STEAM

Sea Traffic Management
in the Eastern Mediterranean

NEWSLETTER

February 2022

IN THIS ISSUE

Structural Funds
of the European Union in Cyprus

Republic of Cyprus

European Union
European Regional
Development Fund

STEAM 2021 Publications

A new book has been released by Springer entitled, "Maritime Informatics: Additional Perspectives and Applications," complementing the original book on Maritime Informatics and also edited by Mikael Lind, Michalis Michaelides, Robert Ward, and Richard T. Watson [1]. Important developments with respect to optimizing berth allocation, and the environmental monitoring design at the port of Limassol, were published in international conferences, VEHITS 2021 [2] and ICED 2021 [3], respectively, and presented by members of the STEAM team. Furthermore, a study by Ekaterini Hadjisolomou et. al. on "Modelling Freshwater Eutrophication with Limited Limnological Data Using Artificial Neural Networks" was published in the MDPI Water Journal [4].
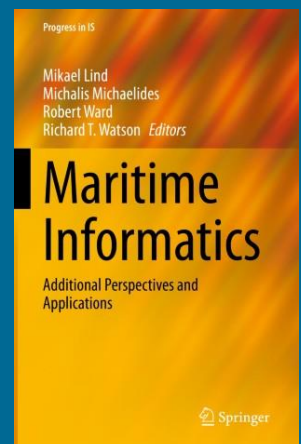
[1] Lind M., Michaelides M., Ward R., Watson R. T. (2021, Eds), *Maritime informatics: Additional Perspectives and Applications*. Heidelberg: Springer.

[2]. Aslam S., Michaelides M., Herodotou H. (2021) *Dynamic and Continuous Berth Allocation Using Cuckoo Search Optimization*, Proc. of the 7th International Conference on Vehicle Technology and Intelligent Transport Systems (VEHITS) 28 – 30 April 2021, Prague, Czech Republic.

[3] R. Abualhaija, D. Hayes, J. Reodica, T. Pieri, M. Michaelides. (2021) *Participatory Process in Environmental Monitoring Design: Examples from the Port of Limassol*, Proc. of the 2nd International Conference on Environmental Design, ICED2021, 23-24 October 2021, Virtual.

[4]. Hadjisolomou, E.; Stefanidis, K.; Herodotou, H.; Michaelides, M.; Papatheodorou, G.; Papastergiadou, E. *Modelling Freshwater Eutrophication with Limited Limnological Data Using Artificial Neural Networks*. MDPI Water 2021, 13, 1590. https://doi.org/10.3390/w13111590

STEAM 2021 Overview

2021 has been a very productive third 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 and are currently under evaluation by the Port of Limassol actors. The Port Call Data Sharing Platform (Perseus) is evaluated for optimizing the port call procedure and enhancing port-to-port communication. There are also ongoing efforts for evaluating the Limassol Shore Center services by the VTS, providing ways to enhance safety and optimize sea traffic navigation. The Environmental Monitoring Platform is evaluated for its ability to access, extract, and analyze air quality, water quality and meteorological data. Last but not least, Power BI reporting composed of a series of dashboards, is evaluated for analyzing KPIs in various ways.

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The Sustainable Port being Empowered by PortCDM 2.0

Historically, we have put a lot of emphasis on the sea window of the port, in concepts such as port collaborative decision making (PortCDM). Lately, inspired from the severe constraints that have emerged in the supply chain, there is a need to secure the flow through the port. In other words, as the port is to be conceived as a transport and logistics hub, it becomes important that the inbound sea transport is synchronized with the outbound transport and vice versa. Building upon the PortCDM concept we should, in our efforts of contributing to the next generation of PortCDM (PortCDM 2.0), expand the focus to relate coordination points from different means of transports with internal port operations. In this way, port actors and visitors may be allowed to synchronize their plans and outcomes in the logistical flow.

It is important to place focus on the sustainable port as a transport hub, energy hub, and digital hub. The port as a transport hub contributes to the seamless flow of goods and passengers through the port without any unnecessary waiting times. The port as energy hub put emphasis on the necessary needs of meeting demands of providing fossil-free fuel to the visitors of the port. The port as a digital hub explores the necessary digital maturity that the port needs to develop in order to fulfil the information needs to direct, such as visitors to the port, and indirect stakeholders, such as cargo owners and transport buyers.

By having a solid understanding of the practice of the sustainable port, the necessary communication and information sharing needed for desired coordination and synchronization may be derived. This is also one of the essential discourses held within the emerging discipline of maritime informatics.

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PortCDM: Beneficial for the Port of the Future

In the age of digitalization, maritime will not be able to meet the demands of today and the future without digital data. Data standardisation, data sharing, and collaboration have become paramount in support of the changes along the whole chain of information processing.

Maritime needs the ability to utilize digital data and integrate it in business processes. Within this environment, and in support of the IMO Maritime Services definitions, the International Port Collaborative Decision Making Council (IPCDMC) promotes port collaborative decision making to increase situational awareness by all port and hinterland actors.

On the technical side, it converted the Port Call Message Format from the STM Validation Project into a standard compatible to the IMO Common Maritime Data Structure, and IALA adopted it as the S-211 Standard. For operational aspects, it created compliancy guidelines including a PortCDM maturity model to enable smooth implementation to the specific needs of ports.

With the implementation of PortCDM, the port actors can gain benefits, validated by the implementations so far. Shipping companies can save bunker and improve fleet optimization. Shipping agents enhance planning and coordination of port calls and spent less time chasing different actors. Terminal operators enhance their ability for berth management, capacity utilization, and increase planning horizons. VTS improve coordination of ship movements and the capability to synchronize the traffic. And finally, ports increase safety and efficiency of port approaches, establish long- and short-term overview of port visits as well as optimized and enhanced capacity utilization.

