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Assessing customs performance in the Mediterranean ports. KPI selection and Best practices identification as part of the MEDNET project

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Abstract

The seamless flow of goods, people and investments across the Mediterranean necessitates a well-functioning port and transport system. More efficient port operations enhance seamless logistics and promote safety, efficiency, interoperability and interconnectivity of transport networks in the Mediterranean area.

To promote the exchange of knowledge and expertise relevant to port and customs procedures and simplification of clearance for vessels and cargoes in the Mediterranean, the MEDNET project was launched. As part of the project a common evaluation framework for the performance of ports in the form of a set of Key Performance Indicators (KPIs) together with a list of the best practices in terms of operations and customs procedures was developed.

In total, 61 ports were analyzed and given a KPI regarding traffic, financial, operational and human resources, sustainability and customs procedures. The values were latter crossed with the current good practices on operation in terms of customs procedures. A small correlation between KPIs performance and implantation degree of good practices in customs procedures was found. This presentation exposes the methodology to assess the ports' performance and the good practices identification.

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1. Introduction

The seamless flow of goods, people and investments across the Mediterranean necessitates a well-functioning port and transport system. More efficient port operations enhance seamless logistics and promote safety, efficiency, interoperability and interconnectivity of transport networks in the Mediterranean area.

In that context, the MEDNET project was launched to establish and operate a network of port authorities and transport experts in the Mediterranean region, focusing on the exchange of knowledge and expertise relevant to port and customs procedures and simplification of clearance for vessels and cargoes. This was expected to improve the common understanding and promote the introduction of information systems to ports operation and potentially to other intermodal modes.

Multiple measures to streamline freight going through port terminals and, therefore, increase the competitiveness of the maritime system, have been adopted through the years. Some, to enforce regional, national or European regulations (like the recent adoption of the Directive 2010/65 on the implementation of Single Window in Customs), others spawning from the initiative of port authorities. In any case, the effectiveness of such initiatives would be hard to quantify, unless they can be checked against a set of performance indicators closely related to what has been implemented.

With this idea in mind, part of the project involved the identification of good practices in the Mediterranean Ports to ease the procedures and assess their effects on the port performance in order to identify the families of practices necessary in any ‘ideal port’. This paper proposes a set of key performance indicators (KPIs) to later construct a framework looking for a link between practices and performance.

A comprehensive list of current practices that could be labeled as good or best practices in 61 ports from 10 countries from the Mediterranean were identified. The goal of this paper being to divulgate the findings made, digest the practices and look for an hypothetical connection between their implantation and the current performance of ports with the aim to identify the best practices that are necessary in any ‘ideal port’. To do so the paper proposes a set of key performance indicators (KPIs) and links the values obtained with the level of ‘good-practicing’ of each port by using a DEA (Data Envelopment Analysis) model.

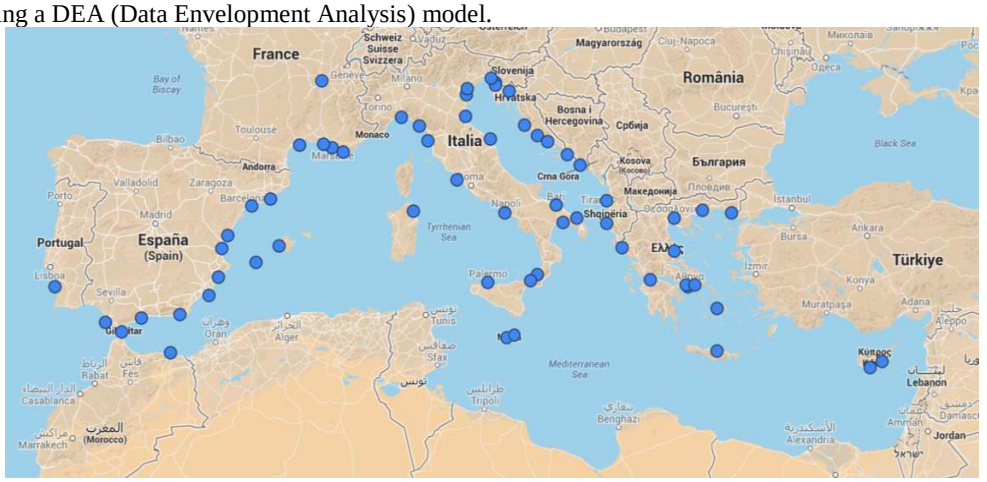

Fig. 1. Participating ports in the survey

The first block of this paper discusses the major precedents on port performance assessment methodologies to, in a second block, introduce a set of KPIs and grade the ports according to them. A third block identifies the families of good practices currently in operation at ports to, in the fourth section, propose a methodology to link KPIs and good practices observations. The results from applying it to the sample of studied ports and conclusions and further developments to be pursued are discussed at the end.

