STEAM

Sea Traffic Management in the Eastern Mediterranean

NEWSLETTER

February 2021

IN THIS ISSUE

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STEAM 2020 Overview

2020 has been a very productive second year for the STEAM project with some important developments and publications, many of which you will have the chance to read about in this newsletter.

The STEAM database is fully operational, storing port call, AIS, and environmental monitoring data, while a plethora of systems have reached maturity. Perseus is a new Port Call Data Sharing Platform developed by Marine Fields and is now receiving live port call data from CPA's Port Community System. There were also considerable efforts in establishing the Limassol Shore Center to be operated by the VTS at the Port of Limassol, providing ways to optimize sea traffic navigation. The Air Quality Monitoring system was developed by CUT for monitoring air pollution in Cyprus, while the Ocean Data Interface developed by CSCS processes and visualizes meteorological and oceanographic data on a daily basis. Last but not least, a Power BI report composed of two fully-interactive dashboards was developed by DeLevant for analyzing KPIs in various ways.

Dr. Herodotos Herodotou, Assistant Professor
STEAM Scientific Coordinator
Cyprus University of Technology
herodotos.herodotou@cut.ac.cy

STEAM 2020 Publications

The United Nations now acknowledges Maritime Informatics as an emerging discipline for a digitally connected, efficient, sustainable, and resilient maritime industry [1], based on the first book on Maritime Informatics that has been published by Springer and edited by Mikael Lind (Research Institutes of Sweden - RISE - and Chalmers University of Technology, Sweden); Michalis Michaelides (Cyprus University of Technology - CUT, Cyprus); Robert Ward (RISE), and Richard T. Watson (RISE and University of Georgia, USA) [2]. The main contributions of the book have also been presented at the World of Shipping Portugal [3]. Furthermore, another work was presented at the World of Shipping Portugal, which employs a fuzzy matching approach for automatically cleaning the manually entered destination field in AIS signals and converting the dirty input records into standardized port names [4]. Finally, a comprehensive literature review has been published in IEEE Internet of Things Journal and presents a recently emerged paradigm in intelligent shipping and application domain of Internet of Things, called Internet of Ships (IoS) [5].

[1]. UNCTAD Newsletter: "Maritime Informatics: an emerging discipline for a digitally connected efficient, sustainable and resilient industry" https://unctad.org/en/pages/newsdetails.aspx?OriginalVersionID=2456
[2]. Book in Springer: "Maritime Informatics" https://link.springer.com/book/10.1007%2F978-3-030-50892-0
[3]. World of Shipping Portugal: "Maritime informatics technology" https://www.worldofshipping.org/WofSP3_Conference/2021_Conference/Conference_Proceedings/WofSP_022f_Full_Paper.pdf
[4]. World of Shipping Portugal: "Employing fuzzy matching for cleaning manual AIS entries" https://www.worldofshipping.org/WofSP3_Conference/2021_Conference/Conference_Proceedings/WofSP_023f_Full_Paper.pdf
[5]. IEEE Internet of Things Journal. "Internet of Ships: A Survey on Architectures, Emerging Applications, and Challenges" https://ieeexplore.ieee.org/document/9090272

New Book Release: Maritime Informatics

We are very happy to announce that the **first book on Maritime Informatics has just been published by Springer edited by Mikael Lind, Michalis Michaelides, Robert Ward, and Richard Watson.**

The book, published by Springer, can be reached at: www.maritimeinformatics.org

This is the first book issued on Maritime Informatics and describes the potential for Maritime Informatics to enhance the shipping industry. It examines how decision making in the industry can be improved by digital technology and introduces the technology required to make Maritime Informatics a distinct and valuable discipline. It addresses the identified need within the maritime industry for smarter collaboration to enhance operations, satisfy clients' expectations of transparency and predictability and respond to societal concerns.

Maritime Informatics can be defined as "the application of information systems to increase the efficiency, safety, and ecological sustainability of the world's shipping industry". The shipping industry covers 90% of the world seaborne trade movements. Maritime informatics takes a holistic approach to shipping, enabling higher levels of transparency, predictability, and visibility of all transport operations connected with shipping. Collaboration within the industry starts with information sharing, which can lead to improved efficiency and enhanced operations. Maritime informatics should be on the strategic decision-making agenda for all stakeholders in the shipping sector, because it embraces the full range of competencies needed to improve the energy efficiency and raise the capital productivity of the industry. In addition, it is an evolving science that can be readily harnessed to address emergent problems because it embraces a systems perspective for improving the quality of maritime decision-making, and thus increasing the safety, ecological sustainability, agility, and resilience of the world's shipping industry. By doing so, it can boost the contribution of the maritime sector to the realization of several goals within the United Nations' 2030 Sustainable Development Agenda.

