

PRACTICAL APPLICATION OF DIGITAL TWIN AND AI AT THE PORT OF ALGECIRAS

A PILOT FOR OPTIMIZING FERRY OPERATIONS



“THE BROADER INTRODUCTION OF AI IN PORTS AND TERMINALS TO MAKE THEM MORE EFFICIENT, SAFER AND SUSTAINABLE IS STILL A LONG WAY OFF, DUE TO DATA AVAILABILITY AND QUALITY REMAINING A CHALLENGE.”



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Artificial Intelligence (AI) is everywhere and is being utilized on many fronts, producing good results from narrow scopes. Whilst image recognition is going beyond traditional OCR systems and video analytics are being used to measure truck queues, the broader introduction of AI in ports and terminals to make them more efficient, safer and sustainable is still a long way off, due to data availability and quality remaining a challenge.

In this paper, the Port Authority of Algeciras Bay (APBA) and NextPort present the results from a Pilot conducted in the summer of 2023, where the most intense ferry operation in Europe was supported by machine learning algorithms and simulation to enable new paradigms for decision-making.

In simple terms, NextPort's Digital Twin brought together descriptive, predictive and prescriptive capabilities, demonstrating that combining different data sources with historical foundations can benefit contingency diagnosis and associated problem solving, providing the user with suitable solutions and predictable outcomes.

INTRODUCTION - CONTEXT & PROBLEM STATEMENT

The operational management of Operación Paso del Estrecho (OPE, and Marhaba in Morocco) brings a challenge to the Port Authority of Algeciras Bay every year. Exact passenger numbers and vehicle flows are uncertain, and there are normal deviations in vessel schedule planning between the collaboration of ferry shipping lines,



port authorities in Algeciras and Tangier, and other stakeholders such as Frontier Security Bodies.

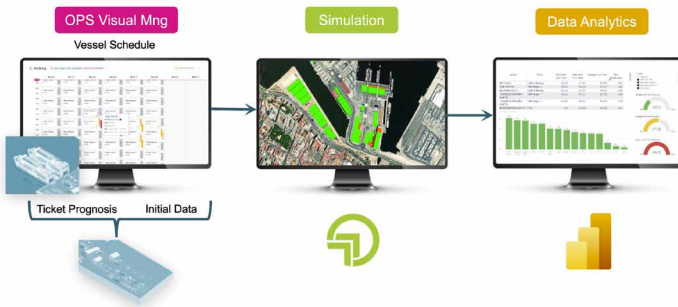
The Pilot research process provided the following understanding of ferry (RoPax) operations at OPE/Marhaba:

- Berth schedules are not reliable enough and the different stakeholders are constantly communicating and fine-tuning plans.
- A berth conflict produces a ripple effect in waterside operations, challenging operations managers to make real-time decisions with the limited availability of high-quality information.
- It is complex to accurately predict parking parcel occupancy, serving to receive and facilitate vehicle transit at ports.
- Measuring performance and

developing statistics for OPE/ Marhaba is difficult as there are several sources of information to correlate.

To tackle these outlined problems, the following solution components were deployed in the Pilot at Algeciras between June and September this year, as part of the NextPort Minimum Viable Product (MVP):

- Operational Visual Management with the Berth Management App that provides conflict alarms and alternative solutions for anticipated contingency management.
- Background Machine Learning (ML) model to predict conflicts and propose alternative solutions, as well as on-demand simulation to evaluate 'what-if' scenarios for proposed solutions.



LEFT
Berth Management
App

An integrated user experience drives decision-making by utilizing data, forecasts conflicts proactively and proposes solutions, which in turn connects waterside and landside operations. It offers the user metrics and key performance indicators as part of a dashboard, through data analysis.

The Pilot's goal was to validate the tools mentioned within the framework of a Digital Twin applied to ferry operations. This validation took place in collaboration with various departments of both the waterside and landside Port

Authority, as well as the Security Port Police.

The Digital Twin solution deployed for the Pilot, still in the MVP stage, includes the following components:

Berth Management App:

The Berth Management application developed by NextPort assists in the coordination of ferry vessel calls. It provides precise and reliable information based on the combination of multiple data sources and historical registries to consider ML-using behavior

patterns, delays, rotations, etc., while it forecasts conflicts and recommends alternative solutions.