2. Performance benchmarking at ports. A literature review

Benchmarking is the systematic comparison of the performance of one port against others. The idea is to compare entities with the same framework of properties, or in this case, procedures, with the outputs –performance– achieved from their implementation. The production entities could be firms, organizations, divisions, industries, projects, decision making units, individuals or, in this case, ports.

A traditional way to overcome some of the difficulties of making comparative evaluations is to use what practitioners call Key Performance Indicators, KPIs. KPIs are a tool to understand and monitor the quality of their performance in relation to their strategic objectives. Moreover, KPIs reduce the complex nature of organizational performance to a small number of values, to control, monitor and improve the quality of the services provided.

The foundation of benchmarking performance and KPI values for ports was set up in 1976, when the United Nations Conference on Trade and Development (UNCTAD, 1976) published a list of port performance indicators, which has become the reference point for researchers ever since. The list divided port performance indicators in two broad categories: financial (aggregate port impacts on economic activity) and operational (input/output and productivity measures).

Later contributions complemented this first set of KPIs with qualitative indicators. Talley (1994), proposed a set of indicators to evaluate the performance of ports considering the economic optimum beyond engineering parameters. More recently, new KPIs have been proposed to cover the current needs of ports, including logistics services, for instance. As an indication, Owino et al. (2006) produced an updated list with 30 different performance indicators and Marlow and Paixão (2003), proposed a set of KPIs highlighting the importance of measuring port effectiveness and its relationship with leanness in the entire logistics transport chain. In the same context, Bichou and Gray (2004) based performance on logistics services, and argued that all performance indicators can be reduced to three broad categories: physical, productivity; and economic and financial indicators.

The use of port performance indicators in the port industry has increased in recent years. Various port authorities have developed and reported port performance indicators in their annual reports. However, clear standards and a common ground with the same data definition is missing. These are required for both the development of aggregated performance indicators (e.g. for a whole country) and to allowing benchmarking between ports. For instance, the Port of Rotterdam uses 32 KPIs to grade port operations and assess the quality of its services or, the Port of Hamburg, developed three sets of indicators –depending on the stakeholder involved– (project StratMoS).

A good use of KPIs, however, requires to compare them. For instance, if one input produces one output and we knew the input–output data from several ports, we could use this to determine who is doing best by simply comparing the numbers, in what is often called productivity, i.e. output per input.

Moreover, the direct use of KPIs has two main drawbacks: i) comparing firms (ports) with highly different outputs and assuming constant returns to scale; and ii) to account several output-input ratios simultaneously since one KPI may not reflect all measurable goals of the port.

Some methodologies address those drawbacks. The books by Bogetoft and Otto (2010) and Cooper et al. (2007) provide a good overview of benchmarking to address them, focused in the Data Envelopment Analysis (DEA).

Tongzon (1995) was the first to develop such methodologies in a port environment. After empirically determinate the main factors over performance for 23 international ports, produced two performance indicators and a set of distinct determinants per each. The effect of each determinant over the indicators was determined with a two-stage least squares estimation procedure. Despite the results were not conclusive, the study identified the necessity to consider the individual efficiency of terminals when assessing port performance and the difficulty in quantifying delays.

At a European level, Cullinane and Wang (2006) provided a relevant study for its scope (69 port container terminals from 24 countries). The authors used a DEA analysis with constant returns to scale (CRS) and variable returns to scale (VRS). Besides finding out that the majority of terminals were low performers, they identified returns to scale and that the geographical area influenced the performance of ports.

Regarding DEA, Panayides et al. (2009) provided a critical analysis on port benchmarking with DEA to find out that better results were obtained with panel data covering several years of a single port than using larger sets of ports or variables. The variables should be kept as small and as representative as possible. Otherwise, too many ports may be qualified as peers (efficient) because there would not counterparts to be compared with them.

