



# PIXEL as a finalised project

**PIXEL CLOSURE EVENT**  
**28 September 2021**

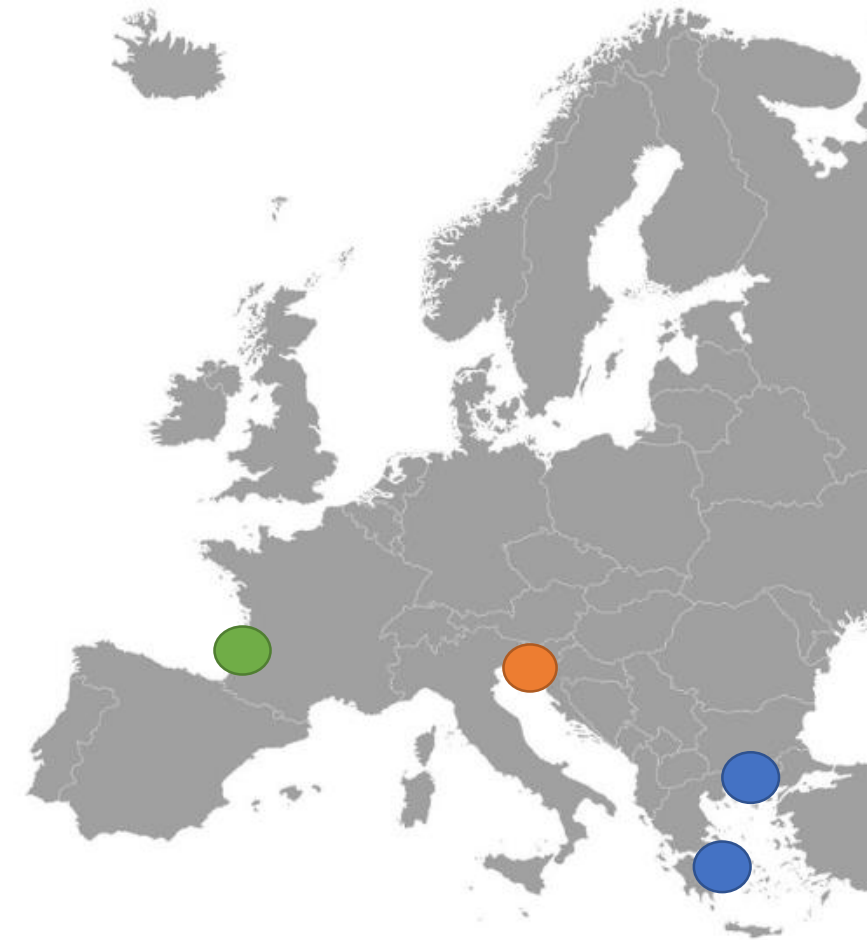
Carlos E. Palau  
Salvador

Professor

Universitat Politècnica de  
València



# Where the IoT meets the Port of the Future



*“Where the IoT meets the Port of the*

Prof. Carlos E. Palau, Universitat Politècnica de València

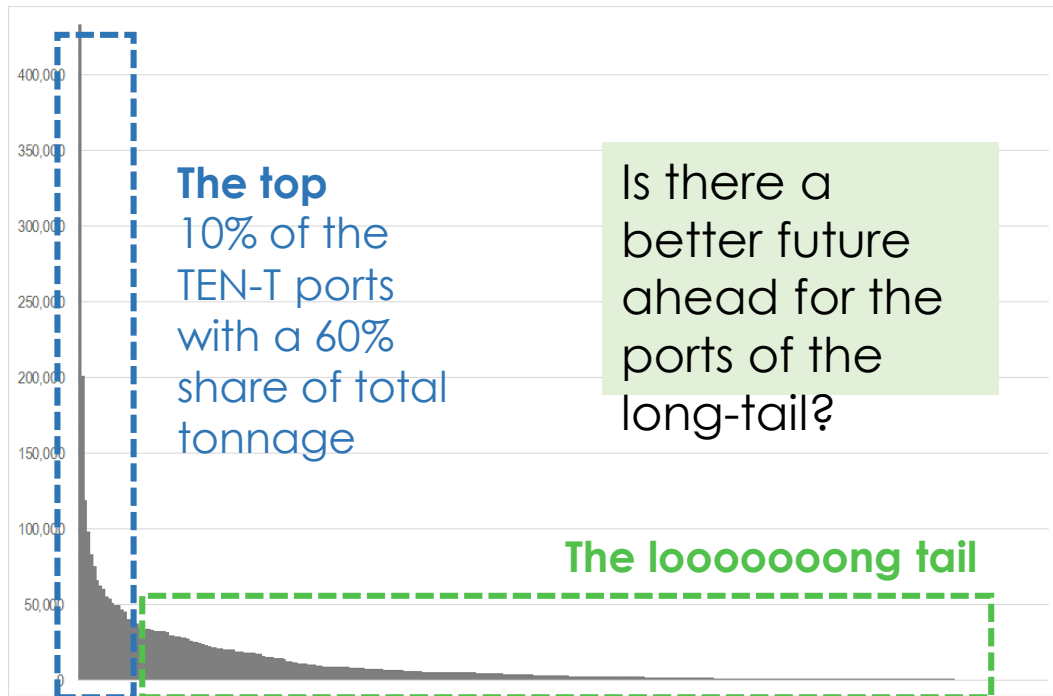
*Future”*



This Communication is part of a project that has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°769355



# Context and origin: Why PIXEL?



Gross weight of goods transported in European Ports in 2017  
(thousand tonnes - Source: Eurostat)

## The challenges faced by (especially) the long-tail ports:

- **Efficient data capture** to continuously drive decision making is still a challenge