The AI functions provide a predictive layer, which is seamlessly integrated into the berth dashboard: it intuitively displays the overall information of vessel calls and berth assignments and also includes reliable estimations on ETAs and ETBs, analyzing and predicting any future conflicts due to overlapping or forecasted delays.

Once a conflict is identified, the application leads the user through a decision-making workflow that connects plans, conflicts and trouble-shooting. Intuitive user screens establish a digital dialogue that augments user capabilities whilst driving them through the decision process.

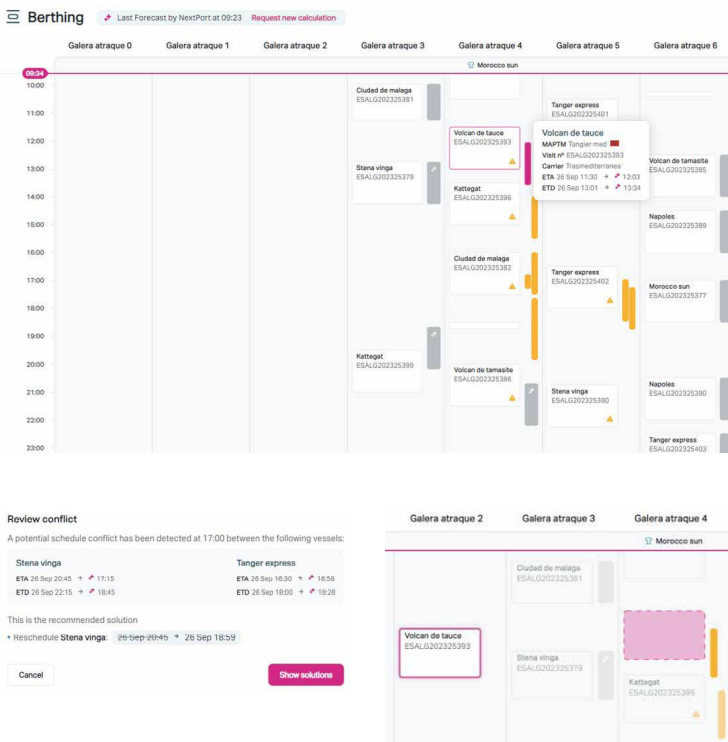
Traffic & Parking Simulation:

As part of this data-driven decision process, NextPort helps evaluate the impact of the proposed alternative solutions on parking areas and vehicle traffic landside. A simulation model closes a feedback loop to connect waterside and landside, producing an estimation of operations for the next 24 hours.

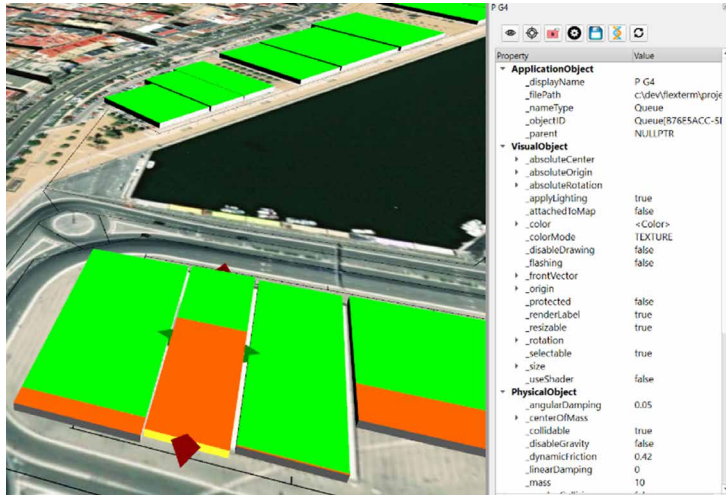
FlexTerm's simulation application utilizes various data sources by combining vehicle arrival forecasts from the prediction of passenger ticket sales and then filtering specific scenarios related to available parking areas and their occupation limits.

