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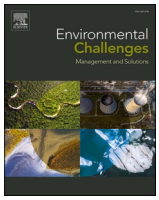

Environmental management systems in Greek ports: A transformation tool?

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ABSTRACT

Environmental Management Systems in ports represent an effort to combine high-quality port services and strong environmental performance with modern management strategies and street-level implementation. The broader use of EMS indicates a shift towards more sustainable port organization, operation and development, but also a trend to optimize objectives, means and procedures through a consistent, well-organized and result-oriented effort. This research paper delves into EMS as transformative tools, with a particular focus on their implementation and impact within Greek ports. Our findings suggest that EMS are powerful tools. They have the capacity to set strategic decisions into motion, establish concrete and measurable targets, introduce new processes and procedures, reorganize existing structures or create new ones, mobilize resources effectively, and generate tangible outputs and effects. Concurrently, EMS may have significant externalities by catalyzing changes in port strategy, governance, structure, or organizational culture. EMS reflect a heightened environmental ambition and engagement on the part of port authorities and serve as catalysts for the environmental mainstreaming and sustainability efforts within the port industry. Nonetheless, it is important to acknowledge that EMS implementation does have certain limits and limitations that should be taken into account when striving for better environmental performance or sustainable port development.

1. Introduction

In recent years ports have been increasingly introducing and implementing Environmental Management Systems (EMS) in line with concrete standards, integrating environmental considerations, principles and objectives in their strategic and business decisions, but also in their daily operations (Puig et al., 2022, 2020). The port industry uses mainly three different standards: ISO 14001, Eco-Management and Audit Scheme (EMAS), Port Environmental Review System (PERS), the latter being the only port sector specific standard (Tatar, 2017; Akgul, 2017; Puig et al., 2017b). They are all voluntary environmental management instruments intended to help ports manage their environmental responsibilities in a systematic manner and optimize results (Hossain et al., 2021; Housni et al., 2022). Ports are making the choice for an EMS, recognizing the value of the EMS in improving their environmental performance and various operations. They also consider EMS as useful management tools that can bring multiple benefits at different levels by improving and streamlining procedures, increasing efficiency, cutting costs over the medium- and long-term, rationalizing business decisions and supporting any choices to be made. They also provide a way for ports to address environmental pressures and challenges and respond to social and political pressure for a more environment-friendly operation and development. After all, ports showcase their certification according to recognized environmental management standards or their participation in networks such as ECOPORTS, in the context of greener operation and development, but also meeting conditions for more sustainable development.

The paper discusses the introduction and implementation of EMS in ports, seeking to highlight and assess their importance for, and effects on, the organization, operation and development of ports in relation to their environmental objectives and choices. Our objective is not to analyze the different standards and implications of each standard for the ports that use it or measure the improvement in ports' environmental performance, their impact on the environment and their environmental footprint in general. The main premise of our analysis is that EMS further an overall environment-friendly shift on the part of ports, whilst creating favorable conditions for the modernization and rationalization of their operation and development. In other words they provide added value that surpasses their intended scope, namely tackling environmental problems and improving the environmental outcomes of port

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operation and development. This hypothesis is discussed in the case of the Greek ports of the Core Trans-European Transport Network (TEN-T). Our analysis sheds light on the issue, highlighting impacts so far, crucial factors, necessary steps and future prospects.

2. Literature review

Along with port operation and development-related environmental pressures, challenges and threats, the environmental dimension of the port industry and ports has drawn academic interest for more than two decades (Trozzi and Vaccaro, 2000), in line with a constantly growing awareness about environmental issues. Indeed, literature on port externalities and impacts has been expanding significantly, in both volume and thematic perimeter (Styliadis et al., 2021). Lately, spurred by the sustainability debate, academic research has shifted its focus towards sustainability issues in ports (Acciaro et al., 2014; Alamoush et al., 2021; Özispa and Arabelen, 2018; Geerlings and Vellinga, 2018; Hossain et al., 2021; Housni et al., 2022) and the sustainable performance of ports and port activities (Lim et al., 2019; Puig et al., 2017a, 2015). Reports from the port industry itself and international organizations also provide useful information and insights (Deloitte and ESPO, 2021; ESPO, 2021a, 2021b; OECD, 2011; World Ports Sustainability Program, 2020), feeding into the academic debate and providing practical guidance to stakeholders.

