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Port System of the Spanish North Coast Side

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ABSTRACT

This study aims at doing a comparative analysis of the Spanish North Port Authorities, in the period 2008-2013, and their positioning based on their perception about the "innovative effort they have made" in the period 2004-2009.

In order to achieve this aim, first, a comparative analysis of freight traffic has been carried out in order to obtain an overview of the Spanish North watershed; secondly, , using Rasch methodology, the strengths and weaknesses of each Port Authority have been identified based on the variable "perceived innovative effort".

As a result of the analysis, the specialization of each Port Authority is shown. In addition, a detailed analysis of the specific facilities of each Port Authority has allowed us to get more information about the specialization of Port Authorities. Finally, the strengths and weaknesses analysis provides an overview of the situation of each Port Authority, indicating the potential lines of action and improvement that they can follow.

We consider that this study may be useful for the Port Authority managers and policy makers due to it offers an overview of the situation of the Port Authority compared to its nearest competitors, helping with decision making and resource allocation.

1. Introduction.

The State-owned Spanish Port System includes 46 ports of general interest, managed by 28 Port Authorities (PAs), whose coordination and efficiency control corresponds to the government agency *Puertos del Estado*, a body answerable to the Ministry of Public Works that is responsible for implementing the government's port policy.

At an earlier time, characterized by a centralized decision-making system, *Puertos del Estado* established the tariffs, financed infrastructures and covered the ports deficit. However, since the introduction of competition and the application of the principle of financial sufficiency to Spanish ports in the 1990s, ports have developed their activity in a highly competitive environment, especially between nearby ports. Given this situation, and considering that the Spanish port system could be oversized, it is interesting to know the position of the PAs by analyzing their strengths and weaknesses. Especially interesting is the competition between ports of the same watershed.

On the other hand, in the search for competitiveness, innovation is said to be a source of sustainable competitive advantages.

It is in this context that the objective of the present work is set. The aim is to carry out a comparative analysis of the PAs, in particular those of the Spanish North Watershed, and their positioning based on their perception of the "innovative effort made". Similar analysis were done by Blanco, Sánchez and Pellón (2015) who analyze the Mediterranean Side; and Blanco,

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Sánchez and Gutiérrez de la Concha (2016) who examined the South Coast.

The PAs of the Spanish North Coast are (See Figure 1): A Coruña, Avilés, Bilbao, Ferrol-San Cibrao, Gijón, Marín y Ría de Pontevedra, Pasajes, Santander, Vigo y Vilagarcía de Arousa.

Figure 1: Port Authorities of the Spanish North Coast Side.

Source: Puertos del Estado (2014).

First, a comparison of all the ports is made so that an overall view of the situation of the watershed can be obtained. This comparison will be made by analysing traffic and infrastructure data. In the second part, we include an analysis of the strengths and weaknesses of each port, in relation to the total score of the watershed, based on the variable "perception of innovative effort carried out by the PAs". In order to do this, Rasch Measurement Theory has been applied to the information obtained through a survey.

The first part of the comparative analysis of the ports of the watershed is made taking into account the evolution of the traffic of goods from 2007 to 2017; either in the form of liquid bulk, solid bulk or general merchandise, as well as distinguishing what goods are transported in containers or using Ro-Ro systems. The objective was to make a comparison of the ports to deduce the specialization of each of them and their market shares.

In the second part, the number and characteristics of the infrastructures, facilities and cranes that each port has are compared. The infrastructures for the deposit of containers, the specific facilities of liquid and solid bulk, as well as the dock cranes and automobiles cranes with which each Port Authority handles the goods were analyzed. Through the observation of their infrastructures, the specialization of the ports and the possible causes of the greater or lesser traffic of goods could be evidenced.

In the third part, the weaknesses and strengths of each port are analyzed through the Rasch Measurement Theory.

Finally, a chapter of conclusions, the bibliography and the appendixes are included.

2. Compared Analysis of the Port Authorities.

The objective of the comparative analysis of the ports is to establish the specialization of each one of them and their market shares. This section compiles the comparison for the different traffic types between the years 2007 and 2017, and infrastructures in 2015.

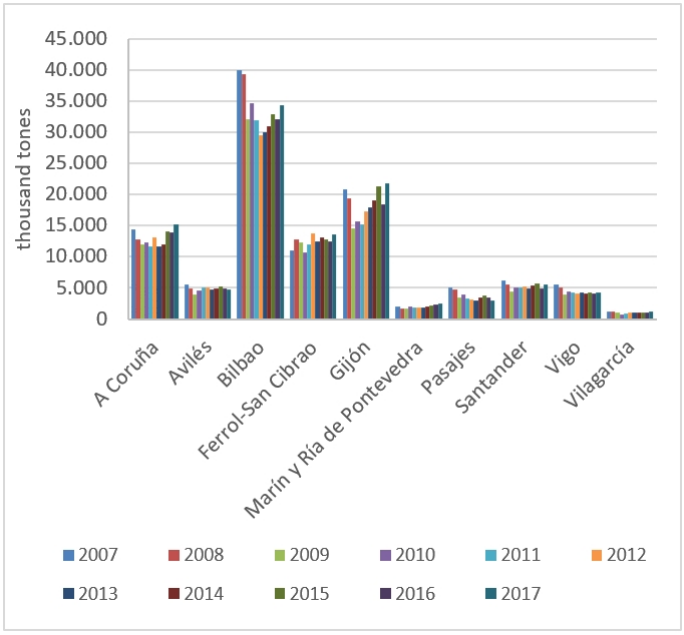
2.1. Comparison of Traffic.

Figures 2 to 9 show the evolution of traffics (total, liquid bulk, solid bulk and general goods) during the period 2007-2017, comparing the ports of the Spanish North watershed. Quantities are expressed in thousand tonnes, and include loaded, unloaded, transit and transhipped goods.

2.1.1. Total Port Traffic.

Figure 2 shows the evolution of total traffic. Bilbao has the highest total traffic (32.28% in 2017), followed by Gijón (20.53%), A Coruña (14.3%), Ferrol-San Cibrao (12.78%), Santander (5.29%), Avilés (4.52%), Vigo (3.98%), Pasajes (2.8%), Marín and Ría de Pontevedra (2.37%) and Vilagarcía (1.14%).