The simulation results in reports and KPIs for the users and Operations Manager, which provide analysis of the occupation and congestion levels landside, as well as waiting time distribution for vehicles crossing the port. This provides operational anticipation and situational awareness in advance, assisting with parking area and parcel utilization and enhancing arrival and evacuation capacity, as well as supporting data decisions such as adjusting or modifying traffic flows at the port.

LEFT
Traffic & Parking
Simulation



RIGHT
Data Analytics
Balance Scorecards



to evaluate the effectiveness of the Algeciras–Tanger Med ferry schedules, as well as identifying other areas of focus such as ferry vessel utilization.

SUMMARY OF THE PILOT AND WAY FORWARD:

Jointly with the Algeciras Bay Port Authority, NextPort concludes the innovation of this Pilot mainly consists of:

- Data processing and analysis from historical registries and capturing real-time events to generate the necessary foundation for machine learning algorithms, in its application to assist berth management and vessel call processes.
- Landside process simulation, in its connection with identified waterside conflicts, to generate future situation awareness and ‘what-if’ scenario analysis to estimate the impact of alternative solutions.
- Monitoring of decision process integration and real-time

Data Analytics Balance Scorecards:

Finally, the solution integrates a data analytics capability that translates into on-demand data visualizations, balanced scorecards and automated learning, complementing knowledge generation for users, not only for simulation, but all general data sources. This enables the analysis

of not only vessel schedule deviations and delays but also the associated root causes, helping Port Authorities to establish data-driven relationships with stakeholders and generate an overall, continuous improvement capability that informs decisions and optimization.

In this case, the focus has been on analyzing ferry vessel rotations



prediction of conflicts to improve decisions using AI and a holistic combination of optimization techniques.

The outcome of the Project is jointly assessed as follows:

- Software prototype of a Digital Twin of the OPE/Marhaba process that allows the scale of ferry/RoPax vessels to be managed more efficiently, determining optimal berthing, time and date in case of conflicts, and considering the impact of such decisions on land operations.
- For APBA, a Digital Twin product that assists with the optimization of ferry operations (conceived as a Digital Twin platform) would be a useful addition to existing applications to connect processes and manage berth locations and parking areas – validated in extreme conditions such as at OPE/Marhaba.
- For NextPort, this meaningful validation – which includes technical feasibility and functional customer value, helps with the next stages of product development for ports and their communities, also extending the resulting decision-making and optimization process to other value chains such as RoRo or container traffic. There is also the possibility of offering the predictive capability to the Port Authority ecosystem, with the mentioned predictions being utilized by other platforms such as Port Community Systems or Port Management Systems.

ABOUT THE AUTHORS:

Jesús Medina is Chief Information & Innovation Officer at Algeciras Port Authority. He is a Telecommunication Engineer, holds an MBA and has a proven track record in port business and technology. He is in charge of leading the digital transformation and fostering the innovation culture at Algeciras Port Authority.

Agustin Martinez is Head of the Planning and Fulfilment Operations Department at Algeciras Port Authority. His duty is to lead the implementation of a process management operative model in the Port Authority and to be in charge of Maritime Operations. He holds a MSc in Telecommunications Engineering.

Jose Garcia is a Telecom Engineer with more than 20 years of experience working for port authorities, Port Community Systems and Logistics companies. He's been responsible for the development with Valenciaport PCS and has long international experience. He joined NextPort.AI as Senior Product Manager, leading software products for ports.

Mario Lucio is a Telecom Engineer with more than 25 years of experience as Project Manager implementing turn-key technological projects in Ports and Terminals: Maritime Traffic Control Centers and the Access & Gate Automation are some of the projects. He joined NextPort.AI as a Project Manager and Subject-Matter Expert for Ports.

ABOUT THE COMPANIES:

Algeciras Port Authority, located at the Strait of Gibraltar, is the first Spanish and fourth European port in terms of total cargo. With more than 110,000 ships/year crossing the Strait of Gibraltar and 7,500 hectares of deep and sheltered waters, Algeciras is promoting a one-stop-shop port concept for vessel services (bunkering, repairs, ship supplies and others).

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the investment and launch of NextPort® as Technology & Innovation brand, M&N seeks to accelerate the development of SmartPorts, as well as the productisation of its capabilities for Digital Twin solutions and practical implementation of Artificial Intelligence for the Maritime Industry.

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