Finally, the work by Tovar and Rodríguez-Déniz (2015) not only provided a good overview of the benchmarking techniques for efficiency (productivity) assessment in ports but also highlighted the necessity to produce clusters of ports with similar characteristics to avoid confusions between inefficiency and heterogeneity. Interestingly, the study assesses different methods used for benchmarking and port clustering, either non-parametric models (DEA) or parametric techniques (Stochastic Frontier Analysis, SFA).

3. KPI construction and good practices identification

3.1. KPI Construction

An initial set of KPIs was identified and classified into six main categories: traffic; financial; operational; customs procedures; sustainability and security; and human resources. The Delphi method was used for the selection of the final set of KPIs and reference values, based on the experience and expert opinion of the MEDNET consortium partners. The initial set of 77 different KPIs was successfully reduced to a more reasonable number of indicators, 27 (Table 1), also in line with the availability of relevant data in the Mediterranean ports.

The methodology for assessing the ports performance in terms of their everyday operations and activities involved the harmonization and classification of the KPIs and their quantification to provide standard benchmarking values for the examined ports resulting in a weighted value for each set of ports (Table 1) and calculated for the 61 studied ports. It was hence possible to capture the latest ranking status of the examined ports at a specific time (Figure 2).

Table 1. . Key Port Performance Indicators (shortlist)

KPI group	KPIs shortlisted
Traffic	Annual number of ship calls; Average tonnage per ship; Total annual throughput; Annual TEUs; Annual bulk commodities; Annual non-bulk commodities; Annual vehicle traffic (trucks).
Financial	Business volume; Profitability; Return on capital invested.
Operational, Human resources and other	EDI system; Single window; Port Community System; Intermodal network; Staff (Port Authority); Staff (Port Community); Tons per ship-hour in port; Turn-around time (cargo); Waiting time after berthing; Time waiting for cargo transfer between modes.
Customs procedures	Entry/Exit Summary declarations; Electronic Customs Declaration (SAD); Economic Operation Registration & Identification (EORI); Authorized Economic Operator (AEO); Time for goods clearance.
Sustainability/security	Environmental management system; Compliance with ISPS.

Fig. 2. KPI evaluation (per set) for the studied ports (only freight ports considered)

KPI Category	Civitavecchia	Genoa	La Spezia	Livorno	Messina	Naples	Olbia	Palermo	Ancona	Chioggia	Molfacone	Ravenna	Trieste	Venice	Bari	Brindisi	Gioia Tauro	Taranto	Alexandroupolis	Elefsina	Heraklion	Kavala	Rafina	Thessaloniki	Piraeus	Igoumenitsa	Volos	Paros	Patras
Traffic Indicators	0,25	0,78	0,46	0,58	0,32	0,48	0,50	0,30	0,23	0,50	0,16	0,39	0,61	0,41	0,21	0,21	0,62	0,53	0,51	0,43	0,29	0,51	0,46	0,33	0,55	0,74	0,22	0,54	0,37
Financial Indicators	0,63	0,63	0,63	0,63	0,63	0,63	0,63	0,63	0,63	0,63	0,63	0,63	0,63	0,63	0,63	0,63	0,63	0,63	0,00	0,39	0,63	0,00	0,17	0,76	0,34	0,50	0,19	0,63	0,46
Operational Indicators	0,66	0,62	0,62	0,62	0,50	0,62	0,48	0,57	0,61	0,56	0,62	0,62	0,63	0,63	0,55	0,55	0,40	0,57	0,52	0,51	0,44	0,58	0,66	0,58	0,66	0,51	0,55	0,40	0,37
Indicators for Customs Procedures	0,78	0,78	0,68	0,68	0,68	0,68	0,68	0,78	0,61	0,61	0,61	0,61	0,68	0,61	0,61	0,61	0,61	0,61	0,78	0,87	0,78	0,78	0,78	0,78	0,78	0,88	0,78	0,78	0,67
Indicators for Sustainability/Security	0,70	0,70	0,39	0,70	0,19	0,19	0,39	0,70	0,70	0,39	0,39	0,39	0,70	0,70	0,70	0,70	0,70	0,70	0,39	0,39	0,39	0,39	0,00	0,39	0,70	0,70	0,70	0,39	0,70
Total Performance Score	**3,01**	**3,51**	**2,76**	**3,20**	**2,31**	**2,60**	**2,66**	**2,98**	**2,77**	**2,68**	**2,40**	**2,63**	**3,23**	**2,97**	**2,69**	**2,69**	**2,96**	**3,04**	**2,20**	**2,59**	**2,53**	**2,27**	**2,07**	**2,84**	**3,04**	**3,34**	**2,44**	**2,74**	**2,57**
% of Ideal Port	**60%**	**70%**	**55%**	**64%**	**46%**	**52%**	**53%**	**60%**	**55%**	**54%**	**48%**	**53%**	**65%**	**59%**	**54%**	**54%**	**59%**	**61%**	**44%**	**52%**	**51%**	**45%**	**41%**	**57%**	**61%**	**67%**	**49%**	**55%**	**51%**

