



Key performance indicators for developing environmentally sustainable and energy efficient ports: Evidence from Italy

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ABSTRACT

In the last three decades, scholars and operators have paid increasing attention to the environmental sustainability and energy efficiency of seaports. To achieve high competitiveness in seaports in response to environmental and energy regulation, port authorities (PAs), policymakers, port users and local communities have to invest considerable resources. This paper investigates the role of the managerial instruments in the decision-making processes of PAs for reducing and preventing negative environmental and energy effects from ports. This research consists of a two-step study. First, we conduct a literature review to analyse the academic views by systematically reading the reports to investigate practitioners' views on the performance indicators for environmental sustainability and energy efficiency in the port industry. Second, we provide, through a qualitative method, a portrait of the Italian seaports and a multiple case study to confirm the developed conceptual managerial key performance indicators (KPIs). Specifically, applying the Balanced Scorecard model, this paper provides managerial KPIs to support PAs in their decision-making processes within the inter-organizational relationships with shipping lines for developing environmentally sustainable and energy efficient ports.

1. Introduction

During the last thirty years, the environmental and energy impacts of port activities have received increasing attention from researchers, institutions and operators. The maritime and port industry has to follow the environmental and energy regulations for monitoring and reducing the negative effects derived from their activities and operations, especially in terms of climate change and global warming (Lam and Notteboom, 2014; Tichavska et al., 2017).

The issues of environmental sustainability (one of the three identified dimensions of sustainability, beyond the economic and social dimensions) (Giddings et al., 2002; Souza and Alves, 2018) and energy efficiency (an important policy addressing commercial and industrial competitiveness and energy security benefits, as well as, increasingly, environmental benefits) represent two correlated concepts that tend to be growing in importance, particularly among seaports, and exert reciprocal influences.

Ports need to improve their performance with respect to energy efficiency (Johnson et al., 2014; Jafarzadeh and Utne, 2014; Tichavska et al., 2017). Those ports that tend to assume environmentally sustainable and energy efficient behaviours through effective strategies and policies have been broadly defined as "green ports" (Lam and Van

de Voorde, 2012; Acciaro et al., 2014a, b; Acciaro, 2015).

From the managerial perspective, the literature on these issues is still scarce, especially in defining and applying useful managerial instruments able to evaluate, monitor and measure the effects of green choices and to control the effectiveness and efficiency of the decision-making processes of the port authorities (PAs). The research and practice mainly suggest and develop operational and technical, or, reductively, economic and financial performance indicators in developing environmental and energy strategies and policies.

This study focuses on the port industry and adopts the perspective of PAs proposing the Balanced Scorecard (BSC) as a strategic managerial instrument. With reference to identified features of environmental sustainability and energy efficiency, i.e., air pollution and waste management, this paper develops managerial key performance indicators (KPIs) capable of supporting PAs in making their decisions and managing their activities and operations with respect to environmental sustainability and energy efficiency regulations.

Our research question is: What are the most effective managerial instruments capable of supporting PAs in their decision-making process regarding environmental sustainability and energy efficiency performance? Can managerial KPIs be useful instruments for providing detailed information and data in managing port operations from the

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perspective of environmentally and energetically sustainable ports?

Our research question has been investigated in the inter-organizational relationships between PAs and shipping lines with respect to two activity modes, manoeuvring (including the segment during harbour transit and docking) and hotelling at berth, where we focus on air pollution and waste management processes, which are the most critical areas.

To achieve these research goals, a two-step study has been conducted: first, academic views have been analysed through a literature review and practitioners' views have been evaluated through a systematic reading of reports on these issues in the port industry to develop a set of managerial environmental and energy KPIs; second, a qualitative study has been conducted building a portrait of the Italian seaports and then developing a multiple case study to confirm the developed conceptual managerial KPIs. This analysis is interesting because it provides managerial KPIs within the port environmental and energy management plan of PAs. It fills the gap still existing in the research and practice, which is mostly focused on operational and technical indicators and reductively on financial and economic KPIs for the environment and energy.

The study is organized as follows. Section 2 provides details about the methodology adopted in the study. Section 3 summarizes the systematic review conducted regarding the main contributions in the literature on and practice of the performance indicators for environmental and energy management, giving a clear scenario about the phenomenon and highlighting the existing gap. Section 4 develops managerial environmental and energy KPIs, adopting the BSC instrument. Section 5 confirms the managerial KPIs through an in-depth investigation of the Italian ports following the last seaport reform and demonstrating the state of the art technology, with further analysis of three Italian PAs with a view for confirming of the identified KPIs. The last section presents theoretical and managerial implications, as well as concluding remarks and suggestions for future research.

2. Methodology

This paper consists of a two-step research process.

