

# Measurement of port performance from users' perspective

George K. Vaggelas

*Department of Shipping, Trade and Transport, University of the Aegean,  
Chios, Greece*

Received 3 August 2018  
Revised 12 November 2018  
15 March 2019  
Accepted 2 April 2019

## Abstract

**Purpose** – Going beyond the usual approach of measuring port performance – focusing on the efficiency of port operations – this paper aims to look into shipping lines and other port users' perceptions on port performance.

**Design/methodology/approach** – The paper develops a framework measuring the perceptions of port users (i.e. shipping companies, shippers, etc.) on port performance. A typology of elements that shape port users' perceptions has been developed with an eye on capturing the peculiarities of different port markets. Based on this typology, a tool to assess users' perspectives, and subsequently evaluate, any given port has been developed. The tool provides port authorities the flexibility they need for customized approaches. The developed evaluation mechanism has been tested on a group of European seaports, and the results are presented by this study.

**Findings** – The framework and its pilot application unveil the key parameters that port users take into consideration when evaluating the effectiveness component of port performance. Moreover, the importance and evaluation ratings of specific performance parameters allow for a GAP analysis of the collected data.

**Research limitations/implications** – The paper advances scholarly and practical discussion on how of port users' perceptions can be a valuable tool for port performance measurement.

**Practical implications** – The proposed tool can be a valuable add-on for port authorities to evaluate their performance from the port users' point of view and take the necessary actions to improve it. Also, the tool can be used for the evaluation of a new process, infrastructure. The evaluation of port users' perception of port performance can and must be part of a European ports observatory, as it is a set of indicators that clearly reflects the satisfaction of port users by engaging their view on port performance issues, instead of relying almost exclusively on port-generated data.

**Originality/value** – The paper develops a framework for measuring port user's perception on port performance, which is flexible and can be applied in any port.

**Keywords** Port performance, Users' perspectives, European ports

**Paper type** Research paper

## 1. Introduction

Port performance measurement is gaining ground in contemporary port management. Intense competition and the transformation of port authorities towards a more



© Pacific Star Group Education Foundation. Licensed re-use rights only.

The research leading to these results has received funding from European Research Council under European Union's Seventh Framework Programme (FP7/2007-2013)/ERC grant agreement n° 605176. The author would like to thank Evie Kladaki and Aimilia Papachristou for their work during the application of the suggested framework and Thanos Pallis for his comments on the earlier drafts of the manuscript. The author would also like to thank the anonymous reviewers for their helpful and constructive comments that greatly contributed to improving the final version of the paper.

commercialized and industrialized role are vital: ports, in their vast majority, are actively engaged into complex supply chains, aiming, among others, to increase market shares. In this environment, port authorities are moving into their transition to “port development companies” (De Langen and Van Der Lugt, 2017).

In this setting, the importance of port performance measurement emerged as a necessary condition for ports to be benchmarked *vis-à-vis* their competitors. In general, port performance can be achieved if a given port task is measured against pre-defined standards of accuracy, completeness, cost and speed. Some ports are monitoring their performance based on pure operational features while others encompass wider aspects, such as administrative and financial performance parameters. This trend has been recorded by the relevant academic research with scholars studying port performance issues (Beuren *et al.*, 2018), focusing mostly on the examination of operational parameters (the efficiency component) of performance especially through the use of Data Envelopment Analysis and Stochastic Frontier Analysis (Nguyen *et al.*, 2018). There are also several studies examining the correlation between port efficiency and the port’s governance model with a focus on the ownership status of a port. Notteboom *et al.* (2000) used the Bayesian Stochastic Frontier Model to a set of 36 European and four Asian container terminals and they concluded that there is not a clear relation between the port efficiency and the ownership status of port terminals (private or public owned). Also, Cullinane and Song (2003) studied the relation between port privatization and/or deregulation policies and operational efficiency. In contrary with Notteboom *et al.* (2000), they concluded that the degree of private sector involvement is positively related with the productive efficiency of ports based on a sample of UK and South Korean ports. Yuen *et al.* (2013) in their study unveiled that foreign participation in the ownership status of Chinese ports increases the container terminals’ efficiency.

One missing link towards a comprehensive port performance evaluation is the inclusion of port users’ perceptions, i.e. how a port’s user perceives and evaluates port performance elements, that is to say, how they rate a port based on their experience. This gap has been acknowledged by academia which progressively turned its interest in measuring the effectiveness components. Brooks (2007) states that port performance measurement provides several efficiency measures, although, on the other hand, little emphasis has been put on port’s effectiveness and meeting port customers’ and stakeholders’ needs, with customer satisfaction measurement being missing in the port industry. The lack of port user’s satisfaction measurement has been identified also by Pallis and Vitsounis (2009) as a major gap for a comprehensive port performance measurement. They argued that ports are focus on the efficiency biased performance measurement, neglecting the perspective of their users.

Contributing to this debate, the paper develops a framework for measuring port users’ perceptions (i.e. shipping companies, shippers, etc.) on port performance. In doing so, a typology of elements that shape port users’ perceptions has been developed with an eye on capturing the peculiarities of different port markets. Based on this typology a tool for assessing users’ perspectives, and subsequently for evaluating any given port, has been developed. As port evaluation is a case-sensitive issue, the tool provides port authorities the flexibility they need for a customized approach. The tool has been applied on a group of European seaports.

The framework, and its pilot application, unveils the key parameters that port users take into account when evaluating the effectiveness component of port performance. Moreover, the importance and evaluation ratings of performance criteria allows for a GAP analysis of

the collected data. The paper discusses both the findings of the field research and the application perspectives of this tool, unveiling barriers, advantages and disadvantages of this process.

## 2. Literature review

Aiming at facilitating international seaborne trade and being accelerators of efficient maritime transport systems and facilitators of supply chains, in which they are embedded (Robinson, 2002), ports need to be efficient. A vast interest on port efficiency measurement has been triggered, among others, by the increasing competition among ports (Tongzong, 1995) and is still evident, as ports are seeking continuous improvements in the port services quality.

Port users' perceptions only recently came at the forefront of the scholarly research on port performance. The majority of studies focused on identifying port efficiency factors as well as on measuring port efficiency followed by a turn towards the exploitation of port performance parameters. For some researchers, port performance includes elements of port attractiveness (Lirn *et al.*, 2004 who identified a list of 47 criteria affecting port attractiveness). Others examined elements of port competitiveness that can also be used for determining port performance, implicitly assuming that efficiency is a proxy of competitiveness. Yeo *et al.* (2011) concluded on 38 components of port competitiveness and applied a methodological framework to measure experts' perceptions (see also the study of Yuen *et al.*, 2012). Brooks (2007) focused on the correlation between port performance measurement and port governance.

