

## **Abstract**

This paper aims at defining a set of indicators to be applied in port areas on the topics of Occupational Health, Safety, Security (OHSS) and Environment. The techniques used to identify and select the OHSS indicators involved two different approaches: i) a bottom-up method, where an extended and in-depth analysis was performed in order to assess the current indicators applied by ports and, ii) a top-down approach, mainly based on legislation and regulations as well as the feedback from stakeholders of the port and shipping industry. The bottom-up approach analysed a total number of 526 ports, allowing the identification of the most frequent indicators used by them. The top-down approach collected valuable opinions and suggestions from the port community members. A consensus between the results obtained in the two approaches was reached in order to provide ports with the most adequate and implementable indicators. The Environmental Performance Indicators (EPIs) have been selected based on the results of previous research projects plus further discussions with port stakeholders. The information provided in this paper can be considered as a preliminary attempt to promote port performance measurement in these four sensitive fields.

**Keywords:** *Occupational Health, Safety and Security Indicators; Environmental Performance Indicators; Port Management; Environmental Management.*

### **1. Introduction**

Ports play a fundamental role in linking sea and land transportation. They have become very complex systems due to the variety of cargoes that they may handle, their close location to the local community or the range of interests and responsibilities of the parties involved. For this reason, the proper management of occupational health, safety, security, and environmental issues within ports is crucial and it requires to continually monitor risks, so that vulnerabilities can be detected and control measures can be implemented. This fact can contribute to reduce uncertainties and, more importantly, the occurrence of accidents that pose a threat to the people, the environment and the ports' assets. In addition, accidents and dangerous occurrences may cause severe disruptions to the ports' services and, therefore, an increase in their operational costs.

Since the strategic objectives of compliance with legislation, cost- and risk-reduction, and environmental protection are essential for any port authority, a key element to attain

these objectives is the use of performance indicators. They provide unambiguous evidence of trends of performance and can be of mutual benefit to individual port authorities, the port sector, the European Commission, and to a range of interested stakeholders, such as terminals operators or shipping companies. Issues such as the ports' reputation or image in terms of environmental protection and safety management also have influence on the decision of stakeholders on the routes and ports of call that they establish (Trbojevic, 2000).

The common saying 'what gets measured, gets managed' backs the idea that regular measurements can surely assist managers to figure out what actions are contributing to improve or deteriorate the performance of a process. It can be stated that indicators provide metrics to measure and report success. Indicators can also be understood as signals that reveal progress (or lack thereof) towards objectives (United Nations, 2002). Indicators play a vital role as they can contribute to keep operational costs under control and to evaluate periodically the success of the policies and strategies that are being implemented by port managers.

The present research has been conducted in the framework of the research project 'Ports Observatory for Performance Indicators Analysis' (PORTOPIA, September 2013 – August 2017). It aims at creating an on-line integrated platform so that port authorities can provide data periodically in order to observe and monitor the efficiency and the overall performance of the European port system. This platform, named PORTOPIA Service Cloud, is expected to be useful not only for the port sector, but also for individual port authorities.

This paper is structured in the following sections: i) the importance of considering Occupational Health, Safety, Security and Environmental performance indicators in ports; ii) the description of the methodology that has been followed and the outputs obtained; iii) the results, which are the final list of the indicators, as well as their definition; iv) the current stakeholders feedback to the suggested KPI's, and finally, v) some conclusions are drawn.

## **2. Importance of OHSS and Environmental indicators in ports**

This section discusses the reasons why Occupational Health, Safety, Security and Environmental indicators should be monitored in ports. The importance for considering these issues within port areas is analysed below.

### **2.1 Occupational health**

The benefits of having a healthy and safe working environment are widely recognised. Many studies in this field conclude that adequate working conditions have the potential to increase labour productivity and consequently improve the organisations' operational performance (e.g. Samuel, 2010; Oxenburgh et al, 2004). Other important benefits are that good working conditions can promote recruiting and retention of skilled workers and the social and economic costs of accidents can be eliminated or reduced.

The European Framework Directive on Safety and Health at Work (EC, 1989), which introduces measures to encourage improvements in the safety and health of workers at work, applies to the working conditions in ports. Although this Directive has given birth to more than 20 individual directives for specific sectors such as the construction, mining and fishing, none of these individual directives are especially dedicated to ports.

Another existing gap in the port sector is the lack of reliable and comparable statistical data on health and safety in ports. This is because there is not any specific NACE Code for the port sector. However, the United Nations International Standard Industrial Classification (ISIC) of all economic activities dedicates a section to 'Transportation and Storage' (UN, 2008).

A study conducted by the European Commission in 2013 investigated port labour practices and revealed that the level of accidents for port workers remains high (Hooydonk, 2013). It also demonstrated that very few Member States collect data on accidents and occupational diseases of port workers. As a matter of fact, only 12 of the 22 maritime Member States have adopted dedicated legislation for port workers. Similarly, just 8 Member States collect statistical data about port workers' accidents, being Finland the only one that published comprehensive data about occupational diseases (Hooydonk, 2013).

## 2.2 Safety

Europe constitutes the densest port regions worldwide. It has more than 1,200 commercial seaports along the 70,000 km of coastal zone, and over 200 ports in its inland waterways. According to the latest 2011 figures, more than 60,000 merchant ships called at European ports, which represented approximately 3.7 billion tonnes of cargo. Bulk carriers accounted for 70% of it, container ships 18% and Ro-Ro vessels 7%, the rest being other general cargo. A total number of 385 million passengers pass by ports every year and about 1.5 million of workers are employed directly in European ports (EC, 2013).

