Simulation of Inventory and Primary Logistics management for Refineries and Depots

Marc Escandell Mari and **Nurul Musfirah Murad**

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Content

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Who are we?

Data Scientist Manager

I am a seasoned simulation modeler with over 10 years of experience optimizing decision-making processes across various industries, including oil and gas, pharmaceuticals, car manufacturing, logistics, airports, finance and others.

Born in the small island of Formentera, Spain, I have a passion for watersports, especially windsurfing.

I hold a degree in industrial engineering from UPC in Barcelona and enjoy coding and developing engaging, aesthetically pleasing user interfaces

Data Scientist

With 2 years of experience in Data Science, I have contributed to optimization and simulation modeling. Among others, I have worked on a project for refinery and depot inventory management, which helped improve logistics across Peninsula and East Malaysia.

During my free time, I enjoy spending quality moments with loved ones, indulging spa treatments or manicures.

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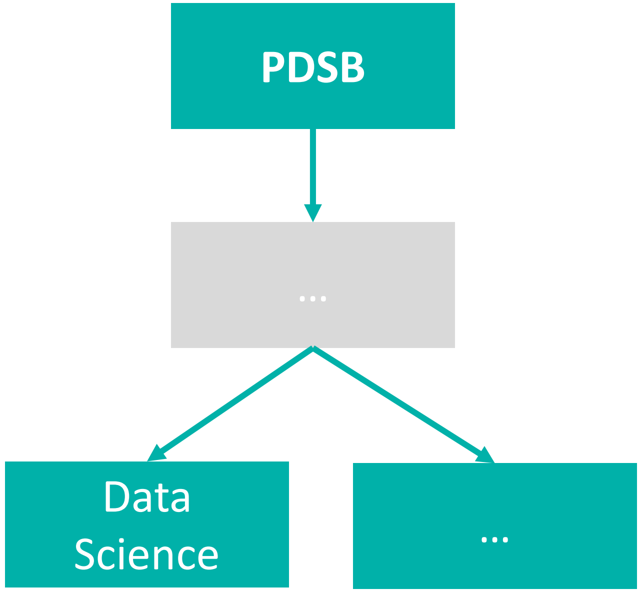
System Simulation is a central competency of the Data Science Department at Petronas Digital Sdn. Bhd. (PDSB)



- Advanced Machine Learning
- Computer Vision
- NLP and GenAI
- **Optimization and Simulation**

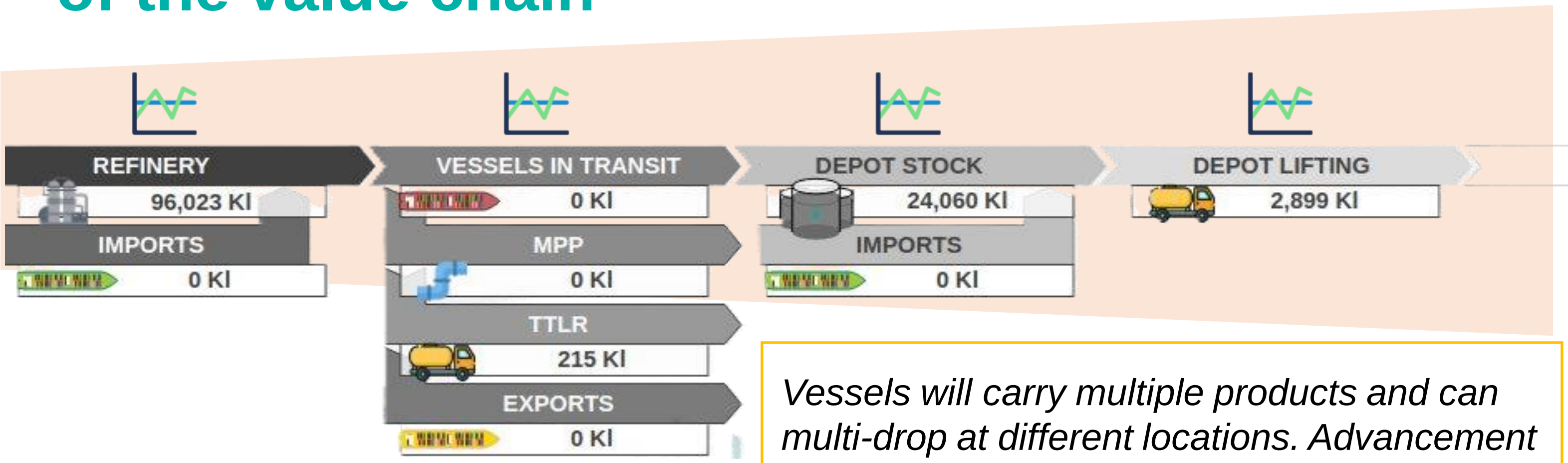
KEY HIGHLIGHTS

*Simulation and optimization-based projects have been, and continue to be, **major contributors** to significant cost savings.*