Significant work has been carried out in measuring port performance. In a general approach, Martilla and James (1977) described the advantages and disadvantages of Importance-Performance analysis with normalized pairwise estimation, aiming at demonstrating that consumer's satisfaction is a function of both expectations and judgments of attribute performance. As Comtois and Slack (2010) concluded, the most widely used method for measuring port performance is data envelopment analysis (DEA), with Ensslin *et al.* (2018) supporting this view. The study of Valentine and Gray (2001) used DEA for examining the relation between container ports efficiency and their ownership status. Park and De (2004) examined the applicability of an alternative DEA for measuring port's efficiency. Lin and Tseng (2007) applied models of DEA for analyzing the operational efficiency of container ports in the Asia-Pacific region and based on the results to identify potential trends. Beuren *et al.* (2018) used DEA to measure and compare the efficiency of the main Brazilian ports.

Port performance research has been redefined following the ascertainment that port performance is a function of efficiency and effectiveness (Brooks and Pallis, 2008), with the latter being neglected up then, although some thoughts have been expressed in literature (Park and De, 2004; mentioned customer satisfaction as part of marketability in their approach). Brooks and Pallis (2008) supported that components of port performance are the efficiency and effectiveness with the latter being the users' perceptions of port performance. From the port's side of view, effectiveness is to do the right thing, to respond to current and potential users' peculiar needs and expectations.

Still, the majority of academic research and industry practices are mainly focused on the efficiency side, i.e. to do things right. Thus, it is no coincidence that port performance has been associated with the operational efficiency alone (Brooks and Pallis, 2013). As mentioned by Beresford *et al.* (2010), common approaches on measuring port performance

are focusing on facilitating vessels, cargo-handling equipment and assets usage. This is the majority of the studies developed by ports where port users usually are participating in the evaluation of performance indexes developed according to the operational profile of the port. Such an approach is based on the assumption that the port performing the exercise knows what is best for a port user and what the port user is looking for. A risk in this approach is to confront port users as a unified entity with the same strategies and goals.

The way to proceed towards a holistic approach is to take into account port users in port effectiveness evaluation. Most port performance measurement schemes fail to include this performance component (Brooks *et al.*, 2011). Consequently, measuring port performance is heavily relied on operational efficiency measures (Pallis and Vitsounis, 2009) resulting in a gap between port performance and port users' expectations.

Roll and Hayuth (1993) in their study on the comparison of port performance with the use of Data Envelopment Analysis, make a reference to the term "port user satisfaction" without further analysis. With the evolution of the related research and the active participation of ports in port performance exercises, port users came into the scene only recently, in comparison with the port performance research (see for example the studies of Lirn *et al.*, 2003; Ng, 2006; Tongzon, 2008; De Langen, 2008).

The most comprehensive attempt on measuring port users' perception on port performance was initiated by Brooks (2007) who identified users' satisfaction as a critical performance indicator to be measured in an effectiveness-oriented organization. Some years and several empirical studies later, Brooks *et al.* (2011) concluded with the proposition of a systematic approach for measuring port effectiveness. Brooks *et al.* analyzed how port users evaluate port effectiveness, which in turn is a synthesis of three questions:

- (1) How do port users evaluate ports?
- (2) What is most important to them in terms of services received?
- (3) How do they evaluate the performance of ports they use?

In other words, they focused on three port performance components, the overall satisfaction, the competitiveness and the effectiveness in service delivery. For measuring port effectiveness, they developed an online survey using 37 evaluation criteria addressing decision makers using Canadian ports. The paper unveiled the rating of each one of the criteria in terms of importance per category of port users (i.e. shipping lines, cargo interests, supply chain partners) and rating of the criteria used in relation with the three components of port performance.

While port users' perceptions play a vital role for developing a comprehensive framework for measuring port performance, any approach aiming at incorporating them in port performance measurement should take into account the subjectivity that users' perceptions entail, as each user has its own assessment criteria to evaluate port performance. Also, it must be highlighted that each port market has its own characteristics that need to be taken into account, for example passenger ports (Vaggelas and Pallis, 2010) have quite different characteristics from cargo ports. These characteristics are related with port operational issues such as the types of port services provided, the different handling needs that each cargo and passenger traffic has, the importance of performance in cargo handling operations, the provision of value-added services, to name a few. With some exceptions (Pantouvakis *et al.*, 2008),

the related studies on port performance measurement have been focused on container ports and terminals.

### 3. Methodological framework and pilot application

#### 3.1 Methodology

The methodology followed is based on a three-step approach aiming at clarifying all the critical aspects on measuring port users' perceptions on port performance towards a holistic approach. As already mentioned, the majority of port performance measurement related studies are focusing on container ports. This study goes beyond the container market aiming at providing a framework applicable to several types of port markets, namely, *container ports*, *dry bulk ports*, *liquid bulk ports*, *Ro-Ro ports*, *break-bulk ports* and *cruise ports*, allowing for a more comprehensive approach on port effectiveness.

Secondly, as the tool used for measuring port users' perception is an online survey (Brooks *et al.*, 2011 stated that best effectiveness metrics from managerial perspective comes from questionnaires addressing users), it is critical to define the term port user, thus defining the target group of the survey. The term "port user" might have as many definitions as the different perspectives someone might have on port operations, the port area, the port cluster, etc. For the purpose of this study, a "port user" is an entity that consumes port services, or uses the port infrastructures.

The third step is to identify the criteria that shape port users' perceptions on port performance. Towards this end and based on literature review, a set of criteria has been developed for each of the six port markets. The criteria are grouped following a sequence that is based on the *sea-port-hinterland concept*, i.e. criteria dealing with operations in:

- the port-sea interface;
- the port area; and
- the port-land interface.

This grouping aims at:

- following the cargo-passenger flows in ports (i.e. from sea to port and then to hinterland and vice versa);
- making easier for the participants to spot the most interesting, for them, part of port operations to be evaluated; and
- to give the ability to the port to identify the performance gaps and focus on a specific segment of port operations (these are the operations related with the sea-port interface, the port-hinterland interface or the in-port operations).

The criteria are related with several port operational aspects such as:

- availability, i.e. whether a port service and/or infrastructure is available upon request;
- accessibility, related with the easiness of reaching the port;
- connectivity, dealing with parameters defining the port embeddedness in transport chains;
- quality, related with qualitative parameters of port services and/or infrastructure;
- timeliness of services, i.e. the provision of services takes place on the most appropriate time;

- adequacy, which is related with the sufficiency of port services and/or infrastructures for a particular purpose; and
- cost, concerning the cost of using port services and/or infrastructure.