Despite the decisive role that European ports play in the supply chain, there has been few studies to examine the impact of operational safety management on the competitiveness of ports. One reason for that may be the lack of public and comparable information that could be used to analyse trends and forecast future results at EU level.

One of these studies, conducted by Darbra and Casal (2004), highlighted the need to improve the safety of port operations. The study analysed worldwide data collected by the Major Hazards Accidents and Incidents Database (MHIDAs) between 1980 and 2002. It revealed that nearly 60% of accidents are linked to the manoeuvrability of ships and movement of cargo in ports, by lorry and/or train. Also, about 15% accidents are associated to cargo loading and unloading, 12% to cargo distribution and storage, 11% to plant processes, and 4% warehousing.

In the same way, the research carried out by Yip (2008) also clearly showed that collisions are the most common type of accidents in ports. The heavy traffic and congestion that large ports have to cope are among the causes of those accidents. Therefore, more effective measures, such as the application of mathematical models for collision prediction, need to be established and resources allocated appropriately. Moreover, the study concluded that the improvements introduced in ports during a period of 12 years resulted in a 50% reduction of accident occurrence rate.

Following the Sea Empress accident in the port of Milford Haven in 1997, the UK amended the Pilotage Act and introduced the Port Marine Safety Code (PMSC) in 2000.

The Code aims at establishing nationally agreed standards and encourages ports to comply with best practices for marine safety, not only for pilotage but also for all port safety functions. The trade unions, particularly Nautilus, have been very critical on this voluntary approach and have asked the UK government to adopt mandatory standards, inspections and enforcement. Additionally, the 2007 Report on the Port Industry in England and Wales has recommended the government to set up a Safety Inspectorate for ports (House of Commons, 2007).

### **2.3 Security**

Following the 9/11 attacks in 2001, security measures were adopted by the United States and the international community to improve the global supply chain security. Although commercial aviation remains a target, it is possible that terrorists may direct their attention to other modes of transport.

Since more than 80% of the worldwide cargo is transported by sea, ships and ports play a crucial role in the supply chain (UN, 2012). Security experts are concerned that cargo or passenger ships can become a target for terrorist attacks. Such attacks could not only cause deaths and local damage but also paralyse global maritime trade.

The International Ship and Port Facility Security (ISPS) Code provides a set of measures to enhance the security of ships and port facilities (IMO, 2004). Among others, the Code aims at establishing a framework for cooperation between governments, the shipping and port industries to detect security threats and adopt preventive measures against security incidents affecting ships and port facilities.

Out of all the types of cargoes handled in ports, containers have drawn the greatest concern because, at present, their integrity cannot be verified along the entire chain. Most difficulties arise since the transport of containers requires the interaction between market players, industry regulatory bodies, others modes of transport, operational systems and legal regimes. Screening 100% of containers is not currently possible due to technology limitations and huge costs. Screening technologies currently used in ports include X-Ray or Gamma Ray, radiation and optical character reading (Scholliers and Toivonen, 2012).

Few information is available on the use of indicators for security in ports. The indicators proposed in this paper were developed on the basis of current international regulations and practices in some ports, for instance in Spain (Fernández-Quirós, and López Quiroga, 2012) and Australia (Australian Government, 2011). However, even the countries where several of their ports have implemented security KPI's present asymmetries. This is the case of Spain, where the Court of Justice of the European Union took action because 20 Spanish ports have yet to adopt and implement the port security plan (EC, 2014).

The UK Marine Safety Code applies major IMO guidelines, standards and practices. At present, the Global Integrated Shipping Information System (GISIS) keeps few data on marine casualties and incidents (IMO, 2015a). The development of initiatives to promote incident reporting by Member States date from 1997, with the development of the IMO Resolution A.849 (20) which introduced the Code for the investigation of marine casualties and incidents.

Similarly, reporting of incidents are required under SOLAS regulation I/21 (IMO, 1974) and MARPOL articles 8 and 12 (IMO, 1973). Annex 4 of the IMO MSC-MEPC/Circ.3 published on the 18th December 2008 requires information from casualties involving dangerous goods or marine pollutants in packaged form on board ships and in port areas (IMO, 2008). At European level, Directive 2009/18/EC establishes a harmonised methodology to investigate and report incidents (EC, 2009). The reports must follow a common structure and be submitted to EMSA that maintains the European Marine Casualty Information Database (EMCIP).

## **2.4 Environment**

Although it is acknowledged that the expansion of port facilities and their associated operations can contribute significantly to the growth of maritime transport and economic development, it may also create adverse impacts on the environment. Port operations and activities may impact on air, water, soil and sediment affecting both the terrestrial and marine environments. Port development and operation should, therefore, be planned and executed with careful consideration of their environmental impacts (Puig et al, 2014).

As environmental awareness is increasing throughout society, effective environmental management is essential if stakeholders are to continue their support for port operations and development (PPRISM, 2010). 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 and regulations.

Ports are complex organisations from all points of view: economically, socially, geographically, and administratively because of the range of interests and responsibilities of the parties involved. In order to evaluate environmental performance of port authorities and to track progress towards continuous improvement, relevant Environmental Performance Indicators (EPIs) may be utilised so that port authorities can demonstrate compliance and continuous improvement with substantive evidence from science-based, quantifiable measures (Puig, 2012).