KPI Category	Algeciras	Alicante	Almeria	Cadiz	Cartagena	Malaga	Valencia	Barcelona	Castellon	Ibiza	Melilla	Palma de Mallorca	Tarragona	Lyon	La Fos / Marseille	Sete	Toulon	Lamaca	Limassol	Koper	Marsaxlokk	Valetta	Sines	Rijeka	Ploce	Dubrovnik	Sibenik	Split	Zadar	Durres	Vlore
Traffic Indicators	0,99	0,07	0,10	0,08	0,43	0,13	0,83	0,88	0,27	0,19	0,15	0,35	0,47	0,31	0,81	0,13	0,16	0,09	0,19	0,40	0,52	0,18	0,58	0,16	0,13	0,21	0,27	0,21	0,10	0,08	0,20
Financial Indicators	0,92	0,49	0,12	0,57	0,89	0,43	0,93	0,98	0,29	0,37	0,26	0,37	0,89	0,47	0,79	0,63	0,50	0,62	0,70	0,85	0,63	0,63	0,83	0,63	0,29	0,63	0,63	0,63	0,63	0,83	0,63
Operational Indicators	0,56	0,50	0,46	0,45	0,57	0,44	0,64	0,61	0,51	0,39	0,29	0,54	0,71	0,62	0,60	0,66	0,62	0,55	0,61	0,72	0,59	0,61	0,67	0,39	0,37	0,47	0,47	0,47	0,34	0,40	0,37
Indicators for Customs Procedures	0,90	0,90	0,90	0,90	0,90	0,90	0,90	0,90	0,90	0,90	0,73	0,90	0,78	0,90	0,90	0,90	0,90	0,45	0,45	0,78	0,57	0,57	0,89	0,57	0,57	0,57	0,57	0,57	0,57	0,78	0,57
Indicators for Sustainability/Security	0,70	0,70	0,70	0,70	0,70	0,70	0,70	0,70	0,39	0,57	0,51	0,57	0,70	0,54	0,70	0,70	0,70	0,70	0,70	0,70	0,39	0,39	0,70	0,70	0,70	0,70	0,70	0,70	0,70	0,70	0,70
Total Performance Score	**4,06**	**2,66**	**2,28**	**2,70**	**3,49**	**2,60**	**4,00**	**4,07**	**2,36**	**2,43**	**1,94**	**2,74**	**3,55**	**2,85**	**3,79**	**3,02**	**2,88**	**2,41**	**2,64**	**3,46**	**2,69**	**2,37**	**3,67**	**2,44**	**2,07**	**2,57**	**2,63**	**2,57**	**2,33**	**2,79**	**2,46**
% of Ideal Port	**81%**	**53%**	**46%**	**54%**	**70%**	**52%**	**80%**	**81%**	**47%**	**49%**	**39%**	**55%**	**71%**	**57%**	**76%**	**60%**	**58%**	**48%**	**53%**	**69%**	**54%**	**47%**	**73%**	**49%**	**41%**	**51%**	**53%**	**51%**	**47%**	**56%**	**49%**

3.2. Good Practices. Concept and identification

In total, 301 good practices were identified from questionnaires distributed among the port authorities of the 61 ports. The results were processed, harmonized and classified following two distinct listings: i) grouping practices involved with each of 12 processes in customs and clearance, and ii) considering the classification of performance indicators for trade facilitation (World Customs Organization, 2014). Tables 2 and 3 shortlist the results.

