PIXEL - Port IoT for Environmental Leverage

Webinar 4 : The Port Environmental index

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Previous webinars

Description: The Webinar is a general presentation of the PIXEL project: (i) What is the need, (ii) Who are the partners, (iii) How we plan to address the need, (iv) Description of the solution, and (v) What is the impact we plan to have.
Goal: We want to inform the industry about our new product, whereas at the same time get some feedback from the port needs

Description: The Webinar will be a presentation of the science behind the PIXEL project: (i) Use Cases and User Stories, (ii) Models, (iii) Algorithms, (iv) Port Activities Scenario
Goal: Scientific dissemination and review of PIXEL technologies

Description: Now that you know everything about the purpose of PIXEL and its different use cases, Models and Scientifics Algorithms from previous webinars, we will present you the engine that allow all of this to work: The PIXEL Platform. We will present the key technical difficulties addressed to implement a replicable, sustainable and scalable platform and the solutions we have developed.
Goal: We want to understand the technologies implemented to run the PIXEL Platform and why they have been chosen

Content

1. The basic - What is the PEI?
2. Significant environmental aspects (SAE)
3. Environmental key performance indicators (eKPIs)
4. Overview
5. PEI – Ports' interest in monitoring eKPIs?
6. PIXEL Pilot ports
7. What are the main obstacles?
8. Current status of environmental performance monitoring
9. PEI visualization
10. Conclusion

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The basic- What is the PEI?

- The PEI is made as a quantitative composite index based on aggregations of individual indicators for significant aspects of port operations

- These single indicators are called **environmental Key Performance Indicators** (eKPIs) and they present a way to form the foundation for the future improvement of the ports

- eKPIs are identified using significant environmental aspects (SEAs)

- SEAs – the aspects that have significant impact on the environment

The basic- What is the PEI?

Statistical toolbox

• Normalization

• Weighting

• Aggregation

Technical toolbox

Data retrieval

The basic- What is the PEI?

The PEI calculation includes:

- Port authorities – The Port Authority Environmental Index (PAEI)
- Terminal operators – The Terminal Environmental Index (TEI)
- Ships – The Ship Environmental Index (SEI)
- All

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Significant environemntal aspects

The procedure is composed of several stages:

1. Identification of port operations and activities
2. Assessment of the severity and probability of a negative impact on the environment
3. Verification of legal requirements
4. Identification of the environmental aspects by which each port process and activity is affected
5. A description of how a particular process or activity is interacting with the environmental aspect
6. A description of the environmental impact of a particular process or activity
7. Evaluation of their level of significance
8. Ranking the overall assessment of significant environmental impacts

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Significant environemntal aspects (SAE)

The significant environemntal aspects are the following:

- Emissions to the atmosphere
- Wastewater emissions
- Waste production
- Noise pollution
- Light pollution
- Odour

Environmental key performance indicators (eKPIs)

There are a multitude of environmental indicators or parameters whom variations can be related to the impacts of port activities.
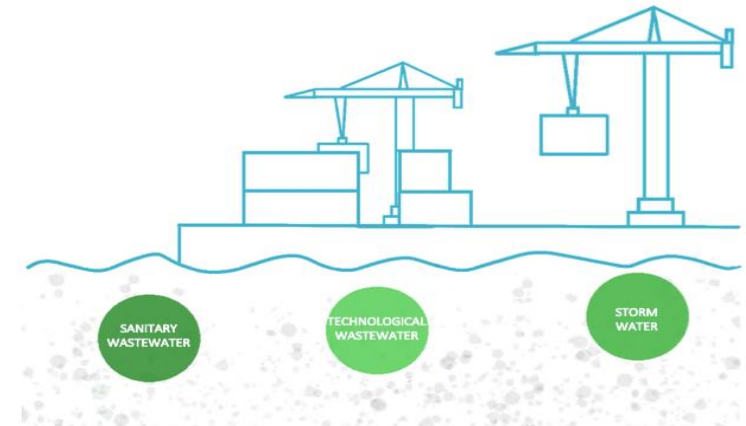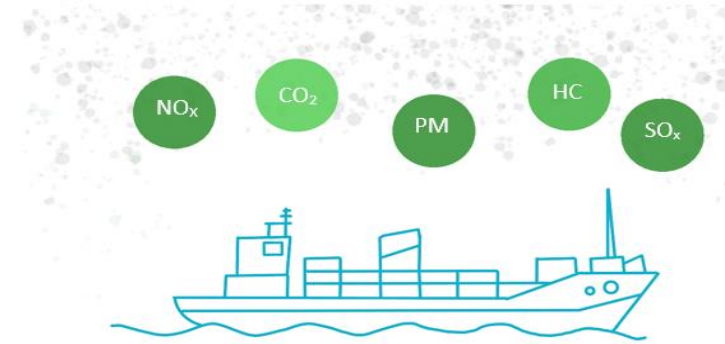
In the PIXEL Project, Environmental Key Performance Indicators (eKPI), have to be:

- **significant**: according to the stakes defined by the impacts that they represent;
- **representative** : differentiate the effects of port activities from any other "outside" effect;
- **measured in real time**, and treated thanks to IoT systems or to use data produced by the ports if they are already existing;
- **quantitative**;
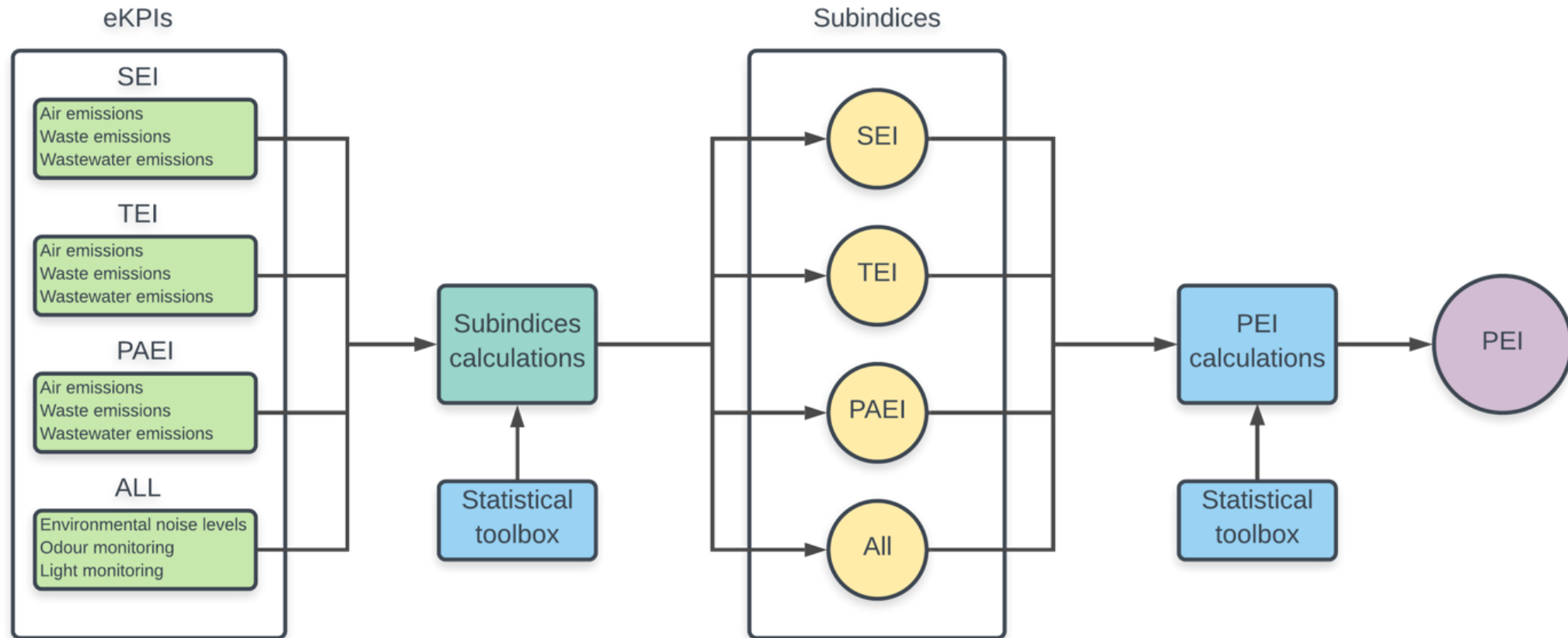- **useful** in PIXEL uses cases application

Environmental key performance indicators (eKPIs)

Different eKPIs represent different environmental aspects and subindices

- Example 1 – eKPIs representing air pollution caused by ships:
  - CO_2, NOx, PM10, PM2.5, SO_2, HC, CO, N2O, CH4

- Example 2 – eKPIs representing waste production of port authorities and terminals:
  - Municipal solid waste, inert waste and hazardous waste

- Example 3 – eKPIs represen port
  - LDEN, Lnight

The Port Environmental Index – Overview

PILOT PORTS

Port of Piraeus

- Tourism-oriented port (cruise ships)
- Interested in noise and air pollution
- Significant port-city interaction
- Vessel planning impact on the pollution

Port of Thessaloniki

- Interested in the impact of cargo handling operations and trucks
- Important aspects: noise and air pollution
- Significant port-city interaction
- Impact of bad weather on air pollution

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PILOT PORTS

Port of Bordeaux

- Energy consumption as the main priority

- Data analyisis and collection

- Use of the solar panels for electricity production, impact of green technologies

Port of Monfalcone

- Interested in the prediction of traffic congestion and parking occupancy

- Main points of interest:
  - Automatic booking system
  - dangerous transport alert

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PEI – Ports' interest in monitoring eKPIs?

eKPIs chosen for the PIXEL Project are directly linked to the emissions or impacts of port's activities. Their quantitative values are pertinent to use in environmental management.