Figure 2: Total port traffic of the Spanish North Port Authorities (2007-2017).



Source: Prepared by the authors on the basis of Puertos del Estado (2017a).

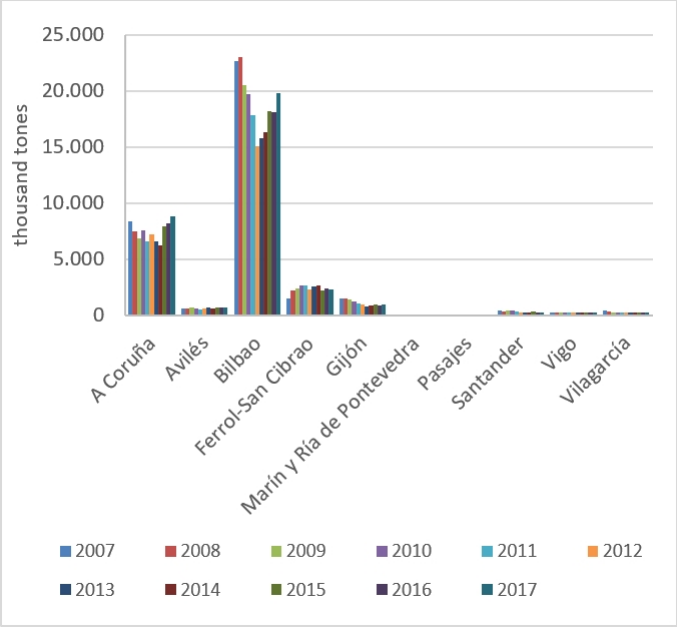
2.1.2. Liquid Bulk Traffic.

Figure 3 shows liquid bulk traffic. The port of Bilbao has the highest liquid bulk traffic (60.06% in 2017) of the watershed, followed by A Coruña (26.68%) and Ferrol-San Cibrao (7.02%), Gijón (2.73%), Avilés (2%) , Santander (0.71%), Vilagarcía (0.59%) and Vigo (0.21%). Marin and Pasajes do not participate in this type of traffic.

2.1.3. Solid Bulk Traffic.

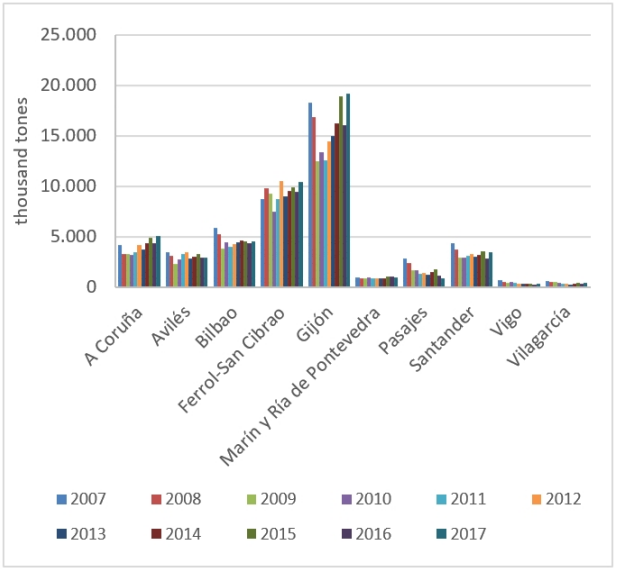
Regarding solid bulk traffic (see Figure 4), the port with the highest total solid bulk traffic is Gijón (39.99% in 2017), followed by Ferrol (21.75%), A Coruña (10.52%), Bilbao (9.45%), Santander (7.23%), Avilés (5.99%), Pasajes (1.74%), Marin - (1.91%), Vilagarcía (0.88%) and Vigo (0.54%).

Figure 3: Liquid bulk traffic of the Spanish North Port Authorities (2007-2017).



Source: Prepared by the authors on the basis of Puertos del Estado (2017a).

Figure 4: Solid bulk traffic of the Spanish North Port Authorities (2007-2017).

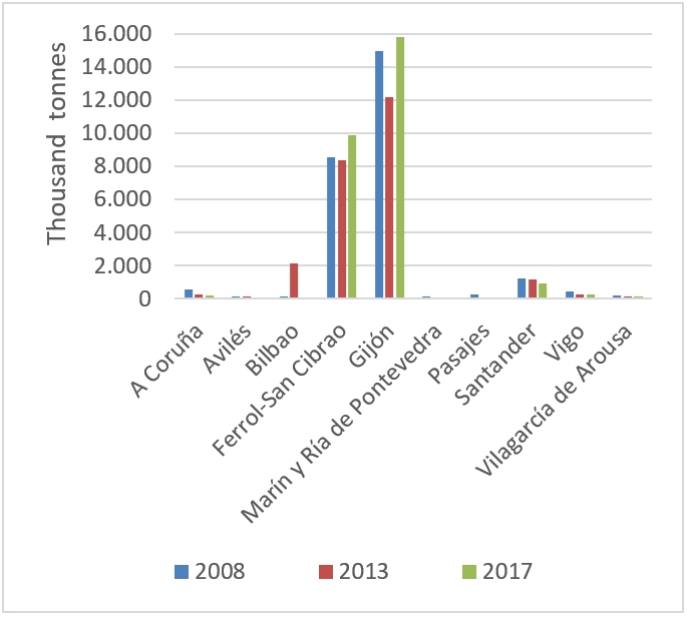


Source: Prepared by the authors on the basis of Puertos del Estado (2017a).

Concerning the traffic of solid bulks, two types can be distinguished: those with special facilities (Figure 5) and those without special facilities (Figure 6).

In 2017, the Port Authority of Gijón was the most important in terms of solid bulk traffic with special facilities (58.33%), followed by Ferrol-San Cibrao (36.47%), Santander (3.36%), Vigo (0.95%), A Coruña (0.68%) and Vilagarcía (0.2%) (Figure 5).