Table 2. – Best practices according to the procedure affected

Procedure considered	Related good practices
ENS declaration	Online declarations lodging; XML Standards and DG TAXUD message structure; Digital signatures; measures to enforce compliance; Automatic risk analysis; Universal-free use;…
Arrival notification	SDTS declaration at port of entry as Arrival Notification; Advance submission; Integration with Single Window/Port Community Systems; Government authorities information share; ENS, arrival notification and SDTS combined declaration,…
Risk identification	All controls taken simultaneously when no risk; common EU framework EU; Electronic certification of control automatically updated; Automatic risk sorting; Algorithms to automatic identification of risks; Reliable operators with reduced controls; Advanced targeting to introduce clearance pre arrival, …
Summary declaration for temporary storage (SDTS)	Integration with Single Window / Port Community System; Multiple declarations (per consignee) or at vessel level; Proof of arrival message; Consistency checks with ENS; Check cargo declared corresponds to presented; Automatic countdowns and starting of goods departure (EXS); Paperless procedures, ENS, arrival notification and SDTS combined declaration;…
Electronic Customs Declaration (SAD)	Custom events history recording and traceability; Simplified transit procedures for containerized rail transport in dry ports; Paperless procedures; Valid electronic official accompanying documents; Electronic messages / digital signatures, …
Export Accompanying Document	Electronic communication of goods arrival; Automatic transmission of customs events with arrival notification; Paperless control; Immediate exchange of all information by the different custom offices, …
Exit Summary Declaration (EXS)	Online declarations lodging; XML standards and DG TAXUD message structure; Digital signatures; Measures to enforce compliance; Automatic risk analysis; Universal-free use; Same massage for transhipment if possible; Traceability system to inform Port Authority of previous customs events, …

Proof of Community Status (T2L)	Electronically available; full paperless automatic procedure; Communication with final port; 2D/3D coding for security control; pdf (electronic) validity suffices; EU integrated and common methodology,…
Customs Cargo Manifest for Departure (CCMD)	Integration with Single Window / Port Community System; Multiple declarations (per consignee) or at vessel level; Automatic deadline settings for EXS or transhipment documentations; Paperless automatic clearance and loading controls for goods, …
Economic Operator Registration and Identification (EORI)	EORI figure; no coding duplicity at EU level; ease to calculation (other coding as a base); Speed up electronic processing and security controls, …
Authorised Economic Operator (AEO)	Reduce controls and optimization of resources; periodic updates to renovate the condition; EU common AEO listing; EU equivalent standards for certification; EU information exchange of goodness, …
Goods release when entering or leaving the CTC	Electronic submission of declarations; Automatic risk analysis and filters; Reduction and automation of revenues; Control to check quantities stored, cleared and released, …

Table 3. Best Practices according to typology

Best practices group	Practices identified
E-customs, digitalization and automation	Computerized customs procedures; reliable and immediate communication between administration bodies and importers; electronic customs declaration (SAD); online clearance; automatic clearance and departure authorizations issuing (green risk); electronic accompanying export document (T2L); electronic invoicing; check, ticketing and passenger control; generalized use of digital certificates/signatures; no physical documents; software to facilitate documentation generation; automatic statistics record and exploitation;…
Systematization, homogenization, simplification	Coding systematization and simplification (EORI and VAT aligning, vessel coding, TARIC use); one-shop-stop customs inspections; same language format in all declarations (XML); centralized service management; border inspection health and phytosanitary controls; simplified taxing levels; harmonized regulations;…
Information sharing platforms. Port communication & information exchange	Single Window at port, national and regional level; wide use of Port Community Systems by all stakeholders involved; custom inspection results sharing regarding importers affected by all customs; use of EORI certification common to all EU countries;…
Advance / Delayed rulings	Pre-arrival notifications; introduction of advanced rulings; possibility for advanced clearance (applied to green risk goods and certified AEOs); post release audit
Risk management and selective controls	Automatic risk assessment; EU common risk criteria; emergency control centers and protocols; systematic compliance with HSSE policies in security, safety, pollution control and health; risk assessment through ticketing (passengers); EU common framework AEO certification; periodic certificate checks on AEO;…
Clearness, transparency and partnership with the private sector	Public access to complete list of customs procedures, fees and taxes; simplified good levels and procedures; easy access to information regarding port services, delays, procedures or other events through web services, SMS and/or social networks; periodic meetings with actors involved; participation of all stakeholders in decision making; periodic surveys to all stakeholders and publication of its results; advisor boards; …
Easy access to multimodal transportation	Automated access systems; seamless connection to other modes of transportation; Bonded warehousing; simplified connection and delayed procedures when working with dry ports or logistic zones;…

4. DEA assessment

A nonparametric approach was proposed to link KPIs and the identified good practices: a CRS, inbound oriented with slacks DEA, despite VRS was also tested as a possible method of resolution. The approach has three main strengths: i) the detection of the peers (or the dominating ports) that can serve as reference to other ports; ii) it allows detecting what practices are likely to provide a higher performance boost if fulfilled; and, iii) the use of slacks (penalize performers that use too much inputs for a given output) (Bogetoft and Otto, 2010).