Maritime Informatics unites practitioners and researchers for their joint efforts in improving the efficiency, sustainability, and resilience of maritime transports. A first graduate level course on Maritime Informatics has just been offered at the Chalmers University of Technology in Sweden and many similar initiatives are currently under way in many other countries across the globe.

"Maritime Informatics unites practitioners and researchers for their joint efforts in improving the efficiency, sustainability, and resilience of maritime transports"

New Book Release: Maritime Informatics

The book's chapters are co-authored by 81 academics and leading practitioners in the shipping industry from 20 nations.

Among these are:

- **several academics and researchers from the Cyprus University of Technology (CUT)** including Sheraz Aslam, Herodotos Herodotou, and Michalis Michaelides from the Department of Electrical Engineering, Computer Engineering and Informatics; Stelios Alexandrou and Photis Panayides from the Department of Department of Commerce, Finance and Shipping;
- **leading practitioners from the Cyprus maritime industry** including Andreas Chrysostomou (MarineFields), Daniel Hayes (Cyprus Subsea Consulting and Services), Despina Theodossiou (Totοtheo Maritime and WISTA), Socrates Theodossiou (Totοtheo Maritime), Ioannis Kyriakides and Zacharias Siokouros (CMMI);
- **as well as leading academics and practitioners from the international maritime industry** including Trond Andersen (NOFO), Michael Bergman (BM Bergmann-Marine), Albert Gonzalez (Barcelona Port Authority), Mikael Lind (Research Institutes of Sweden (RISE)), and Robert Ward (Hydrographic Advisor).

Note that all the aforementioned academics and practitioners are **actively involved in the STEAM project** either as members of the consortium, or as members of the STEAM Associated Stakeholder Network, or as members of the STEAM Advisory Board.

To keep updated on the developments of maritime informatics visit the website at www.maritimeinformatics.org or join the LinkedIn group of maritime informatics at https://www.linkedin.com/groups/12477137/

Assistant Professor Michalis Michaelides
STEAM Project Coordinator
Cyprus University of Technology
michalis.michaelides@cut.ac.cy
+357 99 466169

Cyprus University of Technology

Associate Professor Mikael Lind
Senior Strategic Research Advisor
Research Institutes of Sweden
mikael.lind@ri.se
+46 70 566 40 97

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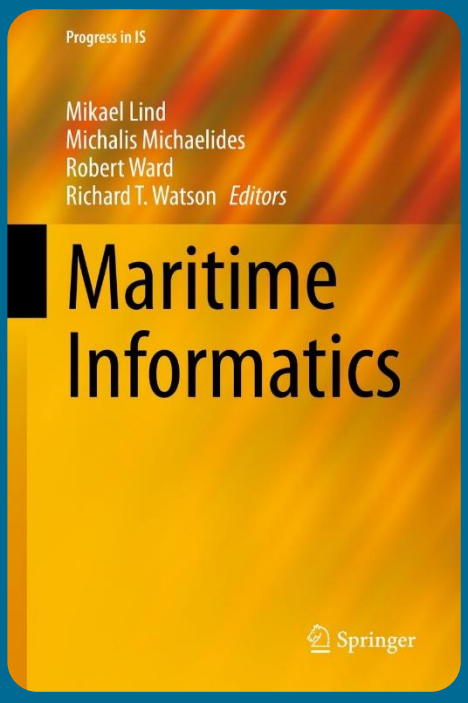
"The book's chapters are co-authored by 81 academics and leading practitioners in the shipping industry from 20 nations. "

