Indicators for monitoring and assessment of Environmental management systems in ports

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Abstract. Ports are no longer content with being the connection of ocean and land transportation, of which they are keys in international logistics and supply chains. Ports have also become industrial production areas. As ports continue to evolve as production areas, they are becoming significant sources of water pollution, solid waste, and noise and air pollution. Due to this increase in environmental impacts, the majority of the world ports have made commitments to development of proactive procedures for a sustainable development by adopting an environmentally responsible approach to preserve and protect the environment. This is despite the need of a diagnostic tool which allows monitoring and evaluation of the progress of environmental management in the different sectors of the port. The present study evaluated the different activities and environmental aspects related to the shipping industry and identified the main indicators to assess and develop an environmental management system (EMS) in order to achieve sustainable development.

1 Introduction

Ports have evolved from the central point where cargoes and passengers are loaded and discharged, to the multimodal distribution hubs that link sea, road, rail, and air routes [1-2]. Nowadays, the innovation of systems and new technology created competition and forces changes in the international logistics chain, including ports, to conduct business in the future [3].

In this context storage demand, deeper waterways, larger terminal space for ship handling and warehousing, inlands roads and rail access has resulted in ports becoming industrial production areas similar to large industrial operations, therefore increasing the ports environmental aspects and negative environmental impacts. [4].

This new dynamic of the port system has led to studies from different approaches. In this regard, Bichou and Gray analyzed the port system from three overviews [5]:

-Macro-analytical: including the ports relationships with public policies, actions that drive the growth of the port and its environmental perspective.

- Micro-analytics: analyzing internal issues as well as relationships with cargo and passenger transfers and their integration into the logistics chains.

- Hybrid: combining elements from the previous sections as well as the role and functions of the port.

Elsewhere, Paixao and Marlow classified ports into four generations, taking into account the terrestrial/maritime transport interface, the provision of services and consolidation of loads, those linked to the production and logistics chains and, finally, the use of just-in-time and lean production techniques in terms of management[6]. In building on Paixo and Marlow's port classification, research conducted in the middle and late 2000's emphasizes the fifth and sixth generation ports [7-8-9].

However industrial ports continue to produce negative substantial externalities on the local and regional level with considerable environmental impacts such as noise disturbance, air pollution and visual impediments [10]. Also, some of the impacts such as sea level rise, high winds, and storm surges can have considerable impacts on ports' facilities, which could endanger a region's import and/or export [11-12-13].

As mentioned, the shipping industry is the vital component of the maritime transport chain and cargo-handling productivity consequently plays an important role in determining the competitiveness of maritime transport, against other transport modes [14]. The majority of the world ports is aware of their environmental impact and has made commitments to the development of proactive procedures for a sustainable development by adopting an environmentally responsible approach to preserve and protect the environment. The sustainable development commitments also allow at the same time, the port to achieve the objective of port development combined with sustainable environmental management in a win-win strategy.

In the literature review for this paper a set of environmental performance indicators was proposed to assess the environmental performance related to ports. The reviewed studies evaluate the performance of

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operational (dust, noise, dredging, and waste) or managerial (certification, compliance, and complaints) as well as conditions (air, water, sediment and ecosystems) of the port [15-16-17-18]. This paper emphases the importance to monitor and assess the port using an EMS structure that highlights the above indicators through an analysis of the EMS Environmental policy, tracking environmental performance, reviewing environmental performance alternatives and integrating sustainable development goals applicable to the port. The indicator based on the port's identified significant impacts selected using the structure of ISO 14001 EMS will guide port managers toward a sustainable development. As port indicators are monitored and measured, the port can better control the management, environmental performance, and overall port conditions.

In this paper we will first quote and analyze the different environmental aspects related to identified shipping industry activities, integrating the problems caused by the port activity itself, due to ships calling at the port such as emissions from inter-modal transport networks serving the port. We will then propose indicators to monitor and assess the port's environmental management system. Through monitoring the indicators identified in this research the port will identify gaps in their EMS. The analysis and the reduction of the port environmental aspects will lead to continual improvement of environmental management tools, which allows monitoring and evaluating the progress of environmental management in the different sectors of any global maritime port setting.

As discussed in the introduction to this study, ports have expanded their operations into additional production capabilities. As ports have expanded their operational processes, the environmental aspects and impacts have also expanded as indicated through our literature review and assessment of port operations. The study conclusion discusses how four areas of an EMS, emphasized in this paper, provide port managers with the opportunity to complete a self-assessment, identify environmental and sustainability indicators, monitor and measure port growth and progress in order to develop the EMS and sustainable development plans in ports.

2 Port impact

There were 8,096 global maritime ports in 2018 that were considered the most fuel efficient mode of transport and important in global trade [19]. Currently, it is predicted that World seaborne trade will grow by a factor of 2.5% from 2020 to 2040[20].

Knowing that each port has three areas contributing to environmental impacts [21]:
-Impacts related to the port activity itself;
-Impacts related to ships calling at the port;
-Emissions from inter-modal transport networks serving the port.