In this vein, greening ports, the port industry, intermodal transport and logistics, with a particular emphasis on seeking solutions not only to existing problems, but also future challenges, emerges as a field of significant interest (Davarzani et al., 2016; Gonzalez Aregall et al., 2018; Notteboom et al., 2021, 2020; Pallis and Vaggelas, 2019). The elaboration of sustainable port strategies, methods and tools gradually contributes to a growing body of literature. As a result, environmental management represents another attractive field (Lam and Notteboom, 2014; Puig et al., 2022, 2020; García-Onetti et al., 2018; Kuznetsov et al., 2015; Wooldridge and Stojanovic, 2004).

Despite the efforts or the importance of relevant issues, only certain aspects of environmental management in ports have been covered by academic research so far. This is for instance the case of risk analysis in ports, especially under safety or security considerations (Chlomoudis et al., 2016, 2012). EMS in ports have surprisingly attracted a rather marginal interest of only a handful of scholars who mainly provide empirical evidence (López-Navarro et al., 2015; Puig et al., 2022; Romero et al., 2014; Saengsupavanich et al., 2009; Akgul, 2017) or attempt to provide some important, albeit more or less general, findings on EMS in ports (Housni et al., 2022, 2021; Tatar, 2017; Hossain et al., 2021). Currently missing systematic and comprehensive studies as well as in-depth-analysis are obviously necessary for a better understanding of EMS implications for ports and the port industry, as well as their implementation and impacts. It is essential to build upon adequate case-specific approaches and their results, which still need to be carried out. As regards Greece's ports, relevant literature has been almost completely lacking with the exception of two papers: the first making only peripheral reference to the topic (Chlomoudis et al., 2022) and the second discussing management of environmental issues in port activities in Greek ports (Palantzas et al., 2014). The externalities of EMS in ports, whether in Greece or elsewhere, have remained to this day completely out of scope. This paper aspires to raise questions and present findings that will fill this knowledge gap and stimulate further discussion and future research (Fig. 1).

3. Methodology and materials

The analysis draws in the first place on the results of a broader questionnaire aimed at collecting data on the situation of Greece's major ports. The survey was conducted between September 2019 and April 2020 and concerns Greece's 25 (sea) ports which form part of the TEN-T (see Table 1).

These are the most important Greek ports in terms of freight or passenger traffic volume and therefore the findings are of particular value. The survey is based on the key informant method, whereby the questionnaire is addressed to the person having the most comprehensive knowledge on the issues in question, in order to ensure reliability of the answers (Kumar et al., 1993). In this case, the Chairman of each of the 25 port authorities was selected as the 'key informant', i.e. recipient of the questionnaire. Nearly all Greek TEN-T ports (23 out of the total 25) participated in the survey with the exception of Santorini and Syros. Thus, the number of respondents is sufficient for the purposes of the survey (T. C. Kinnear; J. R. Taylor, 1996) and also statistically acceptable (Hooley et al., 1990; Kohli and Jaworski, 1990; Narver and Slater, 1990; Ruekert, 1992). Certain aspects of the results were analyzed, grouped and presented in a scientific article entitled "Environmental Mainstreaming in Greek TEN-T Ports" (Chlomoudis et al., 2022).

Our paper looks into these results especially in relation to the above hypothesis. We seek to provide an in-depth analysis based on a follow-up, purpose-specific questionnaire, to which port authorities specifically selected for the purposes of the survey were invited to respond. This second survey was conducted between July and September 2022. 10 ports out of the 25 which took part in the previous survey were selected, by assigning the following inclusion criterion: the introduction

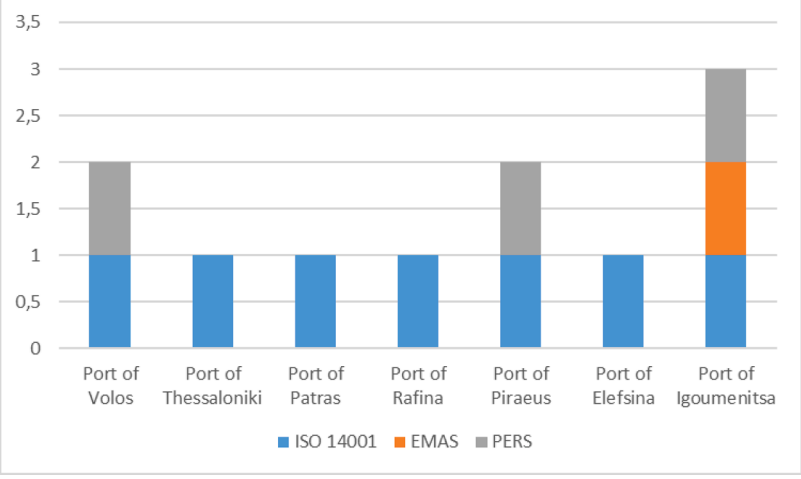

Fig. 1. EMS certifications.
Source: Authors, 2024.