According to the ESPO Port Performance Dashboard (ESPO, 2013), 64% of European ports have identified environmental indicators to monitor trends in environmental performance, increasing this percentage year over year (Puig et al, 2015). Although ports are becoming increasingly aware of the benefits of using environmental indicators, there is not a common approach as to which indicators adopt. This paper compiles a list of selected science-based, practicable, informative, measurable, and representative EPIs which port managers would be able to implement in their port.

In order to guide port authorities in interpreting environmental law and to assist them in reaching their environmental objectives and commitments, the European Sea Port Organisation (ESPO) has launched several initiatives and policy actions. Examples are the publication of the *ESPO Green Guide: Towards excellence in port environmental management and sustainability* (ESPO, 2012), which defines the vision of European port authorities towards sustainability; *ESPO Code of Practice on Societal Integration of Ports* (ESPO, 2010), which provides practical recommendations that guide port authorities in improving their general public image or the *ESPO Code of Practice on the Birds and Habitats Directives* (ESPO, 2007) which collates experiences of port authorities dealing with the Birds and Habitats Directives.

### **3. Methodology**

This section explains the methodologies that have been followed in order to obtain a preliminary set of indicators and the feedback that has been obtained from stakeholders in both, the OHSS indicators as well as the environmental ones.

#### **3.1. OHSS indicators**

As already mentioned, the list of OHSS indicators has been obtained as a result of two different methods: a bottom-up and a top-down approach, leading finally to a consensus on the outcomes of both approaches in order to provide a final proposal of indicators.

##### **3.1.1 Bottom-up approach**

In order to propose adequate and implementable performance indicators on Occupational Health, Safety and Security, it is necessary to identify the indicators that are currently used by ports on these topics. A bottom-up approach was conducted, building an inventory of the indicators that are published by ports in their annual and sustainability reports. In that sense, it was found necessary to perform a sufficiently wide review in order to consider the findings ‘statistically representative’. This means that the sample had to be large enough in terms of both the number of ports scrutinized and their geographical area. This fact was taken into account because diverse regions have different insights, business plans, risk acceptance criteria and, above all, different local or regional legislation. Therefore, with the aim at understanding this complex situation, a broad and extensive assessment of the state-of-art was needed. More details concerning the methodological aspects of the bottom-up approach and respective nuances can be found in Antão et al. (2015). However, for sake of clarity of the present document, the core aspects and conclusions will be discussed and presented in the following paragraphs.

The internet search analysed a total number of 526 individual ports, including 104 ports from the TEN-T Core network, 220 ports from the TEN-T Comprehensive network and the rest 202 of non-EU ports. The discretion of the latest included 95 American based ports (20 from USA and 75 from Brazil), 67 Oceania ports (58 from Australia and 9 from New Zealand) and 40 of the largest worldwide container ports.

The main sources of information that contributed to this state-of-art were, by priority and importance, port annual reports, port sustainability or environmental reports, scientific journals and, lastly, conference publications. Since there was a large number of ports to be researched, a system to properly collect the information in an organised way was needed. A table was created, which included the name of the indicator, the document source, and the name of the ports that have implemented this indicator. Based on this table, a frequency analysis was performed in order to identify the main implemented indicators for each of the three fields under scrutiny. Since the same indicator may be presented in different ways in the literature, a harmonization process was needed in preparing the tables of frequency. **It is important to mention that the research included indicators found in the different port authorities' websites, being difficult to discriminate against the origin of the resulting indicators (i.e. port authority or port stakeholders).**

The results demonstrate that there is a large percentage, more than the 50%, where the reports are not available online or are not in English language. The number of ports with indicators in their reports is even smaller. It was found that just 14% of the examined ports (72 out of 526) provide data on indicators for occupational health, safety and security. From these 72 port authorities, a total amount of 281 different OHSS indicators were obtained. In relation to the distribution of indicators, the number reported for occupational health is high compared to the other two indicators fields. In fact, occupational health has nearly three-quarters of all identified indicators whereas, surprisingly, safety only accounts with 23% and security with 6%.

There is not a uniform distribution on the three categories of indicators within this sample: there are some ports with more emphasis in safety related indicators and others that have more emphasis in occupational health. This difference can even be appreciated within ports of the same country. According to the results, on average, each port provides almost 4 indicators. Nevertheless, there are 6 ports that report more than 10 indicators. There are two ports that are remarkable concerning the identification of OHSS, namely the Port of Sines (Portugal) reporting 17 indicators, and the port of Hong Kong (China) with 19 indicators.

There are some weaknesses in this research that should be taken into account since they may have most probably conditioned the outcomes. One of them is the online availability (or not) of annual and environmental reports. It is obvious that it was not possible to identify the indicators for those ports that do not provide these types of reports online. However, it should be stressed that the unavailability of the reports does not mean that these indicators are not systematically collected and analysed. It simply means that they are not expressed in the online publications of the port. Similarly, it should be taken into account that, in some cases, the online available reports may not provide information on all the indicators that the port is currently using. Ports may would like to emphasize specific indicators or results over the others. Finally, in some specific cases, the language also appeared as another barrier, since some reports are only written in the language of the country of the port, without being translated into English. For instance, some reports were found only written in Danish or Swedish and it was not possible for the research team to interpret them. Below, the main outcomes of the bottom-up research are provided for each category of indicators.

### **Occupational Health indicators**

The number of indicators reported for occupational health and their frequency is high compared to the other indicators. This is explained by the fact that ports are obliged to provide data to insurance companies. In addition, Member States are obliged to report to Eurostat, which has put in place a harmonised method for reporting this kind of indicators (Jacinto et al., 2011). Consequently, the most common indicators reported are in accordance with the European Statistics on Accidents at Work (ESAW).