However, some drawbacks were identified as well: the inputs used were far from representative considering the outputs and both (inputs and outputs) were more qualitative than quantitative values since relative (and weighted) values were finally taken. However, the main alternative in terms of benchmarking, SFA, obliged to define a particular frontier shape and to make assumptions on the distributions of the errors which was not possible.

The specification of variables to be used is critical. Specifying erroneous or unfit inputs or outputs may cause biased results and conclusions. As a rule of thumb, the number of observations, *K*, should comply $K > 3(m+n)$ and K

> m·n, to have meaningful results, with *m* and *n* the number of inputs and outputs. The ideal selection includes the smallest number of output and input measures that adequately capture all essential aspects of a port's operations. Hence, a key issue is the level of aggregation inputs/outputs.

In this case, ideally, outputs and inputs were to be selected from the KPIs, and the efficiency values obtained to be correlated to the completeness of each set of good practices. However, since the data was not sufficiently complete, the level of implementation of the identified good practices was finally taken as inputs.

The level of implementation of the good practices (inputs) was assessed by grading 43 good practices by typology and 84 good practices considering the affected process, organized in 8 and 12 groups respectively (tables 2 and 3). In total, 117 good practices ranked individually for each of the 61 ports graded from 0 to 1, being 1 a 100%.

Regarding the outputs, 27 were too many outputs to considered and some of them are not performance related and should be disregarded. As a result, just the traffic indicators were used (7 values) both in their absolute form and in their normalized (1 to 5 values).

Data was obtained for 61 ports, but only 40 ports had information complete enough to be used.

5. DEA results and discussion

After calculating the DEA efficiency with slacks on the final selection of 40 ports, the results show how well ports are performing considering the amount of implemented good practices. That is, a smaller efficiency value does not mean a port is performing worse than another, it can just mean that it has more efficiency measures implemented than another does. In fact, and at this level of the assessment it would be highly profitable to produce the assessment with panel data, considering the rates of several years.