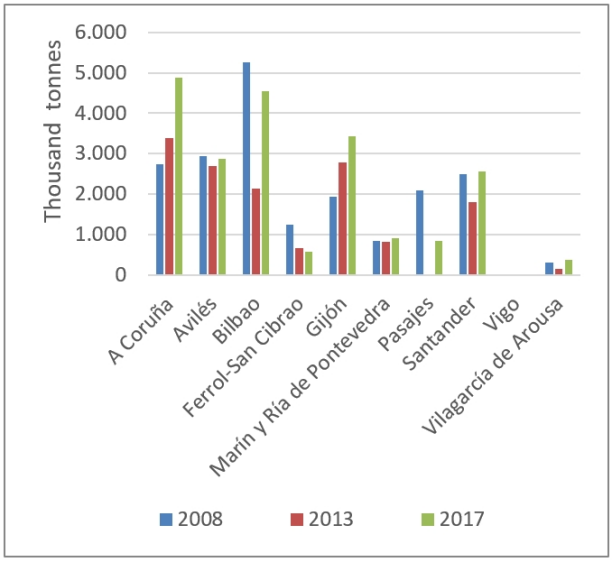
Figure 5: Solid bulk traffic with special facilities of the Spanish North Port Authorities (2008, 2013, 2017).



Source: Prepared by the authors on the basis of PAs Annual Reports. Puertos del Estado (2017b).

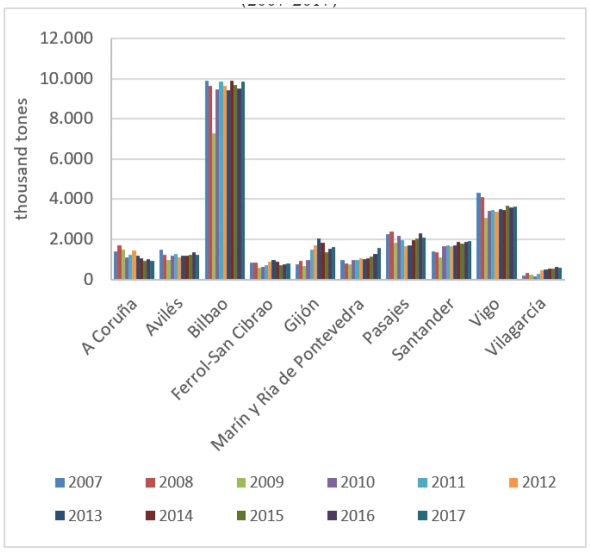
On the other hand, in reference to solid bulk traffic without special facilities (Figure 6), in 2017 the PA of A Coruña (23.21%) was the one that moved more bulks of this type. It is followed by the PAs of Bilbao (21.64%), Gijón (126.34%), Avilés (13.72%), Santander (12.22%), Marín and Ría de Pontevedra (4.36%), Pasajes (3.97%), Ferrol - San Cibrao (2.78%), Vilagarcía de Arousa (1.74%) and Vigo (0.02%).

Figure 6: Solid bulk traffic without special facilities of the Spanish North Port Authorities (2008, 2013, 2017).



Source: Prepared by the authors on the basis of PAs Annual Reports. Puertos del Estado (2017b).

Figure 7: General cargo traffic of the Spanish North Port Authorities (2007-2017).



Source: Prepared by the authors on the basis of Puertos del Estado (2017a).

2.1.4. General Cargo Traffic.

With regard to general cargo traffic (Figure 7), in 2017, the most important PA is Bilbao (40.82%), followed by Vigo (15.05%), Pasajes (8.62%), Santander (7.81%), Gijón (6,69%), Marín and Ría de Pontevedra (6.56%), Avilés (5.02%), A Coruña (3.79%), Ferrol-San Cibrao (3.22%) and Vilagarcía (2.43%).

2.1.5. Containers traffic.

Regarding the general cargo in containers traffic (Figure 8), in 2017, Bilbao stands out (57.52%). It is followed by Vigo (23.04%), Gijón (8.09%), Marín and Ría de Pontevedra (8%), Vilagarcía (2.62%), Santander (0.72%) and Ferrol-San Cibrao (0.02%). The rest of the ports do not present this king of traffic in 2017.

2.1.6. Ro-Ro Traffic (Roll-on, Roll-off).

Figure 9 shows the comparison of ro-ro traffic in the PAs. In 2017 there were only 5 authorities that worked with this traffic. These included Santander (46.95%), Vigo (32.67%), Pasajes (18.19%), Ferrol (2.15%) and Gijón (0.03%).

2.2. Comparison of Infrastructures.

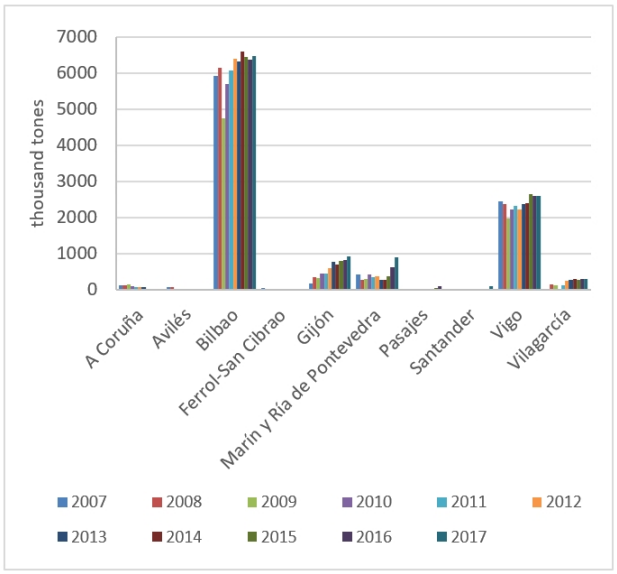
This section compiles the comparative analyses of the special facilities and cranes of the Spanish North PAs.

2.2.1. Special Facilities.

Table 1 summaries the special facilities that each of the PAs had in 2015, where x indicates that the special installation is available.