Based on literature dealing with port performance, efficiency and effectiveness in ports, criteria for evaluating port users' perceptions and experiences from ports, the paper identified a set of criteria that shape the port user's perception on port performance. The review unveiled 21 criteria that are common for the port markets under examination, while 16 more criteria identified for container ports, 14 criteria for Ro-Ro ports, 12 criteria for dry bulk ports, 14 criteria for break-bulk ports, 10 criteria for liquid bulk ports and finally 11 criteria for cruise ports. [Table I](#) presents the criteria that identified through the literature review and have been fine tuned to be used for measuring port users' perception on port performance.

The above-mentioned port markets and the respective criteria have been used for the development of an ICT tool aiming at measuring the users' perception of port performance through a three-step application. With an eye on the active and increased participation of ports, the tool provides the ability to the participating ports to add their own criteria. Thus, the tool gives to the port authority the ability to customize the tool according to their peculiar needs, along with an increased level of confidentiality.

At the first phase of the ICT tool application the participating port selects the port markets and the criteria for which the port wants to be evaluated by the users. At the end of this phase the port authority has develop the structure of the survey that will be sent to the port users.

At the second phase of the exercise, the port authority invites port users to answer the survey through a port performance measurement campaign.

The third phase includes the participation of the port users that have been invited to the exercise. Shipping lines and other port users are asked to evaluate the criteria for each one of the port markets that the port authority has selected. The port user evaluates each criterion based on his experience from the specific port (satisfaction) and on the importance of each criterion in shaping his perception on port performance (expectation).

### *3.2 The pilot application*

The framework and the ICT tool has been tested through a pilot application in selected European ports. Following a promo campaign, eight ports from five European countries accepted their participation in the pilot phase, which run between February and July 2017. These ports are mainly multipurpose ports, thus covering our goal for testing the framework and the tool in different port markets.

A follow-up during the pilot exercise was essential, aiming at achieving the highest possible engagement from the participating ports. Some techniques used were:

- prompt participants to proceed with the second phase of the pilot exercise;
- notify them on the extension of the pilot phase; and
- provide insights into how to increase the response rate by their users.

### *3.3 GAP analysis*

The paper proceeds with a GAP analysis based on the results of the pilot application aiming at providing additional insights for the participating ports. With GAP analysis dealing with the gaps between satisfaction and importance, the methodology can identify priorities for

**Table I.**  
Criteria shaping port users' perception on port performance per port market

	Common criteria			Port-land interface	
	Port			Hinterland intermodal connectivity	Customs operating hours
Sea-port interface	Efficiency of auxiliary services (bunkering, pilotage, etc.)	Coordination of port community/stakeholders	Efficiency of cargo/passenger clearness procedure		
Number of berths-mooring buoys	Vessel-related port costs	Transparency of port charges	Response to innovativeness		
Operational depth	On-time departure	On-time information	Accuracy of information		
On-time arrival	Port operating hours	Response to users' requests	Online information		
Total length of the quays		Port safety	Port security		
		Response to regulation changes			
<i>Container ports</i>					
Feeder container services	Efficiency of (un)loading operations	Services for containers (added value services)	Storage capacity for containers	Connectivity to road network	Connectivity to rail network
Deep-sea container services	Number of operational gantry cranes	Number of operational stacking equipment	Storage capacity for reefer containers	Quality-efficiency of road transport services	Quality-efficiency of the inland waterway services
Container handling cost		Container storage cost		Inland waterway network	Quality-efficiency of rail services
<i>Ro-Ro ports</i>					
Feeder	Trailer (truck) handling cost	Storage capacity for trailers-trucks	Services for trailers-trucks	Connectivity to road network	Quality-efficiency of rail services
Ro-Ro services	Efficiency of (un)loading operations	Storage capacity for reefer trailers	Number of operational tractors	Inland waterway network	Quality-efficiency of the inland waterway services
Ro-Ro services		Trailer-truck storage cost		Connectivity to rail network	

(continued)

Sea-port interface	Common criteria		Port-land interface
	Port		
<i>Dry bulk ports</i> Efficiency of (un)loading operations	Dry bulk cargoes handling cost	Storage capacity for dry bulk cargoes	Quality-efficiency of the inland waterway services
		Dry bulk cargoes storage cost Number of operational cranes	Connectivity to rail network Connectivity to road network
		Open storage capacity for break-bulk cargoes	Quality-efficiency of rail services
		Number of operational cranes	Connectivity to rail network
<i>Break-bulk ports</i> Efficiency of (un)loading operations Break-bulk cargoes handling cost		Services for trucks (weighting)	Quality-efficiency of the inland waterway network
		Warehouse capacity for break-bulk cargoes	Connectivity to road network
		Services to break-bulk cargoes (weighting, added value services, etc.)	Quality-efficiency of the inland waterway services
<i>Liquid bulk ports</i> Liquid bulk cargoes handling cost		Break-bulk storage cost	Connectivity to rail network
		Number of handling equipment for break-bulk storage	Quality-efficiency of road transport services
		Number of operational pipelines Storage tank cost	Inland waterway network
		Efficiency of (un)loading operations	Quality-efficiency of rail services
<i>Cruise ports</i> Cruise passengers handling cost Efficiency of berth allocation system Baggage handling cost		Storage tank capacity	Quality-efficiency of the inland waterway services
		Total available area for passengers Total parking areas	Quality-efficiency of rail services Connectivity to rail network
		Number of operational passenger terminals Efficiency of passengers (un)loading operations Efficiency of baggage handling operations	Connectivity to road network
		Services to passengers	Efficiency of land transport modes

Table I.

improvement. If satisfaction is lower than importance, then expectations are not fully met and there is room for improvement. Such an outcome can be of high value for a port in pursuit of increasing performance and especially effectiveness as it can highlight the underperformed port operations, providing an input for a relating decision-making process.

**4. Results and reporting**

As already explained each criterion has been attributed a twofold evaluation from port users: in terms of satisfaction, and in terms of the given importance. A seven-point scale has been used for rating, with 7 indicating the maximum level of satisfaction and importance and 1 indicating the minimum level. The response rate at the various campaigns launched by the participant ports equals to 19.2 per cent, of the port users invited to the exercise. The overall evaluation of the port markets is presented in Figure 1 and is calculated based on the average of all the evaluations provided for the criteria included in each one. The color of the evaluation rating is related with the seven-point rating scale with red color being ratings (R) in the range  $1 \leq R < 3$ , deep orange ratings in the range  $3 \leq R < 4$ , orange ratings between  $4 \leq R < 5$ , yellow for ratings in the range  $5 \leq R < 6$  and finally green for ratings in the range  $6 \leq R < 7$ .