Monitoring in real times eKPIs and calculation of PEI can assess port in:

1. Their **actual environmental management**

2. The **evolution of their environmental impacts**

3. Their choice of investment in "green projects" to reduce their environmental impact thanks to models : **a decision tool !**

4. To **communicate** on this environmental actions and their goals

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What are the main obstacles?

- The PEI should be available for all ports, regardless of the size and the level of technological advancement

- It should be flexible for external use, not only for the pilot ports

- Automatization of the measurements:
  - Sensors should be applied for the measurements of values related to the eKPIs
  - Is it possible to (re)evaluate significance based on those measurements?" (using an itterative process)
  - Would the PEI be equal for ports presenting data in an automatized way and those doing it manually?"

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Current status of environmental performance monitoring

Objectives:

- Identify the current situation in European ports regarding environmental performance monitoring & sharing of results

- Create a collection of applied metrics ⟶ Alignment of PEI to ports needs

⟶

- Availability of data ⟶ feasibility of PEI structure

- Problems in implementing an environmental monitoring system

- Sharing of results-communication

- Use of benchmarks

Content Analysis of the Environmental Analysis Reports of European ports
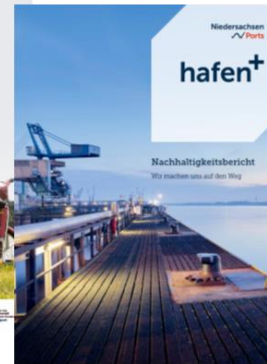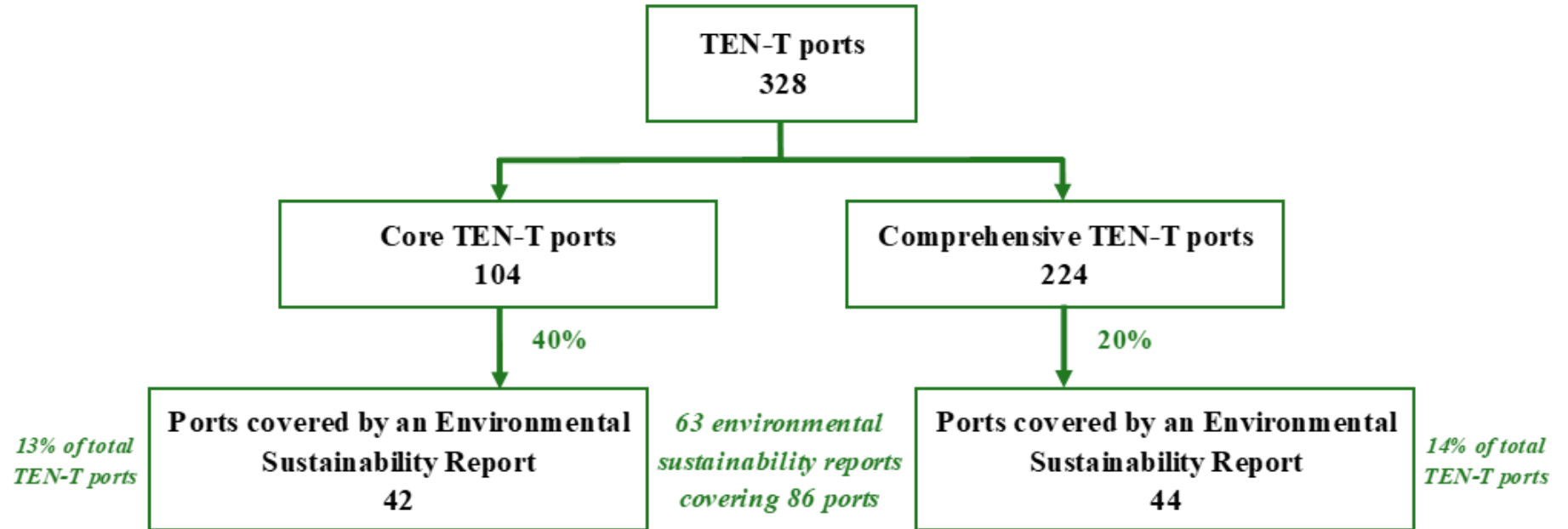
Questionnaire survey to TEN-T ports