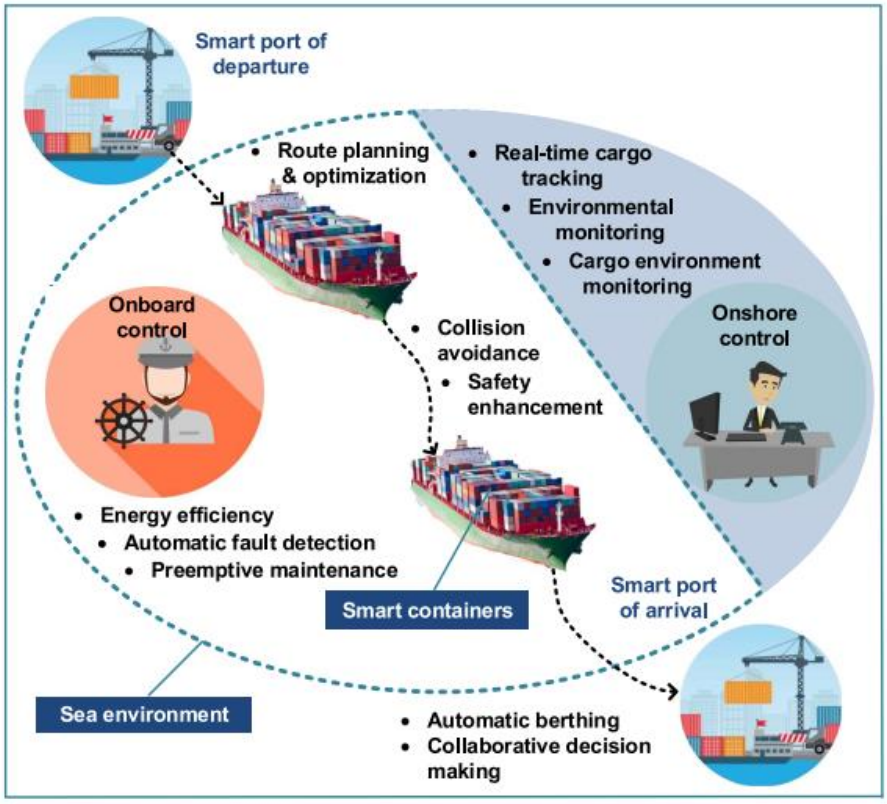


www.maritimeinformatics.org

Internet of Ships

The STEAM members Sheraz Aslam, Michalis P. Michaelides, and Herodotos Herodotou published a recent study in IEEE Internet of Things (IoT) Journal, entitled “Internet of Ships: A Survey on Architectures, Emerging Applications, and Challenges”. This study presents the first comprehensive survey regarding the application of the Internet of Things (IoT) domain for intelligent shipping and discloses a new research area, *Internet of Ships* (*IoS*). IoS refers to the network of smart interconnected maritime objects, which can be any physical device or infrastructure associated with a ship, a port, or the transportation itself, with the goal of significantly boosting the shipping industry towards improved safety, efficiency, and environmental sustainability.

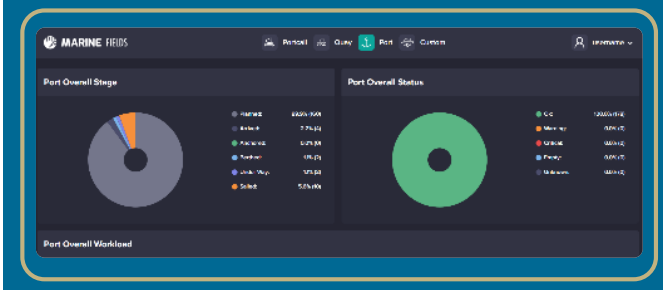
Furthermore, this work also reviews the state-of-the-art emerging applications, which are categorized in three primary IoS application domains: smart ships, smart ports, and smart transportation. The major applications include security enhancements, route planning and optimization, collective decision making, automatic fault detection and preventive maintenance, load monitoring, environment monitoring, energy efficient operations and automated mooring. Eventually, the open challenges presented in the paper also provide a roadmap for optimized maritime operations and autonomous shipping.

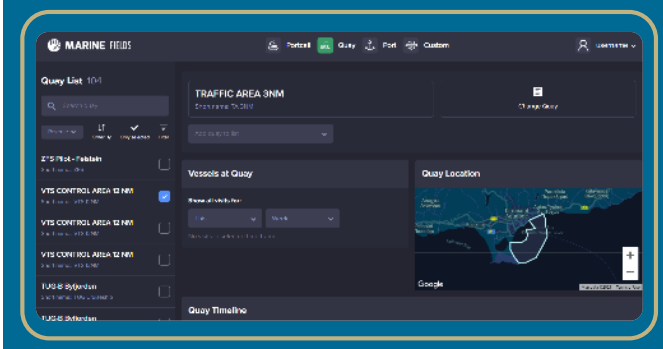


Key applications of IoS

IoT application domains

PortCDM & Perseus





Marine Fields Holding Ltd provides a Port Call Data Sharing Platform aiming at supporting just-in-time operations within a given port, empowered by enhanced connectivity to, and data sharing with, other ports, ships / ship operators, and hinterland operators. The Platform is called Perseus. Perseus BASE forms the back end, i.e., the data sharing platform, while Perseus mobile, and Perseus SAT are the Perseus front-end tools.

Perseus enables actors to share time stamps and common situational awareness among each other associated to port call operations. It aims at providing capabilities for sharing time stamps, in a standardized format between port actors within ports, between ports, between ships and ports, and between ports and hinterland operators with the purpose of enhancing the predictability of the port call operations.

Perseus captures timestamps associated to the port call stretching from estimated/actual arrival to the port area, estimated/actuals on the conduction of nautical services bringing the ship to berth, estimated/actuals on berthing operations, as well as estimated/actuals on preparations for enabling the ship to depart from berth, together with movement and services associated to the departure.

Perseus captures upstream progress associated to port call operations in previous ports, which means that ports will be exchanging data with each other allowing for the upstream progress to be a complementary source, both by adding new data as well as by validating the precision of data.

Perseus port-centric viewpoint provides a holistic picture in a port call timeline, independent of the shipping company, port/terminal operator, or any other service provider, enabling Business Intelligence (BI) with information for both diagnostic as well as predictive BI activities.

