Leveraging IoT and prediction techniques to monitor COVID-19 restrictions in port terminals

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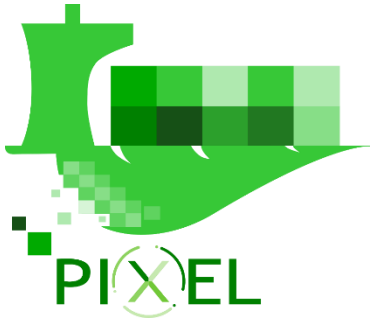

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Introduction

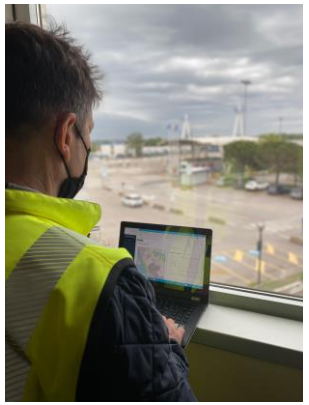
- Ports are essential nodes in the multi-modal supply chain
- COVID-19 restrictions on ports ⇨ limit the density of workers in specific areas to a certain threshold

- Internet of Things promises to be the solution for most monitoring requirements in maritime port services sector:
  - Provides minimization and affordability of the technology
  - Increments the volume of information available

- **Main objective:** propose a monitoring tool running over an IoT-based architecture for helping maritime ports address density of workers restriction in terminal areas.

