000	.640	24	.000

Chapter 3 – A Strategic Diagnostic Tool Applied to Iberian Seaports: An Evolutionary Perspective

A Strategic Diagnostic Tool Applied to Iberian Seaports: An Evolutionary Perspective

Abstract

The highly competitive and rapidly changing environment faced by business has greatly increased the need for strategic planning. The importance of formulating strategies to reach competitive advantages with implications in the performance is becoming increasingly evident in the seaports context. Thus, it is relevant and appropriate to apply strategic positioning tools to seaports given the role of competitive strategies on the growth and development of this industry. This research aims to analyse the strategic positioning of the leading Iberian Peninsula seaports (Portuguese and Spanish seaports) using the BCG (Boston Consulting Group) matrix as a strategic tool in an evolutionary perspective. The portfolio analysis developed subsequently is focuses on annual data of the eight seaports in a selected period of eighteen years (1992-2009) and it focuses on five categories of traffic: liquid bulks (LB); dry bulks (DB); containers (CO), ro-ro (roll-on/roll-off) and conventional cargo (CC). The research allows us to compare and analyse different levels of performance and identify what seaports have improved their strategic positioning during the considered period. The findings reveal a better positioning of Spanish seaports in relation to total traffic. According to the time series analysed, the strategic position of the most seaports in BCG matrix had changed from the first to the third period. Valencia is the only seaport that maintains its Star Performer position in all of the eighteen years analysed. Furthermore, considering container traffic the results evidence Algeciras, Valencia, and Barcelona seaports as having attained a remarkable position of leadership.

Keywords: Maritime transport, Strategic Positioning, European Seaports, BCG matrix, Competitiveness.

1. Introduction

The seaports play an important role in global trade and economic development (Hu and Zhu, 2009). Most of the large volume cargoes in transit between countries, including crude oil, iron ore, grain, and lumber, are carried by ocean-going vessels. The growth in container traffic, the constant guidance and expertise required to increase the capacity of vessels drove the shipping company to focus as much as possible on a limited number of seaports of calls (Van de Voorde and Winkelmans, 2002). In recent decades, the various changes in the seaport industry have had a continuous and important impact on their activities and management (Hayuth, 1993). Nowadays, one key factor for seaports, where not the most decisive, is their competitiveness. The changes stemming from the international redistribution of labour and capital and from market integration and globalization along with a substantial rise in mobility of goods (Van de Voorde and Winkelmans, 2002) brought about consequences for the seaport, especially in terms of the intense competition.

The importance of strategies formulated with the intent of gaining competitive advantage and higher standards of performance is becoming increasingly evident in the context of seaport operators (Evangelista and Morvillo, 1998; Sletmo, 1999; Jenssen, 2003; Panayides, 2003; Song, 2003; Casaca and Marlow, 2005; Cullinane, Teng and Wang, 2005; Parola and Musso, 2007). During the last two decades, the restructuring of seaport operations and management has taken place against the background of international economy and trade globalization; increased competition among seaports and technology changes in the seaport and transport industry; acknowledged financial and operational benefits of private participation in infrastructure development and service delivery (Chen, 2009). Competition in the seaport industry has intensified and as proven by the increased incidence of mergers and acquisitions (Panayides, 2003). However, such options are not always ideal, reliable and applicable to all seaport companies seeking to increase both their market share and their competitiveness.

There are many factors and steps involved in strategic planning such as: defining the business, carrying out a situational analysis, setting objectives and strategic priorities, as well as developing and implementing strategies. There has also been a shift in emphasis from processes to strategic methodologies and tools. There is also an apparent lack of research on strategic planning in the seaport context in general, and on Iberian Peninsula seaports in particular. This is a major gap in the service driven economies that now operate throughout most of the regions in the world and represents a great challenge for both researchers and policymakers. Tracking these changes provides insights into the development of research in the field, as well as highlighting areas for further attention.

Traditionally, the role played by seaports in the history of Portugal ever since the era of maritime exploration has been clear and primarily due to their geographical location (MOPTC, 1999). Since 1990, the Spanish seaports authorities have been facing increased competition due to a set of changes impacting on the industry worldwide (Castillo-Manzano, J. López-Valpuesta, L. and Pérez, J., 2008). These changes include seaports specializing in specific categories of traffic, trends in route selection, the containerization process and the concentration of companies and business (Bichou and Gray, 2005). It is important to bear in mind that the Spanish seaports compete basically among themselves to attract the Spanish peninsular traffic and that 80% of the cargo of the Spanish seaport system corresponds to external maritime flows (Garcia-Alonso and Sanchez-Soriano, 2010).

Within this context, this paper aims to analyse the strategic positioning of Iberian Peninsula seaports from an evolutionary perspective over the period between 1992 and 2009 and thereby identifying the most important seaports in the “Iberian range”.

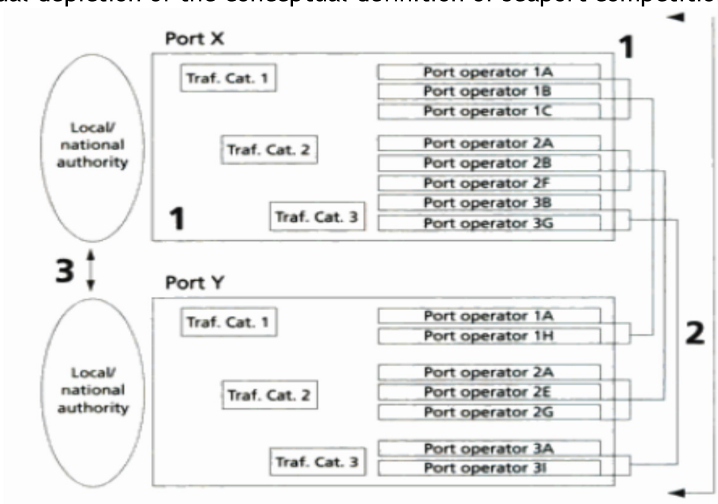
2. Literature Review

The importance of seaports to national economies is highlighted widely in the literature and especially to economies largely dependent on international trade (Song and Panayides, 2008). Interest in economic, management and policy issues in seaports has grown substantially since the mid-1990s (Pallis et al., 2010). The seaport has been characterised by complex growth driven by the interaction of a set of endogenous and exogenous factors (Evangelista and Morvillo, 1998). The main exogenous factors are corporate globalisation and decentralisation as well as industrial relocation. Standing out among the endogenous factors is the intensification of technological and organisational demands, which has contributed towards releasing a stream of innovations.

The seaport has undergone a series of structural transformations which have contributed towards questioning the leadership of countries with longstanding maritime traditions (Evangelista and Morvillo, 1998, Song, 2003; Parola and Musso, 2007). As the contextual and transactional seaport environment has dramatically changed, global competition has been fostered by a series of factors, including the distances that the general cargo travels, the rise of mega-carriers, the emergence of integrated market logistics, the advance of networked lines between seaports operations, and the development of inland transport networks (Notteboom and Winkelmans, 2001). Seaport management has been characterised by fierce competition resulting from structural changes in the industry which large companies acquire and the merge the small in a race to remain competitive (Panayides, 2003).

According to Van de Voorde and Winkelmans (2002), three types of competition can be identified in the seaport sector (figure 1): (1) intra-port competition at the operator level, for example, competition between operators 1A, 1B, 1C, in which each number refers to a traffic category and each letter to a specific operator; (2) inter-port competition at the operator level (competition between the activities of seaports in different seaports) and (3) inter-port competition at port authority level (competition between port authorities – be it national, regional or local –which directly affects the determinants of port competition). This last type of competition is identified between the ports of Hamburg, Rotterdam, Antwerp, and Le Havre in Northern Europe, between the ports of Algeciras, Marseille, Gioia Tauro, and Piraeus in the Mediterranean, between American and Canadian ports along the Great Lakes, between the ports of Hong Kong, Yantian, Shekou, and smaller ports along the Pearl River Delta, and between the ports of Kaohsiung and Shanghai (Kleywegt et al., 2002).

Figure 1- A visual depiction of the conceptual definition of seaport competition



Source: Voorde and Winkelmans (2002)

The environmental conditions strongly determine the way seaports are created, organized, managed as well as their choice of strategy. The changes in environmental conditions generate not only many new opportunities but also new threats to seaports. These changes modify the consistency between strategy and environment and push the seaport into selecting a different strategic orientation. When engaging in strategic decision-making, seaport authorities, terminal operators and seaport users must build upon a conceptual understanding of the dynamics of international seaport competition and perform strategic positioning analyses (Haezendonck et al., 2006). Many authorities and seaport operators are aware that any static approach to cost leadership, centralising around longstanding factors of advantage and depending upon new infrastructures to attract and retain customers are no longer sufficient in themselves to ensure competitive seaport success (Haezendonck, 2001).

In the management literature, the concept of strategy has increasingly been recognized deriving out of awareness that a company must have a well defined field of action and a clear direction as to the sources of its growth. According to Panayides (2003), there is a positive relationship between the pursuit of competitive advantage and business performance in seaport management. The increased emphasis on seaport performance is driven by the intense competition, the need to achieve competitiveness and the maximisation of shareholder profits and from contextual environment pressures. This highly competitive and rapidly changing environment has greatly increased the need for strategic planning. In this context, the concepts and practices integral to strategic planning have generated interest in organisations in many parts of the world as well as across many industries. However, strategic positioning is often not obvious and may be based on customer needs, customer accessibility or a variety of company products/services (Porter, 1996).

Many frameworks, approaches, and techniques can be deployed to analyse strategic cases in the strategic management process. Dyson (1990) lists out a number of analytical techniques, such as: the experience curve, SWOT (Strengths, Weaknesses, Opportunities, Threat) analysis, the PIMS (Profitability Impact of Marketing Strategies) model, and the BCG (Boston Consulting Group) matrix, each with specific advantages and disadvantages that allow a comparative or competitive positioning of businesses or business units. Thus far, efforts have been made to solve the strategic tools problems and some alternative methods have been put forward: i) the concept of GSM (Grand Strategy Matrix) – where companies are parked in the four quadrants of the coordinates according to their respective categories (Christensen, Berg and Salter,1976), ii) A'WOT (Analytic, Weakness, Opportunities, Threat) – a hybrid method to eliminate the weaknesses in the measurement and evaluation steps of the SWOT analysis (Kurttila et al., 2000: Kajanus et al., 2004), iii) ANP (Analytic Network Process) – a multi-criteria decision making technique for solving complicated problems (Yüksel and Dagdeviren, 2007), iv) a fuzzy SWOT matrix – an algorithm for rectifying the shortcomings and problems of the SWOT matrix through the use of fuzzy sets (Ghazinoory et al., 2007; Lee and Chang, 2008).

Although the BCG tool has been criticised as overly simplistic and its growth rate criterion deemed inadequate for evaluating the attractiveness of an industry (Porter, 1980), this matrix has become one of the most popular tools for planners and policymakers (Robinson et al., 1978; Henderson, 1979; Terwiesch and Ulrich, 2008). This matrix identifies the linkages between the business growth rate and the relative competitive position of the organization (identified by market share).

According to the authors above mentioned, the BCG matrix provides an easy way of mapping the market positions of firms and attempts to capture a dynamic phenomenon: the emergence, growth, maturation, and decline of markets. The main contribution of the BCG matrix is the attention it draws to the cash flow and investment characteristics of various types of businesses and how corporate financial resources are shifted from business unit to business unit in an effort to optimise the long-term strategic positioning and performance of the corporate portfolio as a whole (Ansoff and McDonnell, 1990; Khan and Ali-Buarki, 1992; David, 2009). This simple matrix enables managers to classify each division, since renamed a Strategic Business Unit (SBU), into a quadrant based on the growth of its industry and the relative strength of the unit's competitive positioning (Collis and Montgomery, 2008).

This study deploys the BCG matrix as a strategic tool for analysing and evaluating the strategic positioning of Iberian seaports from an evolutionary perspective. The choice of the BCG matrix as an optimal tool of analysing the competitive position of seaports is motivated by the three following considerations (Haezendonck and Winkelmans, 2002): the instrument encompasses a visual technique that is both clear and easy to represent; all the required data is easy to obtain; and it is a universal method that provides credibility.

The basic concepts of the BCG are easy to translate into seaports terms. The product portfolio of the BCG matrix could represent the traffic categories, such as liquid bulk, dry bulk, containers, roll on-roll/off and conventional cargo (Haezendonck and Winkelmans, 2002). This tool proves to be very useful in analysing the competitive positioning of seaports as it determines the present position of the business in relation to competitors and their potential to increase their market share (Haezendonck and Winkelmans, 2002; Haezendonck, 2011). We are also aware of the main weakness of this tool, that is, it has no temporal qualities and does not reflect whether the businesses are growing over time (David, 2009). This strategic instrument is rather a snapshot of an organization or of their business units at a given point in time. In order to reduce this shortcoming, we deploy a portfolio analysis reflecting data from 1992 to 2009, as explained in section 3.2.5.