However, PortCDM doesn't only generate benefits for the port call actors. By sharing data, ensuring credible authentication, and using internationally agreed standards and methods for deriving situational awareness, it establishes transparency, which is a growing demand by all customers. This allows shipping to match competition from other modes of transport.

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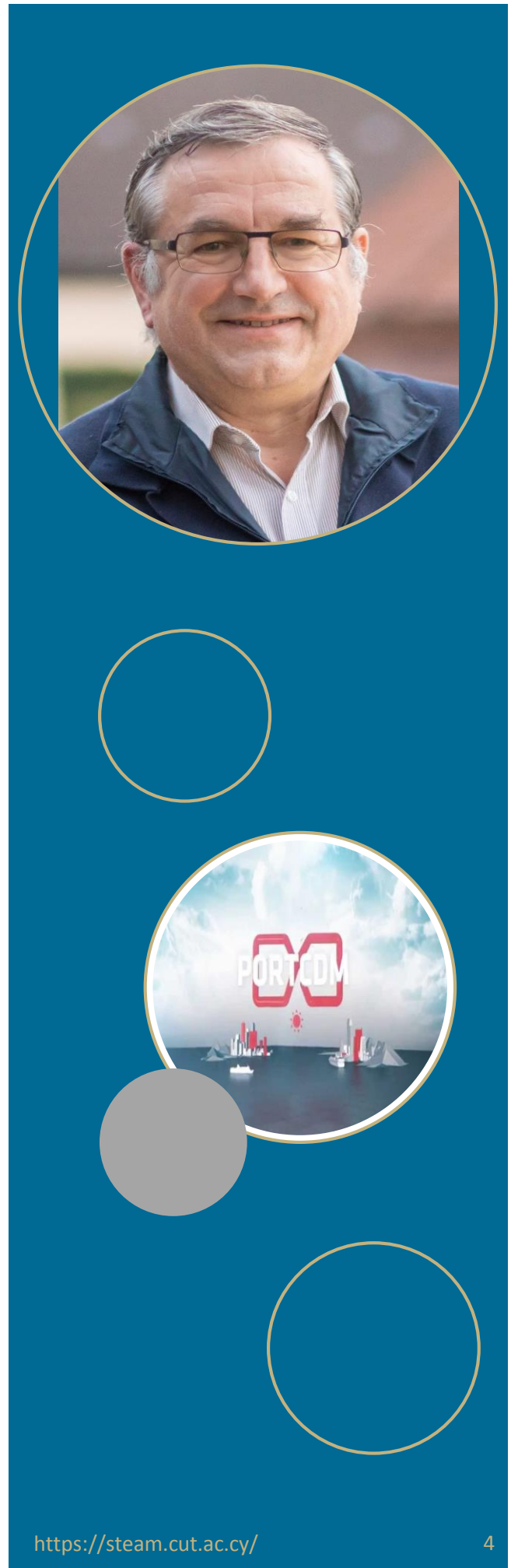
Limassol Shore Center Services

The VTS (Vessel Traffic Services) station has been offering for years high standard navigation services to ships within its area of responsibility. The collaboration between the VTS station and the STEAM project has produced the Limassol Shore Center (LSC), which enriches the variety and scope of services the VTS is able to offer. Specifically the Limassol Shore Center (LSC) provides the following services:

1. Route cross-check
2. Enhanced monitoring
3. Flow management
4. Ship-to-ship collision avoidance
5. Route optimization
6. Safety of life at sea.
7. Environmental pollution monitoring

The offered services are optional for vessels to use but can greatly enhance navigation conditions, safety, and performance for vessels that use them. Tototheo's Marine TM Synergia platform is utilized to perform the key tasks of the LSC. The process is quite straightforward; a vessel navigating near or in the area of responsibility of VTS is asked if they want to receive services from the Limassol Shore Center. If the vessel agrees, the captain is requested to share the vessel route, which is then entered into the Marine TM Synergia system. The system processes the route considering other relevant parameters such as weather and traffic conditions. It then produces suggestions about possible route and speed adjustments. The suggestions are then communicated to the vessel, which may choose to follow them or not. The platform is easy to use and provides the user with a variety of useful information.

Having a multi-year experience as VTS operator, I can say with certainty that the Limassol Shore Center is a concept that will raise the bar of quality for navigation services.

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Achieving PortCDM via 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 SAT is the PERSEUS front-end tool. 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 enables supply chain visibility that in turn enables the actors in the supply chain to improve customer service through proactive status updates, limiting disruptions and risk mitigation. As a result, the supply chain becomes stronger and more agile in the process of having good visibility. The goal of supply chain visibility is to gain advanced insights on how your supply chain works, while reducing risk. Pair those insights with collections of user data, and you are left with a supply chain that can be optimized to be as efficient as possible.

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 both existing systems providers to enhance their functionalities by the consumption of time stamps and allows for third-party innovators to provide new digital services. The use of Perseus puts ports in the position to increase efficiency and safety of their operation.