- Heterogeneous operational **data integration** still leaves much to be desired
- **Expected environmental impact** of operational decisions remains unclear to a large extent
- Commonly agreed **standardised** practices for **assessing**, integrating and **reporting** the **environmental impact** of port operations are missing
- **Digitalisation** moving at a slow pace in most long-tail ports



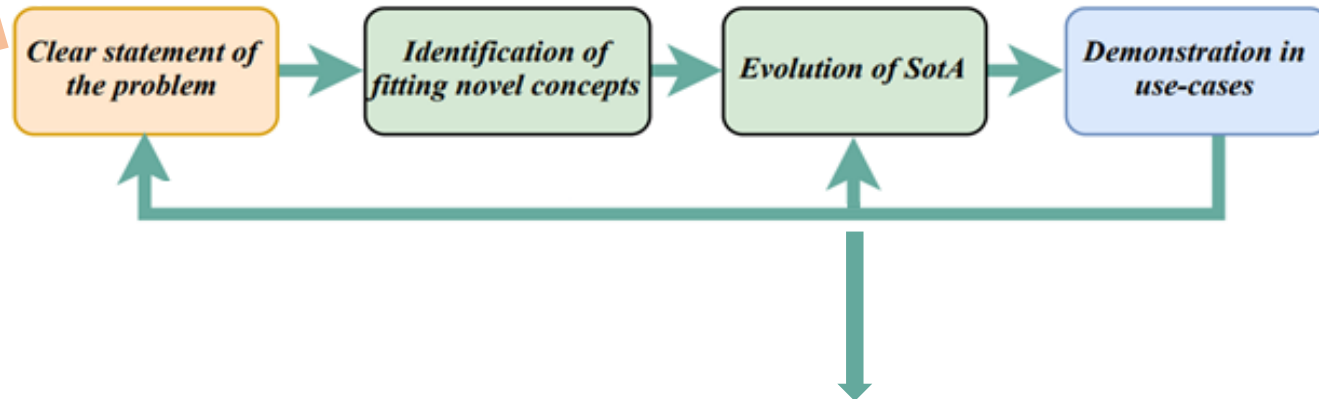
# The PIXEL approach



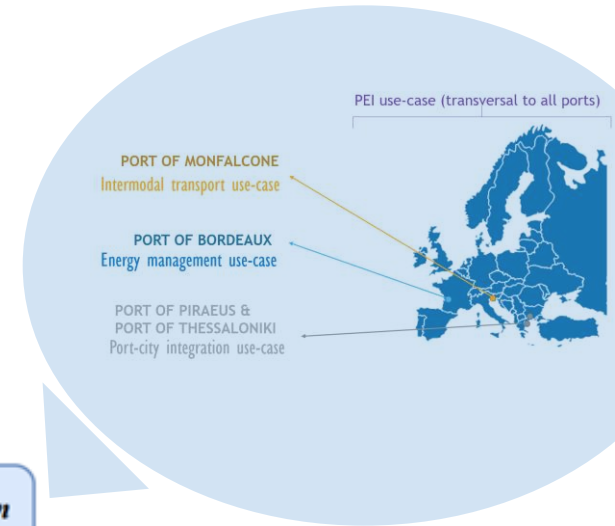
Digitalisation in ports far from optimal  
causing untracked environmental impact

- Ports' complexity and heterogeneity
- No clear open-source "reference" platform
- Expensive vendor lock-in situations
- Restrictive, old-fashioned regulations
- Heterogeneity on ports' ecosystem including many actors playing diverse roles with usually crossed objectives.