The port users gave almost equal importance to each one of the port markets under examination. On the other hand, there are significant variations as regards the satisfaction of port users. The lowest rate of satisfaction is attributed to the container and dry bulk terminals of the pilot ports, with the satisfaction being at the middle of the rate scale, i.e. 4 out of 7. With an average 4.5 the port users rated their satisfaction by using the Ro-Ro and the break-bulk terminals of the pilot ports that are active in these two markets. Finally, the highest rate of satisfaction has been attributed to the liquid bulk and the cruise terminals, which gained an average rate of 5.5.

*4.1 Container port market: satisfaction and importance evaluation*

For the container port market, port users rated high ( $\geq 6$ ), in terms of importance, almost all the criteria that define their overall perception on port performance. On the contrary they gave average values to the criteria based on their experience from using a pilot port. Table II shows the top- and the least-rated criteria in terms of satisfaction and importance. For each one of the two groups (top- and least-rated), the following tables show the top-three and the bottom-three criteria in terms of rating, whenever it's possible, as in some cases more than three criteria have the same satisfaction or importance rate.

Based on port users' ratings, the top criteria based on their satisfaction from using the pilot ports are the number of deep-sea container services, the efficiency of (un)loading

Market	Satisfaction	Importance
CONTAINER MARKET	1 2 3 4 5 6 7	1 2 3 4 5 6 7
RO-RO MARKET	1 2 3 4 5 6 7	1 2 3 4 5 6 7
DRY BULK MARKET	1 2 3 4 5 6 7	1 2 3 4 5 6 7
LIQUID BULK MARKET	1 2 3 4 5 6 7	1 2 3 4 5 6 7
BREAK-BULK MARKET	1 2 3 4 5 6 7	1 2 3 4 5 6 7
CRUISE MARKET	1 2 3 4 5 6 7	1 2 3 4 5 6 7

**Figure 1.**  
Overall evaluation of  
port markets

Source: Author

Satisfaction			Importance		
Ranking	Criterion	Rate	Ranking	Criterion	Rate
<i>Top-rated</i>					
1	Deep-sea container services	5.5	1	Port operating hours, container handling cost, response to users' requests, transparency of port charges, provision of online information, accuracy of information, efficiency of container clearance procedures, customs operating hours, connectivity to road network, quality-efficiency of road transport services	6.5
2	Efficiency of pilotage service	5			
–	Efficiency of (un)loading operations	5			
<i>Least-rated</i>					
3	Storage capacity for reefer containers, container storage cost, efficiency of container clearance procedure, hinterland intermodal connectivity	3.5	3	Efficiency of bunkering	5
			2	Efficiency of ice-breaking services	4
			1	Deep-sea container services	4

Measurement of port performance

139

**Table II.** Top- and least-rated criteria for container port market

Source: Author

operations and the efficiency of the pilotage services. The results unveiled also an above average satisfaction for major operational and connectivity parameters of a container port, i.e. the port's connectivity (sea side) and the cargo handling efficiency. It must be noted that these criteria did not score high in terms of importance. Criteria related with cost, port operating hours, port hinterland transportation, clearance procedures and ports responsiveness are shaping the importance relevant list.

Port users reported that they evaluate low in terms of satisfaction, criteria related with container storage and the related storage costs, the efficiency of clearance procedures and the port hinterland connectivity. The least-rated criteria in terms of importance are the number of deep-sea container services, and the efficiency of bunkering and ice-breaking services.

In terms of port management, the results shows that that for container services, almost everything is significant for port users. This justifies the fact that the container port market is a highly demanding one from the port users' point of view.

#### 4.2 Ro-Ro port market: satisfaction and importance evaluation

For the Ro-Ro port market, port users gave a high rating of 6.5 to 11 elements out of a total of 35 elements that have been selected by the pilot ports and evaluated by their users. Table III shows the top- and least-rated criteria from the perspective of the port users in terms of importance and satisfaction.

Based on port users' evaluation the top criterion based on their satisfaction is the efficiency of dredging operations, while in the second place, they rate high (with 5.5) a set of

Satisfaction		Importance			
Ranking	Criterion	Rate	Ranking	Criterion	Rate
<i>Top-rated</i>					
1	Efficiency of dredging operations	6	1	Total length of quays, operational depth, port operating hours, on-time arrival, efficiency of pilotage services, efficiency of towage services, vessel-related port costs, Efficiency of (un)loading operations, dry bulk cargoes handling cost, response to users' requests, customs operating hours	6.5
2	Number of feeder Ro-Ro services, port operating hours, on-time arrival, on-time departure, efficiency of mooring services, efficiency of (un)loading operations, port safety	5.5	–		6.5
<i>Least-rated</i>					
1	Efficiency of bunkering, vessel-related port costs, storage capacity for reefer trailers, trailer/truck storage cost, efficiency of trailer/truck clearance procedures	4	2	Deep-sea Ro-Ro services, Operational depth, storage capacity for reefer trailers, trailer/truck storage cost, connectivity to rail network, efficiency of rail services	5.5
			1	Efficiency of dredging operations	4

**Source:** Author

**Table III.**  
Top- and least-rated  
criteria for Ro-Ro  
port market

core port services. Overall, port users declared satisfied by the performance level of the Ro-Ro terminals.

Port users rated average (four out of seven) five parameters dealing with port and storage costs, storage capacity, efficiency of clearance procedures and of bunkering services. On the other hand, they evaluated as the less important parameter in formatting their overall perception of port performance, the efficiency of dredging operations, while in the second place they rated equally six parameters. This is a fine example between the expectation and the actual experience of a port user. Although, in terms of satisfaction, the efficiency of dredging operations is high, this parameter is not important in shaping their overall perception on port performance.

#### 4.3 Dry bulk port market: satisfaction and importance evaluation

Also, in the dry bulk port markets, port users gave high ratings in terms of importance, with 11 out of 35 criteria (those selected by the port authorities) being rated with 6.5 (Table IV).