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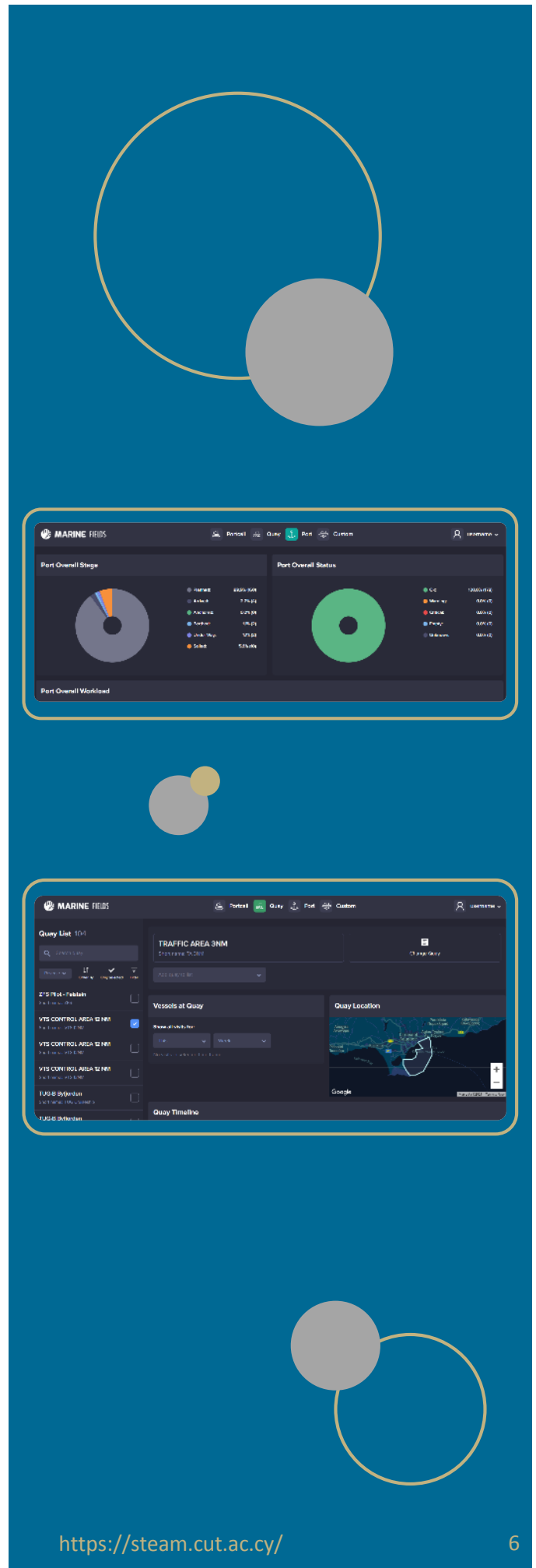
Cyprus Shipping Association

The Cyprus Shipping Association (CSA) was established in 1945 providing a professional forum for its members who are the leading Shipping Agencies in Cyprus. The efforts of CSA are focusing on facilitating improvements in the Cyprus Shipping and Maritime Industry and in support of its members. Also, the development of Cyprus as a maritime and a transhipment hub centre in parallel to improvements in the operation of Cyprus ports and in the laws regulating the shipping and port industry are of primarily importance for CSA. At the same time, CSA looks to safeguard the provision of high-quality service by Shipping Agents in strict adherence to high ethical standard also representing them in their business dealings with the Government, the Legislature, the Operators of ports, the Port and Custom Authorities and all other interested parties and stakeholders. CSA is also actively involved in the health and safety Committee established at Cyprus ports for the protection of port workers from the pandemic of COVID – 19 aiming to safeguard the continuous operation of the ports with very successful results.

Shipping Agents play a hugely influential role in the country's shipping trade and port affairs and constitute a dynamic and progressive section of the business community of the Island. In Cyprus, the Shipping Agents play a dual role, but they are mainly responsible for safeguarding and promoting the interests of their Shipowners both with regards to vessels' operations, and marketing for cargo. Secondly, they are accountable to their principals for the smooth, efficient, and effective operation of their vessels at Cyprus ports such vessels being container ships, ro-ro and car carrier vessels, oil tankers, bulk carrier, general cargo vessels and vessels active in the oil and gas industry. A particularly interesting activity of CSA's Members is the representation of cruise and passenger vessels providing tailor made services for tourists and passengers especially to-day with the pandemic of COVID – 19. CSA sees a number of steps in the right direction such as the establishment of the Deputy Ministry of Shipping, the improvement of the port services by the Operators of the ports, the efforts made to regulate and stabilize the port tariffs and other related issues. Efforts are also made for effectively serving the promising sector of energy which will enormously assist in the further development of Cyprus economy.

"The efforts of CSA are focusing on facilitating improvements in the Cyprus Shipping and Maritime Industry and in support of its members. "

> "CSA will spare no effort and time and continue its efforts closely with all other participants aiming the goals of the STEAM project to be accomplished."

Cyprus Shipping Association

CSA is one of the stakeholders that are involved in the establishment and functioning of the STEAM project whose role and that of its Members i.e., Shipping Agents are important particularly in the port call data related to various ships that are calling regularly or trampers. CSA's Members representing their Shipowners are responsible to lodge with the Port Community System of the Cyprus Ports Authorities all official information and documents (port call data) such as the ship's arrival and departure, the ship's manifests for the discharge or loading of goods, the passenger lists carrying by each passenger or cruise vessel and for any other ship arriving at Cyprus ports for any purpose and/or transaction whatsoever. CSA's contribution for the establishment and functioning of the Port Community System was also very important. Furthermore, for the integration of the port call data into the Perseus platform for further consumption by other stakeholders CSA's contribution and Members are very well recognized and appreciated by the port stakeholders participating also in all other data of the project. CSA Members declare to VTS (Vessels Traffic Service) of CPA the ETA (expected time of arrival) of all vessels along with the ship's documents required as per IMO (International Maritime Organization) directives facilitating thus the procedure for a quick and safe service of vessels. Finally, CSA will spare no effort and time and continue its efforts closely with all other participants aiming the goals of the STEAM project to be accomplished.

