

## Determination of environmental initiatives and measures for port systems: The case of Koper Port

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### Abstract

The article describes the trend towards implementation of environmental initiatives in the maritime and port sector. The introduction of environmental thinking and green management has been analysed to better understand the impacts on European ports. Moreover, drivers influencing port's environmental initiatives and their adoption were analysed empirically on the case of port of Koper which is classified as one of the leading environmentally friendly European ports. Based on an in-deep analysis of developed measures a wider used approach has been proposed which might be used as a platform by the ports in the region and also by other fast developing ports. It is obvious that ports will be forced to implement environmental objects in their long-term development plan. Obtained cognitions should help them to develop a scenario for faster introduction of objects and measures to obtain the status of a green port and follow sustainable development in the future.

### Introduction

Modern logistics introduced new approaches in order to find measures against global environmental impacts but at the same time the global crisis enforces lean supply chains, fast operations and low stocks. Consequently, two directions of development have become fundamental for the future. Firstly, the new environmental consciousness appears as a new global strategy and secondly, the industry aims at obtaining and securing a balanced global development. To some extent these two opposite directions may contradict the green logistics approach [1].

The environment issues are becoming key components of the management of port development activities. Such an approach is anticipated also by industry. Namely, key company executives in Europe believe that green strategy is an important element of a company's strategy [2]. In addition, such an approach is expected also by other logistics and transport operators.

Ports are therefore under the pressure to adopt green initiatives. Van de Voorde et al. [3] believe

that there is a need for research in port's responsibility regarding environment and maritime safety. Kontovas and Psaraftis [4] expose also the role of ships in the green port policy. Their GHG emissions, produced waste and energy consumptions affect ports significantly [5]. Some ports already implemented green thinking in management's decisions and long-term development strategy. One of them is, no doubt, the port of Koper which can be ranked as one of the most advanced ports in green development. Consequently, an in-deep analysis of established measures and actions already in force might serve as a tool to model an appropriate approach also for other ports where the environmental issues are taking an active part in port's management.

Moreover, fast developing regions (like South-East Europe) will soon be forced to develop green consciousness aggressively and introduce environmental friendly technology [6]. The pressure on the transport infrastructure will become very strong and ports or port authorities will be forced to adopt strategies of long-term green development. To some extent this is already the practice, as

European Commission promotes green transport facilities and technologies through new European initiative named Green transport corridors.

With our research we closely analysed global drivers and initiatives that influence port's environmental development. Three groups of elements were analysed from the environmental perspective: requests from green logistics management, port environmentally oriented logistics and global green port initiatives. Moreover, we empirically analysed the port of Koper which already fulfils high environmental standards. The survey gives directions of further environmental improvements and important directions for sustainable development of ports in the region.

## **Environmental initiatives for port sector**

### **The pressure on ports from global green logistics management**

Pressure from global green logistics management became widespread two decades ago, as the environmental degradation caused by CFCs, acid rains and global warming became evident. Climate change, CO<sub>2</sub> emissions, waste collecting, reprocessing and finally redistribution became significant factors in logistical decision-making [7, 8, 9]. This was also recognised by logistics operators since, according to Piecyk and McKinnon [10], over 50% of companies involved in road freight transport operations are likely to see their activities affected by these factors to a significant extent by 2015 and this is expected to rise to over 80% by 2020.

Green logistics deals also with environmental questions, infrastructure exploitation questions, pollution and environmental degradation caused by improper logistics processes and the utilisation of old and environmentally unfriendly transport technology and waste [11]. With efficient infrastructure it is possible to obtain network optimization, modal shift, intermodal transportation, greener processes and operations, and introduce efficient recycling processes. The role of a port in a wider green logistics management is becoming more important than ever. Emmett and Sood [12] see these benefits through reduced impact on the ecosystem and on environmental degradation, enhanced safety and health, better transport operations and good global financial impacts on all levels of national economies. Moreover, Nijkamp [13] see the importance of environmentally friendly operations and transportation in positive competition between ports.