Table 1 presents the outcomes of the analysis of the current state-of-art based on annual and sustainability reports. It presents each indicator, the frequency analysis (number of times that the indicator has appeared) and the name of the ports that report them. The table demonstrates that the number of days lost (15%), frequency rate (15%) and number of fatal work accidents (14%) are the three indicators more frequently identified. In this case, a total amount of 200 indicators were identified in 65 ports, and the table below represents the 55% of the overall health indicators with higher frequency identified in this study.

It should be mentioned that in some cases it is not the port itself to be mentioned but rather a port authority with several ports aggregated. For example, this is the case of the Ports of Madeira which have 3 ports under its jurisdiction. Furthermore, there are cases where the ports applied different perspectives of the same indicator. For instance, the same port can apply a KPI for absenteeism due to accident and another due to illness. As explained in detail in Antão et al. (2015), there was the need of a methodological step, related to a ‘harmonization’ process in order to perform the frequency analysis. These facts are transversal to all the indicator groups under scrutiny. Based on this, it should not be a surprise that in the tables below the number of mentioned ports is sometimes smaller than the frequency figure.

*Table 1: Occupational Health indicators Top 10 frequency analysis (Antão et al., 2015)*

<b>Name of the Indicator</b>	<b>Frequency</b>	<b>Name of Ports</b>
Number of days lost	16	NSW, Hamburg, Lisbon, Livorno, Leixões, Sines, Aalborg, Odense, Portos da Madeira, Setúbal, Tyne, Gladstone, Navegantes, Lyttelton
Frequency rate	16	A Coruna, Lisbon, Bilbao, Livorno, Sines, Setúbal, Ports North Authority, Tasmanian Ports Corporation Pty Ltd, Broome, Gladstone, Townsville, Esperance, Sydney Ports, Auckland, Tauranga, Nelson
Number of fatal work accidents	15	Antwerp, A Coruna, Hamburg, Gothenburg, Setúbal, Broome, Bunbury, Dampier, Esperance, Hedland Port, Albany, Navegantes, Hong Kong, Jawaharlal Nehru
Total number of work accidents	14	Antwerp, Lisbon, Livorno, Leixões, Sines, Koper, Aalborg, Larnaka, Portos da Madeira, Setúbal, Rauma, Aberdeen, Tyne, Geelong
Severity rate	13	A Coruna, Valencia, Lisbon, Bilbao, Sines, Setúbal, Broome, Bunbury, Dampier, Esperance, Hedland, Albany, Tauranga.
Number of work accidents with missed work	12	Antwerp, A Coruna, NSW, Gothenburg, Lisbon, Bilbao, Leixões, Sines, Setúbal, Aberdeen, Bunbury, Sydney ports
Absenteeism due to accident or illness	10	Copenhagen, A Coruna, Hamburg, Gothenburg, Leixões, Koper, Setúbal, Tyne, Navegantes
Percentage of injured workers returned to work within (i) 13 weeks and (ii) 26 weeks	5	Broome, Dampier, Esperance, Hedland, Albany
Percentage of managers and supervisors trained in occupational safety, health and injury management responsibilities	5	Broome, Bunbury, Dampier, Hedland, Albany
Percentage of workers represented in health and safety committees	4	Leixões, Sines, Setúbal, Navegantes

Although some ports appear just once in table 1, it does not mean that they are just using one indicator. The most probable is that they are implementing other indicators but these ones are not present in the top 10.

### Safety indicators

With respect to the safety indicators, Table 2 presents the Top 10 indicators that appear in the frequency analysis. In this case, a total number of 63 indicators were identified in 18 ports, and the table below represents 62% of the overall safety indicators found in this study. The frequency is not regularly distributed, and there is one particular indicator standing out: the number of nautical accidents (33%). It is followed by failure to comply (10%) and training related issues (10%).

Table 2: Safety indicators Top 10 frequency analysis (Antão et al., 2015)

Name of the indicator	Frequency	Name of ports
Number of nautical accidents (significant or incidents in areas under the jurisdiction of the port authorities)	13	A Coruna, Larne, Wilhelmshaven, Rotterdam, Amsterdam, Orkney, Hong Kong
Failure to comply (port regulations, industry safety standards, etc.)	4	A Coruna, Larne, Nelson
Training related issues (number of courses, % budget on safety)	4	Larne, Bilbao, Nantes Saint-Nazaire, Hong Kong
Ship collisions	3	Bremerhaven, Rotterdam, Hong Kong
Near Misses (either nautical or industrial)	3	Larne, Orkney
Number of spills (nautical or industrial)	3	A Coruna, Nelson, Leixões
Fires and Explosions (either nautical or industrial)	3	Bremerhaven, Wilhelmshaven, Hong Kong
Distribution of nautical accident types	2	Rotterdam, Portsmouth
Number of foundering	2	Bremerhaven, Hong Kong
Investment in safety	2	A Coruna, Genova

### Security indicators

With respect to the security issues, the first conclusion that may be drawn is the scarce information provided in relation to this subject. In fact, only 18 indicators were identified in 13 ports, representing a small subset of the ports analysed. The most frequent indicators are the number of port security incidents (33%), the number of security drills (22%) and investment in protection (17%). These three indicators represent, in overall, the 72% of the security indicators that were found implemented in ports.