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Port-to-Port Collaboration Services

In an interconnected world, the flow and sharing of information has enabled optimization of procedures, making life better for many of us. The Maritime Industry cannot be an exception to the rule. A vast amount information is already shared though digital systems such vessel location via AIS systems, cargo information via Port Community Systems (PCS), etc. When it comes to individual ports though, it seems that this is not always the case. Each port tends to operate as a separate ecosystem, with limited communication with other ports, even with ports at very close proximity.

Following this practice, several benefits are missed that otherwise would have been obtained such as:

➢ Better preparation of the next port for the arrival of a vessel.

➢ The next port can be made aware of potential delays in the arrival of vessel(s) and can better utilize resources committed while a vessel is expected.

➢ If a vessel is expected and it is late, the incident will be investigated much sooner. In the event of an accident, response time is critical, the sooner the better.

➢ An additional piece of information will be available to assist in Search and Rescue operations should the need arises.

PortCDM aims to change this with the concept of Port-to-Port Collaboration Services. Ports utilizing PortCDM can be informed of the current status of the vessel and be aware ahead of time that the vessel has departed its previous port of call and it is on its way.

On a technical level, PorCDM achieves this by allowing the entry of the next destination port and the ETA of the vessel to the next port. I am confident that Port-to-Port Collaboration Services are a major improvement to the Maritime Industry with a lot of potential.

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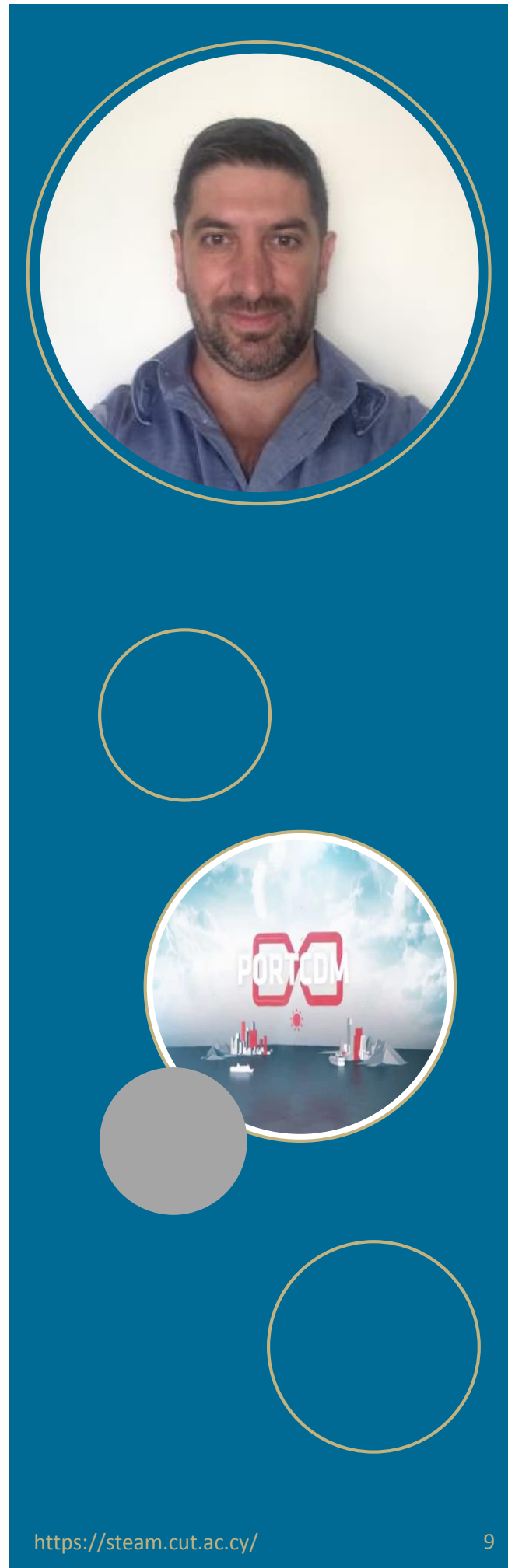
Environmental Monitoring in STEAM

With regards to environmental monitoring, STEAM actions include water and air quality monitoring initiatives. Anthropogenic activities are often sources of air pollutants. O3, NO2, SO2, and CO are important pollutants with implications to human health, environmental degradation, and climate change. Measurements of these parameters as well as air temperature, humidity, and pressure have been collected since March 2020. A bespoke fixed-wing drone carrying compact multi-sensor stations collected data from the Lemesos area (Polemidia). In total, twenty flights took place in the span of five consecutive days. The drone could be further developed and used to identify areas and sources of air-pollution. Apart from the drone, five land stations were set up, additionally measuring particulate matter (PM 10, 2.5, 1.0), a mixture of solid particles and liquid droplets which could include dust, dirt, soot, or smoke. Three air quality stations are set within the Port of Limassol area and two near the anchorage area.

Water quality is monitored through two oil spill alert systems and two buoys. The optical oil sensors register the specific fluorescence of oil and are on land, looking downward, to detect the presence of oil films on the surface of water. Power is provided by a nearby power source. The detector sends real-time data to the CSCS server through wi-fi connection and can be configured to send oil detection alerts to relevant stakeholders. The sensors were placed within the Port of Limassol area in spring 2021. One sensor was removed a few months later, due to interruptions in its function and will be placed at the EDT Offshore Lemesos Port Base.