3. Empirical Study

3.1 Territorial unit of analysis

The territorial research unit of analysis is the Iberian Peninsula, which is constituted by Portugal and Spain. Portugal has nine commercial seaports, but the most important in terms of container traffic are the seaports of Lisboa, Leixões, Setubal, Sines and Aveiro. These seaports are managed by companies with exclusively public capital operating under the auspices of the *Ministério das Obras Públicas, Transportes e Comunicações* (MOPTC - Ministry of Public Works, Transport and Communication) and *Finanças e Administração Pública* (MFAP – Ministry of Finance and Public Administration). The four other seaports are less representative in terms of goods shipping and handling (Viana do Castelo, Coimbra, Faro, and Portimão) and answer to the *Instituto Portuário e dos Transportes Marítimos* (IPTM – Institute of Ports and Maritime Transport). In comparison, the Spanish reality is quite different as its 23 major seaports are managed by companies within the scope of the state holding company - *Puertos del Estado, SA.* (State Ports, SA.), which in addition to the implementation of government defined seaport policies also carries responsibilities in terms of safety (similar to the IPTM). Figure 2 sets out the location of the main Iberian Peninsula seaports (Portugal and Spain).

Figure 2 – Iberian Peninsula seaports

Source: APA (2006)

From the Portuguese seaports, the busiest three (Sines, Lisboa and Leixões) were selected for this empirical study. They represented 82.74% of total traffic in 2009 (Table 1).

Table 1 – Total Traffic in the main Portuguese seaports in 2009

Seaports	Quantity (1000 tons)	Quantity (%)	Accumulative Quantity (%)
Sines (S)	24377	40.11	40.11
Leixões (Le)	14200	23.36	63.47
Lisboa (Li)	11709	19.27	**82.74**
Setubal	5900	9.71	92.45
Aveiro	3007	4.95	97.39
Figueira da Foz	1177	1.94	99.33
Viana do Castelo	407	0.67	100.00
Sum	**60777**		

Source: IPTM (2009)

Regarding Spanish seaports, the top five, Algeciras, Valencia, Barcelona, Bilbau and Tarragona, accounting for 73.59% of total traffic in 2009, (Table 2) were included for study.

Table 2 – Total Traffic in the main Spanish seaports in 2009.

Seaports	Quantity (1000 tons)	Quantity (%)	Accumulative Quantity (%)
Algeciras (A)	69911	20.84	20.84
Valencia (V)	61980	18.47	39.31
Barcelona (Ba)	50884	15.17	54.48
Bilbao (Bi)	32390	9.65	64.14
Tarragona (T)	31703	9.45	**73.59**
Cartagena	20514	6.11	79.70
Las Palmas	19023	5.67	85.37
Huelva	17999	5.37	90.74
Gijon	14600	4.35	95.09
Tenerife	16479	4.91	100.00
Sum	**335.483**		

Source: *Anuários estadisticos de Puertos del Estado* (2009)

3.2 Iberian Seaport Portfolio Analysis

The portfolio analysis used in this research is based on the annual reports of the eight seaports (three in Portugal, five in Spain) for the eighteen year period selected (1992-2009). The analysis is based on five categories of traffic: liquid bulk (LB); dry bulk (DB); containers (CO), ro-ro (roll-on/roll-off) and conventional cargo (CC).

Different types of analysis may be deployed to assess the level of seaport performance in terms of its maritime traffic volume. This study is based on the Product Portfolio Analysis methodology based on the value added for different traffic categories (Haezendonck, 2001). Taking into account the differential value added by several traffic categories, this enables us to gather information both on the success of seaports in attracting cargoes and on generating high added value (Haezendonck and Winkelmans, 2002; Haezendonck et al., 2006). The analytical introduction of the value added concept provides for the conversion of "nominal tonnes" into "intrinsic cargo handling tonnes" or "value tonnes".

By means of a rule, weighted nominal traffic data takes into account the differences in the added value of the various traffic categories and may contribute substantially to seaport management and policy (Haezendonck and Winkelmans, 2002). The rationale behind "weighted" analysis is the existence of differences in value added among traffic categories (Haezendonck, 2001). The weighting of traffic data focuses attention on the added value or welfare created in terms of the contribution made towards the gross output of a city, region or nation (Verbeke and Debisschop, 1996). In order to obtain weighted traffic categories, weighting coefficients need to be applied. Over the years, several weighting coefficients called "rules" have been proposed: i) the Hamburg Rule in 1976, ii) the Bremen Rule in 1982 iii) the Rotterdam Rule in 1985, iv) the Dupuydauby Rule in 1986, and v) the Range Rule in 2001. The Bremen and Rotterdam rules are often adopted and applied in traffic evaluation while the Dupuydauby rule is mentioned in only a very limited number of publications (Haezendonck and Winkelmans, 2002). In this study, the Range Rule was chosen because it is the only one based on a range of seaports. In this study, we considered one ton of conventional cargo to be equal to thirteen of liquid bulks, five of dry bulk, three of containers and one of ro-ro (Haezendonck, 2001). Portfolio analysis was applied to the structure of seaport trade across four levels, which are complementary and provide important analytical outputs (Haezendonck, 2001). However, there is no priority or hierarchy in the applicability of the different levels and they solely display the versatility of portfolio analysis. Just as in the original BCG matrix, the average annual growth rate and the average market share are respectively represented vertically and horizontally. The thickest horizontal line represents the average market share and the most stressed vertical line represents the average growth rate. However, in terms of the nomenclature of the four BCG matrix quadrants, these need adapting to the seaport context. Hence, based on terminology conceptualized by

Haezendonck (2001) we used the following: Star Performer, Mature Leader, Minor Performer and High Potential (Table 3).

Table 3 - The BCG matrix applied to seaport context

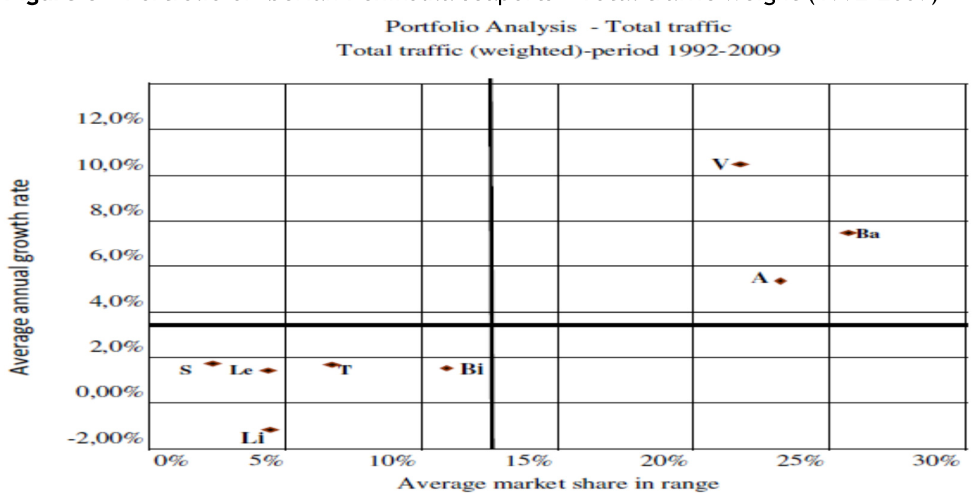
		Relative Market Share	
		Low	**High**
Growth Rate	**High**	High potential	Star performer
	Low	Minor performer	Mature Leader

Source: Adapted from Haezendonck (2001)

3.2.1 First level – Seaport portfolio based on total traffic

In this first level, portfolio analysis compares the market share and the growth rates of the studied seaports, which generates analysis of the external positioning of the seaports within the defined geographical area. In this case, the Iberian Peninsula is approached as a single portfolio of seaports (figure 3).

Figure 3 – Portfolio of Iberian Peninsula seaports – Total traffic weight (1992-2009)



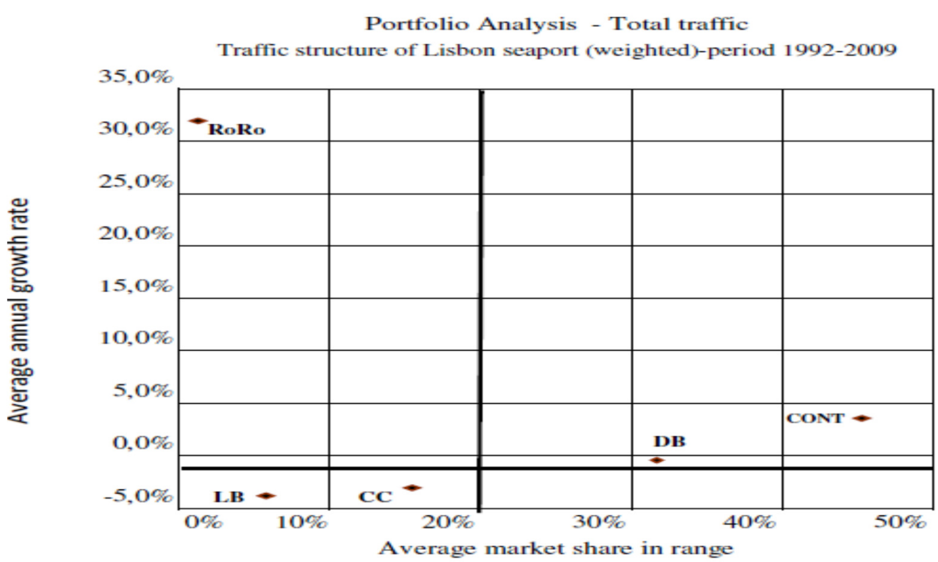
Seaport portfolio analysis based on total traffic between 1992 and 2009 provides the following findings: i) only certain Spanish seaports (Valencia, Algeciras, Barcelona) have risen above the average range both in terms of growth rate as the market share, which places them in the *Star performer* position ii) Two Spanish seaports (Bilbau and Tarragona) are in the *Minor performer* position because their market share and growth rates are below the average range, iii) all Portuguese seaports under analysis have growth rates and market share below the average, which places them in the *Minor performer* position.

This analysis demonstrates a more strategic competitive position of some Spanish seaports when compared with the Portuguese. As noted in the literature, the competitiveness of seaports is influenced by many factors and both internal and external to the industry. According to Van de Voorde and Winkelmans (2002), competition between seaports is influenced by factors such as structure and seaport management, managerial know-how as well as a port's regulatory authorities. Azevedo and Ferreira (2008) also argue that a major obstacle to the competitiveness of seaports has been the immediate payment or non-payment of VAT (value added tax) on goods arriving from third countries that increases operational transport costs. This may be one of several factors justifying a more competitive position in some Spanish seaports, including Valencia, when contrasted with their Portuguese counterparts.

3.2.2 Second Level – Seaport traffic category portfolio

In this second level, portfolio analysis compares the market share and growth rates in the five traffic categories for each seaport, that is, the traffic volumes of each seaport is considered as a five category portfolio. Here we opted in favour of the largest seaports in terms of total traffic by weighted values in each country over the 1992-2009 period (Lisboa and Algeciras). It is noteworthy that although the seaport of Sines attains the highest volume of traffic in the period considered, Lisboa seaport generated the largest volume in terms of weighted values. This occurs because the largest percentage of traffic in absolute values of Sines seaport (74.6%) in these years is liquid bulks with a weighting of 13 tons per ton of conventional cargo. Figures 4 and 5 depict the positioning of the five traffic categories in the seaports of Lisboa and Algeciras, respectively.

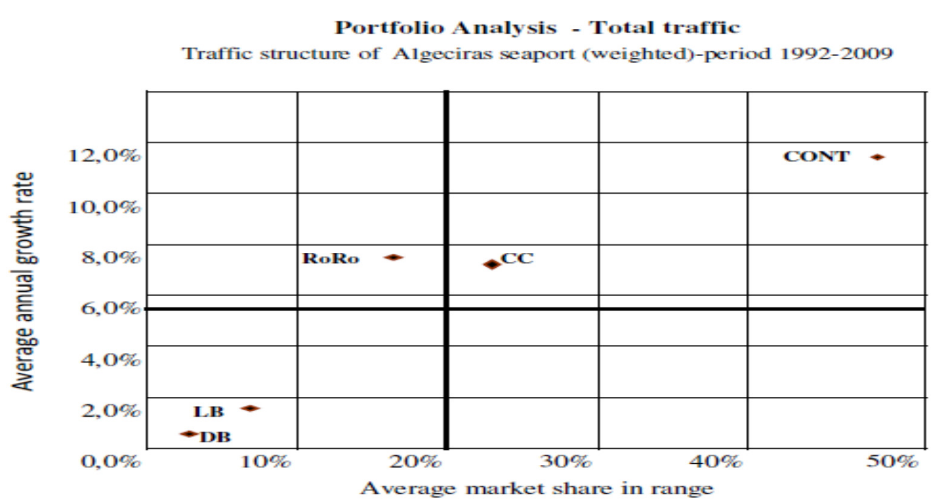
Figure 4 – Lisboa seaport portfolio – Traffic structure (1992-2009)



Analysis of Figure 4 demonstrates how the increased weighted value traffic flows in Lisboa seaport is concentrated in containers and dry bulk with these categories proving the seaport's *Star Performer*, despite the dry bulk showing a negative average growth rate (-0.82%) during the eighteen year period considered. The importance of ro-ro category for Lisboa traffic was limited (market share of less than 1%) in the period considered. Nevertheless, its fast growing (32.26% average growth rate over eighteen years) can therefore qualified this category as having a *High potential* in Lisboa traffic in the sense that a continuation of above average growth over time, could also position this traffic category in a higher than average market share position. In the 2009 Annual Report of this seaport it is possible to see the potential of this category. According to this report, the ro-ro category is the only one whose quantity increased (476%), with over 61.000 tones than that reported in 2008. Liquid bulks and conventional cargo with negative growth rates and with a very low average market share allow us to classify them as *Minor Performers*.