## “problem-driven” approach



PIXEL is the **first** smart, flexible and scalable solution for reducing environmental impacts while enabling the optimization of operations in port ecosystems through the Internet of Things (IoT)

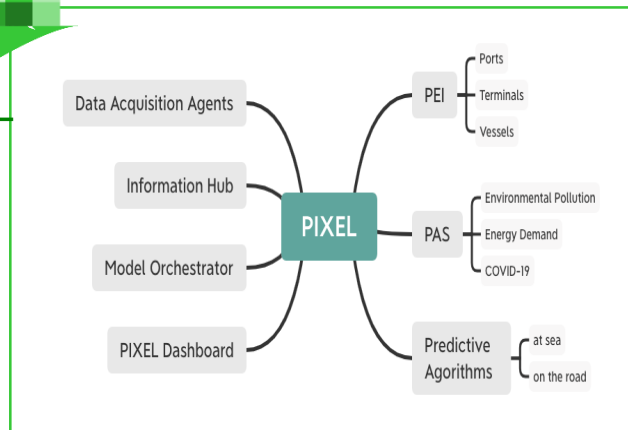
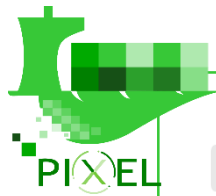


# PIXEL innovative proposal



Complex scenarios

Multiple tools/solutions required



Modular products in a single platform

Realistic innovations  
achieved