The two buoys, equipped with water quality sensors and communication systems, were deployed during the summer of 2021: one near the Limassol Marina and one near the aquaculture facilities just south of the Limassol port. The research buoys have a combination of oceanographic instruments that measure conductivity (salinity), temperature, turbidity, chlorophyll, and refined fuels. Chromophoric Dissolved Organic Matter (CDOM) and Fluorescent Dissolved Organic Matter (fDOM) measurements are also recorded. An increase of dissolved organic matter could lead to a decrease in phytoplankton, which may result in oxygen deprivation. LoRa communication technology transmits data to users onshore. The extremely long-range data links are low bandwidth but require little power.

"The optical oil sensors register the specific fluorescence of oil and are on land, looking downward, to detect the presence of oil films on the surface of water."

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

> **"The research buoys have a combination of oceanographic instruments that measure conductivity (salinity), temperature, turbidity, chlorophyll, and refined fuels."**

In addition to the coordination and design, Cyprus Subsea undertook the integration of sensors with buoys, the design and installation of LoRa stations on land, the mooring system design, and final buoy deployments in cooperation with the Cyprus Marine and Maritime Institute (CMMI) and University of Nicosia Research Foundation. Data collection for the calibration of the sensors and the setup of threshold values for the buoy multisensory stations and oil detectors is on-going.

Real time ocean data from the various sensors integrated on the two research buoys are now available to view and download through this web data service: https://erddap.cyprus-subsea.com/. Visualization of environmental data buoys' data flow is available through Cyprus Subsea's visualization platform (login credentials are required): https://sensors.cyprus-subsea.com/. Contact us at info@cyprus-subsea.com for access to these platforms. For more information, please visit https://cyprus-subsea.com/projects/steam/

Furthermore, not only water quality data, but also data acquired by various other sources are available as well through the Environmental Monitoring Platform developed by CUT (https://environmental.cut.ac.cy/). The platform provides the user with the ability to view and download the data, see data analytics through graphs, and monitor the stations through a live map.