Online interviews with ports representatives

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Current status of environmental performance monitoring

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Current status of environmental performance monitoring

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Country	Number of TEN-T ports	Number of reports	Number of ports covered	% of ports Covered
Belgium	4	1	1	25%
Croatia	7	1	1	14%
Denmark	22	5	5	23%
Estonia	8	1	1	13%
Finland	17	2	2	12%
France	27	2	3	11%
Germany	21	3	11	52%
Ireland	5	1	1	20%
Italy	39	2	2	5%
Latvia	3	1	1	33%
Lithuania	1	1	1	100%
Netherlands	13	4	4	31%
Poland	5	1	1	20%
Portugal	13	5	6	46%
Slovenia	1	1	1	100%
Spain	37	24	35	95%
Sweden	25	4	6	24%
United Kingdom	42	4	4	10%
		63	86	

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Current status of environmental performance monitoring

Content Analysis of the Environmental Analysis Reports of European ports

Questionnaire survey to TEN-T ports

Online interviews with ports representatives

Categories of metrics applied by European ports:

- <u>Environmental impact</u>

  - Air quality (concentrations & emissions)
  - Port waste/wastewater
  - Waste from ships
  - Dredging
  - Environmental incidents

- <u>Resource consumption</u>

  - Energy consumption
  - Water consumption
  - Materials consumption
  - Land use

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Current status of environmental performance monitoring

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5 most common metrics applied & published through SR:

- Annual total consumption of electricity by the PA (KWH, MWH, GJ, % of total energy)   68 ports (21.18%)

- Annual total fuel consumption by the PA (l, m3, t, MWH, KWH, GJ, % of total energy)   58 ports (18.7%)

- Annual total CO_2 or GHG emissions (tCO_2 or tCO_2 equivalent)   50 ports (15.58%)

- Annual total water consumption by the PA (m^3)   45 ports (14.02%)

- Annual total number of complaints related to noise produced by the port operations   37 ports (11.53%)

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The detailed indicators related to organic and inorganic gaseous pollutants other than CO₂/GHG are presented in Table 6.

Table 6: Indicators related to organic and inorganic gaseous pollutants other than CO2/GHG

	Number of ports publishing the indicator(s)	% of reporting ports	% of TEN-T ports
AIR QUALITY			
Nitrogen Oxides			
NO-related indicators:	2	2.33	0.62
Indicator:			
Annual/Campaign average concentration of NO (μg/m³)	2	2.33	0.62
NO₂-related indicators:	17	19.77	5.30
Indicators:			
Annual average concentration of NO₂ (μg/m³)	15	17.44	4.67
Annual total number of exceedances of the hourly limit value of NO₂	6	6.98	1.87
Real time, on-line publishing of NO₂ hourly average value (μg/m³)	1	1.16	0.31
NOₓ-related indicators:	2	2.33	0.62
Indicators:			
Annual average concentration of NOₓ (μg/m³)	2	2.33	0.62
Annual total number of exceedances of the daily limit value of NOₓ	1	1.16	0.31
Sulphur Oxides			
SO₂-related indicators:	15	17.44	4.67
Indicators:			
Annual and/or monthly average concentration of SO₂ (μg/m³)	11	12.79	3.43
Annual total number of exceedances of the daily limit value of SO₂ (125μg/m³)	6	6.98	1.87
Annual total number of exceedances the hourly limit value of SO₂ (350μg/m³)	5	5.81	1.56
Average winter concentration of SO₂ (μg/m³)	1	1.16	0.31
Maximum hourly value of SO₂ during campaign	1	1.16	0.31
Maximum daily value of SO₂ during campaign	1	1.16	0.31
Monthly average concentration of SO₂ on the quayside (μg/m³)	1	1.16	0.31
Carbon Monoxide (CO)			
Related indicators:	5	5.81	1.56
Annual/campaign average concentration of CO (mg/m³)	2	2.33	0.62

