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# Identification and selection of Environmental Performance Indicators for sustainable port development

Martí Puig<sup>a</sup>, Chris Wooldridge<sup>b</sup>, Rosa Mari Darbra<sup>a,\*</sup>

<sup>a</sup> Center for Technological Risk Studies (CERTEC), Dept. Chemical Engineering, Polytechnic University of Catalonia (UPC), Diagonal, 647, 08028 Barcelona, Spain

<sup>b</sup> School of Earth and Ocean Sciences, Cardiff University, Main Building, Park Place, Cardiff CF10 3AT, United Kingdom

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## ABSTRACT

In this paper an identification and selection of Environmental Performance Indicators (EPIs) in port areas has been conducted. A comprehensive inventory of existing EPIs in use in the seaport sector has been identified for monitoring performance of operational (e.g. dust, noise, dredging, and waste), managerial (e.g. certification, compliance, and complaints) and environmental condition (e.g. air, water, sediment and ecosystems). These indicators have been filtered against specific criteria and have been assessed and evaluated by port stakeholders in order to obtain a final set of indicators suitable to be implemented at EU level. A user friendly tool has been developed specifically to assist port authorities in calculating and reporting the proposed indicators. This study has drawn on major research projects to blend academic research with input from marine professionals in order to identify, select, evaluate and validate EPIs that are acceptable and feasible to the sector, and practicable in their application and implementation.

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## 1. Introduction

The current fluctuations in economic growth do not mask the overall marked expansion of international trade or the pivotal role that the port sector plays in the overtly global Logistic Chain. Shipping is vital to the worldwide economy, with around 90% of world trade being carried by the international shipping industry (Shipping Facts, 2013). Worldwide maritime cargo has increased in most of the ports and, as a consequence, port facilities have necessarily been expanded and developed with new quays, deeper channels and modern cargo handling facilities (Alderton, 2005).

It is acknowledged that the development of port facilities and their associated operations contribute significantly to the growth of maritime transport, to the economic development of coastal countries, and to provide both direct and indirect employment to the region (Paipai, 1999). However, port operations and activities may also have adverse consequences on the environment (e.g. Gupta et al., 2005; Dinwoodie et al., 2012), impacting on air (e.g. Bailey and Solomon, 2004; Cooper, 2003), water (e.g. Grifoll et al., 2011; Kröger et al., 2006), and soil and sediments (e.g. Edoho, 2008; Ray, 2008), affecting both the terrestrial and marine

environments. It is the control of such influences that remains the major objective of an Environmental Management System (EMS) (Wooldridge et al., 1999; Quynh et al., 2011).

As environmental awareness is increasing throughout society, effective environmental management is essential if stakeholders are to continue their support for port operations and development. In order to deliver compliance, environmental protection and sustainable development, effective port environmental management needs to take into account the potential impacts on the environment, mitigating options, methods of prediction, information on environmental indicators and legislation (PPRISM, 2012).

Ports are complex organisations from many points of view: economically, socially, culturally and administratively because of the range of interests and responsibilities of the parties involved. These factors in conjunction with the local geography and hydrography mean that each port is unique (Bichou and Gray, 2005). In order to evaluate environmental performance of port authorities and to track progress towards continuous improvement, relevant Environmental Performance Indicators (EPIs) may be utilised (Donnelly et al., 2007). In this way, port authorities can demonstrate compliance and continuous improvement through scientific evidence and quantifiable measures.

There are several guidelines to implement an Environmental Management System (EMS), such as the Port Environmental

\* Corresponding author. Tel.: +34 934010811; fax: +34 934017150.

E-mail address: [rm.darbra@upc.edu](mailto:rm.darbra@upc.edu) (R.M. Darbra).

Review System (PERS) (ESPO, 2011); the Eco-Management and Audit Scheme (EMAS) Regulation (European Commission, 2009) and the International Organisation for Standardisation (ISO) 14001 (ISO, 2004). These standards require an explicit commitment to continuous improvement of environmental performance through the use of performance indicators.

The use of environmental indicators among the port sector has been analysed in several studies, such as the ‘ESPO/Ecoports Port Environmental Review 2009’ launched by the European Sea Ports Organisation (ESPO) and the Ecoports Foundation. 122 ports from 20 European Maritime States participated in this survey. This review revealed that 60% of the respondent ports have identified environmental indicators to monitor trends in environmental performance (ESPO, 2010). Nevertheless, when they were asked to name the environmental indicators used, the responses provided more than 100 different indicators.