Table 3: Security indicators Top 10 frequency analysis (Antão et al., 2015)

<b>Name of the indicator</b>	<b>Frequency</b>	<b>Name of ports</b>
Number of Port security incidents (different types of breaches - ex: access without authorization, thefts and claims, jobs without authorization, etc.)	6	A Coruna, Orkney, Ports North Authority, Gladstone
Number of security drills	4	Valencia, Barcelona, Stockholm, Jawaharlal Nehru
Investment in protection (maintenance and investment)	3	A Coruna, Genova, Sines
Compliance with ISPS requirements	1	Dar es Salaam
Percentage of employees trained in the organisation's anti-corruption policies and procedures	1	Hamburg
Actions taken in response to incidents of corruption	1	Hamburg
Number of Security meetings (police forces and authorities, private security and technological measures firms, shipping companies, shipping agents and foreign consulates)	1	Barcelona
Number of port security inspections	1	Amsterdam

### 3.1.2 Top-down approach

Initially in the top-down approach, a desk study was conducted for a preliminary identification and selection of the indicators. This was based on a review of the published literature, best practices, and legislation which are currently applied with similar purposes in large seaports and other high hazard industries, including shipping and offshore industries.

Concerning Occupational Health indicators, the methodology adopted by the European Statistics on Accidents at Work (ESAW) (Eurostat, 2001) was analysed since it provides a harmonized terminology used by the EU Member States to report data on this issue. In addition, the project Shipping KPIs (Marintek, 2010) was also taken into account because it introduces useful definitions and indicators on the operational performance of ships, which can be easily adjusted and inferred to the specific needs of the port sector.

With reference to Safety and Security, the development of indicators in ports was more challenging. The research demonstrated that presently very few ports report on these types of indicators. Therefore, the basis for defining them took into consideration guidance and legislation adopted at international and European level in those specific fields, such as the International Ship and Port Facility Security Code (ISPS Code) (IMO, 2015b) and the International Convention on Oil Pollution Preparedness, Response and Co-operation (OPRC) (IMO, 2015c).

Table 4 presents all the indicators identified during this process. A total number of 14 lagging and 17 leading indicators were identified as preliminary indicators to be assessed by port stakeholders for the three fields under consideration. Lagging indicators are mainly used to report processes' outputs and are difficult to change (Grabowski et al., 2007), such as the 'Fatality Rate' indicator. Leading indicators try to understand uncertainties and predict potentially adverse situations, before the unwanted event occurs (Hale, 2009), for example the indicator 'Near Misses'.

Table 4: Preliminary indicators identified for occupational health, safety and security as a result of a top-down approach

<b>Occupational Health</b>	<b>Safety</b>	<b>Security</b>
<p><i>Lagging indicators</i></p> <ol style="list-style-type: none"> <li>1. Fatality</li> <li>2. Major injury</li> <li>3. Lost workday</li> <li>4. Medical treatment injury</li> <li>5. Occupational illnesses</li> </ol>	<p><i>Lagging indicators</i></p> <ol style="list-style-type: none"> <li>1. Marine incidents</li> <li>2. Berth incidents</li> <li>3. Landside incidents</li> <li>4. Damaged caused by incidents</li> <li>5. Pollution incidents</li> </ol>	<p><i>Lagging indicators</i></p> <ol style="list-style-type: none"> <li>1. Security offences</li> <li>2. Damage caused by security offences</li> <li>3. Incidents in security restricted areas</li> <li>4. Application of security levels 2&amp;3 in port facilities</li> </ol>
<p><i>Leading indicators</i></p> <ol style="list-style-type: none"> <li>6. Near miss</li> <li>7. Health and safety training</li> <li>8. Compliance with Personal Protection Equipment (PPE)</li> <li>9. Jobs with safety checklists</li> <li>10. Update of safety checklists</li> <li>11. Feedback to safety suggestions</li> <li>12. In time maintenance</li> </ol>	<p><i>Leading indicators</i></p> <ol style="list-style-type: none"> <li>6. Implementation of safety management systems</li> <li>7. Behavioural safety training</li> <li>8. Safety exercises and drills</li> </ol>	<p><i>Leading indicators</i></p> <ol style="list-style-type: none"> <li>5. Port facilities certified for IT security</li> <li>6. Implementation of security measures</li> <li>7. Container examination by physical and non-intrusive means</li> <li>8. Education and training in security</li> <li>9. Security exercises and drills</li> </ol>

13. Application of OSHAS or other equivalent standard		10. Body searches
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Table 4 shows that in the top-down approach 13 indicators were identified for Occupational Health, 8 for Safety and 10 for Security. For each of the proposed indicators, a data sheet was prepared, containing a description, the calculation formula, the potential data sources and problems, the related regulations, among others. This detailed information on the results of the top-down approach was a starting point for discussions with a core group of specialists with experience and expertise in port operations.

In this respect, it must be acknowledged the support of European Sea Ports Organisation (ESPO) for approaching these stakeholders. ESPO is organised around thematic technical working committees that bring together the expert port professionals in the various fields of interest. In reference to the Occupational Health, Safety and Security indicators, two relevant committees of ESPO were selected for the validation of the preliminary indicators. First, the ESPO Labour and Operations Committee gathers experts in labour matters from the European port authorities that directly employ port workers. This was selected as the forum for the validation of the occupational health indicators. Secondly, the Marine Affairs and Security Committee of ESPO brings together the port safety and security experts and harbour masters of the European ports. This was naturally considered as the relevant forum for the validation of the preliminary safety and security indicators.