**Reduction** of environmental impact of port activities

**Reduction** of operational and infrastructural costs



**Improvement** of logistics efficiency in multimodal hubs



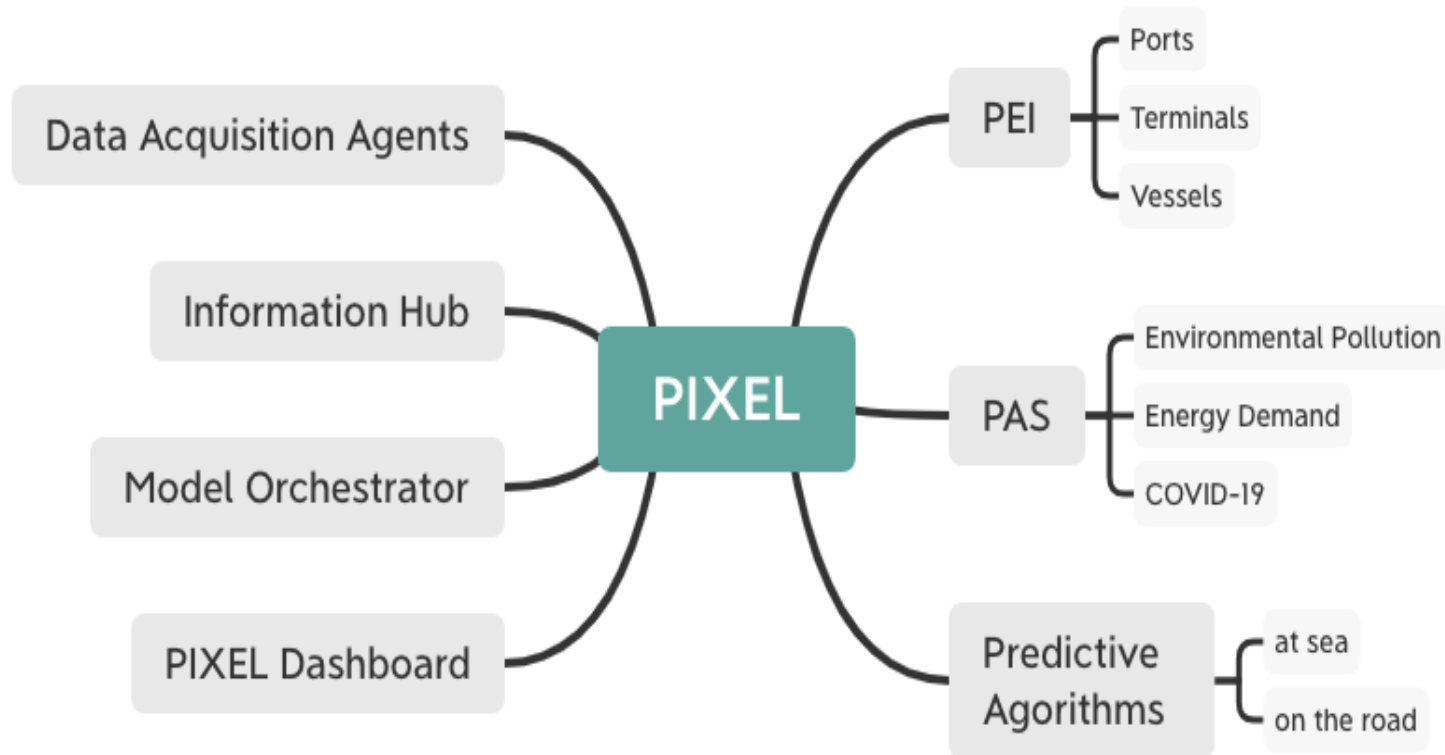
**Better Port-City integration**



**Less dependency** on different technology providers when attempting digitalisation



# PIXEL as a structured solution



## 4 Key Exploitable Results:

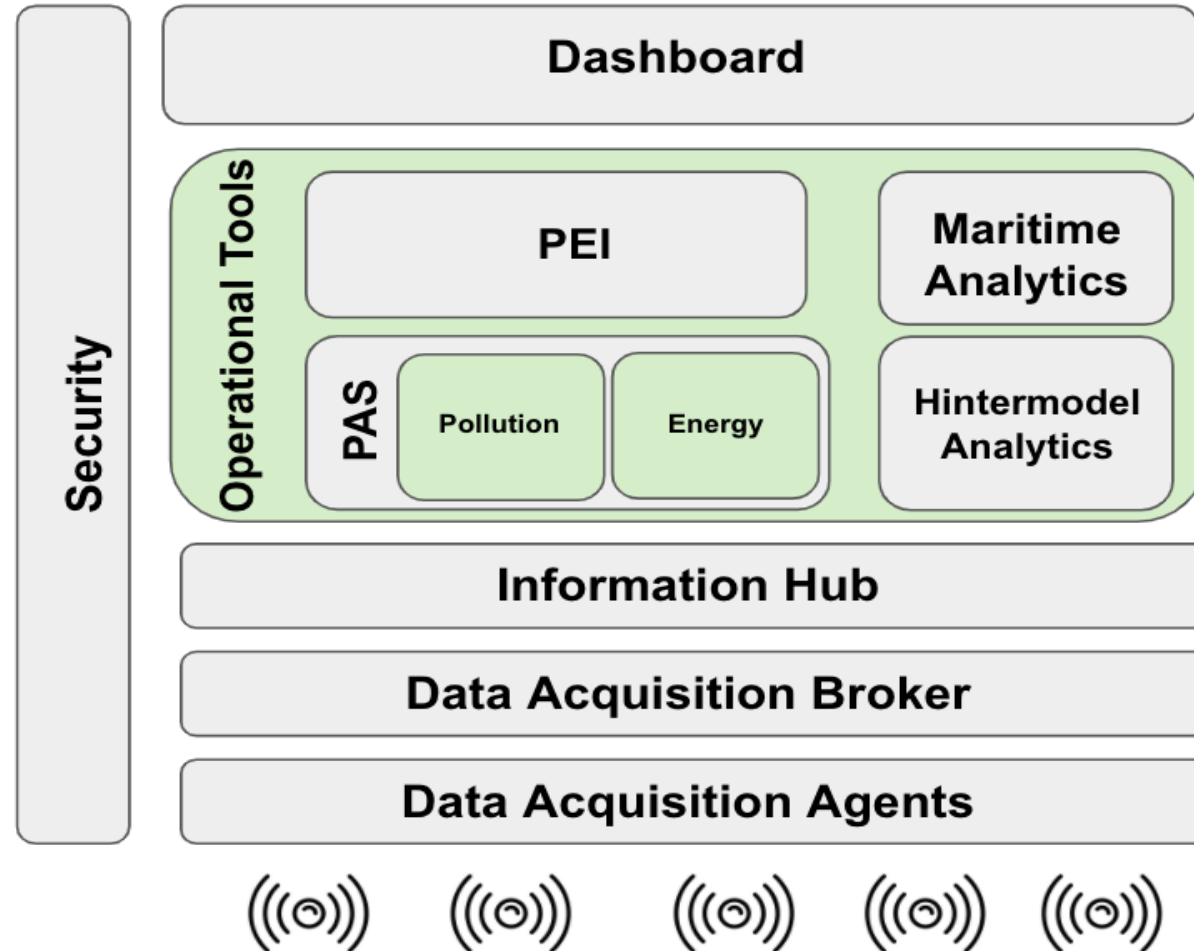
- **PEI** PORT ENVIRONMENTAL INDEX
- **MDA** MARITIME DATA ANALYTICS
- **BDE** BIG DATA ENGINE
- **PAS** PORT ACTIVITY SCENARIO