The Port Authority of Bilbao has the higher number of facilities, with 25. Among them, the most important ones are for petroleum, natural gas, chemical products, steel products, coke and coal. In fact, Bilbao is the only PA with specific facilities for coal.

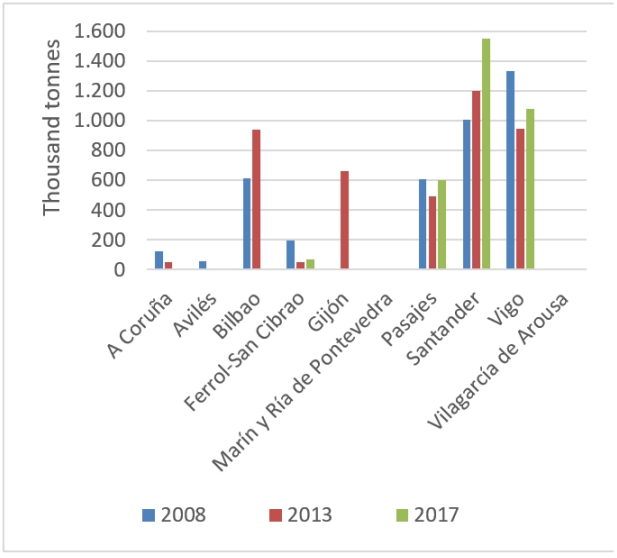
Figure 8: General Cargo in Containers traffic of the Spanish North Port Authorities (2007-2017).



Source: Prepared by the authors on the basis of Puertos del Estado (2017a).

All the PAs have cold stores; 9 of them have ro-ro ramps (all except Marín and Ría de Pontevedra); 8 have special cement facilities (except Bilbao and Pasajes); and 8 have container facilities (except Avilés and Santander).

Figure 9: Roll-on Roll-off traffic of the Spanish North Port Authorities (2008, 2013, 2017).



Source: Prepared by the authors on the basis of PAs Annual Reports. Puertos del Estado (2017b).

2.2.2. Cranes.

The comparison of cranes is summarized in table 2. Bilbao is the port that has the largest cranes (dock cranes and car cranes) and is the only one with cranes of more than 20 tons.

Table 1: Comparison of the special facilities of each PA.

SPECIAL FACILITIES	A Coruña	Aviles	Bilbao	Ferrol - S. Cibrao	Gijón	Marin y Ría de Pontevedra	Pasajes	Santander	Vigo	Vilagarcía de Arousa
Alumina	X	X		X						
Aluminum				X						
Ammonia		X								
Asphalt					X				X	
Asphalt products		X								
Bauxite				X						
Benzene		X								
Benzol		X								
Biodiesel			X	X						
Bioethanol	X									
Cement	X	X		X	X	X		X	X	X
Cereals	X				X					
Chemical products			X	X				X		
Clinker			X							
Coal			X							
Coke	X	X	X							
Cold stores	X	X	X	X	X	X	X	X	X	X
Construction material			X							
Containers	X		X	X	X	X	X		X	X
Diesel oil			X		X			X	X	
Fertilizers			X							
Finished products								X		
Fuel Oil				X						X
Gasoil								X		
Gasoline			X		X					
Glycerin				X						
Granite									X	
Hydrocarbons				X						
Machinery and spare parts			X							
Manure		X								
Methanol				X						X
Minerals									X	
Molasses	X							X		
Natural gas			X							
Oils	X			X					X	X
Paper			X							
Paraffin and Petrolatum										X
Petroleum coke				X						
Petroleum products	X					X		X		
Project loads and special pieces								X	X	
Raw oil			X							
Refined oil			X							
Ro-Ro traffic ramps	X	X	X	X	X		X	X	X	X
Salt									X	
Scrap			X					X	X	
Soda									X	
Sodium carbonate								X		
Steel products			X							
Sulfate			X							
Sulfuric acid		X	X							
Sulfuric acid	X		X							
Tras		X								
Vegetable oils	X									
Vehicles			X				X	X		
Wines and drinks			X							
Wood			X						X	
Zink		X								

Source: Prepared by the authors on the basis of PAs Annual Reports.

Table 2: Comparison of cranes in the Spanish North Aps.

	A Coruña	Aviles	Bilbao	Ferrol - S. Cibrao	Gijón	Marin y Ría de Pontevedra	Pasajes	Santander	Vigo	Vilagarcía de Arousa
Spring cranes										
Between 1 and 10 t						X				X
Between 10 and 20 t	X	X			X		X	X	X	
>20 t			X	X						
Automobile cranes										
Between 1 and 10 t	X	X		X	X	X	X	X	X	X
Between 10 and 20 t										
>20 t			X							

Source: Authors.

3. Strengths and Weaknesses Analysis.

In this section a strengths and weaknesses analysis of each Spanish North Peninsular PA is developed. It is based on their perception of their own "perceived innovative effort made" in different management areas.

3.1. Methodology.

The present study is based on a survey carried out among the 28 Spanish PAs (Serrano, Blanco and López 2009). In that survey, among other issues, the Spanish Port Authorities were asked what they perceived to be the innovative effort they had made in various activities or areas of innovation (see Appendix 1). The reliability and validity analysis can be found in Blanco et al. (2010).

Rasch Measurement Theory was used for the analysis. The computer software used to treat the data was Winsteps 3.75 (Linacre 2011). Specifically two of its applications were used:

a) Variable Map

A first positioning, both for ports and for items, is obtained in the variable map (See Figure 11). On the left side the subjects (the Port Authorities in this case) are located: those located above have a better positioning than those located below. On the right side the items are located (innovation activities in this case) ordered from most important (at the bottom) to least important (at the top).

b) Diagnostic Maps: PKMAP

For the strengths and weaknesses analysis, one of the applications of the Rasch methodology has been used, namely the PKMAP (diagnostic maps). In this respect the works of Sánchez, Blanco and Pérez Labajos (2012) and Sánchez et al. (2013) incorporate a brief explanation of these tools.