Regarding satisfaction, port users gave a rate of 5 to six criteria, dealing with pilotage, safety, security and port's accuracy in vessel's arrival and departure. The least-rated criteria reveal that port users are dissatisfied by the efficiency of dredging operations while they gave an average rating (4 in the seven-point scale) to 11 criteria dealing mainly with core operations in a dry bulk port-terminal such as cargo handling and storage. In terms of

						Measurement of port performance
Ranking	Satisfaction Criterion	Rate	Ranking	Importance Criterion	Rate	
<i>Top-rated</i>						<b>141</b>
1	Port operating hours, on-time arrival, on-time departure, efficiency of pilotage service, port security, port safety	5	1	Total length of quays, operational depth, port operating hours, on-time arrival, efficiency of pilotage services, efficiency of towage services, vessel-related port costs, efficiency of (un)loading operations, dry bulk cargoes handling cost, response to users requests, customs operating hours	6.5	
<i>Least-rated</i>						
2	Operational depth, efficiency of bunkering, efficiency of ice-breaking, Dry bulk cargoes handling cost, coordination of port community, response to innovativeness, online information, accuracy of information, storage capacity for dry bulk cargoes, dry bulk cargoes storage cost, customs operating hours	4	1	Efficiency of bunkering	5.5	
1	Efficiency of dredging operations	3	-	Efficiency of ice-breaking operations	5.5	
			-	Efficiency of waste reception services	5.5	

**Source:** Author

**Table IV.**  
Top- and least-rated  
criteria for dry bulk  
port market

importance, the least-rated criteria included the efficiency of bunkering and ice-breaking operations, as well as the efficiency of waste-management operations, showing the low ranking of these services in port users' perception on port performance.

#### 4.4 Liquid bulk port market: satisfaction and importance evaluation

For the liquid bulk market, the pilot application of the tool, unveiled (Table V) that port users are more than satisfied by the liquid bulk ports and terminals as more than 50 per cent of the criteria (34 in total) received an average rate of 6 and above. More specifically, 1 criterion (tank storage capacity) received a satisfaction rate of 6.5, and 17 other criteria received a rate of 6. It is worth mentioning that port users declared more than satisfied for several criteria dealing with core operations in a liquid bulk port or terminal such as loading and unloading operations, storage, adequacy of port infrastructures, operating hours and time-accuracy of vessels facilitation. On the other hand, and in terms of importance, port users rated with 7 the operational depth, something expected, as the depth is a crucial parameter for liquid bulk terminals, owing to the fact that tankers and especially oil tankers have an increased draft comparing with other types of vessels. In the second place the respondents gave a rate of 6.5 to 11 criteria.

Satisfaction			Importance		
Ranking	Criterion	Rate	Ranking	Criterion	Rate
<i>Top-rated</i>					
1	Tank storage capacity	6.5	1	Operational depth	7
2	Total length of quays, port operating hours, on-time arrival, on-time departure, efficiency of (un)loading operations, On time information, coordination of port community, response to users requests, online information, accuracy of information, port security, port safety, number of operational pipelines, efficiency of liquid bulk cargoes clearance procedure, hinterland intermodal connectivity, customs operating hours, connectivity to pipelines	6	2	Number of berths-mooring bases, Total length of quays, port operating hours, efficiency of pilotage services, vessel-related port costs, efficiency of (un)loading operations, liquid bulk cargoes handling cost, accuracy of information, port safety, tank storage capacity, efficiency of liquid bulk cargoes clearance procedure	6.5
<i>Least-rated</i>					
3	Number of berths-mooring bases, operational depth, efficiency of bunkering services, efficiency of dredging operations, efficiency of mooring services, efficiency of waste reception services, efficiency of pilotage services, efficiency of towage services, response to innovativeness, response to regulation changes, transparency of port charges, tank storage cost, connectivity to rail network, efficiency of rail services	5.5	1	Efficiency of bunkering, efficiency of dredging operations, coordination of port community, hinterland intermodal connectivity	5.5
–	Liquid bulk cargoes handling cost	5			
1	Vessel-related port costs	5			

**Table V.**  
Top- least-rated  
criteria for liquid  
bulk port market

Source: Author

Regarding the least-rated criteria, in the third place from the end with an average rate of 5.5 there are 14 criteria. In comparison with the other port markets, the liquid port market shows a different perception of port users in terms of satisfaction. The lowest rate of satisfaction is 5, showing that port users are satisfied from the liquid bulk ports participated in the pilot phase, as the lower rate is actually quite above average.

#### 4.5 Break-bulk port market: satisfaction and importance evaluation

For the break-bulk port market port users gave the highest ranking in terms of satisfaction to port safety while in the second place there are 19 criteria dealing with almost every aspect of operations in a break-bulk port/terminal. In terms of importance port users gave a rating of 6.5 to eight criteria (Table VI).

Satisfaction			Importance		
Ranking	Criterion	Rate	Ranking	Criterion	Rate
<i>Top-rated</i>					
1	Port safety	5.5	1	Number of berths, total length of quays, port operating hours, on-time arrival, on-time departure, efficiency of ice-breaking operation, vessel-related port costs, efficiency of (un)loading operations	6.5
2	Number of berths, total length of quays, operational depth, port operating hours, on-time arrival, on-time departure, efficiency of dredging operations, efficiency of mooring, efficiency of waste reception facilities, efficiency of pilotage, efficiency of towage, vessel-related port costs, efficiency of (un)loading operations, response to innovativeness, response to regulation changes, on-time information, online information, accuracy of information, port security	5			
<i>Least-rated</i>					
3	Quality-efficiency of rail services	3.5	2	Response to innovativeness, warehouse capacity for break-bulk cargoes, connectivity to rail network, quality-efficiency of rail services	5.5
–	Connectivity to rail network	3.5	1	Efficiency of dredging operations	4.5
1	Efficiency of ice-breaking services	3			

Measurement  
of port  
performance

143

**Table VI.**  
Top- and least-rated  
criteria for break-  
bulk port market

Source: Author

For the least-rated criteria, port users, based on their experience from the pilot ports, gave a rating of 3 out of 7 to the efficiency of ice-breaking services, followed by the connectivity of ports with rail networks and the quality and efficiency of rail services, both of which rated with 3.5. Regarding importance, port users gave the lowest rate to efficiency of dredging operations, which means it is the less important in shaping their total perception on port performance. In the second place of the least important criterion the port users listed four criteria dealing with innovativeness, warehouse capacity and rail connectivity and efficiency.

#### 4.6 Cruise port market: satisfaction and importance evaluation

For the cruise port market, port users gave high ratings to five criteria dealing mainly with timeliness of cruise vessels facilitation and security, which are crucial parameters for cruise business, with the latter being at the epicenter of relevant policies at international and EU level (Pallis and Vaggelas, 2007). In terms of importance, almost

the same criteria as in the case of satisfaction, are ranked high. The only exception is that port users consider of high importance the efficiency in cruise passengers clearance procedures, although this criterion has not been included in the top-rated criteria in terms of satisfaction.

