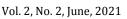# Alternative Approach for Improvement Sustainable Supply Chain Management in the Large European Container Ports

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Abstract

The main objectives of the EU transport policy belongs the limitation of the negative environmental impact from ports. Similarly, companies are adopting sustainable supply chain management practices to response the policy makers' and consumers' demands for sustainable operations. This paper aims to discover how the largest European container ports communicate about their efforts to improve the sustainability of their operations to find out how the ports themselves see their position as a part of transition towards more sustainable supply chain operations. Based on the study, different large European container ports consider environmental issues variously. The risk is that some ports may get competitive advantages by slipping in the environmental questions. Alternatively, if the port does not take sustainability questions seriously and it gets a bad reputation, the risk is that the customers and consumers do not accept the behavior of the port and shipping companies start to avoid that port.

Keywords: Sustainable Supply Chain Management; Port; Waterborne Transport; Environmental Impact; EU Transport Policy.

1. Introduction

The significance of ports for the European Union is irrefutably high: 75% of all international goods traffic is handled via ports. For inner-EU goods traffic, waterway transport amount to 40% of all cargo. In 2011, the EU ports handled about 3.7 billion tons of goods whereof 70% were bulk, 18% container, 7% Ro-Ro (roll-on-roll-off) and 5% break bulk traffic [1]. Taking 2011 as year of reference, the total goods volume is forecasted to rise by 50% until the year 2030 [2].

One of the main objectives of the EU transport policy has been the limitation of the negative environmental impact from ports [3]. The environmental impact of ports may thus be divided into three sub-categories: i) problems caused by port activity itself; ii) problems caused at sea by ships calling at the port; and iii) emissions from inter-modal transport networks serving the port hinterland [4]. To decrease the environmental problems of port activity, EU Commission has set emission standards for the handling equipment, and limited on permitted noise levels. The study made in Britain demonstrated that emissions from shipping at berth are ten times greater than those from ports' own operations [5]. Therefore, the big question is how the port is able to affect those emissions. To decrease environmental problems of port hinterland transportation, EU Commission has set emission standards for vehicles used in the transport, and supported investments in better road and rail infrastructure [3, 4].

Environmental consciousness of European citizens have forced governments and companies to investigate carefully the environmental effects of their decisions. Carbon footprints and ethical questions are important for growing share of

customers, and it is constantly more difficult for the companies to overleap these concerns. Currently, there is big emphasis on the ethical and environmental questions related to production of goods. Therefore, companies have adopted sustainable supply chain management [6] practices by increasing the visibility of their supply chains and by concentrating on ethical and environmental issues in their purchasing, e.g. by starting to offer Fair trade products. The following logical step after ethical production is to focus on how the goods are transported to consumers. For overseas products, sea cargo is the environmentally best alternative to transport goods to Europe, but then there are numerous possibilities how the goods reach the consumer from big European ports. Moreover, the question for used ports becomes relevant.

Port operations cause negative environmental impacts everywhere in any case. However, there are possibilities to affect these impacts. Therefore, the ports are required to limit negative environmental impacts. When organizations apply sustainable supply chain management principles and compare different supply chain alternatives, environmental footprints of transportation has a major role. As the ports are important hubs in logistics chains, the choice of the port is a relevant factor for the viewpoint of the entire supply chain. Thus, the aim of this paper is to find out how the largest European container ports communicate about their efforts to improve the sustainability of their operations. This paper concentrates on container ports, as in accordance with global trends, the share of containerized traffic will continue to increase remarkably.

The paper is organized as follows: After the Introduction, the methodology is explained. Then, the background of port sustainability aims and targets are explained by introducing the most relevant documents presenting EU Commissions attempts as well as some relevant studies related to topic. Next, the summary of review of the ten largest container ports' webpages are presented followed by the comparison of ports' own sustainability intentions with general sustainability aims. Finally, the conclusions are presented.

2. Research Methodology

The methodology of this paper consists of two phases: 1) Literature search of ports' sustainability aims and targets, and 2) review of webpages of the ten largest container port in Europe.