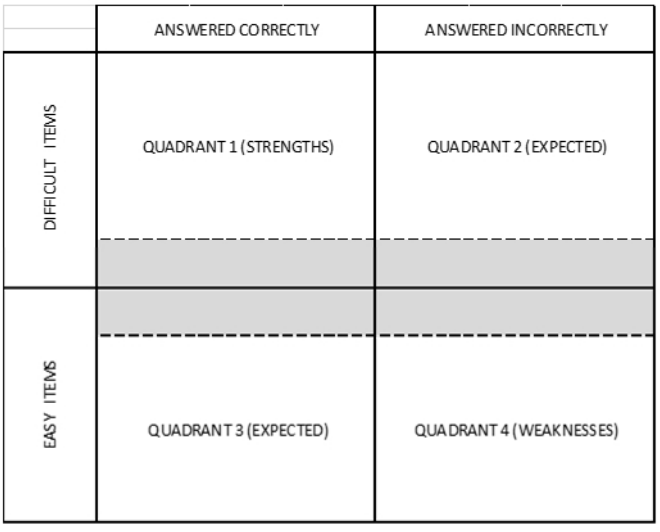
PKMAPs have already been used in other studies. In particular, Blanco, Sánchez and Pellón (2015) analyze the ports of the Spanish Mediterranean slope; and Blanco, Sánchez and Gutierrez de la Concha (2016) those on the southern slope of Spain. This kind of studies are considered to offer more useful results since it is understood that the competition is much greater between the nearest ports.

Through the PKMAP, the program makes a comparison between the individual assessments of each item and the global assessment of each item for the whole set of subjects. The result is displayed on a diagnostic map (PKMAP).

In the case of this study the assessments that a Port Authority gave to each of the 16 items that make up the construct "perception of the innovative effort made by the PAs of the North watershed" are compared with the average importance given jointly to each of the items. Thus, for example, if a Port Authority has a 5 (maximum value) in an item that is not valued by the PAs as a whole, it would have a strength since the innovative effort that the Authority made in this aspect is much greater than that made in general terms by the set of Port Authorities. On the contrary, if a Port Authority has a score of 1 (minimum value) in a highly valued item, it has a weakness, since its innovative effort is very small in an item in which, in general, the innovative effort is great.

The diagnosis map is divided into four quadrants in which the different items will be distributed according to the response given by the subject to each of them (Figure 10). The middle zone in grey represents the level of the subject.

Figure 10: PKMAP Quadrants Interpretation.



Source: Sánchez, Blanco and Perez-Labajos (2012).

In the upper left quadrant, quadrant 1, those items in which the subject has a strength are located. These would be activities in which the Port Authority makes a bigger innovative effort than the average. In the lower right quadrant, quadrant 4, the weaknesses of the Port Authority are located. They are the activities in which it does not make enough innovative effort, while the other Port Authorities do.

The other two quadrants have less interest. Quadrant 3, which is the lower left quadrant, indicates the activities in which Port Authorities have made some effort, but that it does not sup-

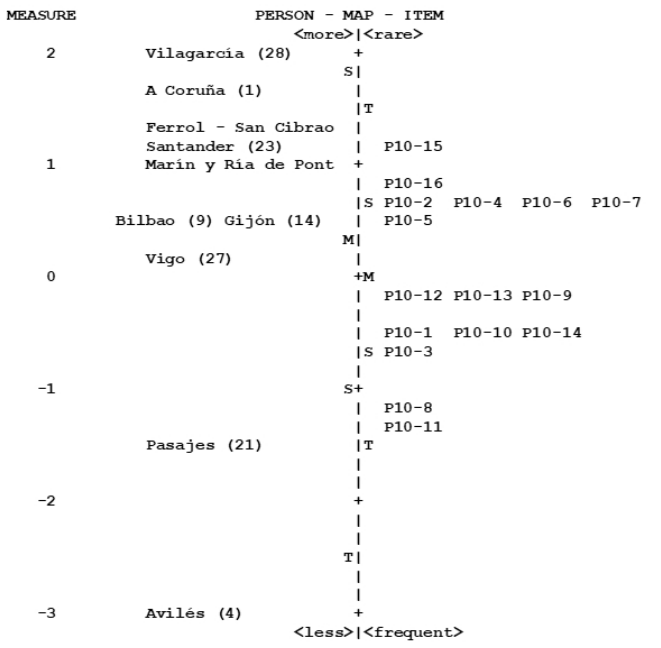
pose any advantage, since the others also have made it. The upper right quadrant, quadrant 2, includes the activities in which the Port Authority has made no effort; but, as the other Port Authorities have not done it neither, it is not a disadvantage.

3.2. REsults.

With the objective of positioning and analyzing the strengths and weaknesses of the Spanish North Coast PAs, an analysis based on the variable "perception of the innovative effort made" by the PAs in different management areas was carried on. In order to do it, first, the variable map is obtained and analyzed and, secondly, the diagnostic maps (PKMAPs) are discussed.

Due to the analysis is focused only on the North PAs, firstly the different activities have been ranked according to the greater or lesser innovative effort that the North PAs perceive to have developed. The results are presented in Figure 11 and in Table 3.

Figure 11: Variable map.



Source: Authors.

Based on this ranking, the next step is to identify the strengths and weaknesses of each PAs using the PKMAP. Through this tool, the program makes a comparison between the individual evaluations of each item and the importance of the items for the set of subjects. The result is presented in a diagnostic map (PKMAP). Appendix 2 presents the PKMAPs of all the Spanish North PAs. However, to facilitate the interpretation of the data, Table 3 schematically includes the strengths and weaknesses that each of the PA has in the different items with respect to the total of the watershed.

For more information, Table 4 includes, for each of the PAs, the measure, the standard deviation (S.E.) and the score. These values indicate respectively the average value of the distribution (where the xxx are in each pkmap graph) and the horizontal lines that represent the average values plus or minus the standard deviation, resulting in the positioning of each port (central strip). The higher the value of this measure the better positioned the port will be. The lower the value of S.E. the more central will be with respect to the average. The score is the sum of the raw scores that the Port Authority gave to all items.

Table 4: Summary of PKMAPs information.