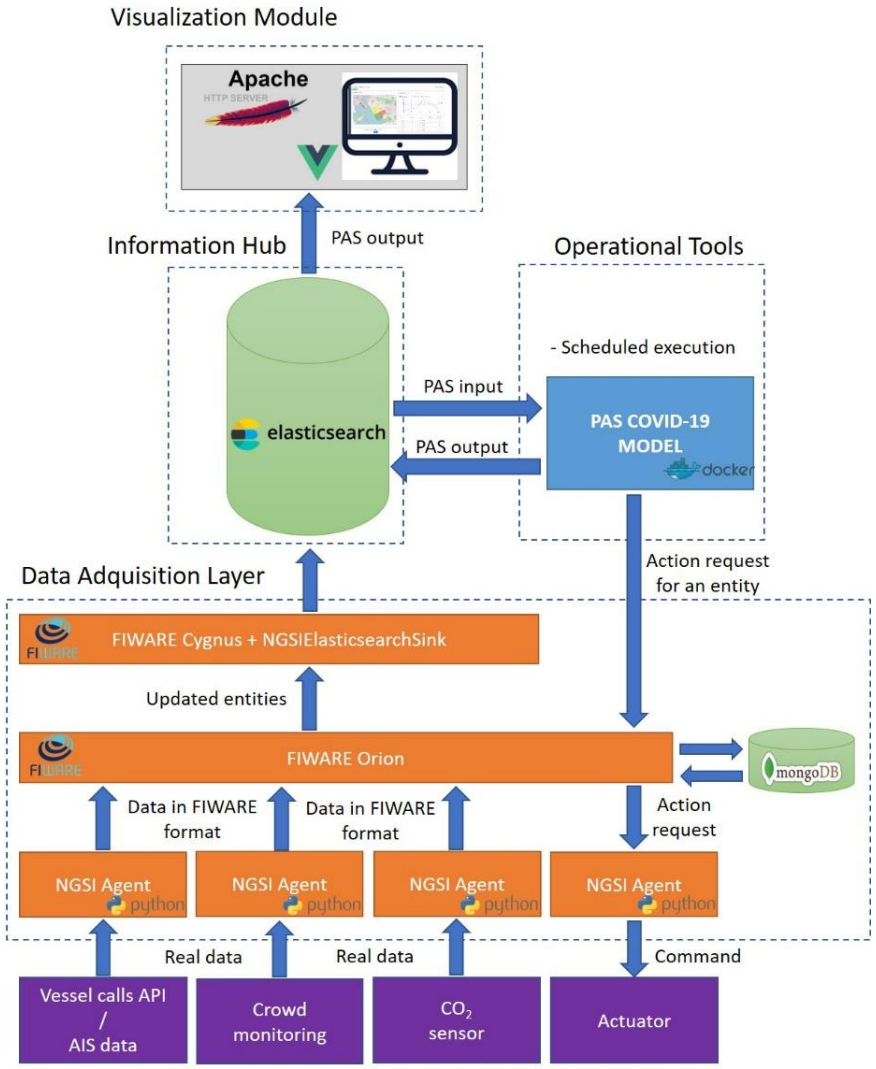
PIXEL

How this paper has advanced the state of the art



- Tackling the concept of "National Single Windows" (NSW) building on a robust existing IoT solution (PIXEL)
- Implementing the principles of flexibility, scalability, and adaptability to diverse IoT scenarios
- Innovative, timely, early adoption of the PIXEL infrastructure while the project is still alive.
- First tool a port manager to know in advance how many workers are expected to occupy one area of the terminal during a particular work shift based on a terminal-operations simulator upon defined supply chains.
- There has not been discovered a prognosis tool based on the logistics activity schedule to forecast a situation surpassing density of population threshold.
- Additionally, previous proposals cannot guarantee a non-invasive, plug-and-play deployment

Proposed architecture



Powered by FIWARE

orion

Vue.js

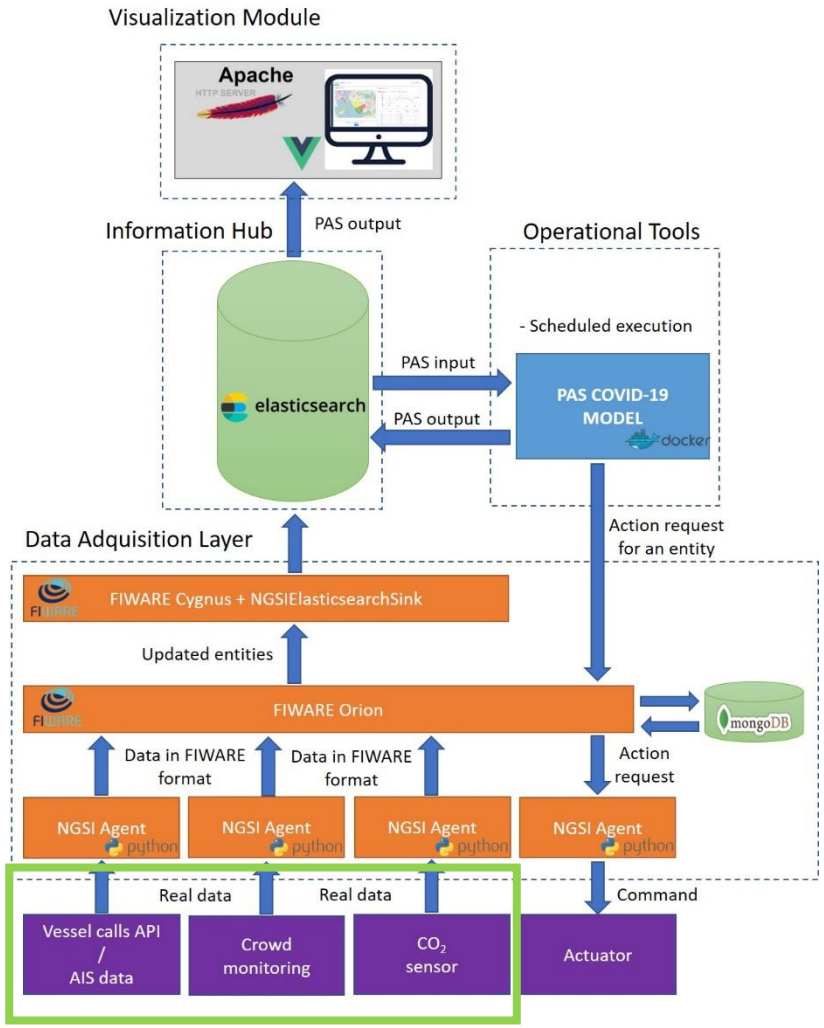
docker

APACHE kafka

elasticsearch

PIXEL

Proposed architecture: data provisioning



- Acquisition of heterogenous data from dispersed sources:

CO_2 pollution: social distancing implies a reduction of CO_2 emissions ➡ CO_2 sensors

Vessel calls: needed for running the proposed tool

➡ remote server (web page or REST API) or AIS

Crowd monitoring: real data is useful to be compared with the prediction results ➡ smartphone based count analysis