As regards the criteria that attracted the least importance and satisfaction of port users, four criteria rated with 5.5 in terms of importance, while in terms of satisfaction the lower rate is 5 attributed to two criteria related with port costs. In the third place, with an average rate of 5.5, there are 14 criteria.

As regards the least-rated criteria in terms of satisfaction, port users declare that the adequacy of parking spaces was the most insufficient parameter in the pilot ports, based on their experience, followed by the services to cruise passengers and the customs operating hours. In terms of importance, port users declared six criteria as being the least important, with an average rate of five out of seven (Table VII).

4.7 GAP analysis

A GAP analysis has been conducted based on the results of the pilot exercise. The GAP analysis has been applied for each port market. If the score of a service is positive (above zero) then port users ranked the service as a very important one, but they are not satisfied by it. In this case, port authority actions are required. If the mean score of a service is negative (below zero) then respondents rated this service relatively unimportant but are very satisfied

Ranking	Satisfaction		Ranking	Importance	
	Criterion	Rate		Criterion	Rate
<i>Top-rated</i>					
1	Port operating hours, on-time arrival, on-time departure, efficiency of ice-breaking operations, port security	6	1	Efficiency of ice-breaking operations	7
				On-time arrival, on-time information, accuracy of information, port security, port safety, efficiency of passengers' clearance procedures	6.5
<i>Least-rated</i>					
3	Customs operating hours	5.5	1	Efficiency of bunkering, efficiency of dredging operations, number of operational passenger terminals, efficiency of baggage handling operations, baggage handling cost, coordination of port community	5
2	Services to passengers	4.5			
1	Number of parking areas	4			

**Table VII.**  
Top- and least-rated  
criteria for cruise  
port market

Source: Author

by it. In this case no action is required. The closer the gap is to zero the better balance there is between importance and satisfaction.

Table VIII presents the GAP analysis results in an aggregated way per port market. There is a GAP scale from -3.5 to 3.5 with a 0.5 pace, in total 15 GAP values that can be attributed to the criteria. For each value the table presents the number of criteria that scored this value per port market.

Port users identified major gaps in the majority of the criteria attributed to the container port market. Their perspective is that certain significant criteria are experiencing low levels of satisfaction. Criteria with large gaps (i.e. from 1 to 2.5) need to be a priority for improvement initiatives. A smaller gap was identified for several criteria, whilst a high negative gap (i.e. high levels of satisfaction and low importance) is only attributed to the “deep sea container services” criterion.

The Ro-Ro market evaluation reveals smaller gaps than the container port market, although a large gap (equal to 2.5) is revealed for the “vessel-related port costs,” thus improvement action is considered essential. Several criteria have a good balance between satisfaction and importance, thus action is not recommended as a priority in these cases, nor in the case of those criteria revealing negative gaps.

The dry bulk market does not reveal a satisfying performance. High positive gaps were identified for most of the criteria that have been evaluated by the port users, showing that there is a need for further improvements. Action is considered essential for all criteria that reveal high gaps between satisfaction and importance.

Liquid bulk port market is one of the markets where port users gave positive evaluations. Positive gaps are small with only those referring to costs (cargo-handling costs and vessel-related costs) and the operational depth having a positive gap of 1.5. The rest either have a balance between satisfaction and importance or they present a very small positive gap.

Break bulk market’s GAP analysis points out that there is a lot of room for improvements. Port managers should primarily focus on actions related to the hinterland connections (rail and road), adequacy of handling equipment for that specific type of cargo and related handling services. For these cases, GAP analysis indicates large positive gaps. Only the efficiency of dredging has been evaluated without unbalance between satisfaction and importance.

Finally, the results of the GAP analysis reveal a smooth picture for participating ports active in the cruise port market. In general, as seen from the above table the positive gaps are not high. Availability of parking areas and the services to passengers are the factors that have been evaluated as the most unsatisfying, revealing a positive gap at the scale of 1.5. Room for improvement though is available for the rest of the criteria with positive gaps, while at the same time port users seem quite satisfied with the rest of the criteria, as a lot of

Port market	-3.5	-3	-2.5	-2	-1.5	-1	-0.5	0	0.5	1	1.5	2	2.5	3	3.5
Container market					1			1		5	12	11	8	1	
Ro-Ro market				1					4	13	13	7	1		
Dry Bulk market										4	16	11	5	1	
Liquid Bulk market							2	12	14	3	3				
Break-Bulk market							1		2	11	20	4			1
Cruise market							3	8	15	10	2				

Source: Author

**Table VIII.**  
GAP analysis per  
port market

them reveal a good balance between satisfaction and importance, with zero or low negative gaps.

In a nutshell, best-performing port markets in terms of the evaluation of port users' perspectives are the cruise and the liquid bulk markets, and corrective actions are needed for the rest of them.

## 5. Discussion: overall experience and lessons learned

The pilot phase implementation has provided a significant feedback, both from the perceived value of the proposed framework perspective, based on the results, as well as from an operational perspective. In general, most of the ports participated in the pilot phase have been open, curious and interested in the process and the results. This is justified by the fact that a lot of non-technical questions have been communicated to the research team referring mostly to the effectiveness of the process itself.

On the added value of the proposed framework and its application, the paper draws attention to a rather neglected parameter on port performance measurement – that of the port users' perception of port performance (Vaggelas *et al.*, 2017). Incorporating port users' perception in any port performance measurement framework can lead to an integrated and holistic approach.

Moreover, the proposed framework provides three key attributes that proved to be essential during the implementation phase. The first one is *customization*, as each port has unique characteristics and needs. The ability of the tool to be customized based on the peculiar needs of a port, through the selection of port markets as well as of the criteria per port market that are going to be assessed by the port users, is an advantage of the proposed framework increasing the degree of applicability and thus the acceptance of the tool.

The second attribute is *confidentiality*, as the ICT tool can be controlled by the port authority or the terminal operator, in case of applying the tool in a specific port terminal, thus securing that the whole process and any sensitive data are only accessible by the authorized personnel. Many ports are reluctant in sharing information because of:

- the sensitive nature of port business in terms of security;
- the fact that ports are business entities; thus confidentiality issues arise especially with regard to business information and data; and
- the fact that ports are usually introvert organizations, though steps have been taken in the past few years toward extroversion.

The third attribute is *flexibility*. A port authority can apply the proposed framework at any given time and for any given reason. For example, on the occasion of the construction of a new container terminal the port authority can run the exercise to selected port users, aiming at assessing their perception on port performance prior and after the new infrastructure.