The aim of literature search was to find out European level aims for improving port sustainability. The European level objectives was searched by going through relevant directives related to waterborne transportation and ports. Then, the search covered different studies ordered by European Commission or organizations related to ports or marine transportation in Europe. In addition, the search covered different types of articles that handle port sustainability issues.

The purpose of review of webpages of the ten largest container port in Europe was to find out how the ports themselves communicate their efforts related to sustainability issues. The search was conducted on English version of public webpages of the selected ports during April 2019. During the search, the authors looked for information that relates to port, mentions about its sustainability aims, and how the port is considering environmental issues in general. Material for review was mostly gathered from ports' annual and sustainability reports and from sustainability, environment and news sections on the webpages. In addition, the search tools in the webpages were used to make searches with more specific key words, i.e. sustainability, environment and different sustainability indicators. During the search, the authors listed all the mentioned topics and examples about sustainability, what sustainability certificates the port have, and how the port is monitoring and measuring its sustainability.

Based on the literature search and review of ports' webpages, it was possible to find out, to what extent the European port industry is considering sustainability issues.

3. Background of European Port Sustainability Aims and Targets

EU aims to increase the share of waterborne transportation especially in short distance shipping as waterborne transport is environmental friendlier way to transport big volume cargo than especially road transport [2]. However, due to large volumes, waterborne transport causes significant amounts of CO_2 emissions and other pollutants, which requires considering environmental impacts of this transportation mode. Currently, shipping emissions in ports are substantial, accounting for 18 million tonnes of CO_2 emissions, 0.4 million tonnes of NOx, 0.2 million of SOx, and 0.03 million tonnes of PM10 in 2011 [7]. Most of those emissions are estimated to grow fourfold up to 2050, if the current procedures continue [7]. Therefore, in order to improve the environmental record of maritime transport, the Commission has invited the Member States and the European maritime industry to work together towards the long-term objective of 'zero-waste, zero emission' in maritime transport [8].

The circular economy concept refers to resource efficiency and sustainability. According to the circular economy approach, waste can be turned into a resource by reusing, repairing, refurbishing and recycling existing materials and products [9]. The essence of circular economy in ports includes [10]:

- Minimizing the use of inputs and the elimination of waste and pollution;
- Maximizing the value created at each stage;
- Managing flows of bio-based resources and recovery of flows of non-renewable resources in a closed loop; and
- Establishing mutually beneficial relationships between companies within each circular chain.

The EU strives for minimising dependence on oil and mitigating the environmental impact of transport [11]. In addition, energy trade is developing with a shift from oil and refined products towards gas. This causes a need for gasification facilities in ports; potential volumes of dry biomass and CO2 transport and storage [2]. According to the Directive 2014/94/EU Member States should provide an appropriate number of LNG refuelling points for maritime and inland waterway transport in order to enable ships to circulate throughout the TEN-T Core Network by 2025 [12]. LNG must be stored in cold (ca. -160°C) complicating the handling, maintenance and distribution, as well as causing higher risk than traditional fuels. This requires new distribution and handling infrastructure, and significant investments from both port authorities and ship owners [11].

According to ESPO/EcoPorts [13], the ports' main environmental priorities include air quality, energy consumption and noise. These three priorities have been in top for the last three surveys in same order. In addition, the following priorities have been in last years' TOP 10 list annually: relationship with community, ship waste, water quality, port development (land), garbage/port waste, and dredging operations (not in 2016 report). During the last two years, climate change has been raised to the list, but similarly dust has dropped out for TOP 10 priority. It is also remarkable that even if garbage/port waste is still in 10th priority in the recent list, its significance has dropped down in every report since 2004, when it was the first priority [13].

As a part of 'Ports: an engine for growth' report, European Commission suggested ports to become more active on improving the environmental image of waterborne transport by implementing infrastructure charging system that favors vessels fulfilling predefined environmental standards [2]. European Commission has advanced this idea by contracting out a study on recommendations and guidelines on actions for port environmental charging [11]. Based on ESPO/EcoPorts report, slightly over half of their survey respondent ports announces to offer different dues for greener vessels [13]. To prevent vessels to throw their waste to sea, European Directive 2000/59/EC establishes that all ships that stopover in European ports are obliged to deliver in port their waste on board of ships, except when they can prove they can store it until their following stopover port [14]. Based on the directive, the ports should also set their waste tariffs based on the vessel size, and not the actual amount of the waste, and therefore the waste tariff should be the same whether the vessels deliver waste or no to port [15]. However, based on study funded by European Maritime Safety Agency, different European ports have different system even inside one country. In some ports, charges increase if the amount of waste is bigger while in some ports financial sanctions are imposed for those ships not delivering any waste [16].