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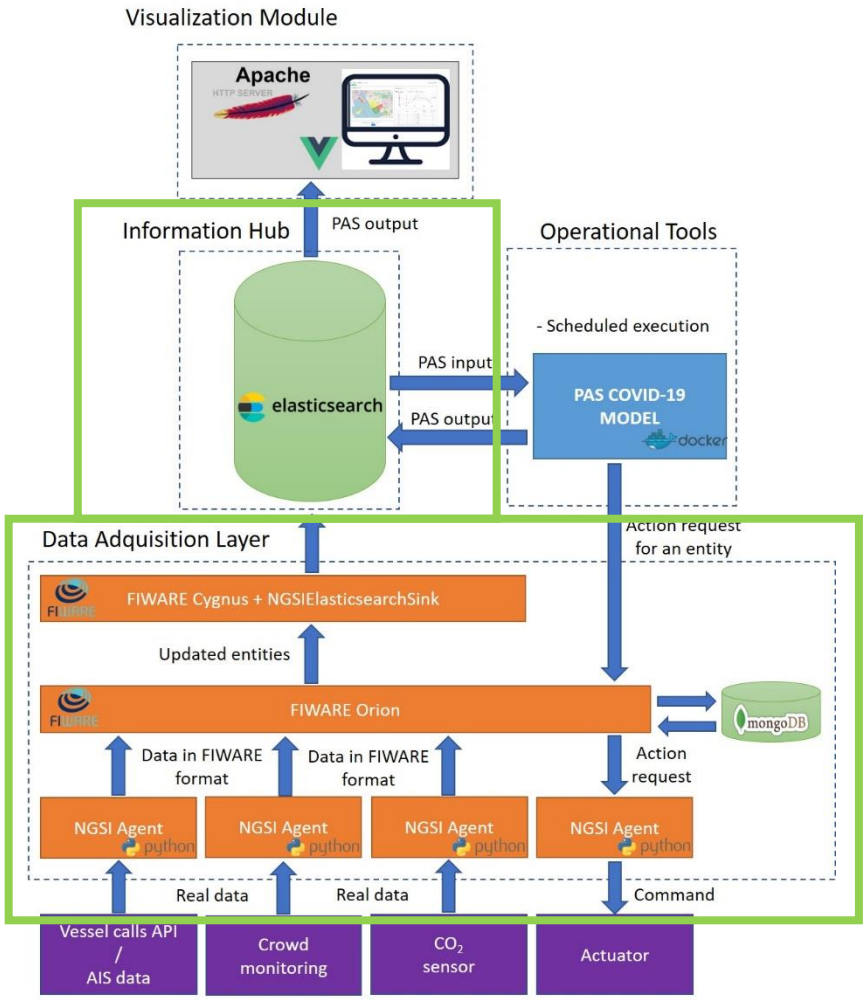
Proposed architecture: data concentration and storage



- Data gathered via NGSI Agents (python): the only component which establishes direct communications with the physical devices.
- Common datamodel: FIWARE Key Performance Indicator (KPI)
- FIWARE Orion as a Context Broker:
  - Data aims to represent the status of the IoT system context in a concrete timestamp
  - Controls and validates the format of the received information
- FIWARE Cygnus and NGSIElasticsearchSink to persist the data
- Powered by FIWARE
- Data storage in a centralized module: the PIXEL Information Hub
  - Elasticsearch database as core module
  - Prepared for big data, high performant and scalable