	Number of ports publishing the indicator(s)	% of reporting ports	% of TEN-T ports
Annual total number of exceedances of the maximum daily 8-hour mean limit value of CO (10mg/m³)	2	2.33	0.62
Annual maximum hourly value of CO (mg/m³)	1	1.16	0.31
Real time, on-line publishing of CO 8-hour average value (mg/m³)	1	1.16	0.31
Annual total number of exceedances of the maximum hourly limit value of CO (350μg/m³)	1	1.16	0.31
Ozone (O₃)			
Related indicators:	5	5.81	1.56
Annual/campaign average concentration of O₃ (μg/m³)	4	4.65	1.25
Annual total number of exceedances of the maximum daily 8-hour mean limit value of O₃ (120μg/m³)	3	3.49	0.93
Real time, on-line publishing of O₃ hourly average value (μg/m³)	1	1.16	0.31
Real time, on-line publishing of O₃ 8-hour average value (μg/m³)	1	1.16	0.31
Annual total number of exceedances of the maximum hourly limit value of O₃ (180μg/m³)	1	1.16	0.31
Non-Methane Volatile Organic Compounds			
Related indicators:	4	4.65	1.25
Annual average concentration of C₆H₆ (μg/m³)	3	3.49	0.93
C₆H₆ daily average concentration (μg/m³)	1	1.16	0.31
Annual average concentration of Toluene (μg/m³)	1	1.16	0.31
Annual average concentration of Xylene (μg/m³)	1	1.16	0.31
Other			
• Real time, on-line publishing of the 30-minute average Volatile Organic Compound (VOC) concentration (mg/m³)			
EMISSIONS TO THE ATMOSPHERE			
Nitrogen Oxides			
NO₂-related indicators:	1	1.16	0.31
Indicators:			
Annual total emission of NO₂ from shipping in the port area (t)	1	1.16	0.31
NOₓ-related indicators:	9	10.47	2.80
Indicators:			
Annual total emission of NOₓ (kg or t)	5	5.81	1.56
Annual total emission of NOₓ from vessels in the port area (t)	2	2.33	0.62
Annual average emission of NOₓ per throughput (kg/t of cargo)	1	1.16	0.31

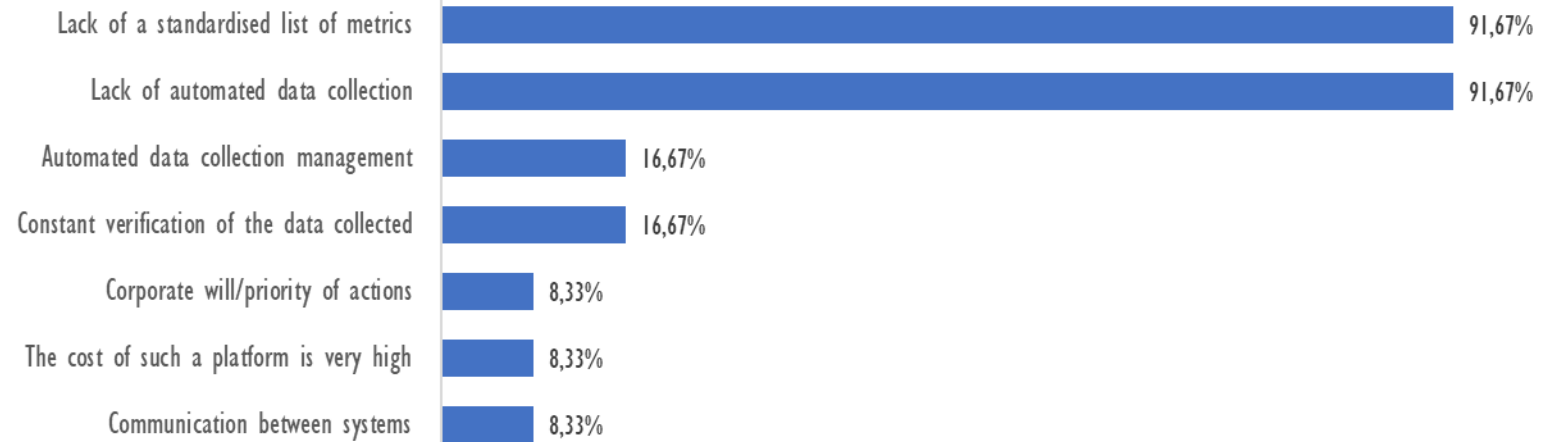# Current status of environmental performance monitoring

Content Analysis of the Environmental Analysis Reports of European ports

Questionnaire survey to TEN-T ports

Online interviews with ports representatives

Main problems

Problem	%
Lack of a standardised list of metrics	91,67%
Lack of automated data collection	91,67%
Automated data collection management	16,67%
Constant verification of the data collected	16,67%
Corporate will/priority of actions	8,33%
The cost of such a platform is very high	8,33%
Communication between systems	8,33%

% assessed as Significant/ Very significant

Problem	%
Lack of a standardised list of metrics	50,00%
Lack of automated data collection	66,67%
Automated data collection management	16,67%
Constant verification of the data collected	16,67%
Communication between systems	8,33%