Accordingly, the preliminary indicators were presented to these two ESPO specialised working committees: the Labour and Operations Committee (Brussels, December 2013 & March 2014), and the Marine Affairs and Security Committee (Kolding, April 2014 and Brussels, March 2015). The methodology for collecting the port professionals' feedback included a detailed assessment of the selected indicators on the basis of a developed template and a round table type of discussion where the participants were able to comment freely on the options presented, to make suggestions for improvement and to propose alternatives if and where needed. In this manner, the opinions, views and suggestions of the members of these committees were collected in order to explore the acceptability of these set of preliminary indicators. The indicators on occupational

health were also presented to the newly launched Working Group Sectorial Social Dialogue for Ports (Brussels, December 2013) and later in March 2014. This is an EU initiative bringing together the representatives of employers and employees in ports to discuss, reach agreement and potentially also propose legislation on port labour matters at European level. The main organisations represented are the ESPO and the Federation of European Private Port Operators (FEPORT) from the employers' side and the European Transport Worker's Federation (ETF) and the International Dockers Council (IDC) from the employees' side.

The feedback obtained in those meetings was useful for refining and improving the scope of the indicators to the needs expressed by the stakeholders. In general, it was felt that port operators were open to share data for indicators on occupational health. The main reason for that is that EU Member States already collect and report this kind of information through Eurostat (EC, 2015). Contrarily, the acceptability of the safety and security indicators found major resistance, meaning that much work was still needed to be done to gain the acceptability of the stakeholders. Below, the particular feedback obtained to each field is presented.

### **Occupational Health indicators**

The indicators for occupational health were presented at the ESPO Labour and Operations Committee and at the Sectorial Social Dialogue Committee for Ports, held in Brussels on the 17-18<sup>th</sup> December 2013 and on the 17-18<sup>th</sup> March 2014. The Committees brought together delegates from the port authorities, terminal operators, dockers and port workers, as explained above.

During the meetings, six main indicators were presented: i) Fatality rate; ii) Major injury rate, iii) Lost work day rate; iv) Medical treatment injury rate; v) Near miss rate; and vi) Occupational diseases rate. Port representatives showed interest especially on the first three indicators. Concerning the variables needed to calculate these three indicators, some stakeholders considered that the use of 'hours worked' and the 'number of employees' could not be easy to calculate. It was proposed that the use of 'full-time equivalent hours' could be more appropriate. On the major injury rate, social partners asked the consortium to have an inventory of how "major injury" is defined across EU ports in order to find a common method of definition.

### **Safety and Security indicators**

Safety and security indicators were presented for the first time at the ESPO Marine Affairs and Security Committee during a meeting held in Kolding (Denmark) on the 29<sup>th</sup> April 2014. The meeting was attended by representatives from the ports of Amsterdam, London, Hamburg, Oslo, Algeciras, Hanseatic city of Bremen, Kolding and Malmo. Other organisations represented in the meeting included Transport Malta, Transport Gruppen and the Finish Ports Association.

Overall, the indicators were not very well welcomed by the majority of stakeholders above, although some of the attendants expressed that the use of such detailed indicators would be very useful for the port operation at internal level. The members suggested that the focus of such indicators should be on the port authorities' roles and responsibilities. Nonetheless, the current differences between ports are challenges to overcome; for instance, landlord ports have completely different roles and responsibilities than service ports (The World Bank, 2007).

Although the initial aim of concluding on a core set of indicators on safety and security during the meeting resulted not possible, a port representative expressed that it would be beneficial for the sector to monitor some core indicators on safety and security. It was argued that this would add credibility to the sector and there are successful examples at some national levels, such as the United Kingdom that has been pioneering in trying to harmonise safety standards through the adoption of the marine safety code for ports.

A second ESPO Marine Affairs committee workshop was conducted in March 2015 in Brussels. It aimed at reaching an agreement on some key meaningful figures in safety and security issues that ports could consider for monitoring and reporting. The experiences of the ports of Rotterdam and London in this field were presented and raised a lively and constructive debate. Overall, members agreed that the monitoring of trends over time regarding nautical accidents in port waters would be a useful way forward with added value for both the sector and individual ports. Related to that, a meeting was held in London in May 2015 between UK ports and the Port of Rotterdam. An agreement was reached on a checklist for the indicator 'nautical accidents' to be proposed for implementation by PORTOPIA.

It should be noted that the ESPO Marine Affairs and Security Committee was never before involved neither in the PPRISM nor in the PORTOPIA projects, and therefore setting up an agreed list of indicators was even more challenging, since this exercise had not been carried out before, and the committee members had to face this experience for the first time.

### **3.2. Environmental indicators**

Environmental indicators were previously assessed in European ports through the development of the research project ‘Port Performance Indicators: Selection and Management’ (PPRISM, January 2010 – December 2011), co-funded by the EU. The research conducted within this project also combined a top-down and a bottom-up approach. The research identified indicators from literature review, such as publications, reports, and standards; and they were assessed through meetings with the Sustainable Development (SD) committee of the European Sea Ports Organisations (ESPO) in order to narrow down to a shorter set of indicators.

Initially, a wide-ranging list of EPIs currently in use or with potential for use within the sector was compiled. A total of 304 environmental indicators were 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). All the identified indicators were evaluated, screened and filtered following two particular approaches: The ‘theoretical’ assessment, in which indicators were evaluated following a set of specified criteria, and the ‘practical’ assessment in which indicators were evaluated by port professionals and port stakeholders. These reviews aimed to obtain a final set of effective environmental indicators that comply with the selection criteria and that satisfy the stakeholders’ requirements and expectations.