### **Drivers influencing port's environmental initiatives**

The European environmentally oriented logistics is highly present also in managing philosophies of

European ports. Namely, the three main fields are systematically covered: environment, society and economy. This approach requires different activities in all three fields, which are interacting between them constantly:

- environment: water and air quality, land use and degradation, noise, biodiversity, waste problems, climate changes and light pollution;
- society: access, safety, health, equity;
- economy: efficiency, growth, employment, competitiveness, choice.

The main objective of a wider port policy is to co-ordinate all activities in a way that brings long-term development and competitiveness, at the same time, fulfils increasing customer needs and environmental requirements. Green port initiative is therefore a new approach versus traditional management philosophy, present in 1990s. According to ESPO's EcoPorts port environmental review [14], the environmental issues were not present in top 10 developing priorities in 1996, meanwhile the environmental consciousness is strongly present nowadays. Namely, in the 1990s the environmental issues were connected primarily with development plans, as dredging activities, port development and water quality. Results obtained by the ESPO's survey in 2009 show that issues as noise pollution, air quality, garbage or port's waste and energy consumption are among top issues in managing ports development. Therefore, it can be anticipated that completely new drivers are influencing port's development strategy.

The drivers for port initiatives in environmental developments are many and vary between different ports. Adams et al. [15] expose that regulatory compliance and court-ordered activities have strong impacts on managing environmental issues, because ports are forced to make investments to follow legal recommendations. Moreover, they define five groups of motives, which influence ports to invest in improving the environmental performance and are influenced by a vast number of different drivers:

- regulatory compliance;
- response to societal pressures, with direct economic benefits;
- development and planning;
- improving operations;
- gain competitive advantage.

The drivers connected with development and planning activities, operational issues and gaining competitive advantages are treated differently by the ports. All three segments are crucial in long-term port development activities. Moreover, they can have direct impacts on short-term economic

operations. Thus, drivers influencing environmental management have impacts on costs effectiveness, on establishing new markets and alliances, on competitive advantages over neighbouring ports and on global green logistics development.

### Green port initiatives

Undoubtedly, the passive role of ports against environmental issues has changed drastically [16]. Considering economic and financial aspects it is important to underline that investments in environmentally friendly technologies and sustainable development have important impacts on financial performance of a port [17], but investments have strong impacts through new business developments, especially in connection with the development of green logistics and green supply chains.

Green port initiatives and their adoption carry a crucial role in ports evolution. Consequently, it becomes important for the management to achieve green port status which undoubtedly requires investments in port facilities and modernisation. The initiatives can be divided into following groups:

- green shipping with use of green ships;
- energy consumption and recycling processes;
- water and land quality;
- sustainable and clean manipulation and internal transport;
- sustainable hinterland transport;
- sustainable accompanying actions in port development, dredging, maintenance, etc.;
- improvements in community and environmental involvement.

The sustainable development of ports is therefore exceeding just system's priorities and consequently states, governments and independent organizations have to establish an adequate model of monitoring and evaluating port's environmental performance. Adams et al. [15] point out that several certified measures are in use to monitor adopted initiatives by the ports and their performances, as Environmental Management Systems (EMS) at ports, including ISO 14001 and 14064 certificates, Environmental Management Handbook (EMH), Port Environmental Review System (PERS), and Eco-Management and Audit System (EMAS). Measures which are analysed and monitored and of special importance are: supporting green ships and ship/shore interface; traffic and transportation; clean air and Greenhouse Gas (GHG) emissions and reduced noise pollution; energy conservation and efficiency; water and land resources management, with purchasing and construction practices; waste and recycling management.