# PIXEL as a technical solution



Powered by  
 FIWARE



# PIXEL as a user-oriented product



First **IoT integrated platform** focused on optimization of operations w/ reduction of **environmental impact**



**Port Environmental Index (PEI)** as a quantitative composite indicator of the overall environmental performance of a port



**Secured dashboard** with **operational tools** for decision support (real time monitoring and predictive analysis)



**Information hub** and optimization operations through **smart models** (energy, transportation, pollution and port-city integration)

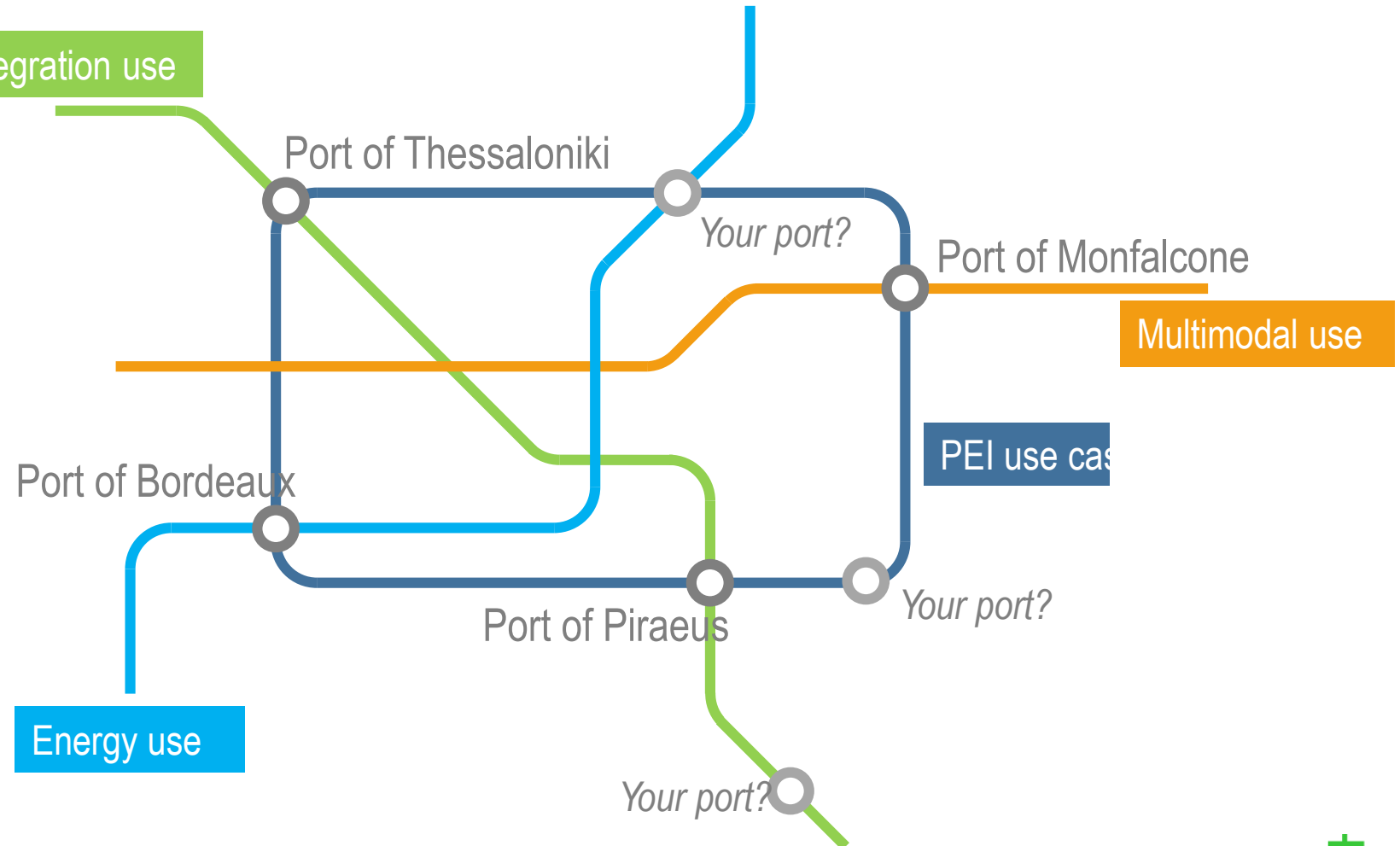




# Cases where PIXEL has been tested... and an open invitation

- **Four use cases** confronting varying environmental issues
- **Three small & medium** ports that have demonstrated the **validity** of the project results
- **One large port** to assure results' **scalability**