	Measure	S.E.	Score
Vilagarcía	2,05	0,34	64
A Coruña	1,72	0,33	61
Ferrol-San Cibrao	1,39	0,33	58
Santander	1,17	0,34	56
Marín y Ría de Pontevedra	1,05	0,34	55
Gijón	0,58	0,35	51
Bilbao	0,43	0,35	50
Vigo	0,20	0,36	48
Pasajes	-1,58	0,37	35
Avilés	-2,94	0,42	26

Source: Authors.

From the observation of the values "measure" and "score", it may be concluded that Vilagarcía would be the best positioned PA followed by A Coruña, Ferrol-San Cibrao, Santander, Marín y Ría de Pontevedra, Gijón, Bilbao, Vigo, Pasajes y Avilés.

Finally, the analysis of strengths and weaknesses shows some discrepancies with the traffic analysis.

Conclusions.

In the present study an analysis of the positioning of the Spanish North Port Authorities (A Coruña, Avilés, Bilbao, Ferrol-San Cibrao, Gijón, Marin y Ría de Pontevedra, Santander, Pasajes, Vigo y Vilagarcía de Arousa) has been carried out.

Firstly, a comparison between the different ports, based on traffic and infrastructures, has been made. Secondly, a strengths and weaknesses analysis has been carried out based on their "perception of the innovative effort made" in various activities of its daily operation.

The individualized and global analysis has allowed us to see the degree of specialization of the different ports. Knowing the specialization of each PA will allow, in future work, to identify more easily what the companies of the hinterland of each PA are. This is important in order to deepen the analysis of the innovation and competitiveness of the PAs since, according to Blanco et al. (2011), the companies working in the PA are responsible for making the investments. Therefore, identifying them is a vital first step.

Bilbao is the port that has a greater total traffic, and also stands out in liquid bulks and general goods, both containerized and in other media. Gijón stands out in solid bulk, both general

Table 3: Item Ranking and Summary of the strengths (S) and weaknesses (W) of the Spanish North PAs with respect to the total of the watershed, based on the PKMAPs.

Item Position	Item number	Item Description	A Coruña	Avilés	Bilbao	Ferrol- S.Cibrao	Gijón	Marín y Ría de Pontevedra	Pasajes	Santander	Vigo	Vilagarcía de Arousa
1	11	Information systems, communication and control systems			S		W		S		W	
2	8	External relations		S					W		W	W
3	3	Port services	W		S	S	W		S		S	
4	14	Projects and construction	S	W			S	W		W		
4	10	Environmental issues	S	S		W	S	W		S		
4	1	Strategic planning	S	W		W	S	S		W		
5	13	Contingency plans and security systems for protecting infraestructure and the environment	S		S	S		W	S	W	W	
5	12	Plans and protection systems	W			S		S	S	S		
5	9	Quality	W	S		W	S	S	W	S	S	W
6	5	Sales and marketing	S			S			W	S	S	W
7	7	Legal services and administrative management	S	S	S	W	W				W	S
7	6	Finance and economics		S	S	W					S	S
7	4	Management of concessions and authorizations			W			S			S	S
7	2	Human resources			W	S					S	W
8	16	Promotion and sponsorship of scientific and technological R&D within the port	S		W		S	W	S		S	S
9	15	Maintenance	W		S		W		S		S	

Source: Authors.

and with special facilities. A Coruña stands out in solid bulk without special installation. Santander in ro-ro traffic.

Bilbao is the port with the higher number of facilities and it also has the largest cranes.

According to the results obtained, based on the variable perceived innovative effort made, the best positioned port would be Vilagarcía followed by, A Coruña, Ferrol-San Cibrao, Santander, Marín y Ría de Pontevedra, Gijón, Bilbao, Vigo, Pasajes y Avilés.

Concerning the best positioned ports, it could be seen that there is not a clear relationship between these results and those obtained in the comparative analysis of traffics and infrastructures. For instance, despite the fact that Bilbao is the port which moves the greatest number of goods and has the greatest number of special facilities, it is ranked in the 7^{th} position in the analysis of strengths and weaknesses.

The analysis of strengths and weaknesses shows some more discrepancies with the traffic analysis. We must be cautious with interpretation. These discrepancies could be due to several reasons.

Firstly, due to PAs are asked about their ”perception”, there is a subjective component.

In addition, the possible influence of size has to be taken into account: In a small port, a small amount of time or money can be perceived as a great effort; whereas in another port, a greater absolute amount may be perceived as a small investment because it is relatively less important compared to its total investments.

Another aspect to keep in mind is the starting situation point, as it may be different from each of the PAs. Thus, investments may have been made prior to the period requested in the survey and this effort is not reflected in the results.

Finally, according to the study by Blanco et al. (2011) the greatest innovative effort is made by the companies located in the hinterland of each port so, the total effort, not just the one made by port authority, should be analyzed.

The results obtained in this work may be of interest to the managers of the PAs, since they allow them to know their situation in comparison with other competing ports, highlighting their strengths and weaknesses. All this information can be useful for them when making decisions about where to invest their resources to improve their competitiveness.

There is also the need to study private innovation and its impact on the development of the hinterland and the port itself in depth. Analyzing the circle of synergies: the port contributes to the economic development of its hinterland, but also the development of the hinterland contributes to the growth of the port.

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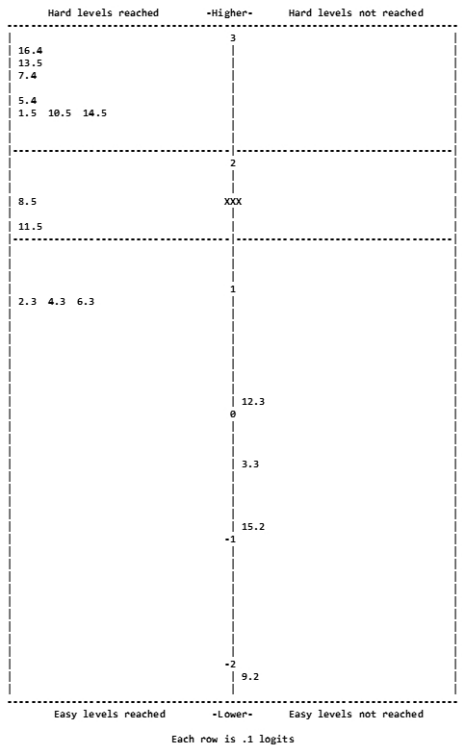
Appendix 1. Survey.