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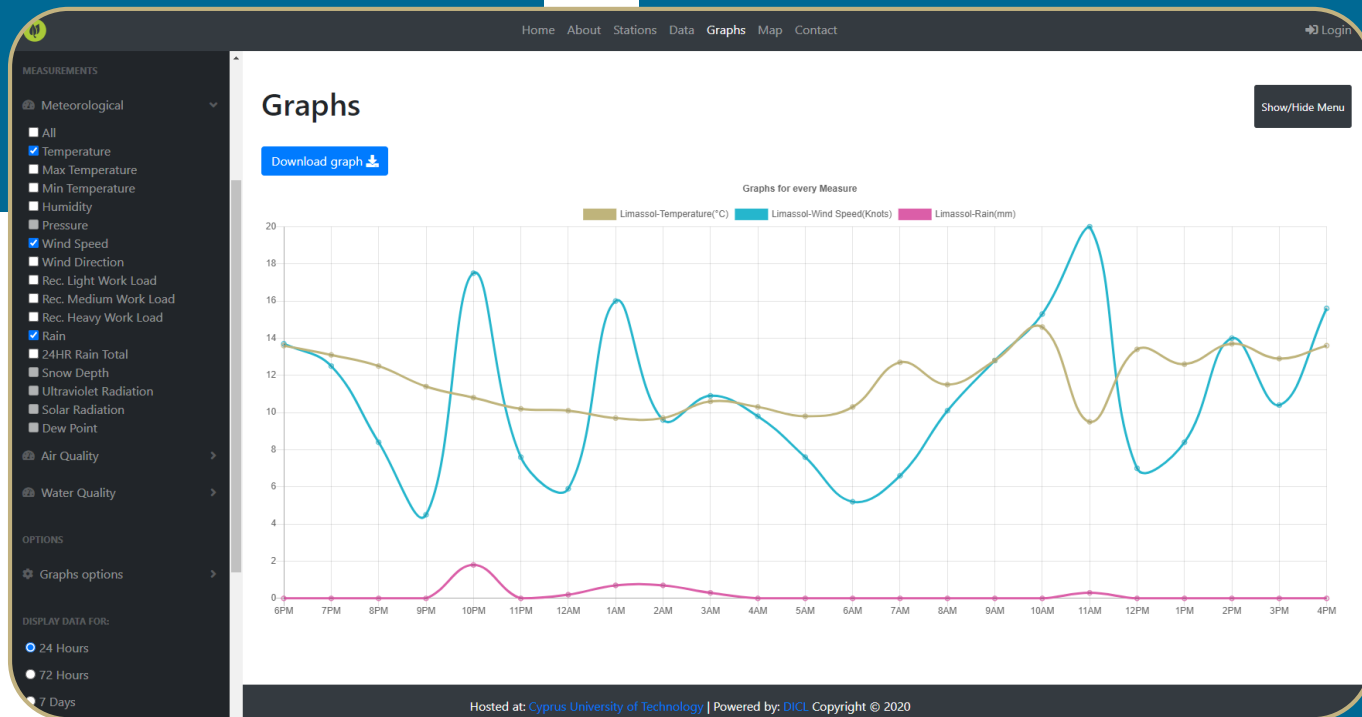Cyprus Subsea Consulting and Services C.S.C.S. Ltd
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Research Buoy off the Coast of Limassol
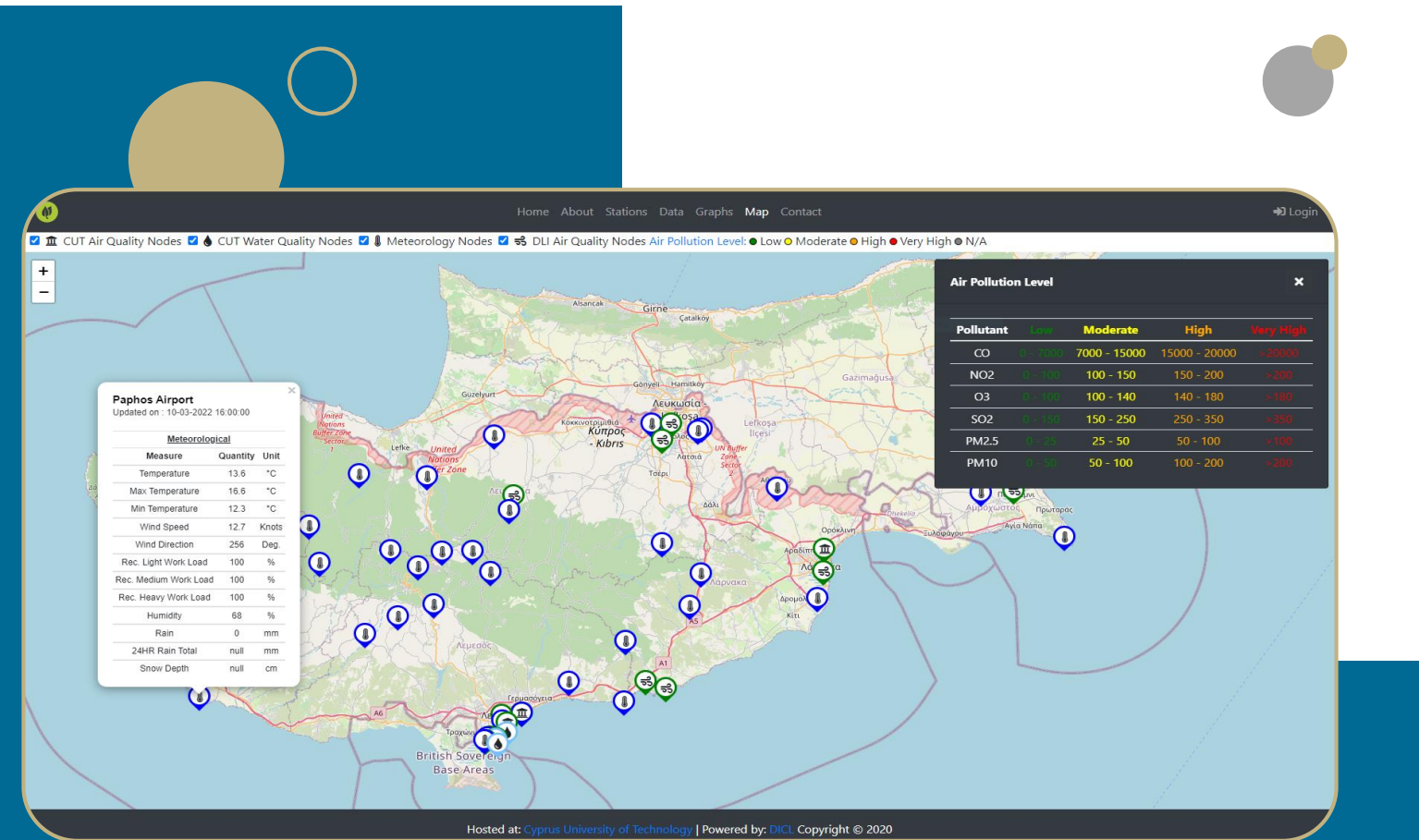
CUT Environmental Monitoring Platform: Live Map

CUT Environmental Monitoring Platform: Graphs

Data Analytics and Business Intelligence

One of the main drives for data analytics as part of the STEAM project is to provide rapid, meaningful insights widely available to support decision-making activities based on those insights. Traditionally, this kind of analysis is done with a data snapshot, transformed, cleansed, and then fed into one-time calculations and analysis that provide results of specific Key Performance Indicators (KPIs) through tables, reports, charts, and other visual aids usually in the form of a report. Every reporting cycle this whole process must be repeated, involving multiple manual steps, until the new set of reports is generated. This inflexibility leads to unanswered questions and missed opportunities to act pre-emptively.

DeLevant's contribution in 2021, was to complete the automation of the cycle started in 2020, improve loading of the daily and periodic (batched) data, provide a secure web-portal, which is visible on the STEAM website, and finally work on the integration of the extensive environmental data that has been collected so far.

The backend technology used to support this feat is based on a curated data warehouse and an On-Line Analytical Processing (OLAP) cube, which consumes data from the data warehouse. This OLAP cube provides the backend data for the Power BI dashboards for secure high-performance reporting via a user's web browser allowing for cross platform viewing (PC, Mac, mobile etc.).