Table 1
Greek TEN-T ports participated in the 2019/2020 survey.

Port Authority	Acronym	Société Anonyme (SA)	Municipal Port Authorities (MPA)	Respondent	Core TEN-T	Comprehensive TEN-T
Chalkida	PAChal	√		√		√
Chania	PAChan		√	√		√
Chios	PAChi		√	√		√
Corfu	PACo	√		√		√
Elefsina	PAE	√		√		√
Heraklion	PAHe	√		√	√	
Igoumenitsa	PAI	√		√	√	
Kalamata	PAKal		√	√		√
Katakolo	PAKat		√	√		√
Kavala	PAKav	√		√		√
Kyllini	PAKy		√	√		√
Lavrio	PAL	√		√		√
Mykonos	PAMyk		√	√		√
Mytilini	PAMyt		√	√		√
Naxos	PAN		√	√		√
Paros	PAPar		√	√		√
Patras	PAPa	√		√	√	
Piraeus	PAP	√		√	√	
Rafina	PARa	√		√		√
Rhodes	PARh		√	√		√
Santorini	PASa		√			√
Skiathos	PASk		√	√		√
Syros	PASy		√			√
Thessaloniki	PAT	√		√	√	
Volos	PAV	√		√		√

Source: Chlomoudis et al., 2022.

and implementation of at least one EMS and/or the participation in the ECOPORTS network, i.e. taking into account ports' experience with a standard and its results and impact. Seven out of the ten above-mentioned ports participated in our survey (hereinafter "respondents"), Elefsina, Igoumenitsa, Patras, Piraeus, Rafuina, Thessaloniki, and Volos, while three failed to respond (Chalkida, Corfu, and Kavala). The relevant ports are presented in Table 2.

The structured questionnaire method with a mixture of closed and open-ended questions was considered as the most appropriate approach for drawing meaningful and useful conclusions, since it aimed at targeted question responses within a predefined framework, but also provided the flexibility for those who participated in the research to provide their own answers. The aim of the research was to gather and analyze data from the port authorities, but also complement findings with some perceptive observations and subjective opinions on the part of the respondents, who are also in this case considered "key informants". The methodology adopted in this study predominantly focused on qualitative analysis, a purpose-adequate approach justified by the nature of the subject matter and the available material for investigation.

The research does not seek to draw general conclusions for all ports, recognizing that idiosyncratic characteristics and specific circumstances of each port create a totally different state-of-play with regard to the introduction and implementation of EMS, their outcomes and impacts. In this respect, a survey targeting a larger sample of ports or a comparative analysis thereof would be a very promising future research project. Moreover, integrating quantitative analysis is anticipated to yield significant results, augmenting correlations with the qualitative analysis attempted in this paper and providing a more comprehensive understanding of the EMS introduction and implementation within diverse port environment, as well as the intricate dynamics at play.

4. Results

Empirical evidence from major Greek ports shows a trend towards monitoring environmental procedures and indicators, standardization of procedures and certification under EMS. More and more, port authorities come to realise that introducing EMS has significant benefits for their port. Therefore, EMS have not only evolved into a necessary tool for the achievement of concrete environmental targets, but are also progressively becoming an integral part of port management.

As shown, in Tables 3 and 4, there are seven (7) ports that introduced and implemented EMS certifications. Four (4) thereof are in the Core TEN-T network and three (3) are in the Comprehensive one. All seven (7) SAs are certified under ISO 14001, but only three (3) thereof have received PERS certification and only one (1), the Port of Igoumenitsa, has implemented EMAS.

As shown in Tables 5 and 6, the implementation of EMS has not only improved the port's image vis-à-vis users and customers (100 % regarding all three mentioned EMS, ISO 14001, PERS and EMAS), but has also improved the operation of the port's internal procedures (100 %

Table 2
Greek TEN-T ports considered in the 2022 survey.

Port Authority	Acronym	Société Anonyme (SA)	Respondent	Core TEN-T	Comprehensive TEN-T
Chalkida	PAChal	√			√
Corfu	PACo	√			√
Elefsina	PAE	√	√		√
Igoumenitsa	PAI	√	√	√	
Kavala	PAKav	√			√
Patras	PAPa	√	√	√	
Piraeus	PAP	√	√	√	
Rafina	PARa	√	√		√
Thessaloniki	PAT	√	√	√	
Volos	PAV	√	√		√

Source: Authors, 2024.