In conclusion, Perseus enables existing systems providers to enhance their functionalities by the consumption of time stamps and allows for third-party innovators to provide new digital services.

Andreas Chrysostomou
Chief Executive Officer
MarineFields Holding Ltd
ac@marine-fields.com

Limassol Shore Center

Past research into safe, secure, and environmentally friendly sea traffic navigation has showed that navigators improved their situational awareness when they had the possibility to see the planned routes of vessels in the near environment, which is the main objective of the establishment of the Limassol Shore Center (LSC). The LSC advices vessels on potential congestions ahead, environmentally sensitive areas, and safety notices, and thus help them to optimize their routes in a safe and environmentally friendly way.

Towards this end, the LSC will be established and operated by the VTS at the Port of Limassol, providing ways to optimize sea traffic navigation in the East Mediterranean region related to route cross-check, flow management, enhanced monitoring, and search and rescue operations. Based on the technologies provided by Tototheo Maritime, the LSC will provide new solutions specifically designed to meet the unique needs and requirements that arise from short sea shipping, such as the real-time coordination of large inbound vessels with smaller outbound ones as well as the unloading, deconsolidation, and reloading of goods for transport to their final destinations.

Specifically, Tototheo Maritime technologies, such as the well-established TM Synergia optimization platform, will power the LSC to provide the following three key services:

a) **Route Cross-check**: Vessels will submit their voyage plan and the LSC will crosscheck and validate the route. The check can include the following validations:

   i. Import the route and optimise it. Return it to VTS for approval and upon that, upload it on the platform for monitoring.

   ii. Apply alarms – route deviation, speed deviation and stoppage. Alerts will be sent to VTS for action.

b) **Review and adjust route** for weather if applicable.

c) **Flow Management**: The LSC will draft optimal routes for the various vessels moving in the area and suggest those routes to the ships. This will result in better optimization of the general flow of vessels in the area. The LSC will use an enhanced traffic image consisting of AIS targets.

Ultimately, the LSC will act as a communication hub in the Eastern Mediterranean region and provide the above services to ships in order to optimize sea traffic navigation in the region.

Andreas Chrysostomou
Chief Executive Officer
MarineFields Holding Ltd
ac@marine-fields.com

TOTOTHEO MARITIME

Map of air quality stations

Air quality station

Air quality drone

CUT Air Quality Monitoring

Monitoring air quality and the environment in general, is vital for the environment itself and for human health. CUT Air Quality Monitoring is a system that was developed by the Cyprus University of Technology for monitoring air pollution in Cyprus.

The system currently includes 5 stations, each one equipped with sensors that take various measurements like CO, CO_2, NO_2, O_3, $PM_{10/2.5/1}$ together with temperature, humidly and pressure. All stations include a waterproof enclosure that enables their placement in the outdoor environment and feature autonomous operation using rechargeable batteries that are continuously charged with external solar panels. Each station stores measurements, sampled every 5 minutes, on its own memory card. Periodically, each station also connects to the internet through Wi-Fi and uploads the latest measurements on a server. All stations were calibrated prior to the installation and are also periodically calibrated to maintain accuracy. Three stations were installed at the Port of Limassol, one at the Limassol Nautical Club, and one close to the Limassol Marina.

For orchestrating the measurements taken by the stations, various software services were developed. A server hosted at the CUT datacenter, periodically requests the data that were sent by the stations. The measurements received are calibrated using machine learning and then stored in a database. The end user is then able to access the data, and also see some visualizations of them through an online platform. To enhance our system's geographical coverage, we have also included some other sources of air quality measurements. Both the Department of Labour Inspection and the Cyprus Meteorology Department provide an Application Programming Interface (API) where other services periodically make requests to receive the latest data and store it in the STEAM database.

Overall, the CUT Air Quality Monitoring system provides the ability to the end users to monitor air cleanliness or pollution. As an additional measure to enhancing our system, drones were given to the Cyprus Ports Authority (CPA) that enable surveillance and environmental monitoring of the port area.

Lambros Odysseos
Research Associate
Cyprus University of Technology
lamody1993@gmail.com

Theofylaktos Pieri
Research Associate
Cyprus University of Technology
tn.pieri@gmail.com

Environmental Monitoring

Ports contribute to water and air pollution due to the dense activity of vessels, which may emit engine exhaust, ballast water, petroleum products, or other liquid or solid waste. Continuous monitoring of ports can help identify the source of pollution and measure the effectiveness of environmental measures. The design of the environmental monitoring plan at the Port of Limassol stems from background research on the available and emerging technologies in relevant environmental monitoring, an overview of the methodologies used in other ports, and consultation with port stakeholders. Air and water quality have been consistently identified as the major points of environmental concern.