And an **open invitation** to any other port interested in using our project results & tools



# Who has made PIXEL become a reality?



UNIVERSITAT  
POLITÈCNICA  
DE VALÈNCIA



**pro<sup>2</sup>DEVELOP**  
Integrating technologies



**CATIE**  
Solutions pour la société numérique



insiel

**creocean**  
Environnement & océanographie

**MEDRI**

**Sdag**  
Autoporto di Gorizia



**CERTH**  
CENTRE FOR  
RESEARCH & TECHNOLOGY  
HELLAS

**PEOPLE**



THESSALONIKI  
PORT  
AUTHORITY S.A.



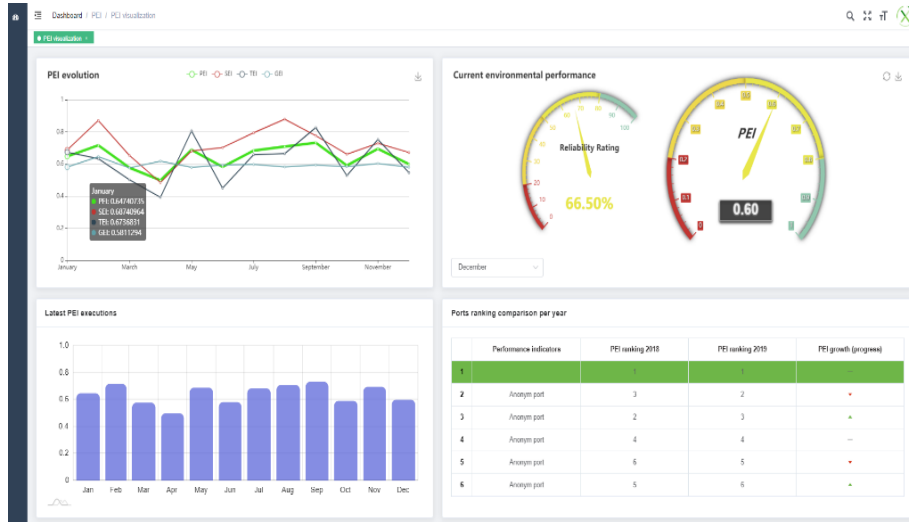
Port Network Authority  
of the Eastern Adriatic Sea  
Ports of Trieste and Monfalcone