4. Summary of the Results of the Ten Largest Container Ports in Europe

The categorization of the findings of webpages of the ten largest container ports in Europe was based on ESPO's [13] environmental indicators and their prioritisation in European ports. Based on the review, one priority, diversity, was added. The priorities can be found in Table 1 and Table 2A/B. Table 1 shows the results of the review on webpages of the ten largest container ports in Europe and the environmental priorities of the ports are presented according to material available on ports' websites. Table 2A/B also shows the typical sustainability intentions of the reviewed ports. It is worth noticing that authors were not able to find any material related to port's sustainability matters in English from the webpages of two ports.

Air quality is the number one environmental priority of European ports and ports have several ways to approach air quality issues. Monitoring and smart monitoring networks including weather stations, particle collectors and sensors for real-time data collecting were mentioned in most of the websites. Shore-side power supply, LNG networks and environmental discounts for clean vessels were also commonly mentioned. Use of green electricity and planning on hydrogen supply infrastructure were mentioned in some of the pages and two port reported using E-nose technology to detect odours from leaks or other environmental incidents. One of the ports also mentioned truck-tracking app for more efficient transport in port and thus promoting air quality.

Energy consumption was mentioned as an important factor in most of the ports and monitoring was mentioned as key-factor to develop more sustainable energy consumption. All of the ports, which reported energy consumption intentions, mentioned education of the employees, electrification of the vehicles and patrol vessels, and improvements in lightning as practical cases. Many ports also reported decrease in paper consumption, use of (electric) bikes in the port area transport and offering ECO-calculators for clients as energy consumption acts. Few ports mentioned promoting new technologies, as electrification of RTG cranes, kinetic recovery container bridges and piloting energy neutral sea locks, as one important factor in cutting energy consumption in the port. One port also mentioned that electrically operated machines, vehicles and vessels are mostly charged during green energy peaks.

Table 1. A list of environmental priorities and ports working on them [17-26]

PORT	INDICATOR										
	Air quality	Energy consumption	Noise	Relationship with the community	Ship waste	Port development	Climate change	Water quality	Dredging operations	Garbage / port waste	Diversity
Rotterdam	x	x	x	x	x	x	x			x	x
Antwerp	x	x	x	x	x	x	x	x		x	x
Hamburg	x	x	x			x	x	x	x		x
Bremerhaven	x	x	x	x	x	x	x	x	x	x	x
Valencia	x	x	x	x	x		x	x	x	x	x
Algeciras											
Felixstowe		x		x		x	x			x	x
Piraeus	x	x	x	x	x	x	x	x	x	x	x
Gioia Tauro											
Barcelona	x	x		x	x	x	x	x		x	

Table 2A. A list of environmental priorities and typical sustainability intentions of the ports [17-26]

Air quality	Energy consumption	Noise	Relationship with the community	Ship waste
Monitoring	Monitoring	Monitoring	Local, National and International Governments	Services for vessels (internal/external)
Smart air quality monitoring networks	Improvements in lightning	Static and predictive noise mapping	Other ports and European bodies	Treatment plants for oil residues
Shore-side power supply	Electrification of the vehicles and patrol vessels	On-shore power supply	Partnercoalitions	Sea and land cleaning activities
LNG network	Education and training for employees	High impulse noise restrictions	NGOs	Free disposal for clean plastic waste
Environmental discounts	ECO-calculators	Noise barriers	Neighbours and visitors	Innovations for plastic waste on
Use of green electricity	Paper consumption	Port zoning	Greening ambassadors	
Hydrogen infrastrucutre projects	Use of (electric) bikes in the port area	Rail and road maintenance		
E-noses	Piloting energy neutral sea locks	Modern construction machines		
Truck tracking apps	Electrification of RTG cranes	Noise dependent fee on railways		
	Charging when green electricity peaks			
	Kinetic recovery container bridges			