In the seaport of Algeciras seaport (Figure 5), the category with the largest market share in weighted values (48.73%) and the higher average growth rate (11.07%) is the containers. This category and conventional cargo are the *Star Performer,* while the bulk traffic category is a *Minor Performer*. The leadership of containers at the Algeciras seaport is a bit of the Authorities of these seaports, as referenced in the 2009 Annual Report, with the creation of a new container terminal that will be the first semi-automatic container terminal in the Mediterranean area. With a market share (17.58%) close to the average (20.00%) and an average growth rate of 7.30%, the ro-ro is a *High potential* category at the Algeciras seaport. This trend seems to have been diagnosed by the authorities of this seaport because according to the 2009 Annual Report, a new ro-ro terminal that would be operational in 2010 is under construction.

Figure 5 – Portfolio of Algeciras seaports – Traffic structure (1992-2009)

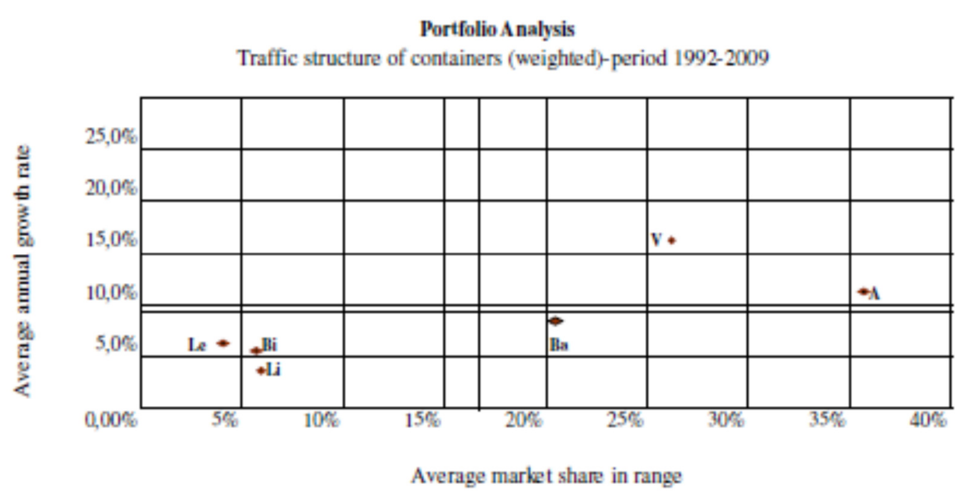


3.2.3 Third level – Seaport portfolio by specific traffic category

In the third level, the portfolio analysis compares and contrasts the positioning of seaports within the range for each traffic category. Thus, the seaport positioning results from each market share category making up the range and its respective rate of growth. From the five categories studied, we decided to choose the container traffic (Figure 6) for the following reasons: it is the category with the largest flow of traffic (with an average market share of 33.41% of total traffic), it has the highest growth rate (397.54%) of the period under analysis and this category has also been the subject of several research projects in recent years which have enhanced the importance of seaport competitiveness (Cullinane et al., 2006; Notteboom, 2007, Sohn and Jung, 2009, Dias et al., 2009). According to Frémont (2009), there are four major reasons for the impressive growth of containerization during the last 40 years. The first two principally involve the maritime leg of transport: the efficiency of seaport handling and the reduction in unit transport cost. The third cause is that the intermodal nature of containers permits door-to-door services and the fourth is the development of logistics services.

According to the APA (2006), container traffic flowing through Iberian Peninsula seaports is substantially concentrated, with 80% of traffic moving through only three seaports: Algeciras, with 29 million tons (Mton) per year on average, Valencia with 22 Mton/year and Barcelona, with 16 Mton/year. After these come the seaports of Lisboa (5 Mton/year), Bilbau (5 Mton/year) and Leixões (3 Mton/year), with container traffic in other seaports of little or practically no significance. Hence, following analysis of container traffic for the 1992-2009 period at the eight seaports analysed, we chose to consider only the five aforementioned seaports, excluding Sines and Tarragona since container traffic is of little significance and even nonexistent in some years (with market shares of 0.84% and 0.64%, respectively).

Figure 6 – Traffic structure of containers (1992-2009)

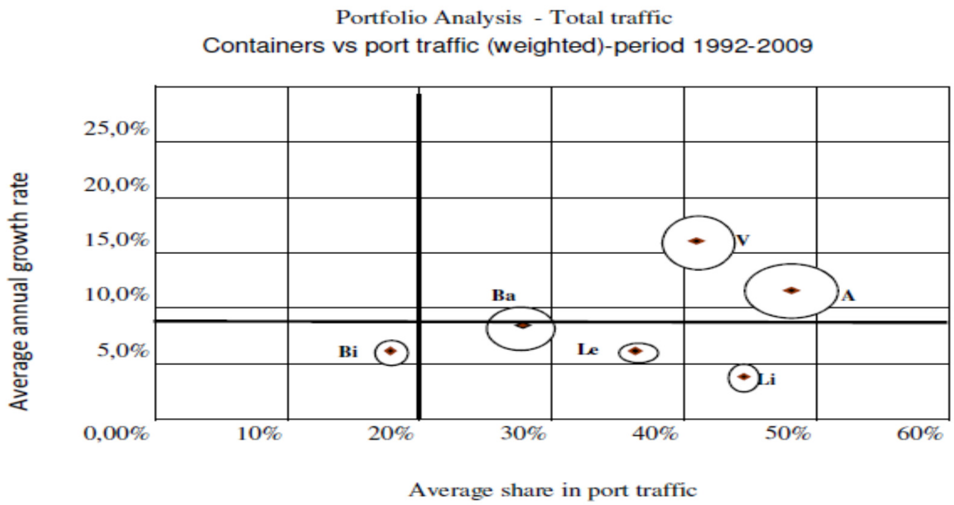


In the Iberian Peninsula, it appears that the seaports of Algeciras and Valencia are clearly the *Star Performers* regarding container traffic. Algeciras is definitely the seaport handling the largest volume of container traffic with a market share of 35.52% and an average growth rate of 11.07% over the eighteen years in question. However, Valencia attains the highest average growth rate (15.28%). Barcelona is the *Mature Leader* of the range regarding container traffic with a market share of 20.40% and an average growth rate of 7.65%, very close to the overall average (8.12%), which suggests that this seaport might have potential for growing its container traffic and to be a *Star Performers* in this range. The seaports of Lisboa, Bilbau and Leixões are the ones with market shares and growth rates below average and correspondingly Minor Performers in this category. The following reasons may be given for the leadership of the Spanish seaports in container traffic: access conditions, especially at the level of the channel depth, and unique conditions for the reception of large vessels and their influence area, especially the existence of high population concentration and/or economic activities in their hinterland areas.

3.2.4 Fourth level – Seaport portfolios by traffic category, based on its market share of overall seaport traffic

In the fourth level, the portfolio analysis also takes into account the weighting of a particular traffic category within the overall range. However, the difference between the third and fourth levels lies in the usage of each seaport's traffic category market share and not the range of traffic. This level also introduces an additional dimension to the portfolio analysis: a circle whose area is proportional to the absolute volume of seaport traffic in relation to the total range. The centre of the circle represents the growth rate and market share. According to Haezendonck (2001), the main advantage of this layout is that each seaport simultaneously displays: the position of a class within the overall seaport traffic framework, the class size considered in relation to the category size achieved by other seaports and the annual category growth rate. In this level, the stronger horizontal line represents the average total traffic market share in the range and the more pronounced vertical line portrays the average growth rate in the category. For the same reasons as detailed above, this study subjects container traffic to analysis (Figure 7).

Figure 7 – Containers vs seaport traffic (1992-2009)



The first conclusion that can be drawn from figure 7 is that container traffic is the main category at all the seaports studied as the seaports of Algeciras and Valencia are the *Star Performers* in the "Iberian Peninsula range" pertaining to containers traffic when comparing the total traffic of each seaport and the annual container growth rate and the seaports of Lisboa, Leixões and Barcelona are the *Mature Leaders*. The seaport of Bilbau is the *Minor Performer* in this range. Based on the analysis of the circles, we may conclude that the seaport of Algeciras handles the largest amount of container traffic in the range, followed firstly by that of Valencia and then by that of Barcelona. The seaport with the lowest level of container traffic is that of Leixões. Although the seaports of Lisboa and Leixões return very low container traffic market shares compared with the total range, as seen in the level above, they feature in this analysis as *Mature Leaders* because their container traffic market share within the framework of each seaport's traffic is both high (44.67% and 34.73%, respectively) and higher than the average total traffic market share for the range.

3.2.5 Dynamic seaport portfolios

Static portfolio analysis should be complemented by dynamic analysis in order to incorporate the progress of positioning over different periods of time (Haezendonck, 2001). The main purpose of dynamic analysis is to analyze the evolution within certain temporal frameworks so as to produce conclusions about future opportunities for seaport development in a given category. Correspondingly, three periods were chosen: 1992-1997, 1998-2003, and 2004-2009. These periods was chosen taken in account the changes, regarding port legislation, occurred in the seaports studied, during 1992 to 2009.

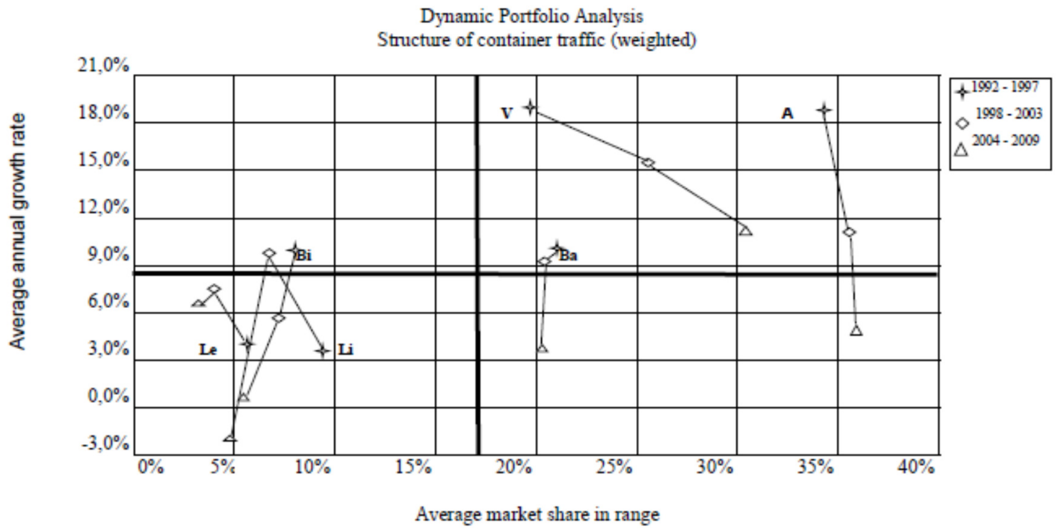
Regarding the matter of seaport legislation, the last decade of the twentieth century and the first decade of this century were a periods of maximum interest in Spain (Suárez de Viveiro and Rodríguez-Mateos, 2002; Castillo-Manzano et al, 2008) and Portugal (Marques and Carvalho, 2009). In Spain, two laws enacted in 1992 and 1997 respectively aimed at increasing the autonomy of individual seaports in the management and organization of its activities. Before 1992 two different models of management coexisted in the Spanish seaport system: autonomous decision making seaports and seaports controlled in its decision-making by the Central Government. Law 48/2003 was a further step in the direction of a seaport model based on the principles of market competition as started by Law 27/1992, by favouring intra-port competition in the form of enhanced participation of private operators in seaport facilities.

In Portugal, in 1998, a governmental white paper entitled "Maritime and Port Policy towards the XXI century" was published. The landlord seaport model was referred as the best method to induce private sector participation. In this model a Seaport Authority owns the seaport infrastructure and fulfils regulatory functions, while seaport services are provided by private operators who own assets conforming to the seaport superstructure and the equipment required for service provision. The Port and Maritime Transport Institute (IPTM) was created by Decree-Law no. 257/2002. It has juridical personality, administrative and financial autonomy and has its own patrimony. Its functions include nationwide supervision, coordination and planning, strategic development, standardization, regulation and fiscalization within maritime and seaport areas.

The results of the study of Castillo-Manzano et al (2008) shows that the enacted legislative changes would help explaining some 35% of the total growth in the Spanish seaport traffic on average over the period 1993–2003, i.e. without the legal reforms the Spanish seaport system would have grown at a much lower pace over this period.

Figure 8 depicts the dynamic analysis of container traffic in the five previously selected seaports. For a better understanding of changes in strategic position in each period, these periods are set out chronologically.

Figure 8 – Dynamic Portfolio Analysis of Container Traffic (Weighted)



Through the dynamic analysis of container traffic, we found that only Valencia was able to maintain its Star Performer position in all of the eighteen years analysed. This result maybe could be explained by the geographic position of this seaport. In their study Castillo-Manzano et al (2008) found that some Mediterranean seaports seemed to be the main beneficiaries of the legal reforms and Valencia is the one seaport within this group.

The seaports of Algeciras and Barcelona made it to the *Star Performer* classification in the first two periods, but in the third, despite the rise in market share in the seaport of Algeciras from 35.54% to 35.78%, the market share in the seaport of Barcelona decreased from 20.53% to 20.05% and the rate of container growth was below average in both seaports (4.87% and 3.85%, respectively), which positions them as *Mature Leader* in this latest period. This result could be explained by the decrease in the total traffic and in container traffic in both seaports in 2009. In this year, the total traffic in the seaports of Algeciras and Barcelona decrease 6.50% and 16% respectively and the container traffic decrease 8.47% and 30.00%. The authorities of both the seaports, in the annual reports of 2009, mentioned the international financial difficulties as a cause.