# How PIXEL looks like – Specific data gathering



# How PIXEL looks like – Usage through a single window

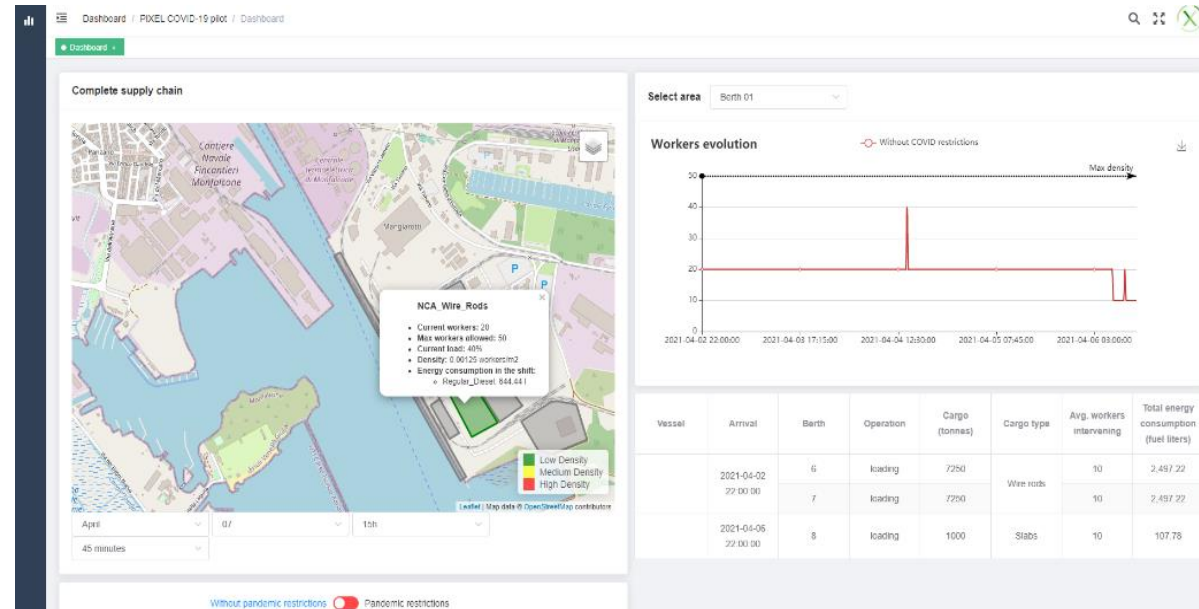


## Pixel Ports

Email

Password

Login





# How PIXEL looks like – Piloting in real ports



# PIXEL in facts and figures – Scientific Excellence



- 23 articles published, including 4 in Q1/Q2 relevant journals



## SMALL AND MEDIUM PORTS' ACTIVITIES MODELLING: INTRODUCTION TO THE PIXEL APPROACH

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### ABSTRACT

Port activities undoubtedly have an impact on their environment, the city and citizens living nearby. To have a better understanding of these impacts, the ports of the future will require tools allowing suitable modelling, simulation and data analysis. This challenge is also tied to another current reality: the heterogeneous data coming from different stakeholders converging into ports are not optimally exploited due to lack of interoperability. Thus, the forthcoming research and development initiatives must address these demands from a holistic point of view. PIXEL (H2020-funded project) aims at creating the first smart, flexible and scalable solution reducing the environmental impact while enabling optimization of operations in port ecosystems. PIXEL brings the most innovative IoT and ICT technology to ports and demonstrates their capacity to take advantage of modern approaches. Using an interoperable open IoT platform, data is acquired and integrated into an information hub comprised of small, low-level sensors up to virtual sensors able to extract relevant data from high level services. Finally, this hub inspires smart models to analyse port processes for prediction and optimization purposes: (i) a model of consumption and energy production of the port with the aim of moving towards green energy production; (ii) a model of congestion of multi-modal transport networks to reduce the impact of port traffic on the network; and (iii) models of environmental pollution of the port to reduce the environmental impacts of the port on the city and its citizens. The main issue tackled by PIXEL is to provide interoperability between these models and allow real integration and communication in the context of an environmental management model. Besides that, PIXEL denotes its developer port's use and its ability to deploy environmental impact mitigation specifying an innovative methodology and an integrated metric for the assessment of the overall environmental impact of ports.

**Keywords:** simulation, algorithms, environment, IoT, environmental impacts, interoperability, port activities, port of the future

### 1. INTRODUCTION

#### 1.1 Small and medium ports context

Ports are essential nodes in the multi-modal supply chain. Several stakeholders interoperate within the same port area assuming different roles with various constraints and requirements. Therefore, ports are complex ecosystems with a multitude of actors (port authority, terminal operators, carriers, citizens, legislators) producing and consuming each day huge quantities of information. Operational data in ports are continuously increasing and depend on different stakeholders. Among these data sources we can mention the following ones: resources tracking, container status, vessel operations, crane scheduling, surface or berths available, air/water quality measurements, or energy consumption and production. In most cases, an optimal exploitation of all the knowledge is still to be understood. This is due to three main circumstances: (i) the information exchange still remains managed in a document-centric fashion, both for reporting to regulatory bodies and to perform the day-to-day services; (ii) if digital information applications exist they are isolated and oriented just for very specific purposes; and (iii) personnel at the ports do not have enough knowledge and awareness of

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www.ieee.org, 2020-12-01 12:00 (UTC+01:00)  
doi:10.2464/BigData/19141



## Framework and Methodology for Establishing Port-City Policies Based on Real-Time Composite Indicators and IoT: A Practical Use-Case

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**Abstract:** During the past few decades, the combination of flourishing maritime commerce and urban population increases has made port-cities face several challenges. Smart Port-Cities of the future will take advantage of the newest IoT technologies to tackle these challenges in a joint fashion from both the city and port side. A specific matter of interest in this paper is how to obtain reliable, measurable indicators to establish port-city policies for mutual benefit. This paper proposes an IoT-based software framework, accompanied with a methodology for defining, calculating, and predicting composite indicators that represent real-world phenomena in the context of a Smart Port-City. This paper envisions, develops, and deploys the framework on a real use-case as a practice experiment. The experiment consists of deploying a composite index for monitoring traffic congestion at the port-city interface in Thessaloniki (Greece). Results were aligned with the expectations, validated through nine scenarios, concluding with delivery of a useful tool for interested actors at Smart Port-Cities to work over and build policies upon.