### The practice from Koper Port

Port of Koper is a multipurpose port, well equipped and professionally qualified for the throughput and warehousing of all types of goods. The port has an excellent location at the head of the Adriatic, the northernmost reach of the Mediterranean, which ensures a competitive position in servicing Central and South-Eastern Europe. Consequently, the port is experiencing a trend of considerable growth in containerised cargo, bulk cargo, liquid cargo and in automotive logistics of finished vehicles. The port throughput in 2011 was 17.05 million tons of cargo, with an increase of 10.9% on 2010 volume. This result is to some extent connected with important investments in infrastructural capacities. Consequently, the port is under strong environmental pressure and it is becoming of crucial importance that the port assumes increasing responsibility in terms of environmental protection.

In the survey we analyse actual adoption of green port initiatives and possibilities to further development in Port of Koper. As the port already obtained important environmental certificates it was foreseen, that the port already fulfils high environmental standards. Anyhow, the survey gives directions of further improvements and important base for other ports in the region. Obtained findings can be the base for a wider used tool, how to implement environmental initiatives in ports system as fast as possible, especially in areas where the environmental policy is under strong development.

### Development directions

The Port of Koper accentuates the importance of sustainable development where the interaction of economic development, environmental protection and social responsibility has the impact on the environment. The port became aware of the environment-protection issues years ago. Namely, over recent years the port has been engaged in expansion and redevelopment activities which has created an upsurge in dust, light and noise emissions. Thus the port's management has set out a plan whose priority is to materialise the concept of a green, environmentally friendly port system.

Activities to achieve a strategic goal to become a green port are divided into the following areas:

- introduction of modern energy-efficient technology;
- ongoing reduction of emissions into the environment through systematically emissions monitoring processes and result reporting;
- provision of prompt and efficient responses in emergency situations;

- continuous improvement of the environment management system;
- building partnership relations with local communities.

In order to follow a variety of activities in environment protection the port has already obtained different certificates confirming port's compliance with numerous standards [18]. The most important standard is undoubtedly EMAS (Environmental Management and Audit Standards), which confirms that the port adjusted its operations according to high environmentally standards. Beside EMAS certification the port obtained ISO 14001:2004 certificate which confirms the existence of a responsible approach to environmental protection through ongoing modernization and the introduction of clean and safe technologies. Moreover, in 2008 the port was granted, OHSAS 18001:2007 certificate for occupational health and safety management system and HACCP ISO 22000:2005 certificate for a preventive management system which allows the identification, assessment as well as the implementation of measures in relation to the handling of foodstuffs. It is important to mention also SEVESO II environmental certificate which permits the management of large quantities of dangerous substances in congruence with the Council of Europe Directive 96/82/EC.

The Port of Koper introduced a pallet of different actions which have important consequences on local environment and are in accordance to obtained certificates and prescribed standards. According to our analysis following fields of environment protection are covered by port's activity: air quality, influenced by dust and volatile liquids; waste management; noise pollution; energy and fuel consumption; illumination pollution; waste and potable water; sea sediments; safety of the sea; construction works and management; interventions in the local environment, with measures presented in table 1.

### Increasing air quality

The port established permanent measurement of dust sediments at ten points inside the port area and additional ten points on locations outside the port. As no legal limits concerning dust sediments are valid in Slovenia, the port applies German guidelines with limit values of 350 mg/m<sup>2</sup>/day of dust sediments. Measurements from 2010 and 2011 show the value of 370 mg/m<sup>2</sup>/day which is lower than planned 470 mg/m<sup>2</sup>/day, but still slightly over the German standard. The port measures also the annual average emission of PM<sub>10</sub> particles (size of up to 10 µm) at two points prescribed by the Ministry of Environment and Spatial Planning. The annual measured results are lower than defined by the guidelines which stands at 40 µg/m<sup>3</sup>. According to the port's report, the measurements were of 26 µg/m<sup>3</sup> and 27 µg/m<sup>3</sup>. Beside described measurement process dust emissions are measured also at the dust source points (loading or unloading of wagons, at berth during loading/discharging of vessels etc.). The results obtained by the port are below the permitted levels.

