PUBLIC SUMMARY OF DELIVERABLE

D7.3 – Ports as Intelligent Logistics Hubs Release 1

Project Acronym	TT
Project Title	Transforming Transport
Grant Agreement number	731932
Call and topic identifier	ICT-15-2016
Funding Scheme	Innovation Action (IA)
Project duration	30 Months [1 January 2017 – 30 June 2019]
Coordinator	Mr. Rodrigo Castiñeira (INDRA)
Website	www.transformingtransport.eu

Document fiche	
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Work Package:	WP7
Task:	T7.2
Nature:	R
Dissemination:	PU

This document is a public summary of a confidential deliverable of the TT project. It serves as a summary of the release 1 demonstrators and provides links for external actors to connect to the TT pilot leaders if they are interested in more information.

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ACKNOWLEDGEMENT

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement Nº 731932.

Motivation

Transforming Transport (TT) demonstrates, in a realistic, measurable, and replicable way the transformations that big data can bring to the mobility and logistics market. TT is structured into 13 different pilots in 7 pilot domains, which cover areas of major importance for the mobility and logistics sector in Europe.

The **Ports as Intelligent Logistic Hub** domain focusses on the shipping of containers. Shipping containers have produced a revolution in the movement of goods driving efficiency throughout the global supply chain and contributing to the market globalisation. The industry agrees that next revolution in container handling will be container terminal automation. However, only a small amount of container terminals around the world are today fully automated (< 3% of such terminals exist today) using unmanned gantry cranes and automated guided vehicles. Unfortunately, for the rest of the manned container terminals around the world to become a fully automated terminal is a big challenge - even unfeasible, due mainly to the required investment. Achieving a progressive automation of port and terminal operations is the right answer for these container terminals, transforming a full manned operation mode into a semi-automatic operation mode.

Big Data Analytics techniques, when properly applied, provide the necessary tools for automating decision processes or for controlling job queues. They allow dynamic job assignment for container handling, taking into account not only operational data but also global data coming from other actors along the value chain. Following this integrated approach, it is possible to know in advance, for instance to a carrier, the expected waiting times or turnaround time to retrieve container. Additionally, port authorities will be able to get an overview of how different terminals are performing in real-time and react accordingly to improve traffic flow. In other words, unlocking the current big data from port operations facilitates optimising the usage of resources and infrastructure. This approach will encourage port stakeholder's engagement to share data and, consequently, reducing the cost per operation.

Furthermore, harvesting operational data from sensors placed inside port equipment makes it possible to monitor failures of specific yard equipment parts. One of the most important aspects in the improvement of operational efficiency is the anticipation of possible failures and, thereby to avoid unscheduled production downtime. These unforeseen stops reduce production throughput, increase unscheduled downtime, and lead to a reduction in production time optimization, resulting in the need for more resources to reach the required productivity levels. These ideas lead to research in and development of solutions with the aid of innovative technology to increase productivity and efficiency of terminals handling container and trailer shipment.

The aim of the domain is to develop a Terminal productivity cockpit, for supporting a common set of shared and specific metrics to evaluate the logistic process of a port Terminal. This logistic process could be depicted as a hub process where the clients are inputs/outputs from different transportation models: vessel, train, and truck. One of the main performance goal for a terminal is to provide the shortest possible time to leave or pick up containers at the lowest possible cost. This time-cost ratio is an overall indicator to measure performance that is transversal for the domain. The most widely used Key Performance Indicator (KPI) is the Truck/Train/Vessel Turnaround Time (T/VTT): the time a specific means of transport spends in the terminal to fulfil an order. At this point turnaround time is known in isolation, i.e. in a specific terminal, and calculated after the order is processed. The integration of Big Data of several stakeholders involved into the containers management will provide better insights and metrics about the overall efficiency at both port and terminal levels. The defined KPIs provide benchmarking capabilities (e.g. related to costs and performance) that may indicate different levels of competitiveness.