Also regarding container traffic, the seaport of Bilbau returned to the *High Potential* position in the 1992-97 periods, with a growth rate (9.97%) slightly above the average range even while its rate of growth and market share fell to below average, classifying it as a *Minor Performer*. The seaport of Leixões was positioned as Minor Performers in container traffic throughout all periods with both its growth rates and market shares below the averages. The seaport of Lisboa was positioned as *Minor Performed* in the first and third period and as *High Potential* in the second period when the average growth rate rose from 3.24% to 9.11%. The better positioning of the seaport of Lisboa between 1998 and 2003 could be explained by the change in the management model (the management model change from tool-seaport to landlord seaport), the simplification of process and the investments in infrastructure, ICT

(Information Communications and Technologies), and in e-commerce. However, after 2004, the regular linear of MSC (Mediterranean Shipping Company) was moved to Sines with negative impact to the containers terminals.

The better strategic positioning of the seaports of Algeciras, Barcelona and Valencia is also supported by the high levels of seaports efficiency identified by Dias et al. (2009). Furthermore, the Bilbau seaport is considered a Minor Performer which is also corroborated by Dias et al. (2009) in terms of efficiency in ranking it the lowest.

4. Conclusions

This research sought to analyse the strategic positioning of Iberian Peninsula (Portugal and Spain) seaports through recourse to dynamic portfolio analysis. The BCG matrix applications have proven its usefulness as a tool to analyse the SBU position that could help in decision making and for short term strategic resource allocations. After due analysis, we would make the following observations: while analysing the Iberian Peninsula as a single seaport portfolio, it does appear that the main Spanish seaports are better positioned in relation to total traffic. This finding immediately raises some questions for future research: what factors have contributed towards this positioning? What benchmarking practices should Portugal take to match or exceed the ranking of Spanish seaports?

Considering the traffic in weighted values, in the two major Spanish and Portuguese seaports (Algeciras and Lisboa) container traffic is positioned as the Star Performer of these seaports. However, ro-ro traffic has also evolved and has a great potential in both seaports if this category continue to growing above the average over time in order to increase the market share. The importance of these two categories for these seaports is visible in the investments that have been made mainly at container terminals.

In general, it would appear that apart from the seaports of Sines and Tarragona, at the eight major Iberian Peninsula seaports, the greatest emphasis has been placed on container traffic, with all showing high rates in comparison with the total traffic at each seaport. However, within the “Iberian Peninsula range” the leadership of the seaports of Algeciras, Valencia and Barcelona in this category is remarkable. Perhaps this leadership could be explained by the access conditions and the hinterland of these seaports. The dynamic analysis enabled a visualisation of the progress in this category in three periods of the eighteen years and found that the position had changed from the first to the third period in most seaports under analysed. The seaport of Valencia is the only one that has maintains its Star Performer position in all of the eighteen years analysed. The seaports of Algeciras and Barcelona shifted from the *Star Performer* classification in the first two periods to *Mature Leader* in the latest period. This result could be explained by the decrease in the total traffic and in container traffic in both seaports in 2009. The authorities of both the seaports, in the annual reports of 2009, mentioned the international financial difficulties as a cause. The seaport of Lisboa and Leixões were positioned as *Minor Performed* in container traffic although in the second period the seaport of Lisboa was positioning in the *High Potential* position. The change of the positioning in the seaports of Lisboa could be explained by the structural changes occurred within this seaport in 1998 and 2004, namely the change in its management model and the moved of MSC liner to the Sines seaport.

In general terms, as the limitations of this study we may point out how the tool used is static in nature, although the long period of time considered in the study serves to significantly reduce this limitation and the need to complement this study with other information especially inputs covering the financial, economic and social structures of seaports and their host environments, so that certain evidence and considerations may be better understood and justified. Despite these limitations, we believe this study contributes to the advancement of knowledge in this area and provides important information for both decision makers and scholars.

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Chapter 4 - Logistics Resources in Seaport Performance: Multi-criteria Analysis

Logistics Resources in Seaport Performance: Multi-criteria Analysis

Abstract

Studying the logistics resource relationship within the framework of the overall performance of the main Iberian seaports performance, this paper discusses how to apply the linear additive Multi Criterion Analysis (MCA) model and Principal Component Analysis (PCA) into such an industry. The model incorporates the contribution of two different performance indicators, operational performance and physical capacity, measured by several indicators. Firstly, the 2009 annual data on the total cargo throughput of sixteen seaport container terminals is collected. The PCA method is then applied to attain the factor loading of each indicator and to normalize the redundancy in indicators thereby producing meaningful results. We correspondingly find (a) operational performance contributed 48.77% and the physical capacity contributed 51.23% to overall performance; (b) the majority of seaports reveal a direct proportionality between their positioning in terms of physical capacity and their positioning in overall performance; (c), this relationship changes whenever the difference in indicator value proves significant, and hence (d) this model is demonstrated to be applicable and reliable in the case of the Iberian seaport industry and demonstrates the effect of encouraging multiple decision-makers to carefully consider identifying key criteria from a given set of alternatives.

1. Introduction

The market environment for the global sea trade has changed considerably over the last fifteen years. Seaports are effectively essential for international trade and commerce. 90 percent of the EU's external trade and over 40 percent of its internal trade is transported by sea (BCI, 2009). Europe's leadership in this global industry is unquestionable as it controls 40 percent of the world fleet. Every year, over 3.5 billion tonnes of cargo and 350 million passengers pass through European seaports.

With the globalization of the economy, one of the greatest changes that organizations have to face is producing and delivering goods/services in large quantities at low cost (Buckley and Ghauri, 2004; Fawcett and Closs, 1993; Mussa, 2003). In this context logistics represent a critical support to organizations. Bagchi and Virum (1998) advocate this position in stating that when competition intensifies, decisions become more globalized and logistics becomes an important strategic area and a source of competitive advantage. The intensive use of containers, intermodal and information and communication technologies have increased the spatial reconfiguration and functional logistical links between seaports allowing them to gain important competitive advantages (Notteboom and Rodriguez, 2005). With the changes in the dimensions of containers and ships, seaports require appropriately scaled infrastructures in order to remain competitive, attract more shipping lines and consequently boost their performance. Itoh (2002) argues that the efficiency of seaport operations is dependent on everything from the design and maintenance of berths, channels, navigation aids, other waterside facilities, stacking areas, cargo handling equipment, warehouses, container freight stations, accessibility and other land-side facilities. In this context, logistical resources, particularly the facilities and equipment (physical capacity), have played an important role in seaport performance levels.

In this study, a seaport's performance is determined by its operational and physical characteristics. Therefore, to improve its performance, substantial improvements in both operational efficiency and physical capacity are essential. The addition of performance indicators, other than simply operational factors, is a key suggestion in much recent seaport research (Brooks, 2007; Talley, 2007). Based on the complexity of the contemporary seaport product, De Langen et al. (2006) suggest that seaport authorities should apply a multifaceted examination of different performance components grounded on the distinction between cargo transfer, seaport logistics and seaport manufacturing products. So, it's necessary to implement several different performance indicators.

The existing literature on seaport performance evaluation has rarely considered the role of the seaport's physical capacity as a significant indicator contributing to overall seaport performance. Even if the seaport's physical resources have been included in analysis (Cullinane et al., 2004; Dias et al., 2009; Itoh, 2002) studying seaport performance levels, this indicator was neither analyzed individually nor was its contribution to overall performance. To fill this gap in the literature, this paper aims to validate the importance of physical capacity to the overall performance of the main Iberian seaports. To this end, a linear additive MCA model was deployed with the weights derived from the factor loadings of the Principal Component Analysis (PCA). Normally, the weights are based on opinions or ad hoc weights, which are subjective in nature and may lead to unrealistic results (De and Ghost, 2003). In order to overcome this limitation, the present model computes appropriate weights for operational performance and physical facility indicators using PCA. The weights acquired from PCA are statistically better predictors for performance evaluation as compared to the weights assigned by judgments. As it is impossible to analyze all the physical resources of seaports as a whole due to the fact each type of cargo differs in both the mode of operation and in the equipment used, container cargo was chosen. For the purposes of this research, container cargo is deemed appropriate because differences in the specific container handling equipment and stacking facilities characterize container terminals. Hence, this study focuses on the container terminals in the main Iberian seaports. The Iberian container terminals play an important role in world maritime transportation, acting as a gateway to/from Europe and Asia. Taking containerized cargo into consideration, Spain took 22nd place in the 2007 rankings, while Portugal came in 53rd among 60 countries (Degerlund, 2009). According to this database, Algeciras container terminal (Spanish) took 29th place and Lisboa container terminal (Portuguese) occupied 143rd place among 365 container terminals worldwide.

Following this introduction, Section 2 provides a brief literature review on resource logistics as a seaport competitive advantage. Section 3 provides an insight into empirical analysis with a special emphasis on methodological issues. Section 4 examines a set of 2009 cross-sectional data on the container terminals of the top ten Iberian seaports by applying the linear additive MCA model and PCA. Finally, section 5 sets out the article's main conclusions.

2. Resource logistics as a seaport competitive advantage

The several changes that have occurred in the seaport industry in recent decades have had a continuous and important impact on seaport activities and management (Hayuth, 1993; Panyides, 2003). Heaver (1993) stated that the role of seaports was first changed by technological innovation in that terminals have been designed specifically with regard to the handling of cargo and specifications required by integrated logistics. Seaport management has been characterized by fierce competition resulting from structural changes in industry within the scope of which large companies engage in takeovers and mergers in an attempt to remain competitive (Panayides, 2003).

According to Evangelista and Morvillo (1998), the implementation of strategies based on acquisition stems from several reasons, including: i) protection of specialized transport activities in a particular market segment, in order to maintain and increase services management and production, ii) execution of major operations with flexibility and ability to adopt quickly to changes in a specific market segment, iii) to optimize the experience curve, and (iv) adoption of a huge control of corporate profits. However, the mergers and acquire options are not always ideal or reliable in all seaports who wish to increase market share and competitiveness. Competitiveness can also be achieved through the formulation and implementation of competitive business strategies that will increase performance (Panayides, 2003). In fact, in response to these competitive movements, other seaports try to differentiate themselves through marketing strategies or specialize in delivering services to a specific geographic area or industry.

According to Panayides (2003), there is a positive relationship between the pursuit of competitive advantage and business performance in the management of seaports. The increased emphasis on seaport strategy/performance relationships derives from intense competition, the need both to achieve competitiveness and to maximize profits for shareholders and from the pressure of the surrounding environment. The strong pressures to raise performance throughout the seaport industry appears to be best achieved through economies of scale, differentiation (in particular through the range of services offered), and focusing on the market analysis of competitors (Panayides, 2003).

Grant (1991) proposes that irrespective of how the strategic management literature tends to emphasize issues related to strategic positioning in terms of choice of cost advantages and differentiation, the fundamental factor in these choices is the deployment of company resources. In the seaport industry, Sletmo and Holste (1993) accept that maritime organizations cannot achieve competitiveness based only on the three generic strategies. They need also to involve intangible assets (human resources with tacit knowledge and specific seaport related skills).This is in line with the resource-based theoretical view.

The resource-based perspective focuses on the internal organization of firms and may, therefore, be viewed as a complement to the traditional strategic emphasis (Haezendock, 2001). As previously noted, this theory sharply contrasts with the conventional view of company strategic positioning, which focuses almost exclusively on the exogenous variables in a firm's competitive environment and examines how these forces influence firm performance (Grant, 1991; Haezendock, 2001).

The resource-based view (RBV) is currently the dominant theoretical framework for understanding heterogeneous firm performance and explaining the attributes that render a resource rent-generating (Azevedo and Ferreira, 2008; Zubac et al., 2010; Perez-Arostegui and Benitez-Amado, 2010). The idea of viewing the organization as a collection of resources comes from the work of Penrose (1959). RBV proposes that firms can acquire short-term (where not long-term) economic rents and sustain competitive advantage by their unique resource position and by the production of superior products at lower cost, higher quality, or superior performance (Ali et al., 2011). Newbert (2008) presents empirical evidence that supports the notion that implementing resource based strategies is an important means by which companies are able to improve their performance and gain competitive advantages.

Many researchers have attempted to establish resource category clusters. Barney (1991) suggests that resources can be grouped as physical, human and capital. Wernerfelt (1984) defines resources as anything that can be identified as a strength or weakness for a particular company and susceptible to being defined as either a tangible or intangible asset bound up almost inherently to companies.

The applicability of RBV theory to the seaport industry has been approached by some recent studies (Rugman and Verbeke, 1998; Panayides and Gray, 1999; Haezendonck, 2001). According to their findings the unique skills of seaports, built based on the common resources are the key elements to coping with their competitors. With reference to seaport resources, some of these prove to be more important than others, as they are necessary to creating and supplying services to customers (Martino and Morvillo, 2008). According to their perspective, resources are those factors necessary to performing both seaport and value-added logistical activities. These resources can be dividable into infrastructures (terminal, quay, etc) superstructures (cranes, depots, and equipments), human capital and information and communication technology systems.