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	Ad-hoc meetings	Permanent stakeholder committee	Press releases	Annual sustainability reports	A PGS TOS online	Other
Emissions to the atmosphere						
City / regional authority	41,67%	8,33%	16,67%	41,67%	16,67%	0,00%
Port users	16,67%	16,67%	25,00%	41,67%	25,00%	8,33%
Citizens / NGOs	33,33%	8,33%	25,00%	41,67%	8,33%	0,00%
Waste & wastewater						
City / regional authority	33,33%	8,33%	8,33%	33,33%	16,67%	0,00%
Port users	41,67%	8,33%	8,33%	25,00%	8,33%	0,00%
Citizens / NGOs	25,00%	0,00%	16,67%	25,00%	16,67%	0,00%
Noise						
City / regional authority	41,67%	8,33%	8,33%	33,33%	16,67%	0,00%
Port users	41,67%	0,00%	16,67%	25,00%	16,67%	0,00%
Citizens / NGOs	25,00%	0,00%	16,67%	33,33%	16,67%	0,00%
Port water & air quality						
City / regional authority	0,00%	0,00%	8,33%	8,33%	0,00%	8,33%
Port users	0,00%	0,00%	8,33%	8,33%	0,00%	0,00%
Citizens / NGOs	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%

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Benchmarks used (environmental impact area)

Emissions to the atmosphere	• Communication with other ports • Annual environmental diagnosis of the port system • Newsletters & magazines from other ports • Annual reports of other ports and companies in the port community
Waste production & wastewater discharge	• Private collectors of other ports/UPF (Union des Ports de France) • Other ports • Annual environmental diagnosis of the port system
Noise	• Annual environmental diagnosis of the port system • Newsletters & magazines from other ports
Dredging	• Other ports/UPF • Annual environmental diagnosis of the port system
Environmental incidents	• Other ports/UPF • Local stakeholders • Press and reports of other ports and companies in the port community