These impacts vary depending upon the port infrastructure, location, networks and actions taken by port managers on the issues addressing environmental impacts (commitment to reduce air pollution, water pollution, solid waste pollution and energy reduction….).

In order to analyze and determine the impact it is important to detect and record all the aspects of the port activities and select those that could have significant impact. Figure 1 presents the activities identified in the different types of port (passengers, cargo, industrial...) [22]. Figure 2 presents the environmental aspects to the port activity [23]. Knowledge of the environmental aspects is required in order to have effective port environmental management awareness [24].

Of course port activities are based on a port's trade and service to customers; therefore they come in all types and sizes. The activities and their environmental aspects in the tables provided are based on the continued growth of ports and will be useful for all port managers reading this study. Though ports continue to expand operations to serve customer needs, including the cities where the port is located tables 1 and 2 demonstrate the change in activities and their environmental aspects over a period of time that indicate growth in production areas, as shown. Ports continue to change processes through continual improvement, however, as this paper demonstrates, as ports use an EMS new activities can easily be brought into the EMS structure and assessed in order to manage them as part of the ports environmental management program.

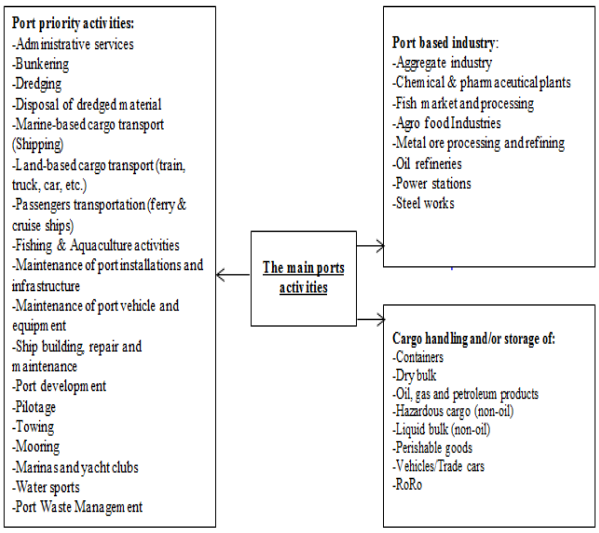

Figure 1. List of the main ports activities

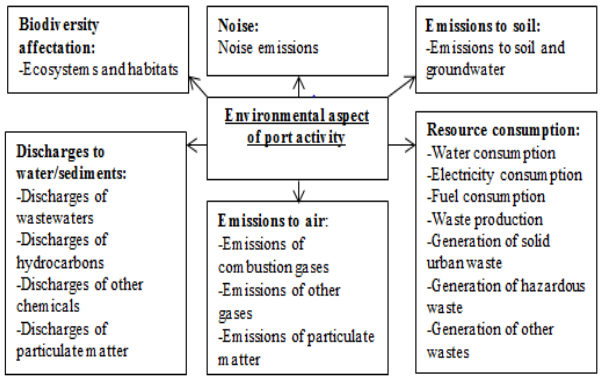

Figure 2. Environmental aspect of port activity

Management of the port aspects can increase or decrease their impact on the environment. The identification and assessment of environmental aspects is one of the requirements and essential tasks for the development and implementation of an Environmental Management System (EMS). Aspects have to be monitored and evaluated. The lack of a diagnostic tool makes this evaluation process one of the most complicated tasks in the environmental management system of a port.

3 Assessment and evaluation of EMS in ports

There are various types of EMS that demonstrate a systematic approach to environmental management, such as a regulatory management system or other models including the European Eco-Management and Auditing Scheme (EMAS) or the ISO 14001 EMS. These standards present a broad range of approaches, tools, frameworks, principles, strategies and processes which can confuse if not understood in relation to a framework for sustainability.

The international maritime organization (IMO) is also trying to guide the ports by convention through applications such as International Convention for the Safety of Life at Sea (SOLAS), International Convention for the Prevention of Pollution from Ships (MARPOL)…[25]. Port managers need a clear framework suitable for all the environmental aspects of port authorities, not only those related to the ships, in order to effectively grapple with the challenge of moving toward a sustainable port.

Therefore, in developing strategies to meet specific United Nations sustainable development environmental goals the port's best strategic approach is to use the ISO 14001:2015 EMS [26]. In this context there are four significant areas of the ISO 14001 that will guide port managers toward a sustainable development. Whatever the environmental management system approved by the port, in order to attain sustainable development, port managers must take into consideration these four headings, which are described below in regard to the importance to sustainable development practices:

3.1 Environmental policy

The environmental policy is an essential pillar of the EMS and ensures its direction and intent as well as effectiveness. The environmental policy guides the management of the environmental aspects and assures the application of the national and international environmental regulations in coordination with port leadership supporting the EMS through providing resources and provides the opportunity to build upon the principles of sustainability.