The final list of EPIs presented in this research is based on the results of the PPRISM project plus further research on port performance indicators and further discussions with the ESPO Sustainable Development (SD) committee.

The first ESPO SD committee meeting was held in Piraeus (Greece) in March 2014. The PORTOPIA research project was presented as the continuation of the PPRISM project on port performance indicators and in which ESPO participates as project partner. Members were informed that the environmental component of PORTOPIA will be populated through the transfer of relevant data from EcoPorts. This was done in order to maintain the successful EcoPorts website as the single window for the provision of environmental data and for avoiding any duplication in the submission of such data. With the PORTOPIA website, information on the performance of the European port sector will be monitored, analysed and reported on a regular basis. Members also were notified that individual port data will remain strictly confidential and only aggregated data will be reported. A proposal on the new indicators was presented to them. It included the indicators already developed and validated within PPRISM, which refer to environmental management, and operational performance indicators, plus three more categories: environmental condition indicators, top 10 environmental priorities and shipping aspects. They are presented and described in the following section of this paper.

In the second meeting with the SD committee, which was celebrated in Barcelona in October 2014, members were updated with the project status and new developments. The PORTOPIA Service Cloud, which already was in an advanced phase, was presented to them. Two main issues concerning the environmental indicators were discussed. The first one was to provide three indicators, namely Carbon Footprint, waste management and water consumption, in a quantitative way; in other words, by providing data. Members argued that as an initial level, it was not feasible to use quantitative indicators, since it is difficult that ports provide this data in a first stage. Secondly, it was asked to the participants whether they agree that the reporting of the performance is done in an aggregated way, at national, regional and EU level. It was accepted by a large majority of the participants.

#### **4. Results**

This section presents the results of the final selection of indicators.

##### **4.1 OHSS Indicators**

With regards to OHSS indicators, a consensus between the results obtained by the two approaches was reached in order to provide ports with the most adequate and implementable indicators.

This consensus list is relatively short when compared to the number of preliminary indicators proposed. One of the criteria in selecting the indicators was to avoid proposing indicators that have a high complex calculation, either because the formulae encloses a considerable number of parameters or because it has not a clear definition. Another criteria was to avoid that port authorities have to make a high effort in gathering the information necessary to calculate the indicator. Therefore, it resulted in the implementation of only 6 indicators for Occupational Health, Safety and Security, which are considered adequate and implementable. These indicators are presented and defined in the following table:

*Table 5: List of resulting OHSS indicators*

<b>Category</b>	<b>Indicator</b>	<b>Definition</b>
Occupational Health	Days Lost	The days lost corresponds to the number of full calendar days' where the victim is unfit for work due to an accident at work. The indicator is normalized by dividing it by the Full Time Equivalent value.
	Fatal work accidents	This indicator assesses the number of fatalities due to occupational accidents over a period of time. The indicator is normalized by dividing it by the Full Time Equivalent value.
	Work related accidents	It assesses the number of work related accidents over a period of time. The indicator is normalized by dividing it by the Full Time Equivalent value.
Safety	Nautical accidents	This indicator assesses the number of nautical accidents in port areas over a period of time. The indicator is normalized by dividing it by the number of port calls.
Security	Port security incidents	This indicator assesses the number of Port Security Incidents over a period of time.
	Investment in protection	This indicator evaluates the percentage of investment in protection divided by the overall investment of the port over a period of time.

It should highlighted that all the above indicators are in the top list within the bottom-up approach. By proposing indicators that have already a high level of acceptance between a set of ports, it increases the probability of acceptance by others.

## 4.2 Environmental indicators

In the framework of the PPRISM Project a set of EPIs were selected, taking into consideration specific criteria and feedback from port stakeholders. These indicators consisted of 9 specific components of environmental management and 3 indicators of operational performance, namely Carbon Footprint, waste management, and water consumption. These indicators were considered to be feasible and acceptable by a wide range of participant ports and other related marine professionals. Actually, many port professionals are actively and currently using these proposed EPIs.

After discussing with port professionals, the set of Environmental Performance Indicators to be included in the PORTOPIA Service Cloud was enlarged, covering in this case, 10 specific components of environmental management, 11 indicators on environmental monitoring, the Top 10 environmental priorities, and 3 indicators on green shipping. All they are qualitative indicators, which are presented in a Yes / No response format. These indicators are presented in Table 6 below.

*Table 6: List of resulting Environmental Performance Indicators*

Category	Indicator	Description
Environmental management indicators	Existence of an Environmental Management System (EMS)	These indicators are seen as measures of a Port Authority's capability to deliver environmental protection and sustainability, and as an effective way in which to demonstrate credentials, competences and programmes to manage a wide range of issues.  This section is composed of 10 indicators, all related to terminology recognised in international environmental standards. All they are qualitative indicators (presented in a Yes / No response format). With the information provided by these indicators, an overall synthesis of the environmental management benchmark performance can be obtained.
	Existence of an Environmental Policy	
	Environmental Policy makes reference to ESPO's guideline documents	
	Inventory of relevant environmental legislation	
	Inventory of Significant Environmental Aspects for the port area	
	Definition of objectives and targets for environmental improvement	
	Environmental training program for port employees	
	Existence of an environmental monitoring program	
	Environmental responsibilities of key personnel documented	
	Publication of a publicly available environmental report	
Environmental monitoring indicators	Air quality	They provide information on the current condition of the environment. It may help port managers to better
	Water quality	
	Soil quality	