The discussion on the deficiencies of the proposed framework starts from the fact that port users asked to evaluate criteria related with port' performance that have been selected by the port authority itself. The twofold approach that has been followed (Phases 1 and 2 of the tool) has been revealed to be rather inevitable. The involvement of port management at the structure of the surveys through the criteria selection has unavoidably provided an aspect of what ports consider important when measuring port performance. As already mentioned, this was inevitable as during the phases of design, development and finally application of the proposed framework and the relevant ICT tool, it has been evident that port authorities sought for a more active participation and control over the design and

implementation of the tool aiming at safeguarding the privacy of the subsequent results. Previous studies, with the most indicative example being that of [PricewaterhouseCoopers and Panteia \(2013\)](#), highlighted efficiency drawbacks in the port industry and in general brought at the forefront the port efficiency as a parameter of port policy. As a result, ports became even more suspicious in participating in relevant studies. A suggestion for future research is to limit the involvement of port authorities in the selection of the criteria to be evaluated by port users avoiding any bias in the process. Also, the active participation of port users in the development of the list of criteria (for example, through interviews) is something worth to be explored in a future research.

Another drawback has been the low participation rate of port authorities and of port users. For port authorities it seems rather difficult to undertake corrective actions, as the insights from the whole procedure reveal that a lot of communication and promotion is needed, but only if contacts have been made with port management key personnel in advance. Promotion campaigns (via e-mails) seem to be rather impersonal and the sense is that if those are addressed to unauthorized departments of a port authority, they rarely get the attention they deserve. Also, a campaign is needed to overcome port's hesitation in participating in a port users' performance measurement exercise, as this is a sensitive issue for the port industry, as already discussed. To overcome this drawback is not just an issue of applying some corrective actions. It is an issue that is strongly related with the nature of port business and the fact that port authorities are rarely extrovert organizations. Thus, to overcome this issue a lot of effort is needed aiming at building trust and a common understanding without prejudices between port authorities and the research community.

All in all, port authorities should adopt a more extrovert strategy, targeting among others, their users. The paradigm of the airline industry, where the airline companies and the airports are evaluated by their users shows that users perceptions should not be a taboo issue but rather a tool for developing business strategies. As regards port users, there were also low response rates revealing some common outcomes as in the case of port authorities. As suggested to all port authorities' representatives that used the ICT platform campaign, a lot of follow-up is needed. Another suggestion aiming at increasing port users' participation would be an informative campaign before proceeding with the online survey. The port authority can also run the exercise periodically to acquaint its users with the evaluation campaign, thus building a long-term relationship aiming at higher participation and response rates in the future.

Concluding, port performance issues and especially the port users' perception on it, continues to be a taboo issue for the port industry. The request from port authorities for having a control over the ICT tool and its application along with the low participation of ports, shows that they are not yet ready to move towards an increasing engagement of their users in a port performance evaluation scheme.

## 6. Concluding remarks

The paper presents a framework aiming at measuring the perceptions of port users – such as shipping companies – on port performance. With port users' perceptions being the missing link in port performance measuring tools, the paper suggests a framework that can lead to a comprehensive approach. The results of the pilot phase reveal several drawbacks in port performance elements in the participating ports especially for the container port market, the dry bulk port market, the Ro-Ro port market and the break-bulk port market.

The proposed tool can be a valuable add-on for port authorities to evaluate their performance from the port users' point of view and taking the necessary actions to improve it. It can also be used for the evaluation of a new process, infrastructure, etc. in a port, as the

exercise can be applied even in the case of one and only criterion for which the port users will provide their feedback. In addition, the proposed tool can be used for several other purposes, i.e. a port authority can use it for performing evaluation processes internally. For example, running an exercise on port authority's employees regarding their perception on port operation and performance. The tool can be used for any purpose aiming at evaluating a decision, a process, an infrastructure or a service in a port, being a useful component in a decision-making process.

As regards port policy implications, the evaluation of port users' perception of port performance can be part of a European ports observatory through a set of indicators that clearly reflects the satisfaction of port users by engaging their view on port performance issues, instead of relying almost exclusively on data generated by port authorities. The measurement of users' perception is the missing link in the existing port performance measurement initiatives, aiming at a more holistic approach where the users are the key for a robust evaluation. The development of a European ports observatory could be the first step towards the creation of a level playing field in the European port industry at least regarding the development of a common ground for port performance measurement.

The paper contributes in the dialog regarding port performance, going beyond the typical efficiency approach and bringing into the scene, the port users' perception on port performance, thus examining the issue from an effectiveness point of view.

Being a vital part of port competitiveness, performance is at the core of port strategies, but usually the approaches used differ, depending on the peculiar characteristics of each port, needs and requests. The proposed framework can be the base for the formation of a common approach towards port performance measurement.

There has been a lot of dialog done lately regarding the improving of quality of port services and the adoption of sustainable development goals. More recently, a coalition of 30 European transport organizations launched a campaign for a "strong connecting Europe Facility for the next financial period 2021-2028." The slogan is "More EU budget for transport, the best investment plan for Europe," a move that reveals an urgent need for quality adjustments within a lack of finance resources. In addition, the international port community is taking up the challenge towards a more sustainable port industry, by setting up the "World Ports Sustainability Program".

Ports, as any other commercial entity, are seeking quality to increase their competitiveness and at the end, their viability in a strongly competitive environment. Port performance, on the other hand, is an attribute of quality and as such, exploiting the measurement of port performance is essential for understanding the notion of quality. The measurement of port users' perceptions on port performance is a strong link in the enhancement of quality of port services as a strategic tool and as such can provide additional perspectives regarding port effectiveness and quality schemes.

## References

- Beresford, A., Woo, S.H. and Pettit, S. (2010), "Improving port performance: from serving ships to adding value in supply chains", in Comtois, C., Mc Calla, J.R., Hall, P. and Slack, B. (Eds), *Integrating Seaports and Trade Corridors*, Ashgate Publishing, Surrey, pp. 137-154.
- Beuren, M.M., Andriotti, R., Bergmann, G., Vieira, B., Ribeiro, J.L.D. and Neto, F.J.K. (2018), "On measuring the efficiency of Brazilian ports and their management models", *Maritime Economics and Logistics*, Vol. 20 No. 1, pp. 149-168.