According to your point of view, and with reference to the last five years(2004-2008), give a score between 1 (no effort) and 5 (extremely high level of effort) for the degree of effort to innovate that has been made within the Port Authority in the following areas:

1	Strategic planning
2	Human resources
3	Port services
4	Management of concessions and authorizations
5	Sales and marketing
6	Finance and economics
7	Legal services and administrative management
8	External relations
9	Quality
10	Environmental issues
11	Information systems, communication and control systems
12	Plans and protection systems
13	Contingency plans and security systems for protecting infraestructure and the environment
14	Projects and construction
15	Maintenance
16	Promotion and sponsorship of scientific and technological R&D within the port

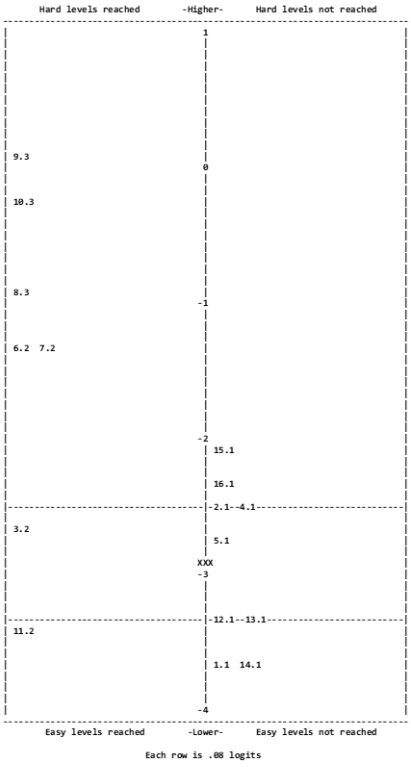
Appendix 2. PKMAPS of the Spanish North APs.

Figure 12: A Coruña PKMAP



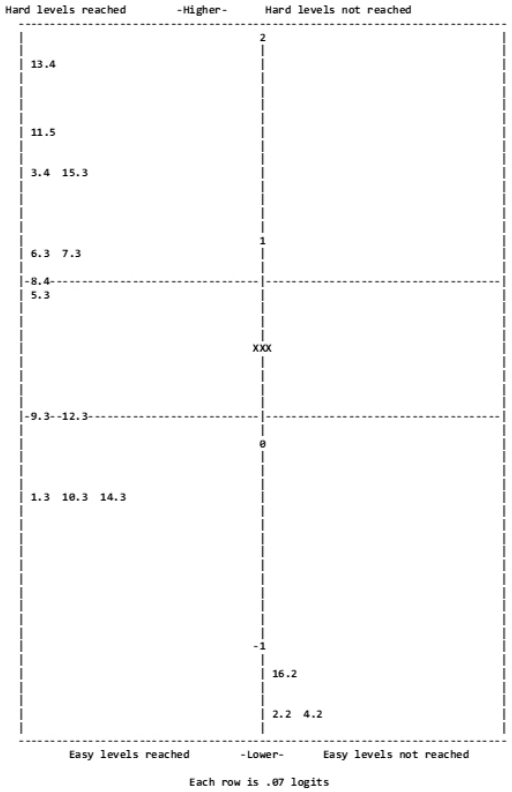
Source: Authors.

Figure 13: Avilés PKMAP



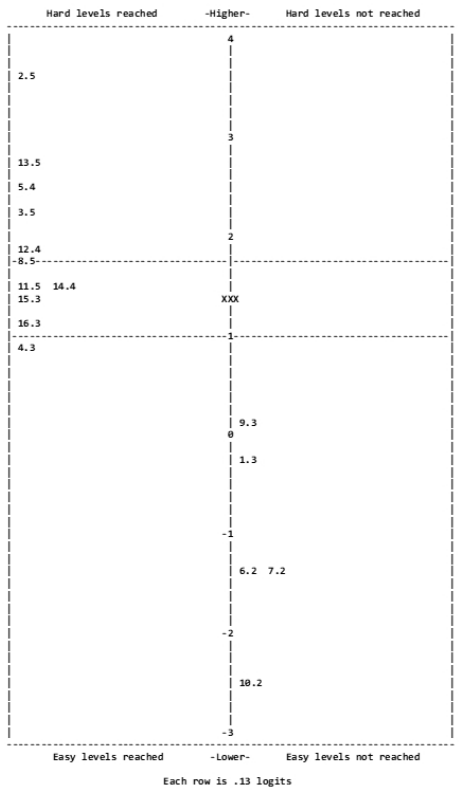
Source: Authors.

Figure 14: Bilbao PKMAP



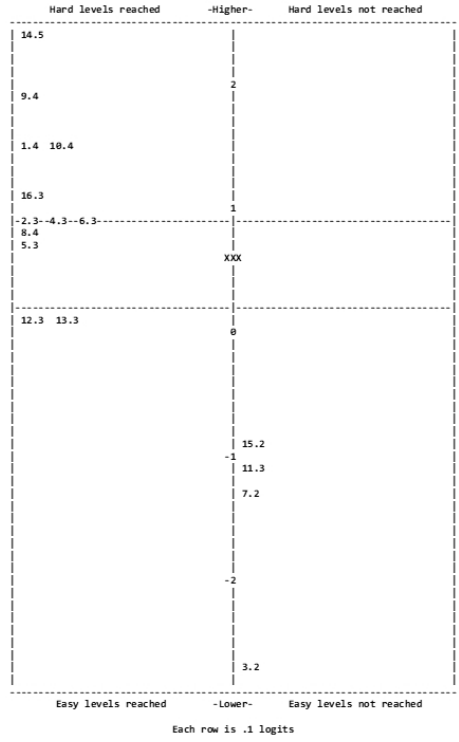
Source: Authors.