Water quality will be monitored in-situ through the installation of two research buoys and two oil spill alert systems. The buoys will be equipped with sensors to monitor temperature, salinity, chlorophyll-a, turbidity, CDOM, and dissolved oxygen. The buoys will be located on either side of the anchorage area – one next to the Port of Limassol close to the port entrance and another buoy will be placed on the other side of the anchorage area offshore from the Limassol Nautical Club.

Near-field optical sensing technology will be used in the port's water quality monitoring scheme. Two hydrocarbon sensors will be fastened within the port. In the docking area, an oil sensor will capture the possible release or leak of oil from vessels. A second sensor will be put in the entrance of the port to better detect the origin of the pollution.

Cyprus Subsea Consulting and Services C.S.C.S. Ltd has also launched a new service – the Ocean Data Interface (https://cyprus-subsea.com/ocean-data-interface/), which processes meteorological and oceanographic data to provide daily conditions, plus several days in the future and in the past, enabling real-time situational awareness. The Ocean Data Interface could serve as an early weather warning system for ship managers and the port control center. Data from in situ water quality observations at the Port of Limassol will also be processed and visualized through a similar interface.

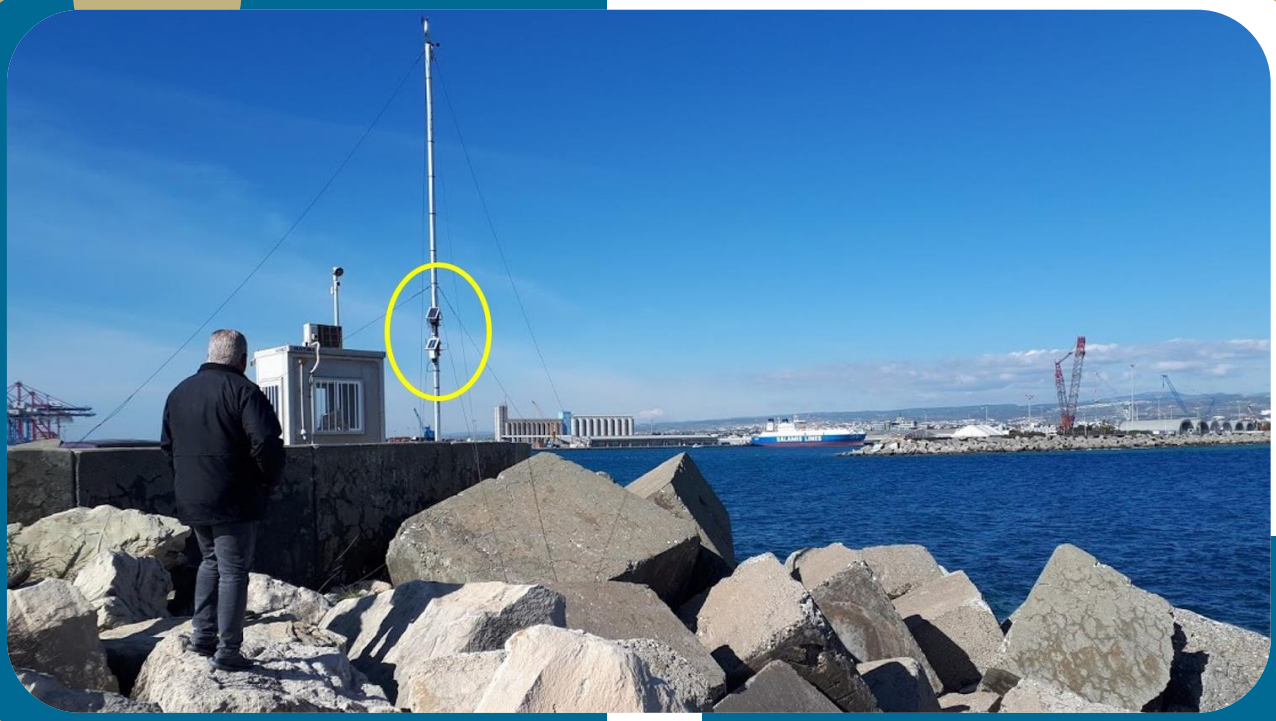
STEAM will implement an environmental monitoring system adjusted to the needs of the Port of Limassol. Local and regional meteorological and oceanographic information is also available to port stakeholders through the Ocean Data Interface. Participants in maritime activities in the Mediterranean can utilize this information for the purposes of increasing operations efficiency, environmental sustainability, and maritime safety.