Table 2B. A list of environmental priorities and typical sustainability intentions of the ports [17-26]

Port development (land)	Climate change	Water quality	Dredging operations	Garbage / port waste	Diversity
Rail connection development	Carbon footprint	Monitoring	Monitorig	Monitoring	Species protection plans
Clean commuting iniatives	Solar and wind power	Contingency plans	Coordinated soil management concepts	Improvements in sorting and recycling services	Green gateways
Transport routes in and to port	Biomass, biomass co-firing, biogas	Daily cleaning of water surface	Recycling dredging material	Manuals for port waste and recycling	Conservation areas
Cycling routes	Adapting new technologies	Goals on reducing spills, pollutants and	Up-date technology and procedures	Campaings and training for employees	Local species planting
Improvements on buildings	R&D activities	Re-use and recycling of materials		Waste management system and representatives	Compensation mitigating sites
Enhancing port landscaping	Off-setting and compensating environmental harms	Use of biocide-free underwater paint		Sustainable procurement practices	
				Land cleaning	

Most common intentions on reducing noise related harms included monitoring, static and predictive noise mapping and on-shore power supply. Few of the port also reported noise restrictions and port zoning as important factors. In addition, rail and road maintenance was mentioned in couple of ports and one port mentioned use of modern construction machines as noise harm mitigation acts. One port also reported that they have noise dependent fees on railways.

Most of the port concerned relationships with the community as co-operation with local, national and international governments and with other port and European bodies to standardise criteria and define environmental protection measures. Some of the ports mentioned working together in partner coalitions with NGOs, industrial, technological and regional stakeholders towards shared sustainability goals. Few of the ports also mentioned accessibility and openness to visitors and neighbours as part of the relationship with the community. One of the ports mentioned special greening ambassadors as a way to enhance the communication in the community.

Either ports offer ship waste handling services for vessels by themselves or external company operates in the port area to offer these services. Four ports mentioned that they regularly clean the waste on seas in port area. Depending on the port, this waste collection may concentrate on oil, plastics or material that propellers of the vessel raise from bottom of the sea.

Six ports mentioned rail transport connection improvements as their port connection development priorities, but also other transport route development to and from ports were mentioned. Six ports also mentioned clean commuting of port workers as important, and therefore, some of the transport route development efforts, e.g., especially emphasis on cycling routes, aims merely to clean commuting of port workers and visitors than improving cargo transport connections. In, addition emphasis on energy efficiency of building and enhancement on port landscape were mentioned.

All eight ports that provides material about sustainability matters in their webpages mentioned the aim to decrease carbon footprint of the port and its operations. Using renewable energy such as solar or wind power, or using non-fossil fuels such as biomass or biogas was most often mentioned as an example to decrease port's carbon footprint. Some ports mentioned about research and development efforts related to e.g. new greener technologies or compensation of emissions and other environmental harms.

Most common intentions to improve water quality included monitoring, and contingency plans to decrease the damages of possible leakages. Sea waste collection intentions were already described when intentions related to handle ship waste were discussed. One port mentioned using biocide-free underwater paint. To decrease the negative environmental effects of dredging especially to water quality, the ports mentioned that they have e.g. coordinated soil management concepts, they recycle dredging material, and they have updated their technologies and procedures.

Regarding port waste, most of the ports highlighted their recycling and reuse efforts and their attempts to separate hazardous waste, sort waste and use waste hierarchy principles. In addition, sustainable procurement practises and land cleaning were mentioned. The ports also mentioned how they aim to sustain the diversity of the local nature despite the port operations. Many ports mentioned that they have built conservation areas close to port or they have financed removal of rare species from port area to nearby conservation areas.