Such positive results could be reached by the port's investments in a retaining enclosure which has been erected around the dry bulk cargo deposits and with water sprays. This solution prevents dust particles from being blown away. In addition, a retaining enclosure has been mounted on transport conveyor belts for dry bulk cargo. The port has made a step forward also in prevention of volatile liquids to evaporate in the air during the loading and unloading operations and through respirators valves. The limiting value for stored liquids is defined at 0.01% of total quantity and for manipulations from movable tanks is set at 0.005% of manipulated quantity. The port reached the results significantly below these measures with 0.008% for stored liquids and 0.0015% for manipulated quantity.

Table 1. Environmental values achieved by Port of Koper (2007–2011) (source: Luka Koper internal reports and [18])

Object	Values realised and measured from 2007 till 2011				
	2007	2008	2009	2010	2011
Total dust particle emissions from dry bulk cargos(mg/m <sup>2</sup> /day)	/	816	1262	370	370
PM <sub>10</sub> emissions across the entire port zone (µg/m <sup>3</sup> )	35	33	24	24.9	26
The percentage of separately collected waste (excl. waste from vessels)	79.8	85.9	85.8	85.6	86
Night-time noise level in the direction of Koper city (dB)	58	58	53	49	51
Energy consumption in the provision of port services (kWh/t cargo handled)	1.34	1.39	1.63	1.59	1.5
Generation of electrical energy from solar energy to meet port's own needs (%)	/	Project	Permission	Permission	Permission
To achieve self-sufficient energy (%)	/	/	Project	Project	Project
Fossil fuel consumption in the provision of port services (l/t of cargo handled)	0.21	0.21	0.23	0.26	0.25
Potable water use in the provision of port services (l/t of cargo handled)	4.31	6.13	8.05	7.88	4,5
Adjustment of illumination of facilities and operations to reduce light pollution	/	/	70	75	80

## Waste management

A variety of waste materials are produced in the port which are sorted and collected separately for recycling and further processing. The port established a Waste Management Centre for the collection and sorting of refuses. Some waste materials are administered by the Centre whereas some are dispatched to authorised agents for further processing. Wastes in the port area can be categorised in three main groups:

- wastes produced from port's activities and operations, such as packaging wastes, metal scrap, cargo remnants, timber wastes and, of course, regular municipal waste;
- wastes generated by other users of the port zone;
- wastes from vessels calling the port as oil-contaminated water, waste waters, galley waste and regular municipal wastes.

According to the analysed data the port increases the quantity of collected waste. The reasons are the increasing numbers of ships and other transport means using the port. Nowadays, the port collects approx. 4,100 t of waste. Over 86% of waste produced in the port is collected separately. Namely, sorted waste materials accounted for 2,700 t, while 500 t are unsorted municipal wastes. The remaining 900 t are mixed municipal wastes and hazardous wastes collected from ships. Moreover, a major proportion of these 900 t collected from vessels is qualified as hazardous and encompasses oil-contaminated materials and oil wastes, galley waste, ash and batteries. It has to be accentuated that hazardous waste is collected exclusively by licensed processors and that no more than 1,100 t of oil waste per annum can be reprocessed by the port's facility.

## Minimising noise pollution

Noise in the port can mainly be attributed to cargo handling operations, the use of machinery and vessel's gen sets which power onboard systems. Consequently, the port is ranked as a type facility group IV or industrial facility where the max noise pollution is set at 63 dB. Moreover, the area close to the port zone is ranked as a type zone III where the max noise cannot exceed 48 dB.

The port performs constant measuring of noise emissions and the values during the night are of special importance. In 2011, the noise pollution during the night hours was at 60 dB in the port area, therefore, still below prescribed 63 dB. Results in the area close to the port zone were between 40 and 45 dB, which is also under defined max value of 48 dB.