Among the many resources which seaports can focus on in order to achieve competitive advantages, this research highlights physical logistical resources, specifically facilities and equipments. As reported by Coyle et al. (1998), in many organizations, logistics represents 20% to 25% of the total cost of products/services. Several researchers (Tongzon, 2007; Pettit and Beresford, 2009; Sohn and Jung, 2009) have suggested that seaport success is closely related to the integration of logistics into their strategies. From the perspective of logistics, seaports may thus be characterized and defined in terms of the flows of goods, services, related information and finance crossing any particular seaport interface. There are various logistics approaches and applications that, despite some differences, share a common concern about managing the interfaces and flows. In the seaport context, due to the complexity of the entire logistics process, efficient management of resources becomes a very important area for achieving competitive advantages.

Limao and Venables (2001) report how poor facilities accounts for more than 40% of predicted transport costs. In turn, when looking at the determinants of seaport efficiency, they found the level of facilities exerts a significant positive influence. The quality of facilities is an important determinant of transport costs. Facilities certainly affect transport costs via its effect on seaport efficiency. There are a lot of activities in seaports that depend on seaport facilities and equipments, like pilotage, towing and tug assistance, as well as cargo handling. Cargo handling usually includes references to physical equipment, fixed or mobile (quay, cranes, etc). Other aspects that have been also referenced as important to cargo handling are those in the immediate sea and landward context that constrain or facilitate loading and unloading capacity, e.g. sheds and storage. The efficiency of seaport operations is dependent on the design and maintenance of berths, channels, navigation aids, other waterside facilities, stacking areas, cargo handling equipment, warehouses, container freight stations, accessibility and other land-side facilities (Itoh, 2002).

3. Research methodology

3.1 Sample characteristics

The territorial research unit of analysis is the Iberian Peninsula, which is constituted by Portugal and Spain. Portugal has nine commercial seaports with the seaports of Lisboa, Leixões, Setubal, Sines, and Aveiro (Cruz et al., 2012) the most important in terms of total traffic. Since 1997, the Portuguese seaport authorities were restructured to introduce a landlord management model, following a political decision set out in the 1997 White Paper for Seaports and Maritime Transport (ESPO, 2004). The main reason put forward was the allocation of commercial activities to the private sector while reinforcing the role of the seaport authority in coordinating the following activities: safety and environment, law enforcement, and improving seaport, maritime and land access. The legal status of seaport authorities changed from being public institutes to become private companies with the state as their only shareholder. Seaports in Portugal remain state owned with the state entirely responsible for their management even though operational services are outsourced to private companies in accordance with concession contracts awarded following public tender processes.

In comparison, the Spanish reality is rather different as its 23 major seaports are managed by companies within the scope of the state holding company - *Puertos del Estado, SA.* (State Seaports, SA.), which, in addition to implementing government defined seaport policies, also holds responsibilities in terms of safety. Since 1990, the Spanish seaports authorities have faced increased competition due to a set of changes impacting on the industry worldwide (Castillo-Manzano et al., 2008). These changes include seaports specializing in specific traffic categories, trends in route selection, the containerization process and the concentration of companies and business (Bichou and Gray, 2005). The legislative framework provides the Spanish seaport system with the instruments necessary to improving its competitive position in an open, global market through endowing a significant and extended scope for seaport authority self-management (ESPO, 2004).

To enable comparison between the seaports of the two Iberian Countries, the largest five seaports in terms of total traffic were selected for each country. Thus, the Portuguese seaports, Sines, Lisboa, Leixões, Setubal, and Aveiro, representing 97.39% of total traffic in 2009 (Table 1), were selected for this empirical study. Regarding Spanish seaports, the top five, Algeciras, Valencia, Barcelona, Bilbao, and Tarragona, accounting for 59.61% of total traffic in 2009, were included for study.

Table 1 – Total Traffic in the main Iberian Seaports in 2009*

Seaports	Quantity (1000 tons)	Quantity (%)	Accumulative Quantity (%)
Portuguese			
Sines	24377	40.11	40.11
Leixões	14200	23.36	63.47
Lisboa	11709	19.27	82.74
Setubal	5900	9.71	92.45
Aveiro	3007	4.95	**97.39**
Figueira da Foz	1177	1.94	99.33
Viana do Castelo	407	0.67	100.00
Sum	**60777**		
Spanish			
Algeciras	69911	16.88	16.88
Valencia	61980	14.97	31.85
Barcelona	50884	12.29	44.14
Bilbao	32390	7.82	51.96
Tarragona	31703	7.66	**59.61**
Cartagena	20514	4.95	64.57
Las Palmas	19023	4.59	69.16
Huelva	17999	4.35	73.51
Gijon	14600	3.53	77.03
Tenerife	16479	3.98	81.01
Castellón	11073	2.67	83.69
Baleares	11732	2.83	86.52
Ferrol	12233	2.95	89.47
Coruna	11496	2.78	92.25
Alveria	3836	0.93	93.18
Santader	4422	1.07	94.24
Avilés	3950	0.95	95.20
Cadiz	3836	0.93	96.12
Pasajes	3468	0.84	96.96
Málaga	2075	0.50	97.46
Vigo	3526	0.85	98.31
Sevilla	4501	1.09	99.40
Alicante	2485	0.60	100.00
Sum	**414116**		

* The year for which the latest data on seaport traffic are available.

However, as the seaports move various types of cargo (liquid bulks, dry bulks, containers, roll-on/roll-off and conventional cargo), to analyze their physical resources as a whole would be impossible due to the fact that each cargo type differs in the loading and unloading mode of operation, the type of equipment used and the unit of measurement available. For example, the storage area, which is an important seaport physical resource, is measured in m3 for liquids bulk terminals, in TEU containers for container terminals and in m2 for dry bulk terminals.

Because of this limitation, from the five traffic categories, container traffic was chosen for the following reasons: it is the category with the largest traffic flow (with a market share of 38.55% of total traffic) in Iberian seaports in 2009; it has the highest growth rate (22%) over the last five years (2004-2009) and given this category has also been the subject of several recent research projects that have enhanced the importance of seaport competitiveness (Cullinane et al., 2004;

Itoh, 2002; Sohn and Jung, 2009; Dias et al., 2009). For Frémont (2009), there are four major reasons for the impressive growth in containerization over the last 40 years. The first two principally involve the maritime leg of transport: the efficiency of seaport handling and the reduction in unit transport costs. The third cause is how the intermodal nature of containers ensures door-to-door services while the fourth is the development of logistics services.

Container traffic flowing through Iberian Peninsula seaports in 2009 is substantially concentrated, with 70% of traffic moving through only three seaports: Algeciras, with 37 million tons (Mton), Valencia, with 42 Mton and Barcelona, with 18 Mton (*Memorias de las autoridades portuarias and Anuarios estadísticos de Puertos del Estado*, 2009; Instituto Portuário e dos Transportes Marítimos (IPTM), 2009). After these, come the seaports of Las Palmas (11 Mton), Lisboa (5 Mton), Bilbao (5 Mton), Leixões (4 Mton) and Sines (3 Mton), with container traffic in other seaports of little or practically no significance. Hence, following analysis of the 2009 container terminal performance at the top ten Iberian seaports, we opted to consider only eight seaports, excluding Setubal and Aveiro since container traffic is of residual significance in 2009 (with market shares of 0.019% and 0.007%, respectively). The container terminals (table 2) selected handled 83.61% of the container cargo on the Iberian Peninsula.

Table 2 - Total container terminal cargo throughput at research seaports

Seaports	**Container Terminal**	**Cargo Throughput (TEU*)**	**Cargo Throughput (1000 Tonnes)**
Algeciras	APM terminal 2000 Isla Verde Container terminal	3,043,268	37,800
Valencia	Valencia Public Container terminal Terminal de contentores MSC Terminal Muelle de Levante	3,653,890	42,482
Barcelona	Terminal Catalunya Terminal Barcelona Terminal Port-Nou	1,800,214	17,625
Bilbao	Abra terminals maritimas Terminales maritimas de Bilbao	443,464	4,757
Tarragona	Muelle de Castilla	221,203	2,456
Sines	Terminal XXI	253,543	3,050
Leixões	North terminal South terminal	454,503	4,546
Lisboa	Alcantara Sul Container terminal Santa Apolonia Container terminal	556,000	5,007

Note: *TEU is the abbreviation for “Twenty foot Equivalent Unit”, referring to the most common, standard size for a container 20 ft in length.

3.2 Model selection and specification

Seeking to improve performance is set out as a core objective of firms and is the case within the seaport industry (Cullinane et al., 2006; De and Ghost, 2003; Dias et al., 2009). By applying stochastic frontier analysis (SFA) and the data envelopment analysis (DEA) within the seaport context, performance has been empirically examined by several authors (Cullinane et al., 2006; Dias et al., 2009; Song et al., 2011).

The methodology applied in this paper differs from this body of previous research in that the linear additive MCA model is applied to assessing the relative importance of two different performance variables: operational performance and physical capacity. The model incorporates the contribution of operating performance indicators and physical facility related indicators in the overall performance of seaports. Commonly, in other models, these indicators were analyzed in conjunction and without analyzing their respective weightings in the overall performance level. This methodology has been deployed in many scientific areas such as the healthcare sciences (Takasuna, 2006), and social sciences (Dubois et al., 1994; Hao, 2010). In the seaport industry, De and Ghosh (2003) and Tongzon and Heng (2005) applied this methodology for developing a composite index.

To assess the proposed objective, this method is more appropriate despite the criticism it was subject to: the weights assigned to variables are either based on opinions or ad hoc weights, which are subjective in nature and may lead to unrealistic results. In order to overcome this limitation, the present study acquires appropriate weights for operational performance indicators and physical facility indicators using Principal Component Analysis (PCA). The weights acquired from PCA are statistically better predictors for performance evaluation as compared to the weights assigned by judgments (Asaf, 1995; De and Ghosh, 2003; Sharma and Sehgal, 2010). In the PCA approach, the first principal component is a linear combination of the weighted variables explaining the maximum of variance across space. Hence, the objective of the weighting mechanism is to explain the maximum variance for all the individual indicators across the seaports at a specific point in time.

The linear additive MCA model is a multi-attribute or multi-criterion decision analysis (MCDA) technique (DCLG, 2009). MCDA is both an approach and a set of techniques with the goal of providing an overall ordering of options, from the most preferred option to the least preferred option. It involves identification of the indicators most relevant to the objective. In linear additive MCA models, there are two inputs, weights and scores. The weights are allocated to all indicators to reflect their relative importance; and the scores are assigned to all indicators to reflect the performance of the seaports in each indicator. The weighted score of each seaport for each indicator is derived by multiplying the weights of each indicator by the scores of each indicator for each seaport. The sum of all weighted indicator scores for each seaport reveals the overall performance of each seaport in terms of all indicators. The weighted score resulting for each seaport may be applied to indicate and compare the overall seaport performance. In summary, each seaport's weighted score (the overall performance) is a linear combination of the weighted score of all indicators resulting from:

$$\mathrm{WS}_{\mathrm{ij}} = \sum_{k=1}^{n} w_{kj} X_{kij} = w_{1j} X_{1ij} + w_{2j} X_{2ij} + ... + w_{nj} X_{nij}$$

Where $\mathrm{WS}_{\mathrm{ij}}$ represents the weighted score of *i*th seaport in *j*th time, w_{kj} is the weight of *k*th indicator in *j*th time, X_{kij} is the Score of *k*th indicator for the *i*th seaport in *j*th time, and *n* represents the total number of indicators.

3.3 Definitions of performance indicators

Hence, seaport performance is measured according to two variables: operational performance and physical capacity. These variables are measurable by a set of indicators. To understand the impact of such variables, it is necessary to identify the indicators with greatest influence over the overall performance of a particular seaport. The indicators chosen derive from the literature review on seaport performance. The operational performance indicators adopted are:

- *Container throughput* - represents the most important and widely accepted seaport or terminal operational performance indicator. This is because it closely relates to the need for cargo-related facilities and services and is the primary basis upon which container seaports are comparable, especially in assessing their relative size, scale of investment or activity levels. Another consideration is that container throughput is the most appropriate and analytically tractable indicator of the effectiveness of a seaport's output (Cullinane et al., 2004). This variable may be measured by the total number of 20 feet equivalent units (TEUs) containers loaded and unloaded in or/and tonnes handled. In this study both are used as two independent variables (TEU handled and cargo tonnage throughput);
- *Number of ships handled* - refers to the total (number of) ships/vessels handled for loading and unloading at container terminals;
- *Capacity utilization* - refers to the proportion (percentage) of total cargo handled at the terminals in relation to total terminal capacity;
- *Ship rate* – Number of containers moved per working hour, per ship and thus an indicator of the speed at which ships are handled. As the container handling aspect of seaport operations is the largest component of total ship turnaround time, the speed of moving cargoes off and on ships at berth has considerable implications for seaport users (Tongzon, 2001);
- *Market Share* – refers to the proportion (percentage) of cargo throughput of the terminals in relation to the cargo total handled by all terminals.