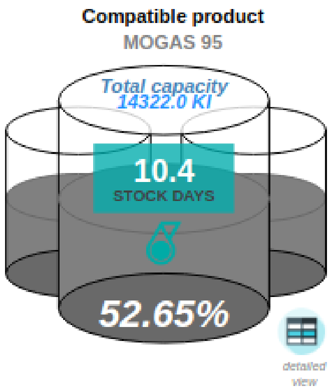
*Simulation acts as an ideal platform and **integrator** for other solutions, such as optimization and machine learning algorithms, seamlessly blending them with domain expertise and processes.*

*The department has developed simulations across diverse and complex areas, including **logistics**, **inventory management**, **refinery processes**, **energy savings**, and even **pedestrian flow** dynamics.*

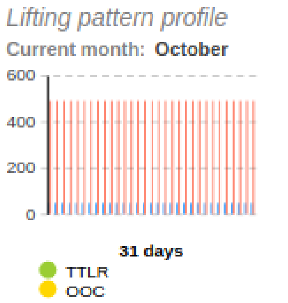
Planning and operations are complicated by uncertainties at various stages of the value chain



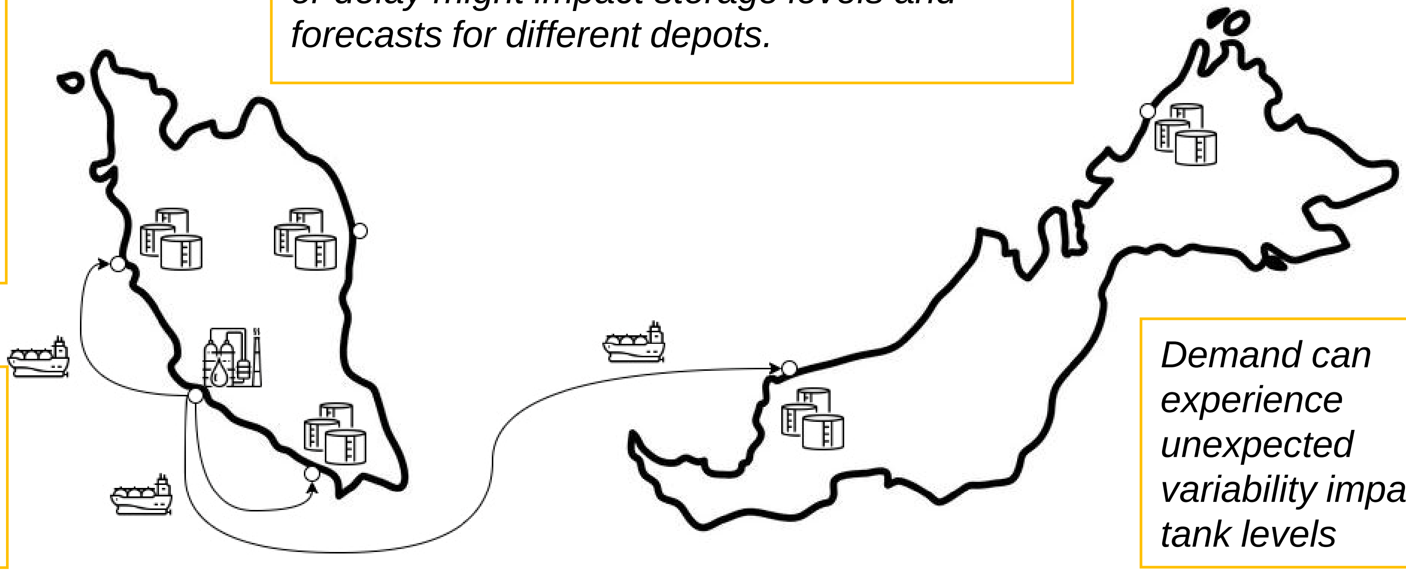
To avoid tank top or an empty tank is the planner primary objective



Vessels will carry multiple products and can multi-drop at different locations. Advancement or delay might impact storage levels and forecasts for different depots.