Rana Abu Alhaija
Environmental Consultant
Cyprus Subsea Consulting and Services C.S.C.S. Limited
rana.a@cyprus-subsea.com

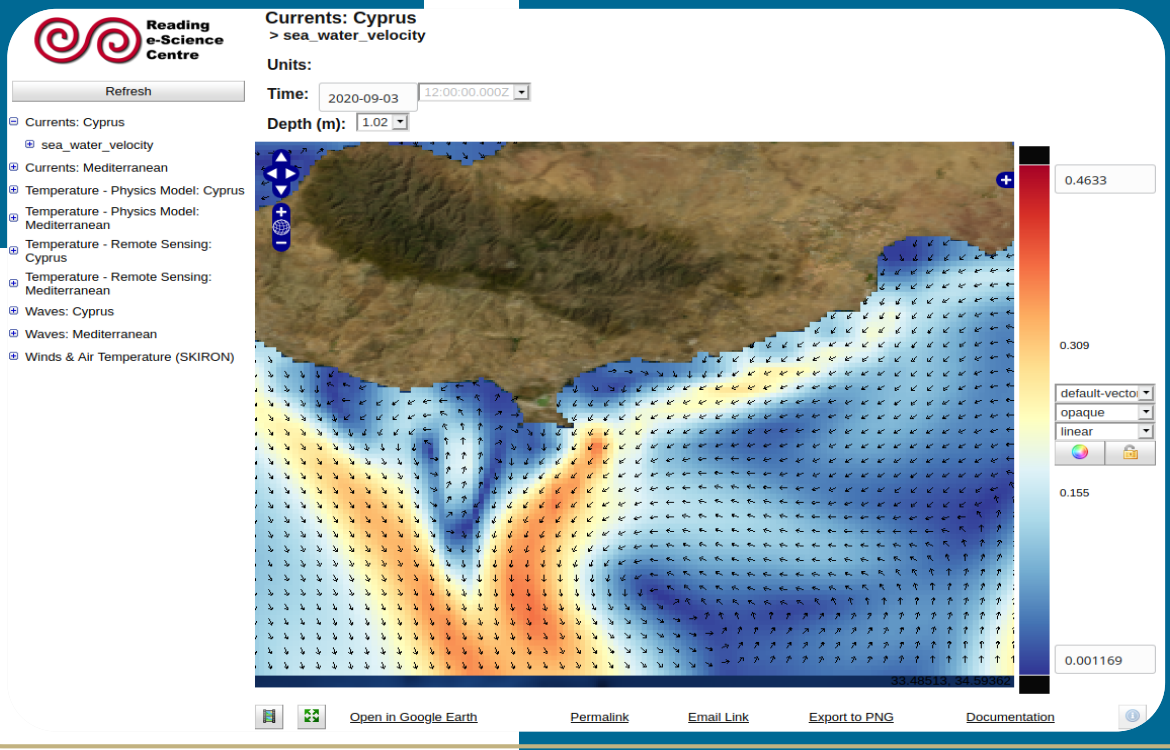
Oil detector test

Research buoys

CYPRUSUBSEA
Consulting and Services C.S.C.S. Limited



Air Quality sensor at the Red Light location



Ocean Data Interface

Data Analytics

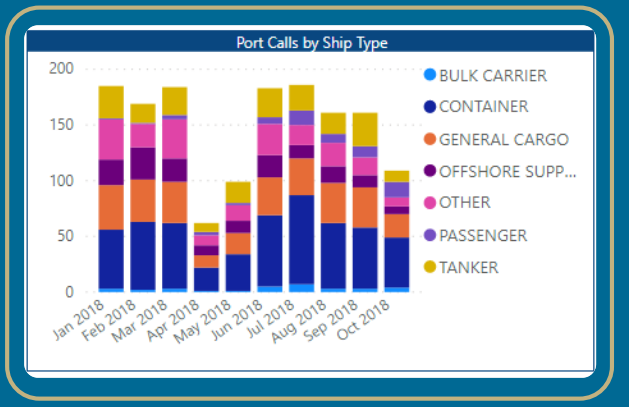
One of the main purposes of data analytics as part of the STEAM project is to provide meaningful insights and eventually support decision-making activities based on those insights. Traditionally, this kind of analysis is done while a data snapshot is taken, transformed, and cleansed, and then fed into one-time calculations and analysis that provide results of specific KPIs through tables, reports, charts, and other visual aids usually in the form of a report. If you would want to do this again with new data, the whole process had to be repeated, involving quite a few manual steps, until a new set of reports is generated.

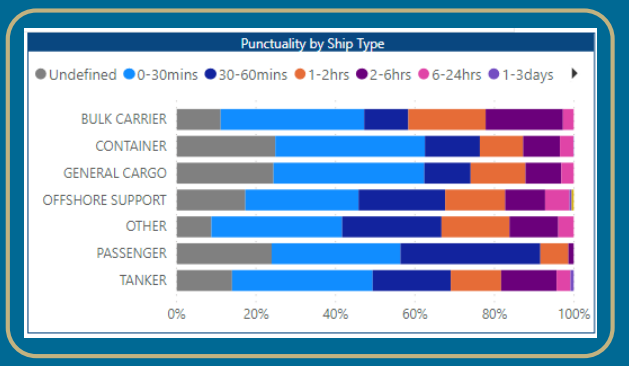
DeLevant's contribution in 2020 was to make this process of data extraction, transformation, load (ETL), and analysis of port call data, live and seamless as to allow for a continuous analysis and interpretation of the events at a port. Ultimately, the ETL will be automatic and be able to be launched at will or scheduled at pre-defined intervals (daily, monthly), providing instant update of the live reports and charts.