These ideas have been developed in two pilot demonstrators: one at Valencia Port (with ITI, NOATUM and Valencia Port Foundation as partners) and another one in Duisport (with UDE, duisport and Software AG as partners). Both pilots have developed a productivity cockpit to gain insights about current operations and predict their future trends.

Valencia Port pilot

The main ambition of this pilot is to provide a set of predictive models to support both the terminal productivity cockpit and the predictive maintenance scenario, which will be developed in the next release. The goal of these models is to provide metric trends and potential maintenance alerts. As both pilots share the same data processing methodology, also potential improvements detected by the replication pilot, as new models or algorithms, will be included in the initial pilot in later stages of the project. From this general ambition, this release has focused in the next requirements: **(R1) Improve RTG crane scheduling, (R2) Deploy an IoT infrastructure to get real-time information from cranes** and **(R3) Collect and calculate relevant metrics to the port and terminal stakeholders.**

Associated to the requirements expressed in the previous section, the specific objectives of this pilot release are the following: **(O1) Develop a web-based cockpit for better decision-making** and **(O2) Design, implement and deploy and optimization algorithm**.

In port processes is common to use information systems to support current operations and monitor the performance status. In the context of the Noatum terminal, they specifically use a Terminal Operating System (TOS) that it is a specific software to monitor metrics such as gate traffic, vessels arrival, resources available, containers stored in the yard, movements performed by cranes, ship arrival estimation, etc.

The first data challenge of this pilot was to analyse and understand the underlying Noatum TOS data schema, and continuously export such data in a ready-to-use format for analytics. Regarding analytics, we have built a predictive model based on neural networks for each of the relevant metrics.

Port and terminal stakeholders will interact with the terminal productivity cockpit using a dashboard that summarizes the main insights in a user-friendly way. The information is organized in the dashboard in four main sections (predictive metrics, historical data, real-time operations and optimization).

Expected business impact could be summarized in four areas:

1. Real-time dashboards display relevant information for decision makers and, hence, improve current decisions regarding resources planning.
2. To improve planning and execution of operations because currently the previous expertise is the main source of knowledge
3. To optimise asset utilization, specifically reducing maintenance work. A maintenance request implies a minimum crane downtime of 30 minutes. Knowing beforehand such scenario will reduce costs and assign another resource before failure.
4. To increase productivity and efficiency, translated to moves per hour increase and cost per move reduction.

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Duisport pilot

Duisport is the world's largest inland container port with 4.1 million containers handled in 2017. The duisport pilot addresses two main requirements: **(1) Improve operational management terminal operations** and **(2) cost optimization of port equipment**.

To achieve better operational management, the first objective named **"Terminal Productivity Cockpit (TPC)"** was defined which exploits advanced data processing and predictive analytics to facilitate proactive decision-making and process adaptation. In particular, the productivity cockpit leverages cutting-edge predictive business process monitoring solutions, i.e., real-time predictive big data analytics for terminal processes.

For the second requirement, the objective **"Predictive Maintenance"** was defined, which aims at preventing and minimizing the occurrence of equipment and system failures. It does so by using available data to predict the need for maintenance and replacement of equipment based on historical facts and equipment usage rather than on estimates. In the setting of the duisport pilot, predictive maintenance serves an important role to reduce the changes for equipment failures and thus, helps to mitigate delays and increase the effectiveness of terminal operations. The PMS complements the TPC in increasing overall terminal productivity.

By June 2018, duisport gathered over 30 million data entries from nine devices, including as fault messages and regular status and location updates. Visual and statistical analytics techniques (e.g., heatmaps, map overlays and mappings for container parking spots) are used to reconstruct processes and loading unit movements in the terminal. This process information is fed into the prediction pipeline to receive predictions for the proactive decision making, using state of the art predictive models (neural networks). To present the gathered and computed information to decision makers the terminal productivity cockpit features a web-based dashboard that was continuously improved considering feedback from several user studies. The dashboard displays the current state of the terminal, the predictions from the predictive models and several KPIs computed from live data for decision making support.

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