Figure 15: Ferrol - San Cibrao PKMAP



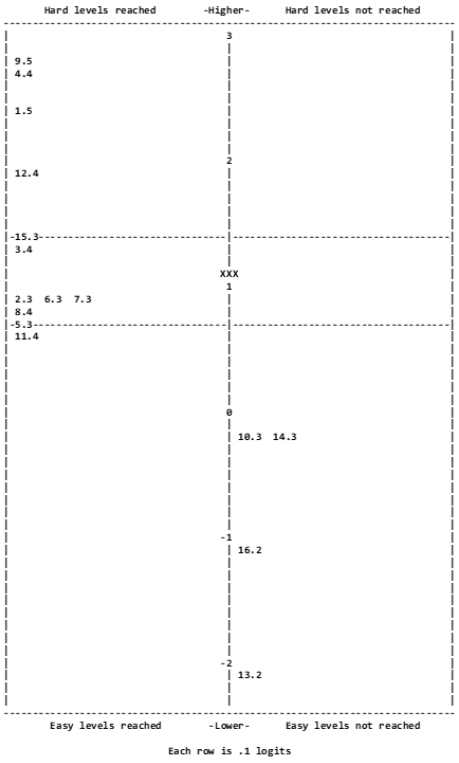
Source: Authors.

Figure 16: Gijón PKMAP



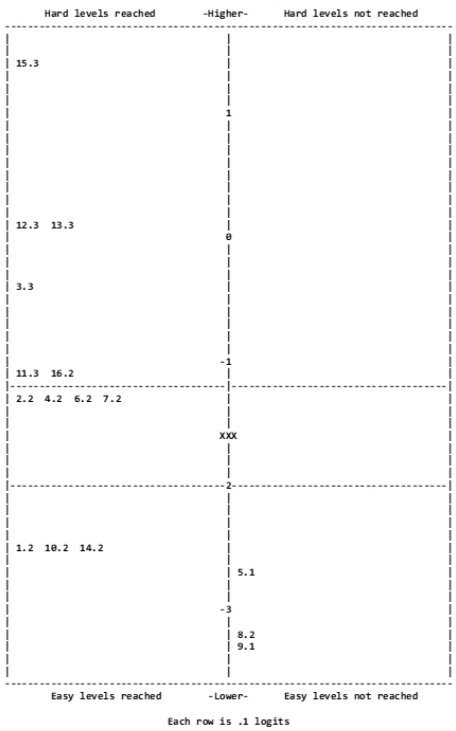
Source: Authors.

Figure 17: Marín and Ría de Pontevedra PKMAP



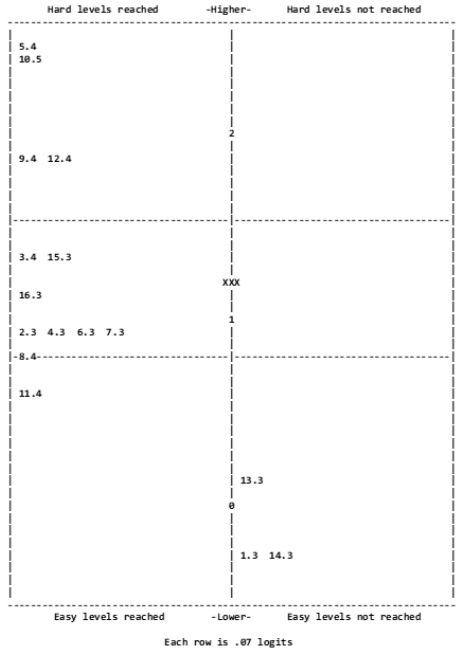
Source: Authors.

Figure 18: Pasajes PKMAP



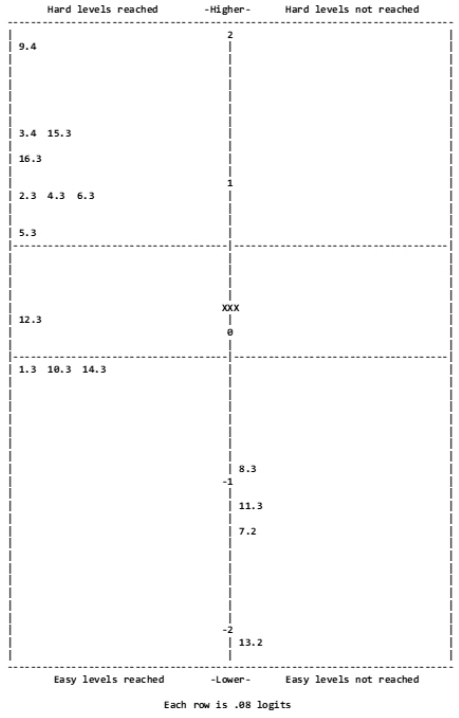
Source: Authors.

Figure 19: Santander PKMAP



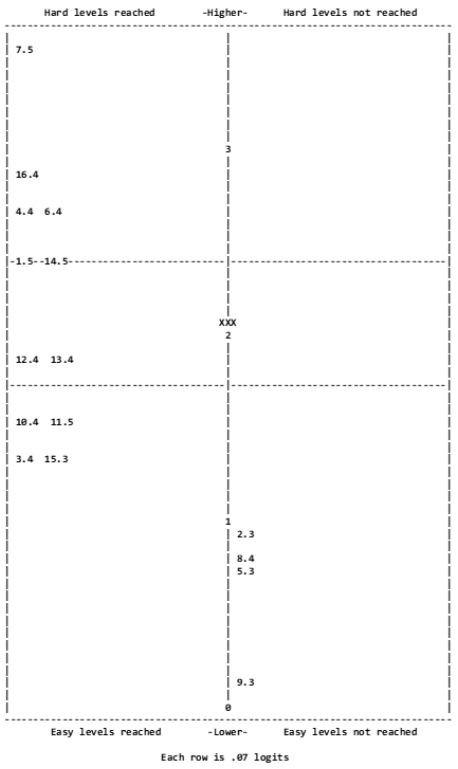
Source: Authors.

Figure 20: Vigo PKMAP



Source: Authors.

Figure 21: Vilagarcía de Arousa PKMAP



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