		EFFICIENCY		good practice overdimension											#	Aggregated slack
		Original	Modified	sx1	sx2	sx3	sx4	sx5	sx6	sx7	sx8	sx9	sx10	sx11	sx12	peers	
Italy	Civitavecchia	52%	36%	0	0	0	0.1	0	0	0	0.2	0.2	0.3	0.3	0.4	3	1.60
	Genoa	95%	74%	0.1	0.2	0.3	0.1	0.2	0.1	0	0	0	0.1	0.4	0.4	2	2.09
	Livorno	75%	58%	0.1	0.1	0.2	0.1	0.1	0	0	0.1	0.1	0.2	0.4	0.4	3	1.69
	Messina	54%	40%	0	0	0	0.1	0	0	0	0.2	0.2	0.2	0.3	0.4	4	1.41
	Palermo	53%	39%	0	0	0	0.1	0	0	0	0.2	0.2	0.2	0.2	0.4	4	1.41
	Ancona	52%	39%	0.1	0.1	0	0.1	0	0	0	0.2	0.2	0	0.3	0.4	2	1.36
	Molfacone	52%	38%	0.1	0.1	0	0.1	0	0	0	0.2	0.2	0	0.3	0.4	2	1.36
	Ravenna	62%	50%	0.1	0	0	0.1	0.1	0	0	0.1	0.1	0	0.3	0.4	3	1.16
	Trieste	77%	60%	0.1	0.1	0.2	0.1	0.1	0	0	0	0.1	0.2	0.4	0.4	3	1.72
	Venice	63%	52%	0.1	0.1	0	0.1	0.1	0	0	0	0.1	0	0.3	0.4	4	1.16
	Bari	52%	38%	0.1	0.1	0	0.1	0.1	0	0	0.2	0.2	0	0.3	0.4	2	1.42
	Brindisi	52%	39%	0.1	0.1	0	0.1	0	0	0	0.2	0.2	0	0.3	0.4	2	1.36
	Taranto	86%	64%	0.2	0.2	0.1	0.2	0.2	0.1	0.1	0	0.2	0	0.4	0.5	3	2.17
Greece	Heraklio	100%	96%	0	0.1	0	0.1	0	0	0	0	0.3	0	0	0	1	0.42
	Thessaloniki	100%	96%	0	0.1	0	0.1	0	0	0	0	0.3	0	0	0	1	0.42
	Piraeus	100%	100%	0	0	0	0	0	0	0	0	0	0	0	0	1	0.00
	Volos	100%	96%	0	0.1	0	0.1	0	0	0	0	0.1	0	0	0	1	0.28
	Patra	100%	100%	0	0	0	0	0	0	0	0	0	0	0	0	1	0.00
Spain	Algeciras	100%	100%	0	0	0	0	0	0	0	0	0	0	0	0	1	0.00
	Alicante	54%	39%	0	0	0.1	0.2	0	0	0	0.4	0.3	0.1	0.2	0.3	4	1.47
	Almeria	54%	39%	0	0	0.1	0.2	0	0	0	0.4	0.3	0.1	0.2	0.3	4	1.47
	Cadiz	54%	39%	0	0	0.1	0.2	0	0	0	0.4	0.3	0.1	0.2	0.3	4	1.47
	Cartagena	64%	52%	0	0	0.1	0.1	0	0	0	0.3	0.3	0	0.1	0.2	5	1.19
	Malaga	54%	39%	0	0	0.1	0.2	0	0	0	0.4	0.3	0.1	0.2	0.3	4	1.47
	Valencia	90%	86%	0	0	0	0	0	0	0	0.1	0.1	0	0	0.1	5	0.36
	Barcelona	93%	90%	0	0	0	0	0	0	0	0.1	0.1	0	0	0	5	0.25
	Castellon	55%	39%	0	0.1	0.1	0.2	0	0	0	0.4	0.4	0	0.2	0.3	4	1.52
	Eivissa	54%	39%	0	0	0.1	0.2	0	0	0	0.4	0.2	0.1	0.2	0.3	4	1.40
	Melilla	54%	40%	0	0	0.1	0.2	0	0	0	0.3	0.2	0.1	0.2	0.3	4	1.31
	Palma_Mallorca	59%	45%	0	0	0.1	0.2	0	0	0	0.4	0.3	0	0.2	0.3	5	1.42
	Tarragona	66%	55%	0	0	0.1	0.1	0	0	0	0.3	0.3	0	0.1	0.2	5	1.11
France	Marseille	100%	100%	0	0	0	0	0	0	0	0	0	0	0	0	1	0.00
Cyprus	Larnaca	73%	44%	0.2	0.3	0	0.1	0.1	0	0.2	0.2	0.3	0.7	0	0.6	2	2.80
	Limassol	69%	43%	0.2	0.2	0	0.1	0.1	0	0.2	0.2	0.3	0.7	0	0.5	2	2.58
Slovenia	Koper	100%	100%	0	0	0	0	0	0	0	0	0	0	0	0	1	0.00
Croatia	Rijeka	100%	100%	0	0	0	0	0	0	0	0	0	0	0	0	1	0.00
	Ploce	100%	97%	0	0	0	0	0	0	0	0	0	0.2	0	0.1	1	0.29
	Zadar	100%	99%	0	0	0	0	0	0	0	0	0	0	0	0	1	0.00
Albania	Durres	100%	100%	0	0	0	0	0	0	0	0	0	0	0	0	1	0.00
	Vlore	100%	100%	0	0	0	0	0	0	0	0	0	0	0	0	1	0.00

Fig. 3. Eficiency of ports considering the number of good practices implemented

Regarding the obtained results, at first glance it may appear that the most efficient (green values from figure 3, column efficiency) are the worst performers in absolute values (red registers in figure 2). However, this only reflects how peers were selected and the non-representativeness of some of the studied ports.

A study on the peers provides observes how the better performer ports only have one port of reference to assess their performance (column # peers from figure 3), even if they are not considered peers (framed ports in the figure). Non-framed ports (no peers) in this situation could interchange positions with their peers with no changes in the overall performance. Ports in those groups are over-performers given the degree of investments in good practices and ports that do not have other –more efficient- ports to compare with. Therefore, it is likely that added good practices in any of the procedure analysed would have a positive effect in performance, as long as the improve procedure returns a zero in figure 3.