**Keywords:** Smart Port-Cities; composite indicator; real-time; Internet of Things; traffic congestion; framework and methodology

### 1. Introduction

Traditionally, port and cities have been working as independent silos, striving separately to reach innovation goals towards better sustainability and economic growth. During the past few decades, the increasing port of urban population growth [1] and expansion of maritime commerce [2] have brought forth environmental and societal challenges which affect both sides. In light of new wave technologies that are already having an impact on port cities, the moment to tackle joint challenges making use of the most advanced innovations towards the future Smart-Cities is now [3]. Looking only at the big numbers, there are 33 megacities in the world (both more than 10 million inhabitants) [4]; 25 of them are port-cities, accumulating more than 25% of global container trade volume [5]. Naturally, then, useful solutions addressing Smart Port-City challenges will be a key game changer from both business and societal perspective in the forthcoming years. This is the context in which this work is framed.

A Smart Port-City is, by definition, the combination of a Smart City with a Smart Port. The notion dates back to the SmartPort initiative proposed by Hamburg in 2012 [6]. However, the concept goes far beyond that. A Smart Port-City entails the integration of information from the two domains in a transparent manner and the realization that port-city actions must be envisaged as a holistic entity taking advantage of the use of massive data [7]. One of the main challenges of Smart Port-Cities is the establishment of effective policies between the Port Authorities (and relevant agents) and the

Sensors 2020, 20, 4135; doi:10.3390/s201914135

www.mdpi.com/journal/sensors



- Commitment with Open Source
- Contributions to open source initiatives (e.g, FIWARE)
- Code available in GitHub (12+ repos)

- Presentation in 15+ conferences in the IoT and environmental sector

Prof. Carlos E. Palau, Universitat Politècnica de València





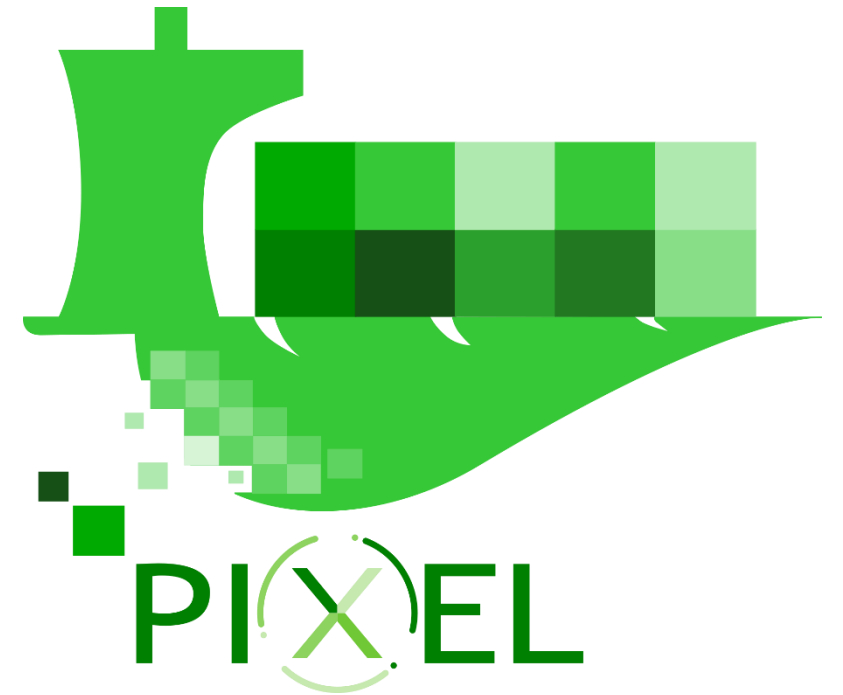
# PIXEL in facts and figures – Industrial and Community presence



- 46 events where PIXEL has been pitched/presented
- Becoming a member of ALICE-ETP
- Becoming a member of AIVP
- Successful collaboration with ESPO, WPSP, PortCDM and other relevant entities of the sector
- Great collaboration with the 3 sister projects:
  - COREALIS
  - PortForward
  - DockstheFuture



# Thank You + Questions?



## PIXEL CLOSURE EVENT



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