The indicators related to physical capacity available are:

- *Berths* – refers to the number of container berths at the terminal.
- *Terminal area* - Dowd and Leschine (1990) argue that the productivity of a container terminal depends on the efficient use of labour, land and equipment. Given the characteristics of container seaport production, terminal areas are the most suitable proxies for the 'land' factor. This indicator is measured in squared meters (m2)
- *Storage Area* - The storage area acts as a buffer between sea and inland transportation or transshipment. The size of a ship is very frequently thousands of times the size of the land vehicles transporting the cargo to and from the port. As such, the utilization of such storage space is normally inevitable. This indicator is measured by the storage area capacity in relation to the total number of in TEU containers stored.
- *Cranes* - As container shipping lines are the most important container seaport clients, the transfer of cargo across a quay between ship and shore fundamentally impacts on seaport performance and is vital to its competitive positioning (Cullinane et al, 2004). In this production process, the most important piece of equipment is the gantry crane. Depending on the quantity of berths and cranes, it is possible to process more ships and faster. This indicator refers to the total number of cranes installed at each terminal.
- *Other equipment* - The main pieces of equipment used within a container yard are the yard gantry cranes and straddle carriers. Other equipments is any machine used to move containers at the terminal (reach stackers, transtainers, straddle carriers, forklifts, yard chassis/trailers; yard tractors)
- *Cargo Capacity*- refers to the numbers of TEU containers that the terminal handled in relation to total capacity.

Any improvement in operational performance will enhance the container terminal as a better preferred destination in comparison with other terminals. Physical facilities like berths, cranes and other equipments represent the capacity of the terminals to effectively handle the cargo loading/unloading and cargo movement activities carried out at the terminals. The physical capacity influences the overall performance of cargo handling and the logistics capacity of terminals.

Based on the argument that container terminals are more suitable for one-to-one comparisons than whole container seaports (Cullinane et al., 2004), this study initially sought to study individual container terminals. However, data sources often reported the required data, especially container throughput, at the aggregate level of the whole seaport rather than by the individual terminals comprising some seaports within the sample. In such cases, the seaport performance indicators are defined as the aggregate of the individual terminal indicators within the seaport. It is important to recognize, however, that such aggregation prevents analysis of the individual terminals within the same seaport, particularly when these container terminals operate as independent units. Nevertheless, for a sample composed at the aggregate seaport level, the data used in the study is the most reliable and comprehensive available. The annual 2009 data, the year for which the latest data on seaport/terminal indicators are available, are collected for each seaport. Thus, the sample of analysis comprised a total of 96 observations. The secondary data required are mostly sourced from the world container terminal database (Degerlund, 2009), *Memorias de las autoridades portuarias and Anuarios estadísticos de Puertos del Estado* (2009) and from official seaport sites. A summary of the major selected indicator characteristics is presented in table 3 with the absolute values presented in Appendix A.

Table 3 - Descriptive statistics of the selected indicators

	Operational Performance Indicators					
	Ship rate (no.)	Market Share (%)	TEU Handled (no.)	Cargo Throughput (1000 tons)	Capacity Utilization (%)	Ships Handled (no.)
Max.	61.76	35.05	3653890	42482	95.24	3023
Min.	16.12	2.12	221203	2456	29.49	469
Mean	31.16	12.50	1303260.63	14725.38	65.92	1436.50
Standard Deviation	16.51	13.11	1367523.34	16471.88	22.64	961.815
	Physical Capacity Indicators					
	Berths (no.)	Terminal Area (m2)	Storage (TEU)	Crane (no.)	Others Equip. (no.)	Cargo Capacity (TEU)
Max.	11	1612300	92339	29	265	5576678
Min.	1	21250	2040	2	13	400000
Mean	3.63	580947.88	25932.25	13.38	122.75	1790250.38
Standard Deviation	3.29	536727.70	28326.51	10.54	100.74	1780958.39

4. Results, analysis and discussion

As mentioned earlier, the linear additive MCA model involves identifying the indicators most relevant for the objective, in this case, the overall performance of seaports. In the linear additive MCA model, there are two inputs, weights and scores. The weights are allocated to all indicators to reflect their relative importance and the scores are assigned to all indicators to reflect the performance of the seaports in each indicator. Thus, it is necessary to calculate the weights and the scores for each indicator in order to obtain the final weighted score.

Indicator Weights

The conventional method of assigning subjective or *ad hoc* weights might lead to unrealistic results. To overcome this limitation, the variable weights are derived from the PCA technique. The rationale behind deriving weights from PCA is to normalize redundancy in the variables when the absolute variable values are correlated, as they measure the same construct (overall performance).

According to Hair et al. (2006), the critical assumptions factor analysis is more conceptual than statistical. Researchers are always concerned with meeting the statistical requirement for any multivariate technique whereas in factor analysis the overriding concerns center as much on the character and composition of the variables included in the analysis as on their statistical qualities (Hair et al., 2006). In terms of conceptual issues, the main assumptions are: where a study is being designed to reveal factor structure (as is the case of this study even though our factor here is the indicators), it should strive to have at least five variables for each proposed factor; the minimum absolute sample size should be 50 observations and the number of observations per variable should be at least five. The chosen sample satisfied all these assumptions: each variable has six indicators, the sample size is 96 and each indicator has eight observations.

In terms of statistical issues, the main assumptions are: the correlation matrix returns correlations greater than 0.3; Bartlett´s Sphericity test should be statistically significant at $p<0.05$ and the Kaiser-Meyer-Olkin is above 0.6. In this study, the correlation matrix records correlations greater than 0.3 (table 4) although it is not possible to validate Bartlett´s Sphericity test and the Kaiser-Meyer-Olkin value as the number of variables (12) is greater than the number of cases (8) and for these tests, the number of variables should be less than the number of cases, i.e., in our case, equal to or below 7. Given we want to compare the weight of the two dimensions, it is preferable to have the same number of variables in each dimension. It correspondingly becomes necessary to reduce the variables to 6 (ship rate, TEU handled, capacity utilization, terminal area, storage area, and other equipments). With these variables the Bartlett´s Sphericity test is 0.002, statistically significant at $p<0.05$ and the value of Kaiser-Meyer-Olkin is 0.77 that is above 0.6 (the assumptions necessary for applying PCA).

However, as the objective of using the PCA in this paper is simply to attain the factor loading of each indicator, the factor loadings of these six indicators in the two samples were compared. The paired-sample T-Test was applied to analyze whether there is any statistically significant difference in the mean scores in the factor loadings of the two samples. The probability value is 0.488, less than 0.05, the t value (-0.748) and the degrees of freedom (df=5) are inferior to 2.571 and the confidence interval stretches from a lower boundary of -0.051736 to an upper boundary of 0.28403. Therefore, we do not reject the null hypothesis that the mean difference is zero. Thus, there is no significant difference between the factor loadings in the two samples. In addition, the final results of this study (the ranking of the operational and physical indicators) do not change when applied to the first or the second sample. Therefore, based on these considerations, and to generate more information and analytical indicators able to assist in explaining the importance of the two variables, the first sample of 98 observations were applied in this paper.

Table 4 – The selected indicator correlation matrix

	Ship rate	Market Share	TEU Handled	Cargo Throughp	Capacity Utilization	Ships Handled	Berths	Terminal Area	Storage	Crane	Others Equip.	Cargo Capacit
Ship rate	1.00											
Market Share	0.911*	1.00										
TEU Handled	0.911*	1.00	1.00									
Cargo Through	0.936*	0.996*	0.996*	1.00								
Capacity Utilizatio	0.487	0.522	0.522	0.501	1.00							
Ships Handled	0.686	0.910*	0.910*	0.869*	0.597	1.00						
Berths	0.512	0.794**	0.794**	0.754**	0.230	0.887*	1.00					
Terminal Area	0.734**	0.892*	0.892*	0.858*	0.388	0.910*	0.908*	1.00				
Storage	0.520	0.726	0.726	0.703	0.048	0.735	0.938	0.876	1.00			
Crane	0.822**	0.915*	0.915*	0.887*	0.519	0.913*	0.795*	0.960*	0.738	1.00		
Other Equipme	0.880**	0.944	0.944*	0.938*	0.550*	0.892*	0.745*	0.862	0.677	0.937	1.00	
Cargo Capacity	0.827**	0.960*	0.960*	0.953*	0.297*	0.873*	0.889*	0.919*	0.868*	0.875*	0.882*	1.00

*Correlation is significant at the 0.01 level
**Correlation is significant at the 0.05 level

The correlation matrix reveals that apart from the capacity utilization indicator, all the indicators have correlations of above 0.60 and the majority of them approximate 0.90. For example, the indicator cargo capacity and ship rate (0.83); cargo capacity and market share (0.96); cargo capacity and cargo throughput (0.95); cargo capacity and terminal area (0.92); and cargo capacity and other equipments (0.88) were found to be heavily and positively correlated. The observed correlations may be caused due to some underlying pattern in the data of variables measuring the same construct (overall performance). This redundancy in variables reduces the accuracy of variables as predictors and therefore, the weights (factor loadings) acquired from PCA facilitates normalizing the redundancy in variables and yields more accurate predictors. The factor loadings indicate the contribution of each indicator and, therefore, the weights (on the basis of factor loadings) derived from using PCA are more realistic and reflect the relative importance of the variables under analysis, hence producing meaningful results. The weights for the indicators derived from the PCA factor loadings are presented in Table 5. The Statistical Package for the Social Sciences (SPSS) package was adopted for deriving PCA factor loadings.

Table 5 – Indicator weights derived from PCA factor loading

	Operational Performance						**Physical Capacity**					
	Ship rate	Market Share	TEU Handled	Cargo Throughput	Capacity Utilization	Ships Handled	Berths	Terminal Area	Storage	Crane	Others Equip.	Cargo Capacity
Factor Loadings	0.859	0.984	0.984	0.968	0.500	0.943	0.866	0.952	0.806	0.956	0.953	0.966
Weights	8.00%	9.16%	9.16%	9.01%	4.66%	8.78%	8.07%	8.87%	7.51%	8.90%	8.88%	9.00%
Sum of Factor Loadings	5.238						5.499					
Sum of Weights	**48.77%**						**51.23%**					

In this analysis, it was found that all six operational performance indicators together contributed about 48.77 percent and all six physical capacity indicators together contributed about 51.23 percent to overall (100 percent) seaport performance. It is important to recognize, however, that the weights derived from the PCA factor loadings are specific to individual cases and non-transferable to others and, correspondingly, the weights assigned to indicators may not be the same for different years.

Indicator Scores

The second stage of the linear additive model is to score each option (seaports) against each attribute (indicators) on a suitable scale. Cardinal scores (in units) are allocated to the (absolute values) indicators on the basis of performance. The scores are calculated in such a way that the seaport with worst performance gets one unit score and the seaport with the best performance gets the highest score according to the level of performance for each variable. This means that in the case of a particular variable, where seaport A performs three times better than seaport B, then seaport A is given a score that is three times that of seaport B. Table 6 sets out the cardinal scores for the indicators under analysis. The rationale behind allocating a minimum score to one unit and not zero for the worst performance is that the zero unit score would further make the overall performance (weighted score) zero when multiplied by weights and would nullify the contribution of the worst performance even though existing. Such an approach serves to increase the accuracy of indicators as predictors while also proving more informative.

Table 6 - Cardinal scores of the selected container terminal indicators of major Iberian seaports

	Operational Performance						Physical Capacity					
	Ship rate	Market Share	TEU Handled	Cargo Throughput	Capacity Utilization	Ships Handled	Berths	Terminal Area	Storage	Crane	Others Equip.	Cargo Capacity
Algeciras	3.83	13.76	13.76	15.42	3.23	4.38	3.00	36.95	8.97	11.50	20.38	7.99
Valencia	3.12	16.52	16.52	17.30	2.22	6.45	11.00	75.87	45.26	14.50	20.23	13.94
Barcelona	1.95	8.14	8.14	7.18	3.19	5.09	5.00	47.00	10.91	11.50	12.08	4.79
Bilbao	1.82	2.00	2.00	1.94	1.50	1.35	2.00	27.67	14.98	7.00	7.38	2.50
Tarragona	1.19	1.00	1.00	1.00	1.00	1.03	1.00	1.00	1.00	1.00	1.15	1.88
Sines	1.40	1.15	1.15	1.24	2.15	1.00	1.00	6.26	2.75	1.00	1.00	1.00
Leixões	1.16	2.05	2.05	1.85	2.57	2.16	2.00	8.72	7.84	2.50	3.69	1.50
Lisboa	1.00	2.51	2.51	2.04	2.13	3.06	4.00	15.24	9.99	4.50	9.62	2.21

Weighted Scores

The weighting of scores involves multiplying each indicator (cardinal) score for each seaport by the weights (derived from PCA) for each indicator. Thus, the weighted scores are the performance scores for each seaport pertaining to each respective indicator. These weighted scores act as indices for comparing seaports performances according to each particular indicator. Table 7 presents the weighted scores for the selected container terminal indicators of Iberian major seaports for the year 2009. The weighted scores not only indicate the best or worst performances but also highlight the extent of differences in the performance of particular indicators at the seaports under analysis. For example, Sines has the second poorest performance in terminal area but is 6.26 times better than Tarragona, which was the worst. Valencia has the best storage area performance and is 45.26 times better than Tarrragona, the worst in this category.