Table 3
EMS certifications.

PORTS	Port of Volos	Port of Thessaloniki	Port of Patras	Port of Rafina	Port of Piraeus	Port of Elefsina	Port of Igoumenitsa	Total
ISO 14001	√	√	√	√	√	√	√	7
EMAS							√	1
PERS	√				√		√	3
More than those above								
Total	2	1	1	1	2	1	3	11

Source: Authors, 2024.

Table 4
Greek TEN-T ports' environmental management systems.

Selected answers	Total	SAs	MPAs	Core	Comprehensive
Yes	**7**	**7**	**0**	**4**	**3**
No	16	5	11	1	15
If yes, in which of the following:					
ISO 14001	7	7	0	4	3
PERS	3	3	0	3	0
EMAS	1	1	0	1	0

Source: Authors, 2024.

Table 5
Implementing EMS improved the port's image vis-à-vis users/customers.

Selected answers	Total	SAs	MPAs	Core	Comprehensive
ISO 14001	6	6	0	4	2
PERS	3	3	0	3	0
EMAS	1	1	0	1	0

Source: Authors, 2024.

Table 6
Implementing EMS improved operation of port internal procedures.

Selected answers	Total	SAs	MPAs	Core	Comprehensive
ISO 14001	7	7	0	4	3
PERS	3	3	0	3	0
EMAS	0	0	0	0	0

Source: Authors, 2024.

regarding ISO 14001 and PERS, but not in the case of EMAS, as per the Port of Igoumenitsa's response).

As shown in Table 7, there are some quite interesting outcomes when the responding ports answer whether or not the introduction and the implementation of an EMS has a positive impact on the port itself and in what way. All seven (7) SAs (100 % of respondents) answered positively. Some indicative answers are as follows:

- Improvement of general environmental performance, development and management (Ports of Volos, Thessaloniki, Elefsina and Piraeus)
- Tracking and monitoring of measurable goals for quality and environment (Ports of Volos and Piraeus)
- Cost reduction / savings (Ports of Volos, Thessaloniki, Patras and Rafina)
- Prevention of environmental pollution (Ports of Patras and Elefsina)
- Improving the reputation / image of the company and satisfying stakeholders (Ports of Thessaloniki, Patras, Elefsina and Igoumenitsa)

As shown in Table 8, EMS introduction and implementation affected mainly the "corporate culture" and the "structure" of responding ports (100 %), as well as their "goals" and "daily operation" (100 %). At the same time, more than 85 % (85.71 %) of SAs, EMS introduction and implementation affected, their "general philosophy" and their "strategic decisions". Moreover, as shown in Table 9, EMS introduction and implementation has a positive impact on third parties. Indicatively, it brings about awareness, collaboration and compliance by involved parties, and also improves quality of life and strengthens a sustainability culture (Table 10).

On the other hand, there are some difficulties for responding ports which proceeded to EMS implementation. Most importantly, respondents were faced with a high cost of developing and maintaining the system, bureaucratic procedures and having to comply with a changing legislative framework.

As shown in Table 11, regarding the future adoption of EMS certifications, all responding ports answered that they would proceed to the adoption of a new EMS certification. The exception to this rule is the Port of Thessaloniki, which would not proceed to the adoption of PERS.

5. Discussion

5.1. Why do Greek TEN-T ports introduce EMS?

There are numerous reasons why Greek ports opt for an EMS, as set out below. Not all of them apply in each case and they evidently have a different weight in ports' incentives for such a decision or the determination with which the port implements an EMS.

- Ports see an EMS as a response to the challenges that the modern port industry faces in its everyday operation and development. The need for quality port services and achievement of environmental objectives increasingly determines port authorities' strategy and decisions.
- They strive for a rationalization of procedures, a better use of resources, a stronger link between the objectives pursued and the means available, cost-cutting.
- Ports try to keep up with current developments and handle modernization pressures from the industry (e.g. shipping or logistics companies, other port industry stakeholders, etc.).
- Ports often use the EMS as an opportunity to address regulatory issues.
- EMS give ports an opportunity to respond to social and political pressure for a better environmental footprint, environmental protection and sustainable operation and development. Improving company image is often a strong motivation for port authorities.
- Raising environmental awareness and a shift in terms of how ports' role and output is perceived in order to be more in line with environmental protection and the principle of sustainable development are top incentives. Change of business culture in ports at management level is crucial for choices to be made.
- EMS are often the result of peer review pressure and participation in port networks (e.g. ECOPORTS).
- Information from other ports and port industry stakeholders, as well as dissemination of best practices and optimum results from the sector also play an important role.