- Brooks, M.R. (2007), "Issues in measuring port devolution program performance: a managerial perspective", in Brooks, M.R. and Cullinane, K. (Eds), *Devolution, port governance and port performance*, Elsevier, London, pp. 599-629.
- Brooks, M.R. and Pallis, A.A. (2008), "Assessing port governance models: process and performance", *Maritime Policy and Management*, Vol. 35 No. 4, pp. 411-432.
- Brooks, M.R. and Pallis, A.A. (2013), "Considering the perspectives of port users", *Port Technology International*, Vol. 60, November, pp. 27-28.
- Brooks, M.R., Schellinck, T. and Pallis, A.A. (2011), "A systematic approach for evaluating port effectiveness", *Maritime Policy and Management*, Vol. 38 No. 3, pp. 315-334.
- Comtois, C. and Slack, B. (2010), "Measuring port performance: lessons from the waterfront", in Hall, P. V., McCalla, R., Slack B. and Comtois, C. (Eds), *Integrating Seaports and Trade Corridors*, Ashgate, Aldershot, pp. 119-136.
- Cullinane, K. and Song, D.W. (2003), "A stochastic frontier model of the productive efficiency of Korean container terminals", *Applied Economics*, Vol. 35 No. 3, pp. 251-267.
- De Langen, P.W. (2008), "Port performance indicators", *ESPO Conference*, 24 of September, Bilbao.
- De Langen, P.W. and van der Lugt, L.M. (2017), "Institutional reforms of port authorities in The Netherlands; the establishment of port development companies", *Research in Transportation Business and Management*, Vol. 22, pp. 108-113.
- Ensslin, L., Dezem, V., Dutra, A., Ensslin, S.R. and Somensi, K. (2018), "Seaport-performance tools: an analysis of the international literature", *Maritime Economics and Logistics*, Vol. 20 No. 4, pp. 587-602.
- Lin, L.C. and Tseng, C.C. (2007), "Operational performance evaluation of major container ports in the Asia-Pacific region", *Maritime Policy and Management*, Vol. 34 No. 6, pp. 535-551.
- Lirn, T., C., Thanopoulou, H. and Beresford, A. (2003), "Transshipment port selection and decision – making behaviour: analysing the Taiwanese case", *International Journal of Logistics*, Vol. 6 No. 4, pp. 229-244.
- Lirn, T.C., Thanopoulou, H.A., Beynon, M.J. and Beresford, A.K.C. (2004), "An application of application of AHP on transshipment port selection: a global perspective", *Maritime Economics and Logistics*, Vol. 6 No. 1, pp. 70-91.
- Martilla, J.A. and James, J.C. (1977), "Importance-performance analysis", *Journal of Marketing*, Vol. 10 No. 1, pp. 13-22.
- Ng, K., Y.A. (2006), "Assessing the attractiveness of ports in the North European container transshipment market: an agenda for future research in port competition", *Maritime Economics and Logistics*, Vol. 8 No. 3, pp. 234-250.
- Nguen, H.O., Nghiem, H.S. and Chang, Y.T. (2018), "A regional perspective using metafrontier analysis: the case study of Vietnamese ports", *Maritime Economics and Logistics*, Vol. 20 No. 1, pp. 112-130.
- Notteboom, T., Coeck, C. and Van Den Broeck, V. (2000), "Measuring and explaining the relative efficiency of container terminals by means of Bayesian stochastic frontier models", *International Journal of Maritime Economics*, Vol. 2 No. 2, pp. 83-106.
- Pallis, A.A. and Vaggelas, G.K. (2007), "Enhancing port security via the enactment of EU policies: Operational and economic implications", in Bell, M., Bichou, K. and Evans, A. (Eds), *Risk Management in Port Operations Logistics and Supply Chain Security*, Lloyd's of London Press, London.
- Pallis, A.A. and Vitsounis, T.K. (2009), "Port performance: measuring port users perspectives", *WCTR Conference – Special Interest Group 2*, University of Antwerp, May.
- Pantouvakis, A., Chlomodis, C. and Dimas, A. (2008), "Testing the SERVQUAL scale in the passenger port industry: a confirmatory study", *Maritime Policy and Management*, Vol. 35 No. 5, pp. 449-467.

- Park, R.-K. and De, P. (2004), "An alternative approach to efficiency measurement of seaports", *Maritime Economics and Logistics*, Vol. 6 No. 1, pp. 53-69.
- PricewaterhouseCoopers and Panteia (2013), "Impact assessment on: measures to enhance the efficiency and quality of port services in Europe", Study submitted to European Commission – Directorate General for Mobility and Transport, Unit B3 Ports and Inland Navigation, July 2013, Brussels.
- Robinson, R. (2002), "Ports as elements in values-driven chain systems: the new paradigm", *Maritime Policy and Management*, Vol. 29 No. 3, pp. 241-255.
- Roll, Y. and Hayuth, Y. (1993), "Port performance comparison applying data envelopment analysis (DEA)", *Maritime Policy and Management*, Vol. 20 No. 2, pp. 153-161.
- Tongzon, J.L. (1995), "Determinants of port performance and efficiency", *Transportation Research A*, Vol. 29A No. 3, pp. 245-252.
- Tongzon, J.L. (2008), "Port choice and freight forwarders", *Transportation Research Part E*, Vol. 45 No. 1, pp. 186-195.
- Valentine, V.F. and Gray, R. (2001), "The measurement of port efficiency using data envelopment analysis", *Proceedings of the 9th World Conference on Transport Research*, 22-27 July, Seoul.
- Vaggelas, G.K. and Pallis, A.A. (2010), "Passenger ports: services provision and their benefits", *Maritime Policy and Management*, Vol. 37 No. 1, pp. 73-89.
- Vaggelas, G.K., Kladaki, E. and Pallis, A.A. (2017), "Measuring the missing link in port performance evaluation: Port users' perspectives", *Proceedings of the International Association of Maritime Economists conference, Kyoto*, 27-30 June.
- Yeo, G.T., Roe, M. and Dinwoodie, J. (2011), "Measuring the competitiveness of container ports: logisticians perspectives", *European Journal of Marketing*, Vol. 45 No. 3, pp. 455-470.
- Yuen, A.C.L., Zhang, A. and Cheung, W. (2012), "Port competitiveness from the user's perspective. An analysis of major container ports in China and its neighboring countries", *Research in Transportation Economics*, Vol. 35 No. 1, pp. 34-40.
- Yuen, A.C.L., Zhang, A. and Cheung, W. (2013), "Foreign participation and competition: a way to improve the container port efficiency in China?", *Transportation Research Part A*, Vol. 49, pp. 220-231.

**Corresponding author**

George K. Vaggelas can be contacted at: [g.vaggelas@stt.aegean.gr](mailto:g.vaggelas@stt.aegean.gr)