Through working with stakeholders to impose its environmental initiatives, planning studies with fixed targets to meet, and benchmarking with other ports to revise the port EMS policy provides the intent and guidance for efficient management of the impacts of significant aspects building the foundation of sustainable development.

3.1 Improvement of environmental performance

To develop the EMS port management must continually improve environmental performance through describing environmental impacts of the ports. This is completed by scheduling manager reviews of the port's environmental performance to assist in support of the environmental policy that proposes methods to monitor and measure environmental performance.

All parties, especially ship captains, must be in communication when discussing the port's environmental performance goals. This provides the ability to propose trainings about contribution to the reduction of environmental impact and continually reviewing the sustainable development goals.

This progress is recorded and the port's environmental performance should be distributed to all stakeholders in order for them to understand their responsibility in meeting the port's sustainable development goals.

3.2 Environmental performance alternatives

In order to increase its environmental performance the port must try to reduce the substances as defined by MARPOL Annex 1-6 , encourage the use of clean technologies and option to alternate energy (fuel type) as well as the reuse and recycle of resources used in shipping, such as ballast water treatment and residue/waste/spill control.

Good programming, logistic and scheduling efficiency such as reduction of idle and waiting times is required to reduce air emissions and increase the use of environmentally friendly shipping equipment and facilities. The port should also present incentives to green ships by proposing reduction of price for the ships using LNG.

In reviewing environmental performance alternatives port managers can align their environmental management practices to encompass sustainable development goals.

3.3 Sustainable development goals applicable by port

Among the 17 United Nations sustainable development goals, seven of them could be applied by interested ports: Goal 7: Affordable and clean energy; Goal 9: Industry, Innovation and Infrastructure; Goal 11: Sustainable cities and communities; Goal12: Responsible consumption and production; Goal 14: Life below water; Goal 15: Life on land; Goal17: Partnerships for the goals [27].

For each one of these headings there are several indicators. Table 1 details the indicators that are important to track. The port must absolutely not neglect these indicators, especially since sustainable development has become pertinent to the maritime and port industries for supporting and facilitating continued growth in trade by providing cargo-handling facilities, transshipment and other auxiliary services for ships

without compromising the environmental, social, or economic aspects [28].

Table 1. Indicators for sustainable development port

Environment-al policy	**Improvement of environmental performance**	**Environmental performance alternatives**	**Sustainable development goals applicable by port**
Application of national and international environmental regulations	Guidelines describing environmental impacts	Reduction of substances as defined by MARPOL Annex 1-6	Goal7: Affordable and clean energy
Leadership support in providing resources	Scheduled manager review of the environmental performance	Use of clean technologies and option to alternate energy (fuel type)	Goal9: Industry, Innovation and Infrastructure
Working with stakeholders to impose environmental initiatives	Methods to monitor and measure environmental performance	Reuse and recycle of resources used in shipping	Goal11: Sustainable cities and communities
The reduction of resources to meet sustainability goals	Ship captains are included in communication of the port's environmental performance goals.	Ballast water treatment and residue/waste/ spill control	Goal12: Responsible consumption and production
Meeting percentages of the targets fixed on the basis of studies	Review of sustainable development goals are scheduled and progress is recorded.	Logistic and scheduling efficiency for such as reduction of idle and waiting times	Goal 14: Life below water
Percentage of benchmarking completed with other ports to revise your EMS	The port's environmental performance plan is distributed to all stakeholders.	Use of environmentally friendly shipping equipment and facilities	Goal 15: Life on land
Management of the impact of the significant aspect	Port stakeholders know and understand their responsibility in meeting the port's sustainable development goals	Reduction of price for the ships using LNG	Goal17: Partnerships for the goals

4 Conclusion

Since environmental sustainability became a pressing issue for maritime shipping management, ports must demonstrate an interest and ability in analyzing and reducing the environmental aspects of port activity in order to reduce the ports environmental impacts.

As mentioned above, container traffic increases, ports continually increasing in size and throughput to compete in the global trade increases the port's environmental pollution. The EMS and sustainable development plans in ports serve a role to make this growth transpire without imposing additional externalities that harm the environment.

Port authorities must find ways to continually improvement their EMS. The four areas discussed are significant points of an EMS that port managers must manage and control in order to better build the port's EMS to support the UN's sustainable development goals. This study presents discussion and guidelines to assist global ports in better understanding the importance of completing a self-assessment, identifying environmental and sustainability indicators, monitoring and measuring progress in order to attain sustainable development.

The four areas emphasized in this paper provide port managers with the opportunity to implement best practices to reduce their environmental impacts at both the local and global levels. These points are classified under four headings Environmental Policy; Criteria for improving port performance; Environmental performance alternatives, and Performance devoted to Sustainable Development.

This study is ongoing by the authors who are researching and presenting diagnostic tools, that will allow the evaluation of continuing progression of environmental and sustainability management, which will strengthen the continual improvement process of the EMS.

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