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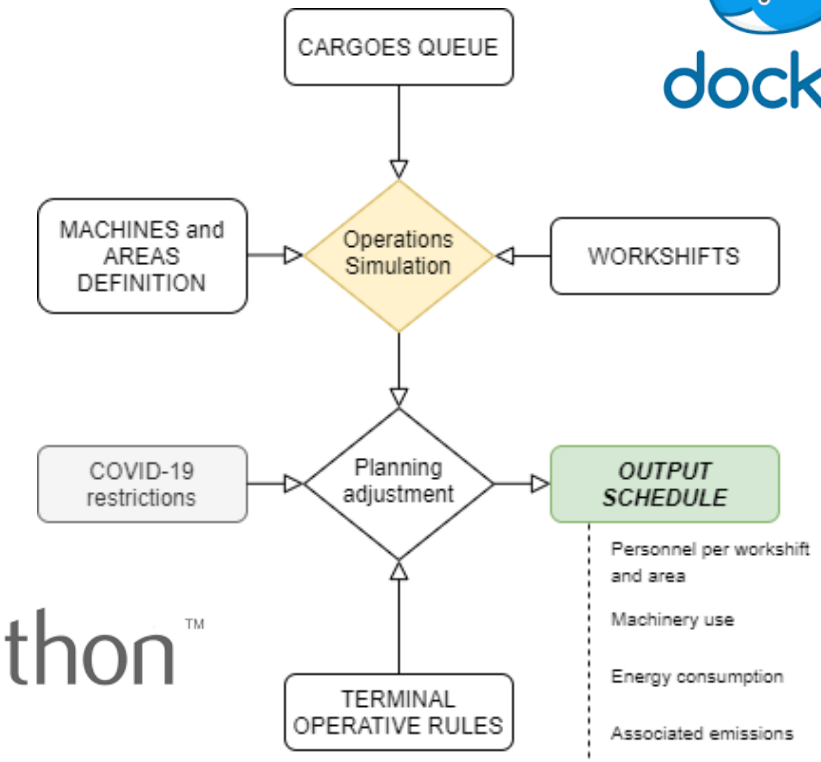
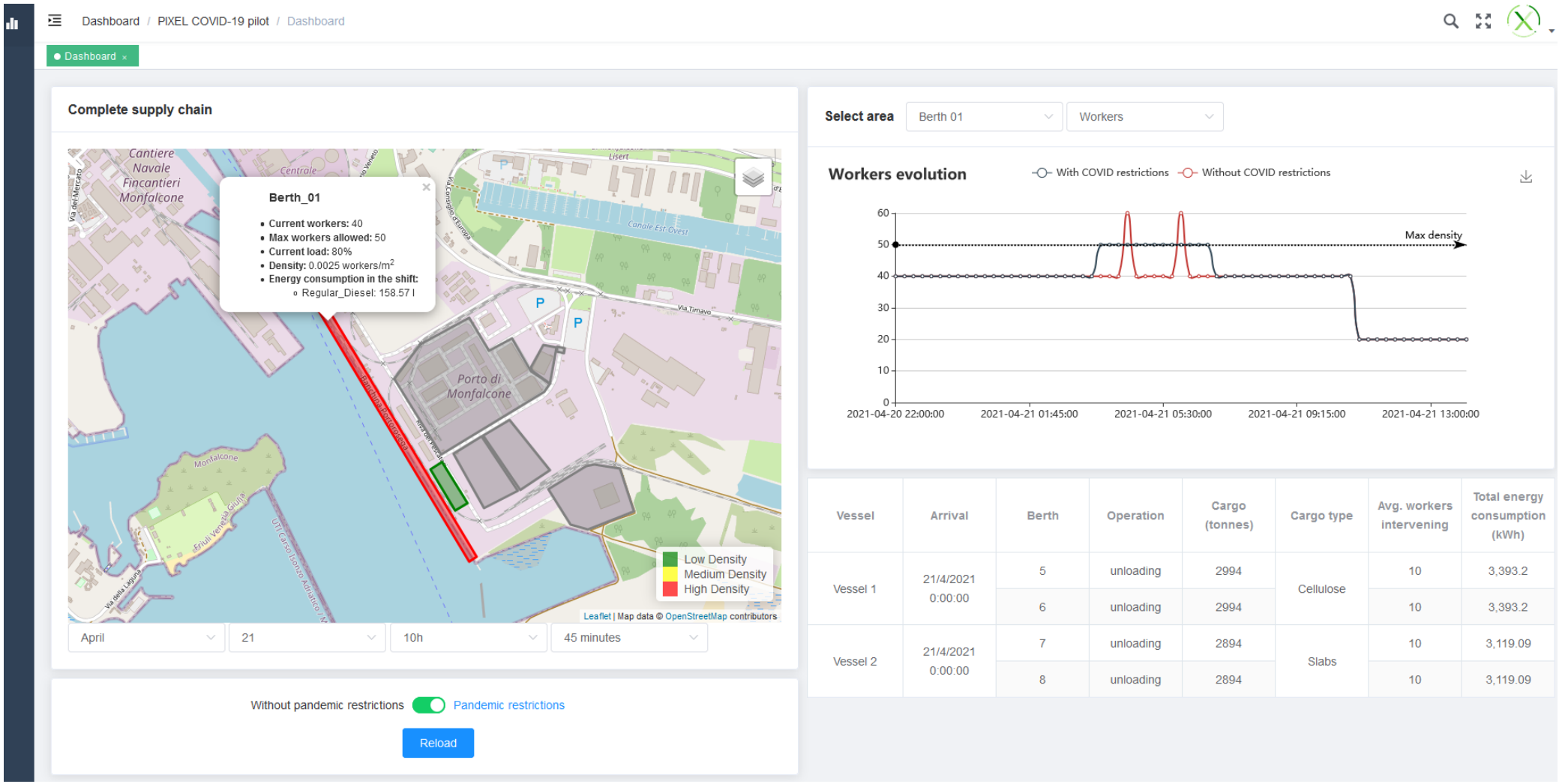
Terminal supply chain simulation: the Port Activity Scenario model