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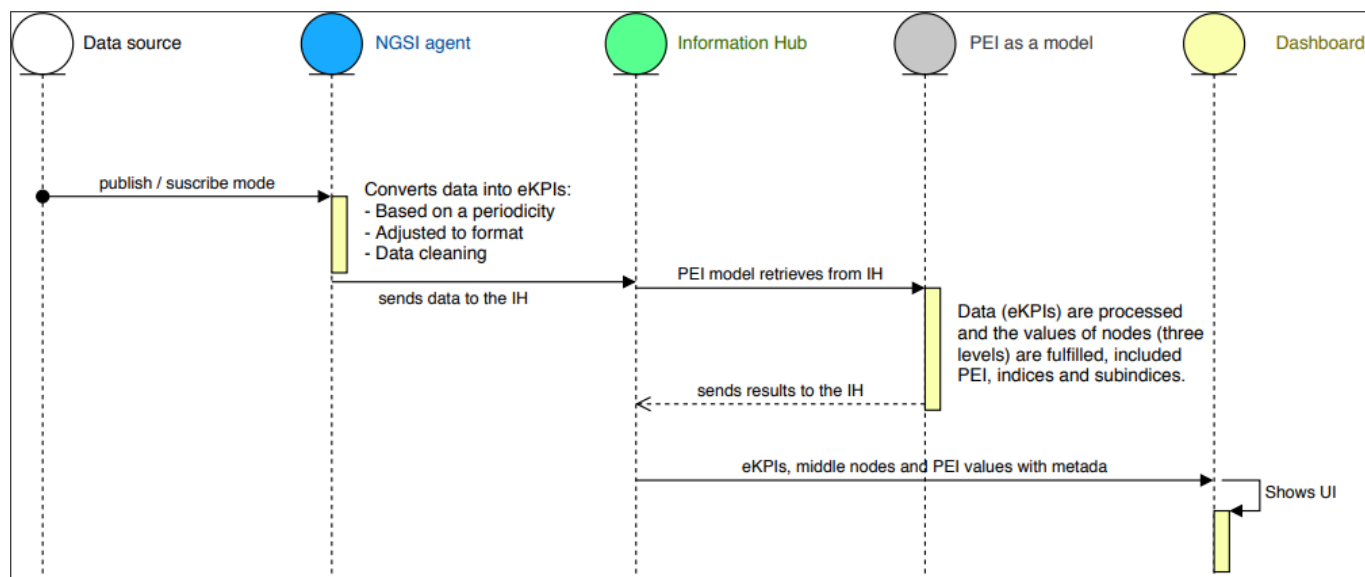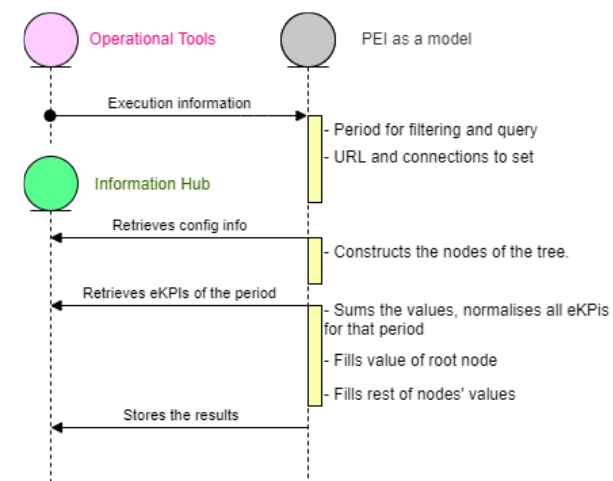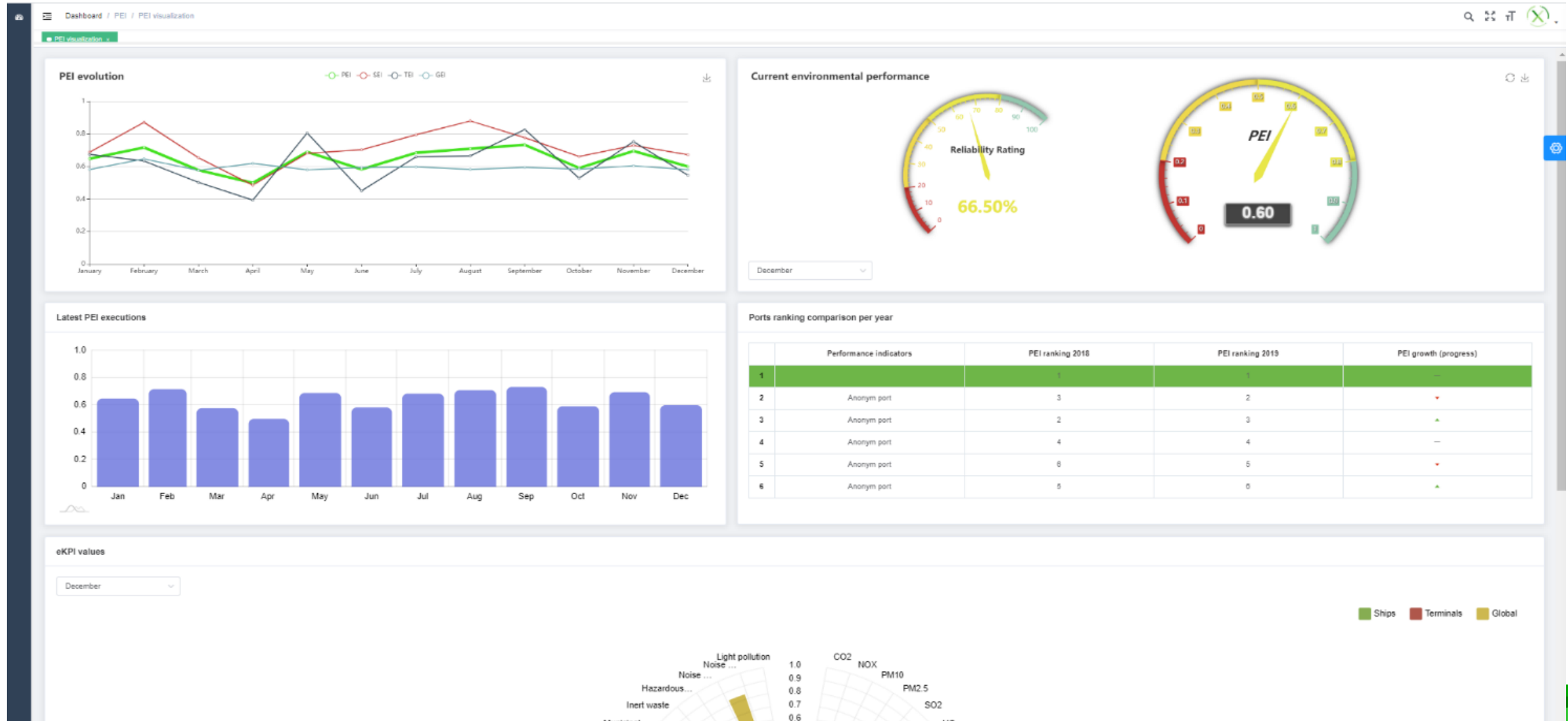# Data flow in the PEI – from the origin to your screen

1 – Read properties from the PEI instance.json file generated by the Docker image (via OTs) → 2 – Retrieve and validate the tree structure → 3 – Build tree structure → 4 – Retrieve all inherited eKPIs for the calculation period → 5 – Calculate global eKPIs for the corresponding period and normalize them → 6 – Run the PEI calculation drawing from the values of the global eKPIs for that → 7 – Build the output JSON with the results and the required global → 8 – Storage of the output in the Information Hub