Table 7- Weighted scores of the selected container terminal indicators of major Iberian Seaports

	Operational Performance Indicators						**Physical Capacity Indicators**					
	Ship rate	Market Share	TEU Handled	Cargo Throughput	Capacity Utilization	Ships Handled	Berths	Terminal Area	Storage	Crane	Others Equip.	Cargo Capacity
Algeciras	30.65	126.02	126.02	138.97	15.05	38.43	24.21	327.75	67.38	102.35	181.02	71.90
Valencia	24.99	151.31	151.31	155.85	10.35	56.59	88.77	672.99	339.93	129.05	179.65	125.48
Barcelona	15.60	74.55	74.55	64.66	14.85	44.67	40.35	416.87	81.90	102.35	107.24	43.09
Bilbao	14.53	18.36	18.36	17.45	7.01	11.81	16.14	245.44	112.47	62.30	65.58	22.50
Tarragona	9.49	9.16	9.16	9.01	4.66	9.02	8.07	8.87	7.51	8.90	10.25	16.88
Sines	11.18	10.50	10.50	11.19	10.01	8.78	8.07	55.52	20.62	8.90	8.88	9.00
Leixões	9.30	18.82	18.82	16.68	11.97	18.93	16.14	77.33	58.90	22.25	32.79	13.50
Lisboa	8.00	23.02	23.02	18.37	9.93	26.90	32.28	135.20	75.02	40.05	85.38	19.91

To better understand the contribution of the operational performance indicators and the physical capacity indicators to seaport performance levels, based on the sum of the weighted scores, ranks are allocated to the eight major Iberian seaports as shown in table 8. The total overall seaport performance scores reveal that Valencia gets the highest scores and ranks first among all Iberian seaports in container cargo, while Algeciras is second and Barcelona third. Bilbao, Lisboa, Leixoes, Sines, and Tarragona hold fourth, fifth, sixth, seventh and eighth positions, respectively. The leading position of Valencia comes as no surprise as the city is the leading seaport on the Mediterranean trade, specialising in containerized cargo courtesy of a dynamic hinterland, the latest generation in terms of facilities and an extensive network of regular connections to major seaports worldwide. Valencia's leadership is based on a location in the center of the western Mediterranean, which positions the Valencia seaport as the first and last stopover for major shipping companies from the Americas, the Mediterranean and the Far East.

Table 8 - Major Iberian seaport container terminal rankings (2009)

	Operational Performance		Physical Capacity		Overall Performance	
	Sum of weights score	Rank position	Sum of weights score	Rank position	Sum of weights score	Rank position
Valencia	550.40	1	1535.87	1	2086.27	1
Algeciras	475.14	2	774.59	3	1249.73	2
Barcelona	288.87	3	791.80	2	1080.67	3
Bilbao	87.53	6	524.43	4	611.96	4
Lisboa	109.24	4	387.85	5	497.09	5
Leixões	94.51	5	220.90	6	315.41	6
Sines	62.16	7	110.98	7	173.14	7
Tarragona	50.50	8	60.47	8	110.97	8

Table 8 provides the evidence for the following considerations about the influence of physical capacity on overall seaports performance. First, three seaports (Valencia, Tarragona and Sines) emerge similarly ranked in operational performance and physical capacity and this position remains in terms of overall performance. Among the seaports returning difference in the ranking between operational performance and physical capacity, the majority of seaports reveal a direct proportionality between their position in terms of physical capacity and their position in terms of overall performance (the cases of Bilbao, Lisboa and Leixões). Bilbao holds a higher positions in terms of overall performance due to its higher physical capacity ranking as compared to its operational performance ranking. It is interesting to observe that Bilbao holds sixth position in terms of operational performance, but fourth position in terms of physical capacity, which ultimately places it in fourth place in terms of overall performance. Similarly, Leixões and Lisboa hold lower positions in terms of overall performance due to their lower physical capacity rankings as compared to their operational performance scores. This result reinforces the idea that physical capacity contributed more to the overall performance than the operational performance. The physical condition of Bilbao, with natural water depths reaching 32 meters and the high degree of terminal specialization, enable it to gateway any type of vessel and handle all kinds of goods, which constitutes a significant competitive advantage. The physical capacity of Bilbao is superior to Leixões and Lisboa across three indicators identified above as highly important to container terminal operational efficiency. Bilbao's container terminal area is 1.82 times that of Lisboa and 3.17 times the size of the container terminal area of Leixões. Furthermore, the TEU storage capacity of Bilbao's container terminals is 1.5 times that of Lisboa and 1.91 times that of Leixões.

However, two seaports (Algeciras and Barcelona) do not reflect this trend. Barcelona holds a better position in terms of physical capacity than in operational performance but remains in the same operational performance position. On the other hand, Algeciras returns a worse position in operational performance than in physical capacity while remaining in the same operational performance position. It is thus necessary to look at the contribution of each indicator in order to explain this situation (table 9).

Table 9 - Correlation between indicators values and seaport score rankings

	Operational Performance						Physical Capacity					
	Ship rate	Market Share	TEU Handled	Cargo Throughput	Capacity Utilization	Ships Handled	Berths	Terminal Area	Storage	Crane	Others Equip.	Cargo Capacity
Operational performance weighted scores	0.91 *	1.00*	1.00*	0.99*	0.54	0.91*						
Physical performance weighted scores							0.93*	0.99*	0.91*	0.95*	0.89*	0.95*
Overall performance weighted scores	0.81 **	0.96*	0.96*	0.94*	0.42	0.93*	0.91*	0.98*	0.87*	0.96*	0.92*	0.97*

*significant at 0.01 level; ** significant at 0.05 level

Table 9 reveals that of the operational performance indicators, all the variables except for the capacity utilization level are highly correlated with the seaport operational performance ranking scores. This indicates that these variables significantly contribute to seaport operational performance levels and in turn significantly dependent on the volume of cargo handled, the number of vessels handled, market share and the ship rate. All physical capacity indicators are found to be highly correlated with the seaport physical capacity ranking scores (i.e. all correlations above 0.9). This reveals that they all significantly contribute to the physical capacity of seaports. This result also convincingly supports the allocation of higher weights to all the physical capacity indicators. In relation to overall performance, all the variables except for capacity utilization are strongly correlated with overall performance. This demonstrates that all of the indicators selected significantly contribute to the overall performance of seaports apart from the level of capacity utilization.

This analysis and the fact that the contribution made by physical capacity (51.23%) is slightly greater than that of the operational performance (48.77%) may explain the divergence between the positions of Algeciras and Barcelona in the ranking. The weighted physical performance score of Barcelona is higher than Algeciras because in the three physical capacity indicators (number of berths, terminal area and storage area), where Barcelona has a higher absolute value than Algeciras, the correlation is high. Thus, with a slight variation in the contribution made by the two performance variables and a significant difference between the absolute value of the operational performance of these two seaports, the overall performance is subject to a greater influence of operational performance. Algeciras seaport, with a great location and excellent natural conditions is the reference point for maritime shipping lines linking Asia with Europe and America, and Africa with Europe. Between 2007 and 2010, these seaports have invested €360.5 million.

It is important to highlight this scenario is soon set to change with the widening of the Panama Canal in 2014. Container terminals will have to adapt their facilities to the new reality should they wish to remain competitive. According to its sponsors, the Panama Canal expansion will become a globalized development platform, as a unique seaport with terminals in two oceans. In 2015, when the expansion project goes fully operational, traffic of 8.4 million TEU per year is expected. The new infrastructure enables the passage of vessels of up to 13,000 TEU container ships, 366 meters long and 15 meters deep. The challenges are clear: making infrastructures more competitive within the scope of the prevailing environment, as well as meeting the growing demand for tonnage appropriate service levels for each market segment. Significant investment is currently ongoing in various seaports that will subsequently impact on their rankings. For example, Leixões is expanding its berths in order to increase their capacity and thus the competitiveness of this seaport by enabling "Post-Panamax" ships to be handled and thus accessing 75% of world container cargo trade. Similarly, the Sines container terminal is undertaking the expansion of its berths by over 210 meters resulting in a total of 940 meters and thus raising the terminal's handling capacity to 1.32 million TEUs per year.

5. Conclusion

Globalization, the elimination of trade barriers, the unprecedented growth of containerization and the increase in seaborne trade have had an impact on maritime transport and logistics chains. In these environments, the importance of formulating strategies to attain competitive advantages with implications for performance is becoming increasingly clear. The crucial question arising out of evaluating seaport performance is just how to measure performance. Seaports have traditionally evaluated their performances by comparing their actual and optimum throughputs. However, in an environment in which seaports are engaged in mutual competition, a seaport should be concerned about whether or not it can compete for cargo. In this context, physical logistics resources should play an important role to the extent that both infrastructures and equipments must be appropriate to deal with the new challenges, such as changes in ship sizes. Firm resources and capabilities may be deemed an influential theoretical framework for explaining how competitive advantage within firms is achieved and sustained over time. Recently, there has been a reinforced interest in the role of firm resources as a foundation for firm strategy. Logistics management and resources have increasingly been recognized as a key factor in establishing seaport competitive advantage. Endowing the physical conditions for effective intermodality is a determinant factor in seaport development plans, as well as the development of organizational conditions able to reinforce competitiveness by attracting ever rising cargo flows. Thus, this study represents an attempt to provide a satisfactory answer as to just how physical logistics resources influence overall seaport performance levels.

In this study, the seaport's performance is determined by its operational and physical characteristics. The linear additive MCA and PCA models were applied to establish a ranking of container terminals at the ten leading Iberian seaports based on these two variables. Accepting the caveat stemming from the limitations inherent to the data analyzed and the additive linear MCA models, this research concludes that operational performance contributed 48.77 percent and the physical capacity contributed 51.23 percent to overall performance. This study furthermore demonstrates that the majority of seaports (Bilbao, Lisboa and Leixões) reveal a direct proportionality between their position in terms of physical capacity and their overall performance positioning. This finding reinforces the idea that physical capacity contributes more to the overall performance than the operational performance. In addition, we also highlight how this relationship changes whenever the difference in variable value is significant. This was the case with the Algeciras and Barcelona seaports. Nevertheless, particularly with the widening of the Panama Canal in 2014, this scenario may be expected to change because container terminals will have to adapt their facilities and equipment to the new reality should they wish to remain competitive, especially those Iberian container terminals that previously served as the shipping gateways to Europe and Asia.

The main limitation of this study derives from the fact that the conclusions presented are limited to the selected sample of the ten largest Iberian seaport container terminals. With the availability of more seaport data and the inclusion of more facilities, applying this methodology to similar seaports based on a larger sample size represents an interesting area for future research.

Another limitation stems from the fact that the linear additive MCA model is considered a simplistic technique and, although the multivariate PCA technique was deployed here to suppress this main limitation, the weights derived from PCA factor loadings are specific to individual cases. Correspondingly, the weights assigned to the variables may vary over different years. However, like many MCA procedures, this model proves applicable and reliable in the case of the Iberian seaport industry and does have the effect of encouraging multiple decision-makers to consider carefully when identifying key criteria from a given set of alternatives.

Despite these limitations, we believe this study contributes to the advancement of knowledge in this area and provides important information for both decision makers and scholars. For scholars, this study proposes another methodology for analyzing seaport performance, principally how to analyze the contribution of different performance dimensions through recourse to MCA. For decision makers, this study opens up another perspective on seaport performance, i.e., not only looking at the operational performance but also at the physical capacity of seaports.

Although this study has set out some evidence on the importance of physical resources in the seaport industry, there remains significant scope for future research. The lack of access to more important operational performance indicators such the turnaround time (total time spent by a vessel from arrival through to departure) and the average pre-berthing time (the time a vessel waits before docking) for most of the sample's seaports constrained this research. Thus, it shall be interesting to see further research, applying this methodology, on how these indicators contribute to overall performance.

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Appendix A – Absolute value of the selected indicators

	Operational Performance Indicators						Physical Capacity Indicators					
	Ship rate (no.)	Market Share (%)	*TEU Handled (no.)	Cargo Throughput (1000 tons)	Capacity Utilization (%)	Ships Handled (no.)	Berths (no.)	Terminal Area (m2)	Storage (TEU)	Crane (no.)	Other Equip. (no.)	Cargo Capacity (TEU)
Algeciras	61.76	29.19	3043268	37800	95.24	2053	3	785184	18302	23	265	3195431
Valencia	50.36	35.05	3653890	42482	65.52	3023	11	1612300	92339	29	263	5576678
Barcelona	31.43	17.27	1800214	17625	94.01	2386	5	998700	22247	23	157	1914894
Bilbao	29.28	4.25	443464	4757	44.35	631	2	588000	30552	14	96	1000000
Tarragona	19.12	2.12	221203	2456	29.49	482	1	21250	2040	2	15	750000
Sines	22.52	2.43	253543	3050	63.39	469	1	133000	5600	2	13	400000
Leixões	18.73	4.36	454503	4546	75.75	1011	2	185249	16000	5	48	600000
Lisboa	16.12	5.33	556000	5007	62.82	1437	4	323900	20378	9	125	885000

Part III

Final Considerations

As referred to by several authors, a good theory needs to be simple, sober and realistic. These were the underlying principles guiding the four empirical articles that make up this doctoral thesis. Following a thorough review of the literature, covering a range of different positions across academic theories, we identify the following contexts in the seaport industry: i) seaport competitiveness is influenced by several factors both internal and external to the industry; ii) to improve seaport competitiveness, seaport service providers need to deeply understand the seaport user's experience, determining the antecedents of competitiveness, identifying performance gaps and determining where a seaport can best concentrate efforts for improvement; iii) the importance of formulating strategies for the attaining of competitive advantages with implications for performance is becoming increasingly clear in the seaport context and thus the resource based approach may be deemed an influential theoretical framework for explaining how competitive advantage within seaports is achieved and sustained over time and iv) the management of logistics resources has increasingly been recognized as a key factor in establishing seaport competitive advantage.