The port already implemented different measures as contribution to significantly lower noise pollution. The following actions are of significant importance: relocation of noise-producing activities within the port area by the movement of cargo handling activities away from the town centre, optimisation of operations to reduce overall noise levels and permanent monitoring of noise and use of noise maps.

Nevertheless, the port still has some possibilities to further reduce noise emissions, like:

- extension of the high voltage power network to the quaysides, enabling ships at the berth to use the power grid and not their gen sets which produce a significant level of noise;
- modernisation of handling and transport equipment, in order to secure environmental and user-friendly technologies;
- install visible warning devices instead of audible alarms for machinery operating during the night.

## Reducing energy and fuel oil consumption

The consumption of energy and fuel oil is an important environmental issue for every port, thus the pressure of efficiency is increasing on port of Koper, especially because the port experienced the period of increasing consumption of energy per manipulated tone of cargo (see Fig. 1). Namely, from 2007, when the consumption of energy was around 1.35 kWh per tonne of cargo, the consumption increased to 1.63 kWh per manipulated tonne of cargo. The result in 2011 was a little bit lower, as it did not surpass 1.5 kWh per tonne. With this result, the port did not reach the target set at 1.30 kWh/t. Big consumers are quay cranes and cooling plants at the Fruit Terminal. In addition, the port preferably uses high rated output machinery, which consumes more electrical power.

The consumption of liquid hydrocarbon fuels also has been increasing constantly since 2006. In 2010 consumption overpassed 0.25 litres per manipulated tonne of cargo. The internal target value set at 0.20 litre per manipulated tonne of cargo was not achieved, therefore, the port must take further actions toward decrease of fuel oil consumption.

With consideration to the results the port must further follow the strategy of reducing energy and fuel consumption. This might be possible with increased efficiency and optimal utilisation of internal transport, further development of port area and utilisation of shorter transport routes within the port and introduction of alternative energy sources for machinery. The last action should be implemented

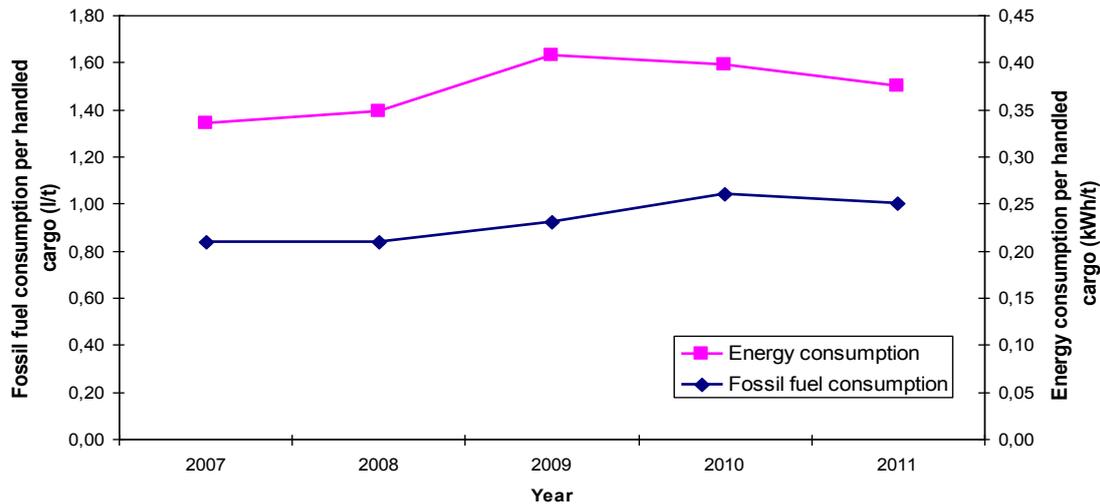


Fig. 1. Fossil fuel and energy consumption per ton of handled cargo (2007–2011)

with the installation of a solar plant, which will provide a green source of electrical energy.