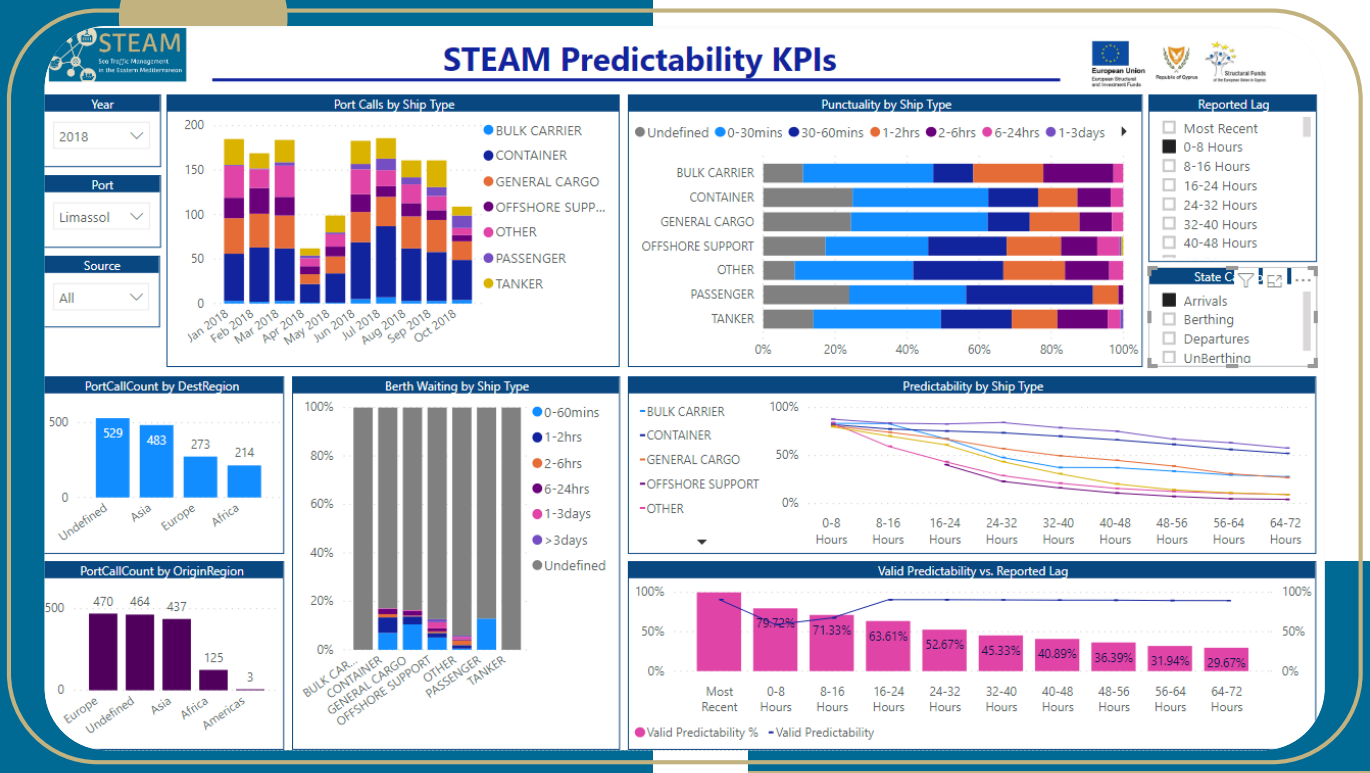
Even though the ETL is not yet fully automatic (something to do in 2021), most of the remaining components have been put in place. The backend technology used to support this feat is based on a Data Warehouse database and a multidimensional cube build on top of the Datawarehouse along with a Power BI report powered by the multidimensional OLAP cube for very fast performance.

The Power BI report is composed of two dashboards. These dashboards are fully interactive and the KPIs can be sliced and diced per port, time-period, vessel type, origin or destination ports, and various other categories. In the first dashboard, the report user can interact with the various graphs to explore and extract information regarding port call count, predictability and punctuality regarding arrivals, departures and berthing times. In the second dashboard, significant productivity KPIs are visualized based on various filtering conditions.