5.2. What has been achieved so far?

Taking stock of the experience of the Greek port industry with EMS so far, we find that Greece's major ports have already introduced and

Table 7
Positive impact of EMS introduction and implementation.

PORTS	YES	NO	Positive impacts on areas of port organization, operation and development		
Port of Volos	√		Improvement of general environmental performance and development demonstrated through the implementation of good environmental management practices (e.g. EV charging station, installation of photovoltaic systems, replacement of lighting with LED type lighting, etc.) and the improvement of environmental target-indicators	Higher quality and often innovative services for the benefit of port users, workers and the local community	Easier tracking of measurable goals for quality and environment
Port of Thessaloniki	√		Cost-cutting	Better management of environmental issues	Improving the company's environmental performance and image
Port of Patras	√		Prevention of pollution incidents	Improving the reputation of the company [added value]	Cost savings in energy matters
Port of Rafina	√		Control-recording of consumption of electricity—water—diesel fuel—heating fuel, thereby reducing expenses	Exploitation of solar energy through photovoltaics, sustainability and reduction of electricity costs Provision of services on ships	Aesthetic Upgrade of environmental image
Port of Piraeus	√		Environmental management	Environmental pollution from commercial ships	Organizational structure of ports for the protection of the environment
Port of Elefsina	√		Environmental effects of port activities		
Port of Igoumenitsa	√		Monitoring and compliance with the Legislative framework	Improving stakeholder satisfaction	

Source: Authors, 2024.

implemented one or more EMS, some of which participate in the ECO-PORTS network. These are among Greece's leading ports in terms of freight or passenger traffic volume—all of them operating in the form of Sociétés Anonymes. The remaining two prominent TEN-T ports, Heraklion and Lavrio, have not yet opted for an EMS. It should be pointed out that these ten ports are all characterized by a certain dynamic and obviously have a profound interest in environmental matters.

A first evaluation of ports' performance with regard to EMS shows that they helped ports address environmental problems and/or challenges and improve port operations, as expected, albeit at varying degrees of success. Many positive changes and a general improvement of the environmental footprint of the ports must be therefore partly attributed to the EMS. For instance, easier monitoring of measurable quality and environmental targets, better monitoring and compliance with the legislative framework, provision of higher quality and innovative port services, energy cost savings, pollution incident prevention, improved reputation, stronger confidence among port users for handling environmental issues are some of the benefits that have been identified by the responders. Even if not every process or output has reached the desired result and not every problem has been successfully solved, a good start has been made and further efforts can build up thereon.

In addition, respondents indicate that EMS have had positive indirect effects both for ports and third parties. These are mainly associated with ports' strategic vision and business culture, strategic decisions and everyday operations, but also with improved compliance on the part of users and providers of port services with environmental legislation and codes of practice, raising of environmental awareness among stakeholders, adapting business strategy and practices to meet environmental standards, etc. While the questionnaire responses have highlighted the positive implications of EMS for ports, they lack specific references and detailed clarification regarding their depth and intricacies. Further research is imperative to explore these multifaceted enhancements and achieve a more comprehensive understanding. Nevertheless, the assertions made by port experts underscore a dynamic and progressive landscape within Greek ports, indicating an ongoing evolutionary process. Some learning effects seem also to take place among ports and third parties, creating a stimulating spiral process. Although indirect effects are still rather weak and not always present, there is a certain optimism for further advancements in the next years.

5.3. What are the impacts?

Port operations and structures directly related to EMS appear indeed to be well exposed to modernization pressures, as anticipated. Therefore, concrete results associated with these operations and activities conducted by staff in these structures are partly already visible, but also very likely to become even more so in the years to come. Moreover, a certain culture seems to gradually emerge in the port industry that can effectively facilitate and promote environmental objectives and sustainable development.

Operations and structures that are only indirectly and peripherally related to the EMS seem to be less affected or not affected at all. Any impact here arises rather as a result of management decisions, which, based on a general perception of environmental issues, include environmental objectives or at least reflect a general interest in this respect. Even in this case, however, effects are quite limited, since these perceptions are not necessarily transformed into substantial changes with practical consequences and results. Notwithstanding this fact, an EMS creates of course a window of opportunity for changes with environmental targeting or the introduction of environment-friendly contents, initiatives and measures.