#### Challenges in illumination pollution

The port uses artificial lights in some storage facilities, handling areas and transport routes during the night. Moreover, the increasing throughput and the use of new areas increase the need for additional illumination. The extension of working hours on some terminals poses the additional need for illumination. These limitations have a direct impact on the surrounding environment. Concerning illumination issues two segments should be carefully analyzed. The first one is the standard of external illumination according to the legislative requirements and the second one embraces considering the energy consumption for illumination.

According to actions in 2011, the port additionally invested in lights modernisation. Namely, additional 5% of lights were replaced. Thus, approximately 80% of external illumination at the Port of Koper is already in compliance with the legislation which shall enter into force in 2016. Today, approximately 15% of energy consumption by the port is consumed for illumination. This percentage should be reduced by new investments in light technology according to new legislation.

#### Waste and potable water

The measures related to waste and potable waters are not among the top priority issues by the Green port agenda, however, port systems are huge water consumers and therefore they produce a lot of waste water. The port of Koper partly still uses cesspits which are going to be replaced by own smaller sewage treatment plants. Besides, the port has a short term plan to replace 50% of such sewage systems by 2013.

Potable water is used for port operations including cooling foodstuffs, timber processing and washing machinery. On the other hand, the system to reduce dust pollution through spraying and the fire safety hydrant system are supplied via internal water networks fed by water drawn from boreholes and collected rainwater. This solution significantly helps to reduce consumption of potable water.

According to the results obtained in 2009 and 2010 the port consumes approximately 8 litres of potable water per tonne of cargo handled. In 2011 the consumption decreased to 4.5 litres per tonne of cargo handled. The best result was still obtained in 2007 when just 4.3 litres of potable water per tonne of cargo were consumed. Thus, actual consumption is in line with defined goal of 5.8 l/t of cargo handled.

#### Sea sediments

The port performs regular dredging in the port area, in order to ensure required depth in the port basins, at quays and in sea corridors to enter the port area. The quantity of sediments varies according to performed works. From 2006 till 2009 no particular dredging works were performed. Namely, the quantity of sediments in all three years till 2010 was below 20,000m<sup>3</sup> of sediments. During 2010 works increased intensively, thus the quantity of sediments increased to over 80,000 m<sup>3</sup>. Consequently, the question of deposit appears to be inevitable. Till now, the port used sea sediments for port area extension but these areas became limited. Therefore, new options must be analysed and worked out. The fact that the sea sediments do not contain hazardous compositions facilitates the use of sediments as secondary raw material also outside the port area. If adequately treated and dried the sediments can be used for embankments, as

building material, in roads constructions, etc. The port should focus its researches in this field, as this would reduce dredging costs in the future. At the same time impacts on the environment can be reduced significantly.

## Vision of environmental development

### Developing environmental model for port management

The economic situation in South East Europe is not as good as in the developed western or northern parts of Europe and the recent global economic crisis made the situation for maritime ports in the region even worse. Moreover, the entire region is economically underdeveloped which affects port's throughput directly. Consequently, investments in infrastructure are limited. In addition, the green infrastructure and superstructure provisions, pollution issues and congestion costs, and safety issues are not top priority issues by the management.

The Rijeka port made important steps toward the environmentally friendly port with various actions to monitor air and sea quality and noise pollution. Important objects are still in a project phase, therefore, experiences and findings from Koper port might be used as the platform for further development. Furthermore, the situation in ports of Split, Ploče and Bar is almost the same. Green port policy is going to be introduced steadily as ports have opened different studies of enlargement. These actions will influence environmental impacts during investments and later on with developing operations. Southern ports Bar and Durres are following green initiatives with even slower dynamics, be-

cause green initiatives are not at the top of management's priorities.