5. Comparison of Ports' Own Sustainability Intentions with General Sustainability Aims

Search of ports' webpages gave an overview of ports' viewpoints and efforts in sustainability issues, even if they offer only partial information what ports have done in this area. If the consumers or potential customers of the port want to get easily information about certain port's relationship with sustainability, the port's webpages is most probably how this information is gathered at first. However, even if it turned out that two ports does not offer any material in English about their sustainability considerations and many other ports does not even mention environmental actions that are obliged by law, we do not assume that these issues are not acknowledged. Most probably, the ports see, e.g., vessel waste treatment as self-evident, and they have therefore not mentioned that in their sustainability report. In addition, outside companies handle some of the environmental related issues in some ports, and therefore the port may not see relevant to mention those companies' attempts to improve the sustainability of the port. It is also assumable that companies applying sustainable supply chain management principles make their logistics related decisions by using other sources than ports' webpages.

On the other hand, it seems to be rather difficult to get a big picture about certain ports' environmental improvement attempts, as some ports gave out of all proportion to rather irrelevant details. E.g. one port highlighted their attempt to reduce the amount of used printing paper which is surely profitable but obviously rather small factor when calculating total footprint of port's operations. Many ports use standard form sustainability report to present their intentions related to sustainability. This kind of presentation has benefits and difficulties. The purpose of sustainability report is to present company's environmental consciousness and intentions in standardized way and to fulfill the regulations. However, many of those reports contains list of predefined factors, which are not opened up and then

leave issues open to interpretations. Therefore, the sustainability reports may give rather restricted overview of port's intentions related to sustainability.

As a summary, the ports report their sustainability intentions in various ways and may not concentrate on the most important things in their communication. Based on the study, it seems that majority of the ports are aiming to decrease the harmful environmental impact of port operations in various ways and have related development efforts and plans. In addition, they also consider their position as a part of surrounding neighborhood and supply chains by acknowledging the railway connections for cargo and commuting of people working and visiting in port area. However, based on the study, the ports development intentions are minor focused on port's own operations and hinterland connections, but the vessel side has minor attention. The ports collect and sort ship waste, offer LNG for vessels if needed, many of the ports remove waste from sea around vessels, and some of the ports offer electricity for vessels during berthing to decrease the vessels' need to use fossil fuels. Still, the ports seem to still searching suitable ways to have an effect on the biggest environmental problem of the port: Berthing of vessels. Some ports' efforts to tie the amounts of tariffs with the environmental friendliness of vessel and its behavior e.g. related to ship waste is a good attempt for that.

EU regulations set targets and standards for port's sustainability improvements. Based on the study, it seems that the practices and intentions related to sustainability issues are different around Europe. Even if two ports does not present any material related sustainability in English and most probably some ports have lacks in their sustainability presentations, reviewed available material exposed many differences.

6. Conclusions

Based on ports' various ways to report sustainability issues, large European container ports consider environmental issues variously. As there are differences, how EU regulations and targets are met, there is a need to harmonize the practices inside EU area. Otherwise, some ports may get competitive advantages by slipping in the environmental questions.

Currently, growing share of consumers are interested about the circumstances where imported goods are produced. The logistics and how the goods are transported has not yet received so much attention. So far, the discussion about environmental impact of transportation of goods have mainly remained in higher level in a form of discussion of benefits of locally produced goods versus imported goods, and CO_2 emissions that shipment of goods from one continent to another produces. However, the rise of sustainable supply chain management will enlarge sustainable production to cover also sustainable transport including intermodal logistics hubs like ports. Therefore, as ports are the major logistics hubs between producer and consumer, it is relevant how the port considers sustainability questions. Moreover, if a port does not take sustainability questions seriously, it might affect the reputation and there is a risk is that the customers and consumers do not accept the behavior of the port, which might affect their business.

This paper proposes an alternative approach for studying visibility of sustainable supply chain management practices. It is obvious that the final major decisions related to logistics partners are not made by using the partner organization's webpages. However, the webpages offer an easy approach, e.g., for journalists and consumers to find information about different companies. Therefore, the influence of webpages should not be underestimated. Still, for an environmental perspective, it is more important what organizations really do to improve the sustainability of operations than how they communicate about their intentions. Hence, the future research could study how single supply chain echelon, such as port, can make sustainable operations as a competitive advantage, and what kind of communication it requires.

6. Declarations

6.1. Data Availability Statement

Data sharing is not applicable to this article.

6.2. Funding and Acknowledgements

6.3. 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.

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