This means that although ports are becoming increasingly aware of the benefits of using environmental indicators, there is not a common approach as to which indicators adopt. Therefore, there is still need for research in this field. This paper aims at identifying and selecting key Environmental Performance Indicators (EPIs) for sustainable port development in European ports. It presents the concept, benefits and types of EPIs, the methodology applied for their selection, the resulting set of effective performance indicators and finally some tools and applications to calculate and report them.

This research has been carried out within the framework of the research project Port Performance Indicators: Selection and Measurement (PPRISM) (January 2010–December 2011) funded by the European Commission.

## 2. Environmental Performance Indicators (EPIs)

### 2.1. Concept

An Environmental Performance Indicator (EPI) is defined as “an information tool that summarises data on complex environmental issues to show overall status and trends of those issues” (United Nations, 1997). Indicators are developed and used predominantly to highlight the performance of a biological, physical, chemical, environmental, economic or social system (Jakobsen, 2008). In the case of environment, EPIs concern an organisation’s impacts on living and non-living natural systems, including ecosystems, air, water, soil and sediment (Dantes, 2003).

### 2.2. Benefits

Indicators are increasingly being developed and used as management tools to address environmental issues (e.g. Belfiore, 2003). The use of indicators is strongly recommended due to several reasons. Firstly, indicators monitor progress and provide a picture of trends and changes over time (e.g. Lehane et al., 2002). The second reason is that indicators provide simplified data that clearly show not only how an individual authority is performing, but also assess the national and regional benchmark performance of the sector (EPCEM, 2003). Thirdly, indicators may be used to evaluate the effectiveness of policies implemented, by measuring the progress towards environmental targets (e.g. DEFRA, 2003) and to provide a firm basis for future objectives (Dantes, 2003). In addition, they have a key role in providing early-warning information, capable of serving as a signal in case the situation is getting worse, indicating risk before serious harm has occurred (EPCEM, 2003). Finally, environmental indicators may be used as a powerful tool to raise public awareness on environmental issues (Gautam and Singh, 2010).

### 2.3. Users

Nowadays, indicators are widely used worldwide by scientists, governments, private-sector companies, public entities and the general public. Within the port sector, potential users of environmental indicators include workers of the Port Authority; companies and industries that invest in the port (such as terminal operators or shipping agencies); policy-makers; and civil society organisations (such as NGOs or local inhabitants). Other users of indicators include auditors, banks, and insurance companies.

ESPO has continuously encouraged its members to identify Environmental Performance Indicators. In fact, this was initially suggested in the ESPO Code of Practice 1994 (ESPO, 1994), the first European ports’ code of practice of its kind. Later on, the updated Environmental Code of Practice 2003 (ESPO, 2003) reiterated the importance of identifying EPIs and carrying out environmental monitoring. This Code set out 10 recommendations which the EU port sector was encouraged to follow, being one of them “to promote monitoring, based on Environmental Performance Indicators, in order to measure objectively identifiable progress in environmental port practices” (ESPO, 2003). The use of indicators has also been reaffirmed in the recently published ‘ESPO Green Guide; towards excellence in port environmental management and sustainability’ (ESPO, 2012).

### 2.4. Types

According to ISO 14031: Environmental Performance Evaluation (ISO, 1999), there are three categories of Environmental Performance Indicators:

- i. Management Performance Indicators (MPIs) which “provide information about the management efforts that influence the environmental performance of the port”.
- ii. Operational Performance Indicators (OPIs) which “provide information about the environmental performance of the port’s operations”.
- iii. Environmental Condition Indicators (ECIs) which “provide information about the condition of the environment”.

## 3. Methodology

The development and selection of environmental indicators has become a relatively complex process because of their multifunctional nature (Kurtz et al., 2001). For instance, they are expected to reflect a wide range of environmental issues, show trends over time, predict changes, and influence management decisions (Donnelly et al., 2007). As a consequence, the selection of environmental indicators should be accompanied by a rigorous validation process.

Although several methods for the selection of indicators have been suggested (e.g. Hammond et al., 1995; OECD, 2001), there are two main approaches to select indicators: the top-down and the bottom-up. The top-down approach is based on identifying indicators from literature review (e.g. publications, reports, and standards) and narrowing down to a final set of agreed indicators. The bottom-up approach consists of compiling the final set of indicators from the proposals of sector stakeholders based on their perceptions of issues and significance (Chamaret et al., 2007). The methodology followed in this research combines both approaches.

### 3.1. Compilation of indicators

Initially, a wide-ranging list of EPIs currently in use was compiled. In order to provide an exhaustive database of possibilities,

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