The Power BI reporting is currently composed of a series of dashboards. These dashboards are fully interactive with KPIs that can be filtered or 'sliced and diced' per port, time-period, vessel type, origin or destination ports, and various other categories. In one 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 other dashboard, significant productivity KPIs are visualized based on various filtering conditions.
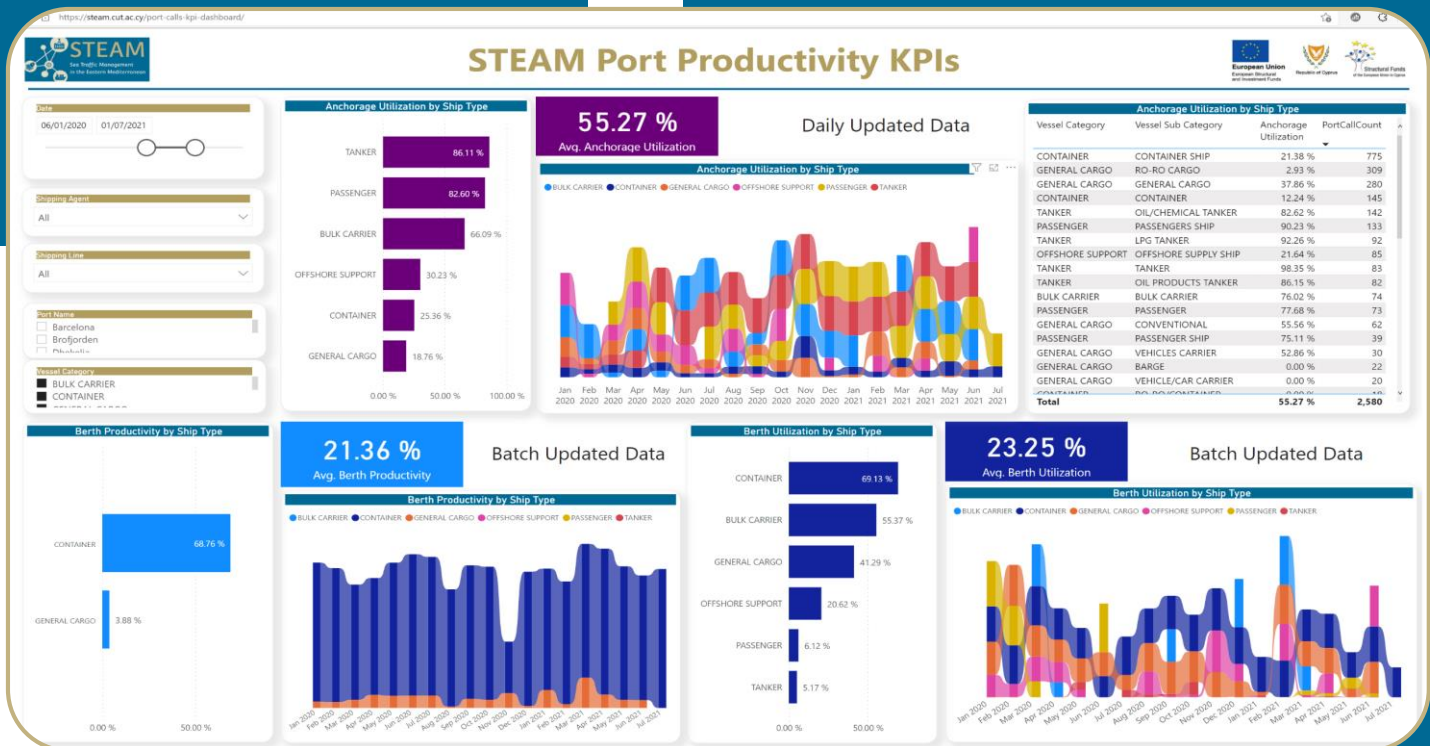
An updated version of the report, expanding this functionality significantly, will be delivered early in 2022.

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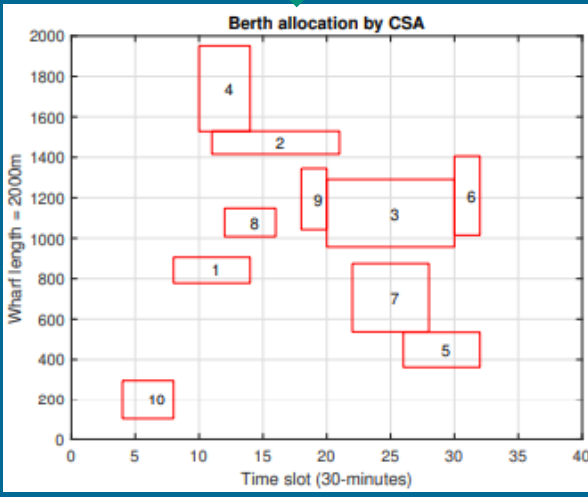aris.televantos@delevant.com
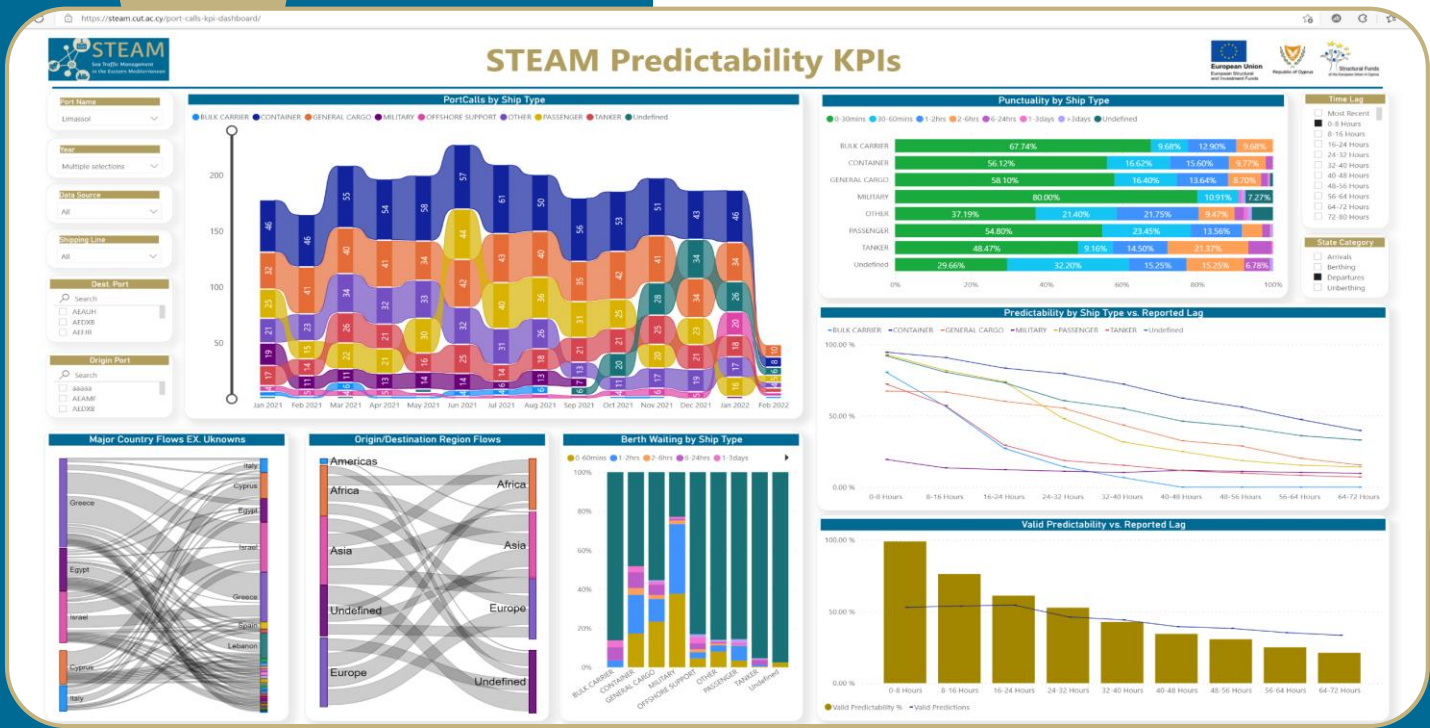
Dashboard with Predictability KPIs