Based on this, we propose a model of regional environmental approach for Eastern Adriatic ports, based on steps already adopted by port of Koper and according to green port initiatives (Fig. 2). According to our findings 6 groups of activities are of special importance. In our model we highlight 11 fields already in use by port of Koper and additional three fields exposed by new environmental initiatives, as actions in supporting green ships, supporting green inland transportation and new IT platforms.

### Defining measurable goals

All ports must pursue the aim to further increase their environmental consciousness, because it is an inevitable global trend to develop and adopt green logistics management in every transport system. Consequently, the port management must define measurable goals for further system's environmental improvement. Based on our research we propose 9 basic objectives with measurable goals. According to achieved results by Koper port in last five years, it can be anticipated that some goals are ambitiously defined but at the same time they are representing an average value obtained by main European ports. Especially, objects as reduction in total dust particle emissions from dry bulk cargos fewer than  $250 \text{ mg/m}^2/\text{day}$  and to maintain  $\text{PM}_{10}$  emissions across the entire port zone below  $30 \text{ } \mu\text{g/m}^3$  seem ambitious. Moreover, a reduction of energy consumption in the provision of port services under  $1.3 \text{ kWh}$  per tonne of cargo handled

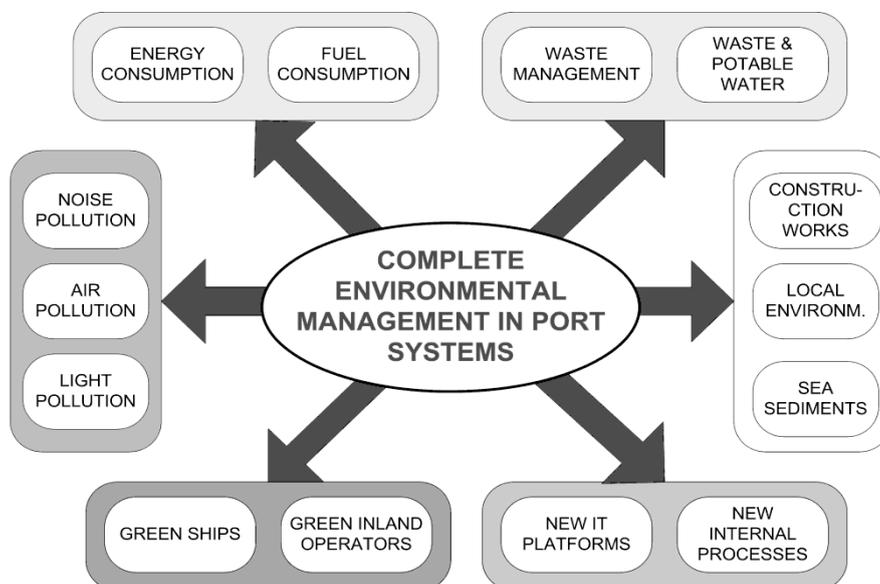


Fig. 2. The model for environmental and sustainable development of port systems (prepared by authors)

is hardly achievable, because the trend in the last two years was upwards. Almost the same seems to be true for the objects of potable water use in the provision of port services reduction, as the trend goes upwards.

On the other hand, some objects are more or less connected with investment strategy and secured financial funds. Namely, the activities related to cesspits and small treatment plans to sewerage system, adjustment of illumination of facilities and operations in order to reduce light pollution and actions to generate electrical energy from solar energy are achievable just with investments and obtained permits. No other commercial or operational factors are influencing these goals.

For sure, achieving above objects and goals would classify Adriatic ports as green ports in European and global society but there are still some new procedures or actions which might be adopted by the port management, even though they are to some extent penalising some groups of transport operators, carriers and other commercial companies. Namely, some northern European ports started to introduce lower taxes for transport operators, which use wagons with noise-reducing brakes and locomotives equipped with diesel soot filters. The ports are reducing port dues also to vessel carriers, when calling the port with greener ships. This means that vessels of less consumption of fuel oil, producing lower CO<sub>2</sub> emissions and lower noise emissions.