Our interest in the seaport sector derives from the irrefutable role that this sector plays in the development of the host country and as widely defended by a diverse range of authors. In this thesis, seaports are studied across four fundamental research facets: i) competitiveness levels; ii) competitiveness factors from the stakeholder perspective iii) strategic positioning; and iv) logistics resources. As aforementioned, these four areas stem from the research questions that we now proceed to answer.

1.Are there different levels of competitiveness among Iberian seaports?

To answer this question, we made recourse to the Data Envelopment Analysis approach for measuring seaport competitiveness in accordance with their efficiency levels. The results suggest that Iberian seaport efficiency levels differ significantly not only from seaport to seaport but also within each seaport over time. Unlike the ranking in terms of cargo throughput, the most efficient Portuguese seaports are Leixões and Setubal and their Spanish peers are Algeciras, Barcelona and Tarragona. This has proven that reported in other studies: seaport efficiency does not necessarily correlate with cargo throughput.

On analysis of the evolution in Iberian seaport efficiency between 2005 and 2009, we find that Algeciras and Barcelona emerge as the most efficient performers in every year when compared with the others. In this analysis, both the Sines and Lisboa seaports (the main Portuguese seaports) do not attain 100.00% efficiency in any of the years under review. It is thus suggested these two seaports strengthen their co-operation processes in order to raise their respective competitive standards. Furthermore, while the Valencia seaport was the second largest Spanish seaport, it also did not reach 100.00% efficiency in any year under consideration. Applying cross section data for 2009 resulted in the conclusion that, on average, the seaports analysed could operate at 83.74% of their current levels while still returning the same output value. When compared to the others, and despite still having low efficiency scores, the Aveiro and Sines seaports reveal a major improvement in efficiency over the 2005 to 2009 period. Using two different DEA models allow identifying that the probable dominant source of inefficiency at the Aveiro seaport results from its lack of economies of scale.

Beyond measuring the efficiency level, we also identify the contribution of inputs/output to seaport efficiency and the causes of inefficiency. When looking at the input/output contributions to the efficiency level, we find the “turnover” variable to be the output most contributing to the efficiency scores of the seaports under study. In general, we see that all inefficient seaports need to decrease their fixed assets and the amount of labour inputs and/or increase the number of ships handled.

Following this research into competitiveness levels, we proceeded to learn what are the key factors affecting seaport competitiveness from the stakeholder perspective. Hence, we are now in a position to respond to the second research question:

2. What are the key factors of seaport competitiveness from the stakeholder perspective? Do perceptions of the importance of these factors differ between users and service providers?

Using the Analytic Hierarchy Process (AHP), we investigate the key factors to seaport competitiveness from the stakeholder perspective and the respective strengths of their preferences. The perceptions of both seaports users and seaports service providers were incorporated to reveal any potential discrepancies between these two groups of stakeholders. The results from AHP surveys of liner shipping companies and seaport service providers reveal the two groups are in disagreement over the importance of key factors to seaport competitiveness. Vessel turnaround time (time delays, loading/unloading rates) is considered by liner shipping companies to most influence competitiveness. From the seaport authority and terminal operator perspectives, seaport facilities and equipment are the most important factor. However, both do agree that intermodal links should also be taken into consideration. Nowadays, it is important for seaports to be integrated into intermodal links that allow door-to-door efficient cargo transportation, using two or more modes of transport from goods origin to destination. As the variability in weighting the factors differs so little in both groups, the results of this study support the idea that seaport competitiveness is a mix of different factors and no single factor proves sufficient for deciding seaport competitiveness.

In relation to the performances of the most representative Iberian seaports in accordance with the five key factors of seaport competitiveness, it can be concluded that significant differences exist throughout all five factors at the seaports analysed and no seaport attains the best ranking in all five factors. Analysis of the importance-performance matrix confirms that vessel turnaround time is important to users and also the factor on which seaports do not perform well. Therefore, Iberian seaport authorities and operators need to focus on improving their performance in this aspect in order to attract more shippers to their seaports.

As broadly defended by the literature, the concept of strategy has increasingly been recognised as deriving out of an awareness that a company must have a well defined field of action and a clear direction as to the sources of its growth. The highly competitive and rapidly changing seaport environment has greatly increased the need for strategic planning and leading onto our third research question seeking to identify the strategic positioning of Iberian seaports within the Iberian range.

3. How are Iberian seaports strategically positioned within the Iberian range?

Through recourse to the BCG matrix, we study strategic seaport positioning from an evolutionary perspective. The findings reveal that when analysing the Iberian Peninsula as a single seaport portfolio, it does appear that the main Spanish seaports are better positioned in relation to total traffic. In relation to the different traffic categories, container traffic is positioned as the star performer at all seaports. Furthermore, considering container traffic, the results display Algeciras, Valencia, and Barcelona seaports as having attained remarkable leadership positions. This leadership may be partially explainable by access infrastructures and the hinterland of these seaports. The importance of this category to the seaports analyzed is reflected in the level of investment ploughed into container terminals. However, ro-ro traffic is also evolving and demonstrates great potential for Iberian seaports.

According to the time series analyzed, the strategic positioning of most seaports in the BCG matrix fluctuates between the first and the third period. The seaport of Valencia is the only one that maintains its position as Star Performer in all the eighteen years analysed. The seaports of Algeciras and Barcelona shifted from the Star Performer classification in the first two periods to Mature Leader in the latest period. The authorities of both seaports, in their 2009 annual reports, mentioned the prevailing negative international financial environment as a cause. The seaports of Lisboa and Leixões were positioned as Minor Performers althou*gh the* Lisboa seaport was positioned in the High Potential position in the second period. This Lisboa seaport positioning change may be due to the structural changes taking place at this seaport in 1998 and 2004, specifically changes in the management model and the movement of the MSC (Mediterranean Shipping Company) liner to the Sines seaport.

Following analysis of the seaport strategic positioning, we may now move onto our final research question:

4. What contribution do logistics resources make to the competitiveness and performance of this sector?

With the purpose of analyzing the contribution of logistics resources to seaport performance levels, we consider that seaport performance is determined by operational and physical capacity indicators. The physical capacity indicators considered are physical logistics resources. Using the linear additive Multi Criteria Analysis and the Principal Components Analysis model, results show operational performance contributed 48.77% whilst physical capacity represented 51.23% of overall performance. Furthermore, this research demonstrates that the majority of seaports reveal direct proportionality between their positioning in terms of physical capacity and their overall performance positioning. This finding reinforces the idea that physical capacity contributes more to the overall performance than operational performance. In addition, we also highlight how this relationship changes whenever the difference in the value variable is significant. This was the case in the Algeciras and Barcelona seaports.

We now move onto the limitations of our research. As all such research inherently contains its own limitations as the studies carried out do not provide any definitive responses to the questions raised but rather provide foundation stones for building up new discoveries and future lines of research.

Limitations and Future Lines of Research

Any research inevitably incurs its own limitations. The perfect study has never and will never be carried out. Indeed, these respective limitations vary in accordance with the deliberate and the subconscious choices made.

The first limitation found in our research was the high level of complexity surrounding each of the respective issues, a facet that was duly recognized throughout the course of this research. This limitation occurs not only because the issues themselves are very complex but also because studies on the seaport industry, especially on competitiveness, are relatively recent in addition to the lack of any consensus as to the best means of statistically capturing seaport performance and competitiveness. As regards this latter dimension, we sought to overcome this lack by setting out a sufficiently broad reaching theoretical framework enabling us to perceive the various different positions of authors and adopt an analytical methodology best adapted to such purposes.

The second limitation stems from the fact that some of the statistical tools used in the present research, such as the linear additive MCA model and the BCG matrix, are perceived as simplistic and static techniques. Whilst the multivariate PCA technique was deployed to suppress the main limitations of the linear additive MCA model and the dynamic analysis of the BCG matrix covered a long period of time, which serve to significantly reduce such a limitation, it proved important to complement these tools with other data especially specific seaport activity inputs. This was the case with the indicators for total time spent by a vessel from arrival through to departure and the time a vessel spends waiting before docking, that is, the turnaround time. The lack of full access to these important indicators affecting the seaport competitiveness constrained this research.

The third limitation is associated with the complexity inherent to the seaport industry. Because of this complexity, to study all the stakeholders involved would be interesting and relevant to our research approach but impossible in practice. Finally, although our sample includes the most representative Iberian seaports, and hence is statistically valid, it still does not include all Iberian seaports and hence the conclusions do not extend to smaller seaports. Therefore, the results presented here are limited to the selected sample of most representative Iberian seaports.

Correspondingly and as regards future lines of research, we would suggest extending the study to all Iberian seaports. We also recommend applying this study to the same seaports for the period since 2009 for the purpose of analysing and comparing i) the effects of the global financial crisis and economic recovery on seaports, ii) the effects of the latest restructurings of some seaports, for example, the Aveiro seaport link to the national railway network, operational since 2010, provides for the movement of around 600,000 tons, and iii) the effects of the enlargement of the Panama Canal, that will impact on the world's shipping routes as from 2014 and consequently on the Iberian seaport positioning, especially Portuguese seaports. With the widening of the Panama Canal in 2014, the maritime scenario may be expected to change because container terminals will have to adapt their facilities and equipment to the new reality should they wish to remain competitive, and especially those Iberian container terminals that previously served as the shipping gateways to Europe and Asia. Thus, it shall be interesting to see further research, applying the methodologies proposed, about how these changes shape the seaport environment going forwards at both the international level and at that of Iberian seaports in particular and how they contribute to moulding overall seaport performance.

Cooperation between seaports is another research theme that requires future attention with the objective of analysing the complexity and progress of such relationships and their implications for performance. Although it has been referred to in the literature that rather than competing, seaports must cooperate in order to achieve their goals, how this cooperation (and coopetition) might be brought about and the implications for seaport performance have not been studied. Stronger collaboration between the different seaport industry actors, within which seaports authorities are clearly prominent, would benefit from such a research agenda.

Finally, as regards the importance of the national logistics system to seaport competitiveness, we would particularly like to verify how, when countries are able to improve their logistics system performance standard, this impacts on the operational and financial performances of seaports. In particular, considering intermodal links, it would also prove relevant to see how the fact Portugal does not have operational intermodal links at most seaports, unlike Spanish seaports, conditions the positioning of Portuguese seaports within the European seaport context.

Managerial Implications

Stemming from this study are two major research implications with consequences for both the seaport community and governments.

Taking into consideration how the seaport industry is a sector of great uncertainty and complexity, the capacity to adapt to prevailing contingencies is fundamental. The greater the level of this adaptive capacity, the greater the competitive advantage over other players in the market. One means of attaining this is through strategic positioning analysis, identifying the positioning of each cargo type as a means of redefining strategies, for example, whether or not they should concentrate on every cargo type or specific cargo types. Another means is learning which key factors come into play in the decision making process of seaport users and identifying seaport strengths and weaknesses in relation to these factors. With this understanding, seaports could better position themselves and formulate strategies for gaining competitive advantages. Therefore, if any of the seaports aim to surpass their competitors, they must attempt to be more competitive in the most important factors. From this research, it is clear that Iberian seaport authorities and seaport operators could concentrate on improving turnaround times and intermodality should they wish to retain or attain competitive advantage.

Another implication from this research applied to the terms and conditions of public policies. This implication is more addressed to Portuguese seaports because *th*ey need to improve their strategic positioning within the Iberian Peninsula and towards the other European seaports. First, the authorities need to better understand the complex environment that seaports currently face. Only thus is there any real likelihood of adopting the appropriate policies tailored to these sectorial realities prevailing in the 21st century. Seaports players need mechanisms that ensure inclusive and timely infrastructure planning and delivery and mechanisms that ensure mitigation and compensation for local externalities. While, on the one hand, it is noted that some of the public initiatives taken in recent years, such as the Maritime Policy for the 21st Century White Paper in 1998 and the Strategic Commission on the Oceans in 2003, have hitherto not had practical effects, on the other hand, stakeholders have not demonstrated the ability to properly pressure and engage with the political structures. From our point of view, if other European countries overcome the crises in maritime sector, studying what they did and looking for similar lines of action is a fundamental requirement for Portugal. For example, the Netherlands and Spain, when founding maritime clusters, these countries improved their seaport sector performance. However, this only proved possible thanks to public policies implemented by their respective governments. In the case of the Netherlands, the ship owner associations convinced the government to look at the industry's fundamental problems and develop innovative policies for shipping. In Spain, the legal structure for promoting and developing maritime industry clusters came into effect in 2007.

Against this backdrop, therefore, the challenge for Portugal is increasingly strong and rigorous, because recovery is made more difficult by continuing decline. As regards other European experiences and the results of this research the Portuguese and Spanish seaport authorities, with the support of their governments, should co-operate and work together in order to enhance the role of Iberian seaports on international trade routes. To be competitive, Iberian seaports need to provide an integrated supply chain door to door service, infrastructures able to meet these new challenges, regular, frequent, reliable services, and competitive cost structures. Regarding the last factor, Spanish seaports are better positioned than their Portuguese counterparts with lower charges in effect. However, Portugal could improve its position in the Iberian Peninsula by deepening ties and cooperation with Portuguese language speaking African countries taking greater advantage of the seaports in countries such as Cape Verde, Angola and Mozambique, opening up gateways to other markets and regions.

Despite the limitations mentioned above, we believe that the results from this research will not only contribute to advancing the theory and the methodology for analysing seaport competitiveness but also help seaport managers and policy makers by providing analytical results and quantitative evidence about: i) the key factors that users deem important and therefore the factors that they most need to improve; and ii) the inputs they need to raise or lower to attain efficiency.