- Models the schedule and performance of terminal operations needed to effectively operate a vessel (load/unload) and the processes involved
- Needs previous configuration (PAS forms) filled by the Port operators
- Enhanced to include the COVID-19 restrictions in its calculations
- Consists of various custom *Python* scripts
- Containerized using Docker and completely integrated in the PIXEL infrastructure
- Scheduled execution orchestrated by the PIXEL Operational Tools
- Results:
  - Workers density per area
  - Energy consumption
  - Machinery use
  - Pollutant emissions



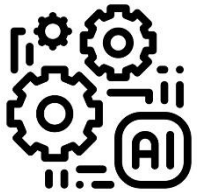
Usability overview



Vessel	Arrival	Berth	Operation	Cargo (tonnes)	Cargo type	Avg. workers intervening	Total energy consumption (kWh)
Vessel 1	21/4/2021 0:00:00	5	unloading	2994	Cellulose	10	3,393.2
		6	unloading	2994		10	3,393.2
Vessel 2	21/4/2021 0:00:00	7	unloading	2894	Slabs	10	3,119.09
		8	unloading	2894		10	3,119.09

Future work and research lines

- Within the scope of the PIXEL project, the Port of Monfalcone expects to use the tool before the end of 2021
- Incorporation of Artificial Intelligence (AI) for:
  - Forecasting deviations in the density restriction compliance
  - Cross-relation discoveries
  - Pattern recognition
  - Long-term planning

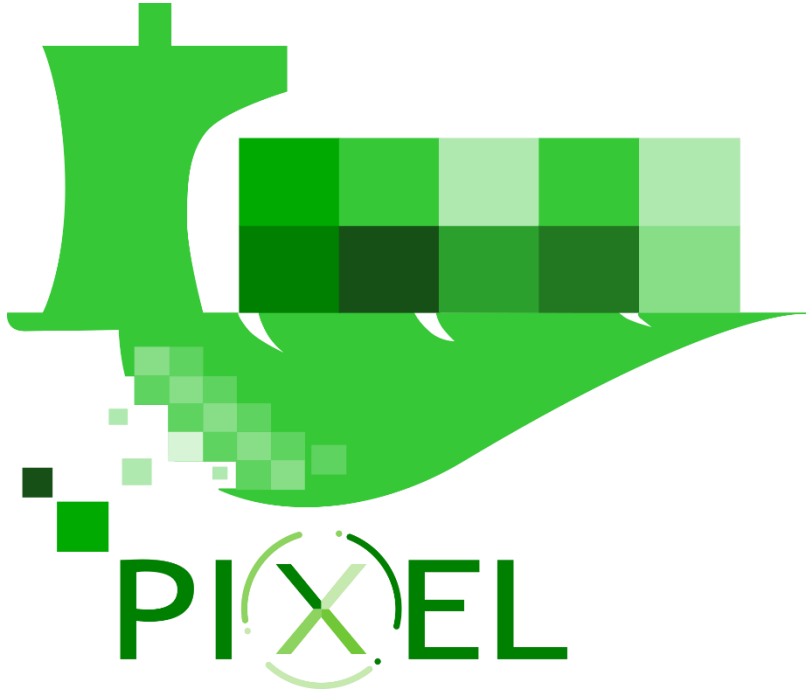


- Inclusion of additional data sources:
  - Cameras to record the actual density of workers per area
  - Other IoT-related sources such as RFID tags or wearables

- Aggregation of functionalities to cover the control of other type of measures (crew change at vessel arrival or departure)

PIXEL

Thank You + Questions?



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