Dashboard with Port Productivity KPIs

| Ship #	ETA	HT	ETD	PBP	LoS
1	4	3	8	778	128
2	5	5	11	1416	113
3	10	5	15	957	334
4	4	2	8	1437	423
5	13	3	16	362	173
6	15	1	18	1015	391
7	11	3	15	434	338
8	6	2	9	1008	140
9	9	1	11	1043	302
10	2	1	3	102	194

Cuckoo Search Algorithm

Dataset and Solution Representation by CSA

Enhanced Berth Allocation Using Cuckoo Search Algorithm

The berth allocation problem (BAP) is one of the most important optimization problems in container terminals at ports worldwide. From both the port operator's and the shipping lines' point of view, minimizing the time a vessel spends at berth and minimizing the total cost of berth operations are considered fundamental objectives with respect to terminal operations. This study solves the BAP where berth positions are assigned to arriving ships with the objective of reducing the total service cost, which includes waiting cost, handling cost, and several penalties, such as a penalty for late departure and a penalty for non-optimal berth allocation. First, the BAP is formulated as a mixed-integer linear programming (MILP) model and then solved by metaheuristic-based Cuckoo Search Algorithm (CSA). To validate the performance of the proposed CSA-based method, two benchmark approaches are implemented, namely, the genetic algorithm and the optimal MILP solution. Next, we conduct several experiments using a benchmark dataset as well as a randomly-generated larger dataset. Simulation results show that the proposed CSA algorithm has higher efficiency in allocating berths within a reasonable computation time than its counterparts. This work has been submitted as an invited paper to Springer Nature Computer Science.

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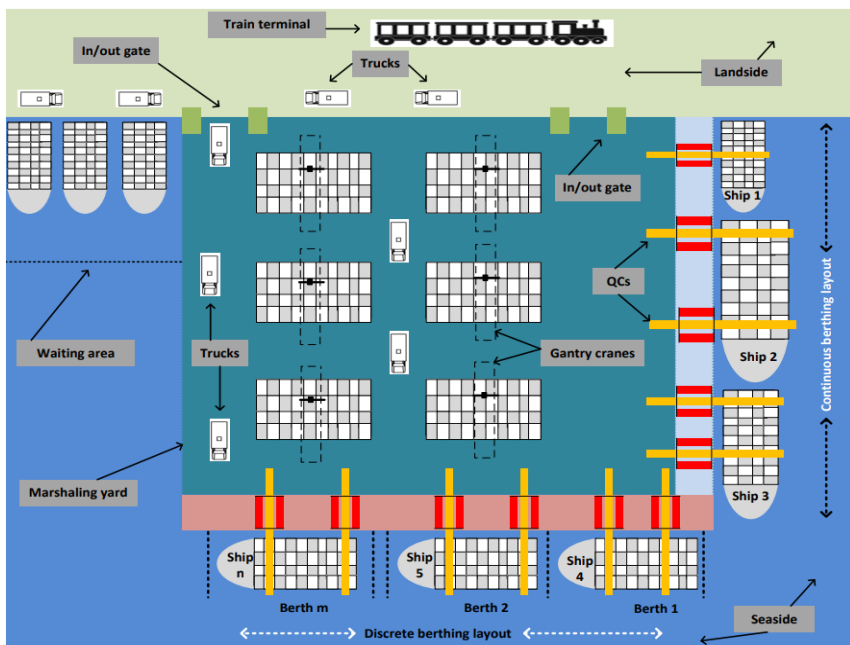
An Overview of Maritime Container Terminal

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.

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