Results of EMS are sometimes obstructed by negative predisposition, phobic attitudes and behavior, or even resistance to changes from port staff, irrespective of their level/hierarchy. Most often port staff do not fully understand or share the targets and priorities set in the EMS. Thus, in the case of a top-down EMS introduction, results largely depend on

Table 8
EMS introduction & implementation—affected elements.

PORTS	Port of Volos	Port of Thessaloniki	Port of Patras	Port of Rafina	Port of Piraeus	Port of Elefsina	Port of Igoumenitsa	Total
Corporate culture	√	√	√	√	√	√	√	7
Structures involved in relation to the adoption or pursuit of wider environmental objectives	√	√	√	√	√	√	√	7
Other services not directly involved			√		√	√		3
None of the above								
Other (specify)								
Total	2	2	3	2	3	3	2	
General philosophy	√	√	√	√		√	√	6
Vision		√	√	√		√		4
Strategic decisions		√	√	√	√	√	√	6
Goals	√	√	√	√	√	√	√	7
Daily operation	√	√	√	√	√	√	√	7
None of the above								
Other (specify)							Improvement of environmental indicators	
Total	3	5	5	5	3	5	4	

Source: Authors, 2024.

Table 9
Positive impact of EMS introduction & implementation on third parties.

PORTS	YES	NO	Port fields / example		
Port of Volos	√		Third parties, involved parties through constant updating on the environmental management of the port	Compliance by all involved parties with environmental protection rules	Immediate and effective response to failure/ non-management/ compliance observations
Port of Thessaloniki	√		Third parties and their own environmental aspects are taken into account		
Port of Patras	√		User confidence in the management of environmental issues in the area in which it operates		
Port of Rafina	√		Improved quality of life	Sustainability	
Port of Piraeus	√		Achieving waste recycling targets in collaboration with waste collection and management providers		
Port of Elefsina	√		5 E (Exemplify, Enable, Encourage, Engage, Enforce)		
Port of Igoumenitsa	√		Adoption of environmental and sustainable culture		

Source: Authors, 2024.

Table 10
Difficulties of EMS implementation.

PORTS	Difficulties of EMS implementation		
Port of Volos	The harmonization of the parties involved with the rules of environmental management		
Port of Thessaloniki	High cost of developing and maintaining the system		
Port of Patras	Strict bureaucratic procedures		
Port of Rafina	Exogenous factors of environmental burden		
Port of Piraeus	Multimodal activity	Lack of common application framework with the third parties involved	
Port of Elefsina	Comparison of environmental management and performance with other ports	Encouragement and awareness of users to the environment port management	Confirmation of the port's compliance with environmental legislation by parts of the local community
Port of Igoumenitsa	Continuous monitoring and implementation of frequent amendments of the legislative framework		

Source: Authors, 2024.

management choices, as well as on the willingness and energy which the implementation and necessary changes are promoted with by management. In any event, results are not guaranteed, since they depend on a multitude of factors and also their interaction.

5.4. Limits and limitations

The introduction and implementation of the EMS in ports face some intrinsic limits and limitations, while their results depend on certain factors and requirements that need to be met. Among these, particular attention should be drawn to the following:

- First of all, EMS cannot solve ports' each and every problem, meet all environmental challenges in ports and face all their needs, achieve high quality services or produce added value for ports on their own.
- The EMS must be part of a broader business strategy for the ports and go along with other concepts and tools (e.g. master/business plans, maritime spatial planning, KPIs etc.).

Table 11
Future adoption of EMS certifications.

	Future adoption of EMAS / PERS		Based on the experience of participating in the ECOPORTS network—Future adoption of PERS		Based on EMS implementation experience and participation in the ECOPORTS network—Future adoption of PERS	
PORTS	YES	NO	YES	NO	YES	NO
Port of Volos					√	
Port of Thessaloniki				√		
Port of Patras	√					
Port of Rafina	√					
Port of Piraeus			√			
Port of Elefsina	√					
Port of Igoumenitsa						

Source: Authors, 2024.

- The complexity of port systems and processes in ports and the large number of stakeholders and third parties involved do not create a favorable environment for EMS and their results.

Especially with regard to Greek ports, it should be pointed out that:

- Greek ports face some serious difficulties both in relation to the introduction and implementation of the EMS.
- Among the main obstacles are: the real cost of changes, a long transition period, human resource needs, path dependency and fear of changes, internal or external resistance or negative reactions.
- Business culture in ports does not necessarily support environment-friendly decisions and drastic or far-reaching measures. This seems to have changed only very recently and in most cases through a slow and arduous process.
- EMS introduced and applied by Greek ports are therefore kept at a minimum level and to the extent strictly necessary for their purpose. This hinders the full deployment of EMS' positive effects.