Table 2. Environmental goal to maintain sustainable development (source: Luka Koper internal reports and [18])

Object	Goal	Average value realised by Koper port in 2007–2011
Total dust particle emissions from dry bulk cargos (mg/m <sup>2</sup> /day)	250	704
PM10 emissions across the entire port zone (µg/m <sup>3</sup> )	under 30	28.6
The percentage of separately collected waste (excl. waste from vessels)	above 80	84.6
Night-time noise level in the direction of city area (dB)	48	53.8
Energy consumption in the provision of port services (kWh/t cargo handled)	1.3	1.49
Generation of el. energy from solar energy for port's own needs (%)	15	Under development
Self-sufficient energy (%)	80	Under development
Fossil fuel consumption in the provision of port services (l/t of cargo handled)	0.18	0.24
Potable water use in the provision of port services (l/t of cargo handled)	5.8	6.17

Moreover, some ports already invested in electric cars used within the port area and are investing in new IT platforms, which can secure additional time saving for ships and rail being accepted in the port for manipulation. Therefore, additional green port initiatives are laid in front of Adriatic port systems. Some of them should be adopted, even though this might result in lower income or give the impression that the port authorities are in favour of certain groups of clients.

### Expected obstacles by limited support from the economy

We foresee, that further investments in green port measures will continue to be a strong challenge for port authorities. Undoubtedly, the crisis puts pressure on some logistics elements which are not in favour of green logistics concepts. In such circumstances the pressure on costs reduction is present. Namely, Corbett et al. [19] affirm that increased manipulation and transport speed have direct impacts on higher air and noise pollution and at the same time energy consumption increases drastically. Ports are forced to introduce lean concepts in internal operations and transportation and secure just-in-time concept for clients using port's services.

New projects of port enlargement are also planned by the port's management. As financial funds are limited and projects have limited time of realization, the building process is executed in a way where dust pollution and noise pollution limitations are not fully considered. Moreover, ports have difficulties to penalise transport operators when using high noise wagons or old trucks. It has been ascertained that, to some extent, industry is not motivated to introduce green logistics initiatives. In addition, clients do not recognize the benefits of green thinking massively, thus the pressure on the ports is not as strong as it is in Western Europe.

Nevertheless, ports must see the necessity to implement green port initiatives in their development plan. Therefore, there is a strong need to promote and gradually develop a regional approach for green port development, through activities we propose in our model. All ports should be open to develop a macro green port strategy for the entire region. Experiences from Koper port might be used as a platform for a wider used approach where an active cooperation between government institutions, industry and logistics operators should be necessary. All these parties should be motivated to develop a sustainable green port model which

should be adapted to the regional situation and market's expectations. Ports may become more competitive and ready to support new European transport initiatives as Green transport corridors. Therefore, further research and proposals are foreseen as a very important approach to reach this environmentally important goal.

## Conclusions

Environmental pressure on port systems is becoming very strong. Consequently, ports are forced to implement green initiatives in their agenda. According to the analysed case of Koper port important improvement in environment saving can be achieved. Thus, coordinated actions and well defined objects must be adopted by the port management and port authorities. Moreover, environmental approach has to be incorporated in long-term development plan.

As foreseen Koper port has a well developed environmental policy where important actions in noise and air pollution were adopted. Furthermore, measures in light pollution and energy consumption gained positive results during the last five years. Besides, the port has still some objects open where further improvements are expected.

Cognitions in the case of Koper port can be used as a source to develop a useful model for faster and synchronised implementation of environmentally friendly activities in other ports on the Eastern Adriatic coast. Namely, according to our analysis these systems lag behind Koper port in environmental policy. The farther to the south one moves, the wider the gap between ports is. Thus, it would be of high importance for the region and regional transport sector that ports develop cooperation between them, various government institutions, industry and logistics operators. The proposed model should simplify this process. Consequently, they could become more competitive and would operate on high environmental standards.

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