The remaining ports are less efficient, meaning that the amount of good practices implemented has reached a more mature state and the number of peers used to check the efficiency of each port is bigger. This behaviour is country-wise, with similar peers among all ports in one country, proving that the data (and measures) are usually provided (and implemented and harmonized) at national level.

A further analysis of this second group of ports shows correspondence between the level of integration of good practices and the obtained efficiency, meaning that ports with more good practices in fact perform better, therefore showing some correlation between the two aspects. It is not possible, however, to affirm if they perform better because of the good practices, or if the good practices happen to be implemented in better performer (and busier) ports.

Finally, a last reading from figure 3 points at that more mature ports (Italian and Spanish) still have room for improvement in the 5^{th} to 7^{th} procedures considered, that is, implementing good practices in Electronic Customs Declarations (SAD), the Export Accompanying Document, the Exit Summary Declaration (EXS) since they are already at the frontier in terms of efficiency under those headings.

6. Discussion and conclusions

The goal of the research presented was to identify good practices already in operation in European Maritime ports, a benchmark on their performance and a tool to identify what good practices are needed to improve the performance of any port in the set. 27 KPIs and 113 good practices were considered and 61 ports analysed, 40 of them providing a reasonably complete database of values.

In a second stage, an input oriented DEA with constant returns to scale and slacks was used to look for relationships between degree of implementation of good practices and performance. It was observed that when inputs (good practices) are organized and grouped according to the process affected, results become more distinct and descriptive.

Two main different groups of ports were identified, regarding the maturity of the implemented good practices (and probably in database reliability. Less mature ports are likely to improve in performance with the implementation of any new practices, whereas the more mature ports show that there is still improvement available in terms of Electronic Customs Declarations (SAD), the Export Accompanying Document, the Exit Summary Declaration (EXS)

However, the results should be taken with caution, a more complete and accurate database in good practices, a more specific series of KPIs and panel data would likely improve and polish the obtained results and the conclusions derived from them.

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References

Bichou, K., Gray, R., 2004. A Logistics and Supply Chain Management Approach to Port Performance Measurement. Marit. Policy Manag.

Bogetoft, P., Otto, L., 2010. Benchmarking with DEA, SFA, and R, 1st ed. Springer, New York Dordrecht Heidelberg London. doi:0.1007/978-1-4419-7961-2

Cooper, W.W., Seiford, L.M., Tone, K., 2007. Data envelopment analysis: A comprehensive text with models, applications, references and DEA-solver software: Second edition, Data Envelopment Analysis: A Comprehensive Text with Models, Applications, References and DEA-Solver Software: Second Edition. doi:10.1007/978-0-387-45283-8

Cullinane, K., Wang, T.-F., 2006. The efficiency of European container ports: A cross-sectional data envelopment analysis. Int. J. Logist. 9, 19–31. doi:10.1080/13675560500322417

Marlow, P.B., Paixão, A.C., 2003. Measuring lean ports performance. Int. J. Transp. Manag. 1, 189–202. doi:10.1016/j.ijtm.2003.12.002

Owino, E.L., Wang Dr., T.-F., Pasukeviciute Dr, I., 2006. Performance measurement in European container terminal industry: an empirical investigation, in: IAME Proceedings. Melbourne, Australia.

Panayides, P.M., Maxoulis, C.N., Wang, T., Ng, K.Y.A., 2009. A Critical Analysis of DEA Applications to Seaport Economic Efficiency Measurement. Transp. Rev. 29, 183–206. doi:10.1080/01441640802260354

Talley, W.K., 1994. Performance indicators and port performance evaluation. Logist. Transp. Rev. 30, 339–352.

Tongzon, J.L., 1995. Determinants of port performance and efficiency. Transp. Res. Part A Policy Pract. 29, 245–252. doi:10.1016/0965-8564(94)00032-6

Tovar, B., Rodríguez-Déniz, H., 2015. Classifying Ports for Efficiency Benchmarking: A Review and a Frontier-based Clustering Approach. Transp. Rev. 35, 378–400. doi:10.1080/01441647.2015.1016473

UNCTAD, 1976. Port performance indicators (TD/B/131/Supp.1/Rev.1). New York.

World Customs Organization, 2014. Performance Indicators for the Agreement on Trade Facilitation.