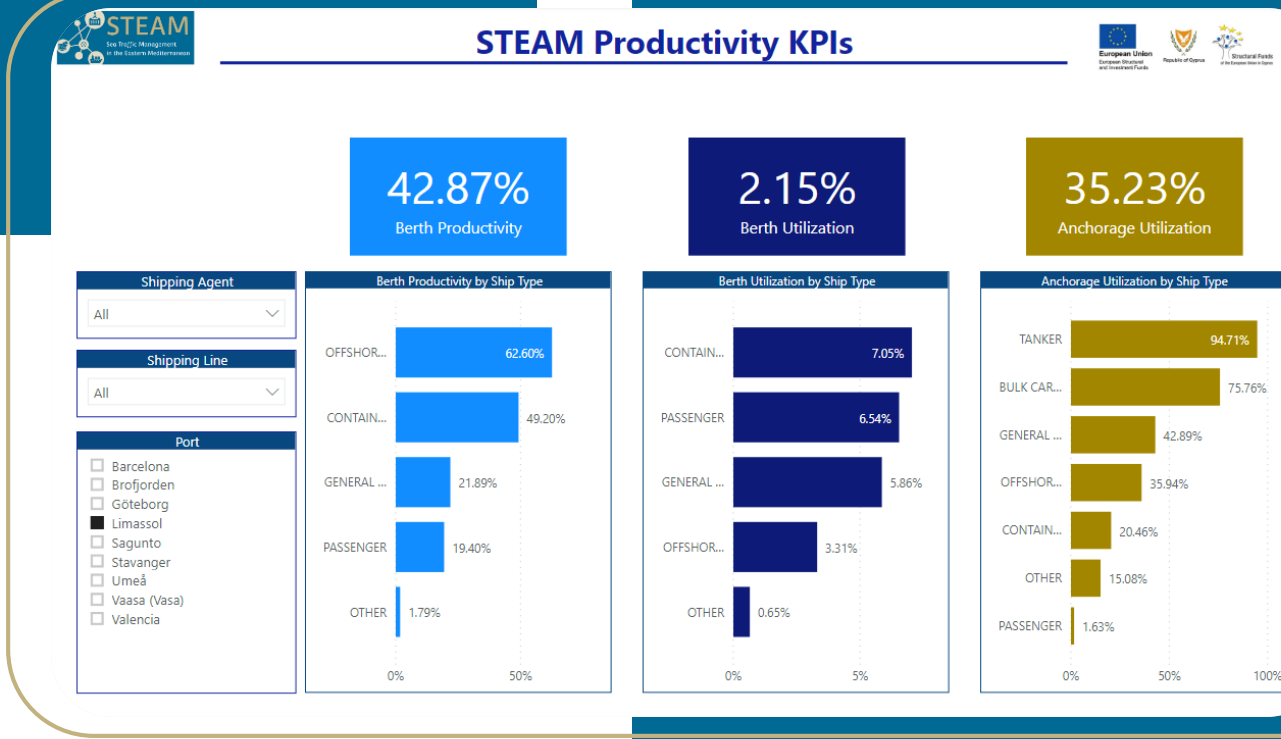
Aris Televantos
Managing Director
DeLevant Bussiness Solutions Ltd
aris.televantos@delevant.com







Power BI Dashboard - Predictability KPIs



Power BI Dashboard - Productivity KPIs

STEAM Vision & Objectives

STEAM (Sea Traffic Management in the Eastern Mediterranean) is a three-year project that has started in Jan. 2019 with a budget of approximately one million EUR. The primary goal of STEAM is to develop the Port of Limassol to become a world-class transshipment and information hub adopting modern digital technologies brought to the maritime sector, as well as a driver for short sea shipping in the Eastern Mediterranean.

Towards this end, the ports of Cyprus, and especially the Port of Limassol will have a vital role to play due to its strategic location, as an information hub, exchanging information with both nearby ports and ships in the Eastern Mediterranean area for optimizing the ships' routes, expanding the planning horizon for port operations, and avoiding possible dangers. The geographical location of Cyprus encourages the use of Cyprus ports as transshipment hubs for short sea shipping.

In the STEAM project, the implementation of the STM concept will be significantly extended and enhanced by the successful testbed conducted at the Port of Limassol through the further development of Port CDM, which will enable real-time situation awareness to all participants involved in maritime activities in the ports of Cyprus. Moreover, the Port of Limassol will be modernized with innovative technological solutions and advanced data analytics providing new decision-support tools and services for maritime stakeholders.

Dr Michalis Michaelides, Assistant Professor
STEAM Project Coordinator
Cyprus University of Technology
michalis.michaelides@cut.ac.cy

Consortium Members

Cyprus University of Technology

RISE

Cyprus Ports Authority

CYPRUSUBSEA
Consulting and Services C.S.C.S. Limited

Cyprus Shipping Association

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Associated Stakeholders Network

DP WORLD Limassol

EUROGATE Container Terminal Limassol

P&O Maritime

Maritime Institute of Eastern Mediterranean

CSC
Cyprus Shipping Chamber
Navigates Cyprus Worldwide