	Sediment quality	recognise the potential impacts of the Port Authority's activities, products or services that may interact with the environment.
	Terrestrial habitats	
	Marine ecosystems	
	Noise	
	Energy consumption	
	Water consumption	
	Carbon Footprint	
	Waste	
Top 10 Environmental priorities		Ports are required to rank, from an extensive list of 35 port environmental issues, the top 10 issues that the port consider that are its main priorities, where 1 is the most important.
Shipping aspects	On-shore power supply (OPS)	OPS is the provision of shore side electrical power to a ship while it is at berth, so that its main and auxiliary engines are turned off
	Differentiated Fees for Clean Shipping	They consist of financial incentives to encourage shipping companies to reduce their environmental impacts. Port authorities offer reduced fees if the vessel has a good and proved environmental performance.
	Liquefied Natural Gas (LNG) bunkering	Provision of LNG bunkering facilities

## 5. Stakeholders' feedback to the suggested KPI's

A fundamental aspect for the acceptance of the proposed indicators is the validation process. This process is being made directly with the different committees, through meetings or workshops, where the proposed indicators are presented and discussed. In this chapter it is presented a brief overview of the different activities being made towards this critical objective.

### 5.1 First Marine Affairs and Security committee (MA&S) workshop in April 2014

The MA&S committee was one of the few committees of ESPO that did not have an active involvement in PPRISM as the safety and security component was missing from PPRISM. This gap is now addressed by work package 3 of PORTOPIA that is all embracing port performance in the fields of environment, health, safety and security. The feedback and contribution of the MA&S committee was then enquired for validating the performance indicators that have being developed on safety and security and for defining the best way forward.

It became apparent from the discussions that the initial aim of concluding on a core set of indicators on safety and security during the meeting was not possible. The set of indicators that was used as a basis was not considered helpful and at the same time there was not much willingness and time for the members to get pro-actively involved in this discussion. Some members expressed however their belief that it is beneficial for the sector to monitor some core indicators on safety and security. It was argued that this would add credibility to the sector and there are such successful examples at national level (e.g. monitoring of nautical accidents in the UK).

The outcome of the MA&S meeting was discussed in a PORTOPIA project consortium meeting on 14 May just before the ESPO annual conference in Gothenburg. In line with the commitments by the consortium and ESPO, it was then agreed to work with a core team of ports that already have experience in monitoring and reporting on safety and security indicators. The idea is to build on the already existing experiences and on that basis to come back with a more concrete proposal to the MA&S committee at a later stage.

### **5.2 Second MA&S committee workshop in March 2015**

The workshop on safety and security performance indicators was driven by ESPO's commitments in the PORTOPIA project and aimed at reaching an agreement on some key meaningful figures that ports could consider monitoring and reporting. The presented experiences of the ports of Rotterdam and London in this field raised a lively and constructive debate. Overall, members agreed that the monitoring of trends over time regarding nautical accidents in port waters would be a useful way forward with added value for both the sector and individual ports. The secretariat will now be investigating the appropriate implementation of such an indicator on nautical accidents.

### **5.3 Meeting in London May 2015**

This meeting occurred between UK ports and the port of Rotterdam. An agreement was reached on a checklist for nautical accidents data to be proposed for implementation by PORTOPIA.

Obviously this is a long process but these first approaches clearly states that these committees are more than willingly improve the current states through the acceptance of implementation of some of the proposed indicators.

## **Conclusions**

The paper has demonstrated that the issues of Occupational Health, Safety, Security and Environment are crucial elements that have to be rigorously considered within port areas. These issues are important not only to comply with legislation, but also to diminish operational costs, guarantee environmental protection, ensure healthy working conditions reduce the occurrence of accidents, among others.

The advantages of using indicators have been presented along this paper. Indicators are very useful elements that assess the performance and track trends over time on these issues. The implementation of indicators in ports has the potential to improve current methodologies to collect and publish data about workplace fatalities, injuries and diseases.

The culture and practice of identifying, monitoring and reporting performance indicators is reasonably widely established within ports, with many examples of existing good practice having been demonstrated for several years. Ports are actually highly encouraged to use indicators for monitoring their performance. Nevertheless, since it does not exist any protocol or standardisation on the OHSS and environmental indicators that ports should implement; guidance on which indicator use is needed.

This paper presents a set of acceptable and feasible indicators to use in ports. In order to obtain this list, an extensive research has been conducted, followed by an assessment and a validation process, with the interaction of several port stakeholders and players. The top-down approach provided an initial set of OHSS indicators, and the feedback obtained in the several ESPO Committee meetings was helpful to have a preliminary idea of the stakeholders' requirements. The bottom-up approach demonstrated which indicators are currently used by ports. The OHSS indicators proposed for implementation were based in this latest assessment. It is also important to mention that

the research proved that a large percentage of ports do not provide any information or data on OHSS in their annual or sustainability reports.

Feedback from stakeholders on environmental indicators also was supportive to include more indicators apart from the already identified and validated within PPRISM. The paper presents the new categories of port environmental indicators that have been established. In order to involve as many ports as possible, the indicators should be presented in a user-friendly way. As mentioned before, data on EPIs is collected in a continuous way through the completion of the Self Diagnosis Method (SDM) questionnaire at the ECOPORTS website and then transferred to the Cloud Service. All these indicators are included in a qualitative manner (Yes/No answer).

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