First, we analyse and summarize the most relevant contributions in the literature on and in practice of using performance indicators for environmental sustainability and energy efficiency in the seaport industry for systematizing and evidencing the main research orientations of scholars and the prevalent practitioners' view.

We considered only published studies and reports in the maritime and port field clearly focused on KPIs on environmental and energy issues in the port industry over a 15-year period (2002–2017). The online search adopted and combined the key words “environmental sustainability”, “energy efficiency”, “environmental pollution from ships”, “maritime industry”, “port industry”, “managerial perspective”, “control measurement for environmental performance”, “environmental performance”, “port authorities”, “environmental performance indicators” and “energy efficiency performance indicators”. This was performed in both the ISI Web of Science (WoS) and Google Scholar (GS), the main freely accessible web search engines specializing in academic and practice contributions. The papers were selected using the following criteria. First, they had to have been published in journals during the period from 2002–2017, or in the reports or contributions in practice. Second, the papers and reports had to have been published in English and contain at least one of the selected words and terms directly or indirectly in their titles. Third, the articles had to have dealt with research issues and the keywords, i.e., KPIs and, in general, environmental performance indicators or energy efficiency performance indicators, need to be included. The reported studies were analysed, using spreadsheet software, to identify relationships between the issues investigated, evidencing the nature of the performance indicators proposed, i.e., operational, technical, economic, financial or management performance indicators on environmental sustainability and energy

efficiency. We briefly read the abstract of each paper that resulted from the online search and then undertook a complete reading of each paper after evidencing its relevance to specifically emphasize the focus on developing environmental or energy performance indicators for competitive green ports. Additionally, we briefly read the reports and contributions in the practice by professional organizations and experts for outlining their role and function in suggesting environmental and energy KPIs for ports.

To fill the gap still existing in the literature and in practice, i.e., the lack of identified managerial KPIs for developing green ports, according to and matching the main contributions existing in the literature on the topic (Peris-Mora et al., 2005; Saengsupavanich et al., 2009; Denktas-Sakar and Karatas-Cetin, 2012; Puig et al., 2014, 2015a, b; Laxe et al., 2016; Seguí et al., 2016; Antão et al., 2016; Roos and Neto, 2017; Puig et al., 2017b), we develop and propose managerial KPIs for PAs regarding the air pollution and waste management processes.

Second, we conducted the qualitative research for confirming the developed managerial KPIs in the Italian ports, checking their applicability with operators and proposing their improvements. The portrait of the Italian seaports in terms of environmental sustainability and energy efficiency behavioural models has been built taking into consideration the integrative scheme developed according to the previously mentioned studies, especially the Final Survey Model cited and adopted by Seguí et al. (2016) and Puig et al. (2017a, b), through an Internet search, by reading and investigating the websites and all the available published documentation (reports, documents, archival data, etc.). Each Italian port authority has been analysed and classified taking into consideration specific dimensions, i.e., the presence of an environmental management system (EMS), the type of EMS adopted (ISO14001, EMAS, PERS), the existence of several plans and reports (e.g., EP, energy efficiency policy, inventory of relevant environmental and energy legislation, the publication of an environmental report, and so forth).

In the second part of the empirical analysis, conducting a multiple case studies, we use the techniques of semi-structured interviews, indirect observations and archival data analysis. Three PAs, the ports of Cagliari (Sardinia), Genoa (Liguria) and Naples (Campania), were chosen for several reasons. First, these three ports are of the most representative ports in Italy because of their cargo and passenger traffic and their size in terms of land surface and volume of business. Second, we selected these ports because of their position along important traffic routes that cross the Mediterranean region involving the ports of southern Europe, Italy and North Africa, as well as the ports of northern Europe and Asia. Third, these ports are all located in the Tyrrhenian sea, which presents the highest volumes of cargo and passenger traffic compared to the Adriatic Sea in the Mediterranean region (SRM, 2018). Fourth, we also chose these three ports because each of them represents a part of the Tyrrhenian sea (north, central and south), i.e., the port of Cagliari within the central area, the port of Genoa for the north area, and the port of Naples for the south area. Fifth, these ports are paying increasing attention to environmental and energy issues with a strong interest in adopting an environmental sustainability and energy efficiency policy to be more competitive, through their promotion and communication activities and developmental strategy plans, as is shown, for example, by staff of the port of Cagliari being involved in the environmental issues within the European Sea Ports Organization (ESPO). Thus, all these ports can play, if adequately supported by institutions, the role of territory and the socio-economic actors, a leverage role for environmentally and energetically sustainable growth (SRM, 2018). Finally, all these ports are located in the city, specifically the port infrastructures are in the centre of the town; this means that their port activities and operations for cargo and passenger traffic have relevant and direct impact on the overall community and territory, especially in terms of air and noise emissions and waste generation.

The case study approach is well-documented and recognized throughout the academic literature as a useful method for examining

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