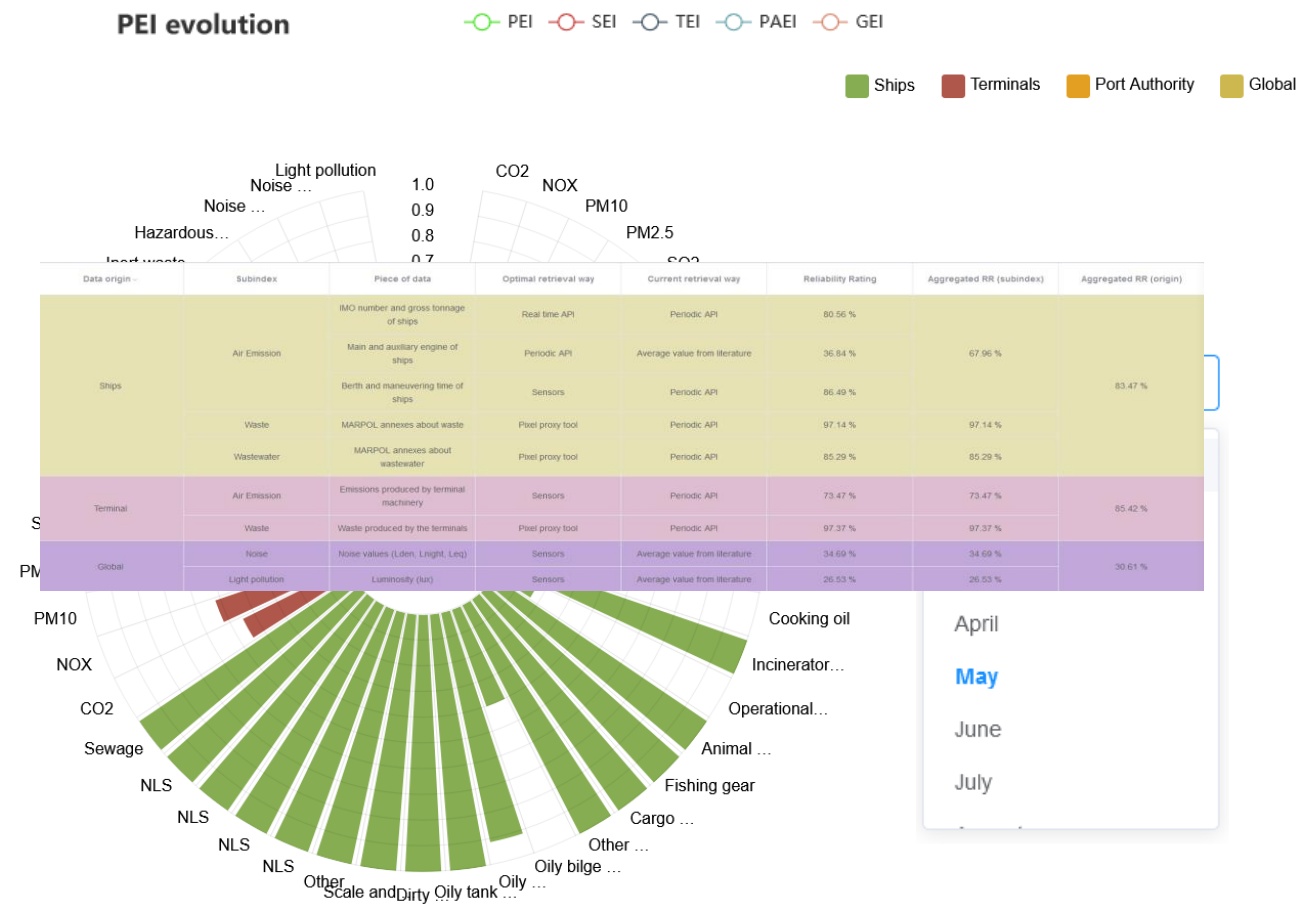Diagram of the data flow in PEI and relation with PIXEL modules

Flow of PEI calculation and actors involved

PEI Visualization – Overall aspect

Pieces of visual information – The art of interpretation

- Evolution in time of PEI and subindices
- Performance of last period (with associated

information for proper interpretation)

- Ranking between ports

- Specific (normalised) values of the eKPIs

of last period

- RR (how far from the ideal data gathering

technology are the eKPIs being fed from)

PEI – conclusions

- The PEI is a composite indicator created with the intention to measure the ports' performance and environmental issues and to track them during the years

- Environmental issues are to be tracked using eKPIs

- Real time eKPIs monitoring and the calculation of the PEI should also serve as a decision tool („should the port invest to reduce the negative impacts or not?")

- Ports and the PEI developers/managers should communicate with each other on the subject of environmental actions and related goals

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PIXEL Partners

Thank You + Questions?

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Webinar 4 : The Port Environmental index
1st of July, 2021

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