5.5. Necessary steps

In order to get the most out of an EMS, ports need in the first place to thoroughly consider the multiple benefits of introducing and implementing such a system to its full extent. Management and administration should realize that an EMS can impact organization, operation and development of the port in many different ways and create added value beyond its main target, namely meeting environmental challenges and improving environmental performance of the port. An EMS is a modern necessity for ports aiming at the solution of concrete environmental problems or aspiring positive environmental results, but it can also be a powerful tool for port transformation and transition to a more sustainable enterprise. This can only be achieved through the embedding of the EMS in everyday life at the port and in each and every decision regarding every single aspect of port operation and development, as well as through its prioritisation. At the same time, it is clear that an EMS should be part of an overall environmental/sustainability strategy of ports, so that joint efforts and synergies can be promoted in the short-, medium- and long-term.

Therefore, ports need to explore possibilities and opportunities. They should most probably reorganize their internal administrative structure, adapt their procedures and reorientate priorities accordingly. They need to ensure adequate human resources, regularly train existing personnel through target-oriented actions and recruit new qualified and specialized employees. Ultimately, it is the people working in a port, those who will implement an EMS, design strategies and elaborate policy measures and put them into effect, who facilitate change. And clearly, EMS success hinges on the prevailing workplace culture in the port, so that efforts should also concentrate on changing mentality in a more environment-friendly way. It is only a favourable setting that allows changes to lead to positive results. The Greek ports surveyed in our research do not start from scratch, but they still have a long way to go.

5.6. EMS in ports as a governance problem?

Considering the significant role EMS can play in improving the environmental performance and footprint of ports, but also the enhanced efforts towards environmental protection and sustainability within the framework of EU environmental policy and the European Green Deal, EMS in ports are expected to be at the forefront in coming years.

The choice of ports for an EMS over the last two decades represents not only a trend in the port industry. It is the answer of ports to the challenges that they face, reflecting their certainty about the multiple benefits that it brings.

Taking that into consideration, the question raised is whether EMS in ports is or should be a governance problem. In other words, if introducing an EMS should become an obligation for ports, as the result of a regulatory approach, and/or if incentives or funding for ports should be provided. Although there is no easy answer to this question, EMS is and must remain an issue for ports to decide. Nature of the port industry as well as differences among ports make flexibility in the matter indispensable. Ports shall continue to opt for or against an EMS and if they do, they choose the EMS that suits their needs and strategies better. No general obligation should be imposed, since the burden for ports would be heavy and perhaps in many cases, especially for smaller ports, even unnecessary. Overregulation in the sector must be avoided. Besides, one-size-fits-all-approaches are usually not adequate for the port industry. It seems more appropriate to use soft measures aiming to encourage and support the industry, as well as enable a better implementation of the EMS. Ports' response to smart governance tools is anticipated as a very positive one. In this respect, it is important for national governments and the EU to choose wisely the right mix of right instruments in order to achieve the best possible results.

5.7. Current and future necessities: a practical illustration

As the regulatory landscape evolves, ports face an urgent need to strengthen their environmental strategies. In this context, EMS can play for example a pivotal role in guiding ports through compliance with regulatory frameworks such as the recently adopted Corporate Sustainability Reporting Directive (CSRD) (European Union, 2022). This directive mandates a broader set of large and small and medium-sized undertakings to disclose information regarding perceived risks and opportunities from social and environmental issues, as well as the impact of their activities on people and the environment. EMS empower ports to anticipate and adapt to evolving regulatory frameworks like the CSRD by fostering innovation, resilience, continual improvement, and driving ambitious environmental targets, resource optimization, and stakeholder engagement in sustainable practices. This proactive stance positions ports to navigate evolving regulatory landscapes adeptly while steering towards a sustainable future. Aligning EMS practices with the reporting requirements outlined in CSRD allows ports to enhance their environmental stewardship. EMS provide a structured approach for ports to measure, manage, and improve their environmental performance. In the new landscape, they enable ports to streamline reporting processes, ensuring a targeted, smoother, and more efficient compliance with the stringent provisions of the CSRD. EMS and CSRD appear capable of achieving a mutual enhancement that elevates ports' compliance with regulatory demands. However, EMS extend beyond mere regulatory compliance, accelerating the transition towards sustainable practices and catalyzing broader transformations that advance sustainability objectives and solutions. Simultaneously, the CSRD prompts and guides ports to introduce or enhance EMS, outlining reporting standards that necessitate organized environmental

management and reporting systems while driving necessary fundamental changes toward sustainability.

5.8. What are the prospects based on the experience so far?

Introduction and implementation of EMS in Greek ports have already produced some results that have been presented and analyzed above. Although they are evaluated as rather moderate in general and with regard to the hypothesis of the present analysis as insignificant, first steps have been made and a basis for further progress has been created. It is a fact that ports have been reluctant so far to opt for far-reaching changes corresponding to the EMS, changes that would enable a better implementation and enhance their results. Thus, there is still plenty of room for adequate measures in ports and port industry and also some real opportunities, for instance within the framework of the EU funding for actions and programmes in the sector or horizontally targeted. Ports are expected to realize more and more the benefits arising from the EMS, but also see the necessary steps they need to take in order to maximize their impact and take action to this end.

Modernization pressures and challenges ahead will continue to push for a better and more efficient integration of EMS in port operation and development, as well as for relevant structural changes. The EU environmental policy with all its aspects and elements and the sustainability paradigm will most probably keep creating favorable conditions for introducing EMS in ports and adjusting processes and structures accordingly. Prospects are therefore optimistic. However, the transformation power of EMS will fall short of expectations in most, if not all, cases, unless ports undergo fundamental changes.

6. Conclusions

Our analysis shows that EMS introduction and implementation in Greek ports or participation in the ECOPORTS network have a rather field-specific and limited impact. Thus far, the assumption that positive impacts are spreading to port sectors, activities or structures that are not system-related is suggested by some survey responses, but cannot be indisputably confirmed. Neither seems an EMS capable of meaningfully affecting strategy and management of port/business culture. Only where the conditions are ripe, for example port administrations have heightened environmental awareness, is there stronger interest in EMS and are concrete results more likely. Nonetheless, far-reaching EMS-relevant actions are not supported in most cases, and major changes even less. Furthermore, effects surpassing a mere response to environmental issues specifically addressed by the EMS are expected to be very limited, if none at all.

Taking into account the complexity of port systems, it is clear that positive effects from EMS introduction and implementation in ports depend on many different factors, across a wide range of aspects such as the size, organisational structure or general circumstances of the port, the views on possible benefits for the port, the predominant perception in the port on environmental and sustainability issues, the overall setting or juncture. The nature and weight of these factors may obviously vary, as they impact EMS outcome in ports in different ways and to different degrees.

The port industry's increasing interest in the environment and sustainable development creates a certain optimism for the introduction and implementation of EMS in ports. The consolidation of EMS is expected to create positive inputs for ports and third parties, even if it is not possible to guarantee outputs. Ports may of course considerably improve prerequisites for positive results of EMS and enhance existing potential. To this end, substantial changes in ports at various levels are absolutely necessary. These changes are nevertheless very demanding, effort-intensive and time-consuming, as well as difficult to achieve. This fact raises some questions and moderates optimism.

Future research on the subject may cover a much bigger sample of ports with different characteristics from other European countries or regions of the world and possibly provide a comparative analysis, placing the hypothesis of our contribution into a broader analytical/research context. Furthermore, while the current study focused on qualitative analysis to explore the aforementioned hypothesis, additional qualitative and quantitative research endeavors could provide deeper insights into the impact of EMS implementation in ports. Integrating quantitative methodologies alongside qualitative insights and the combination of different relevant aspects could offer a more comprehensive understanding of the relationships between EMS implementation and diverse facets of organizational aspects in ports and the port industry in general, port performance dimensions, such as operational efficiency, service quality, customer satisfaction, sustainability, etc., and port development. An in-depth analysis of the factors significantly contributing to the effects on, and synergies within, ports regarding EMS introduction and implementation would not only shed light on the subject but also yield practical results beneficial for the industry. Moreover, considering additional stakeholders beyond Port Authorities within the research scope would further enrich the analysis. Extending the research scope has the potential to yield substantial insights, not only specific to ports but also pertinent to the broader industry. It could serve to validate findings and offer a more nuanced perspective on the multifaceted dynamics within port environments.

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Constantinos Chlomoudis: Conceptualization, Formal analysis, Funding acquisition, Investigation, Methodology, Resources, Writing – review & editing. **Petros Kostagiolas:** Conceptualization, Formal analysis, Investigation, Methodology, Software, Validation, Writing – review & editing. **Petros Pallis:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Validation, Visualization, Writing – original draft, Writing – review & editing. **Charalampos Platias:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The data presented in this study are available upon request.

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