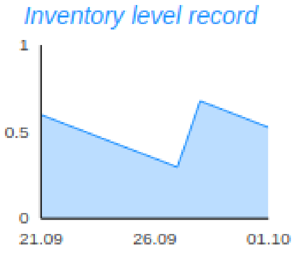


Vessels fill their tanks at the refinery that has storages for end product. Insufficient stock can cause delays.



Vessel trip time can experience delays due to unexpected failure or weather conditions

Demand can experience unexpected variability impacting tank levels



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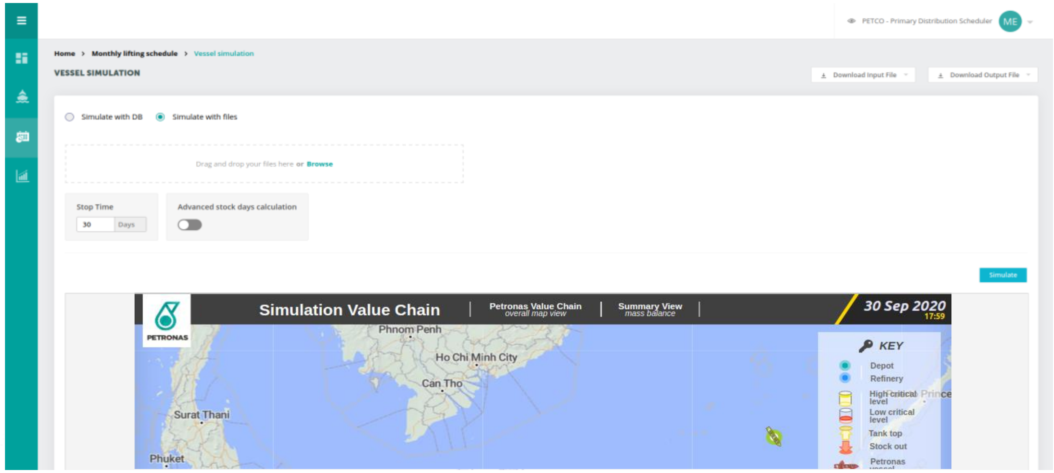
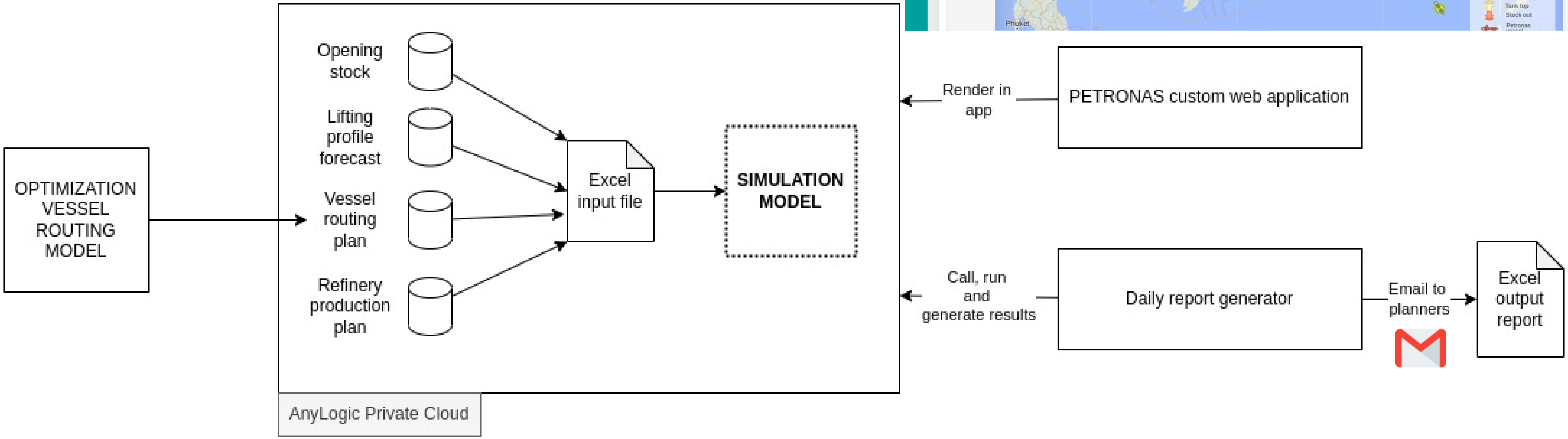
The developed simulation encompasses the entire process from refinery production and storage to vessel distribution and final lifting at depots

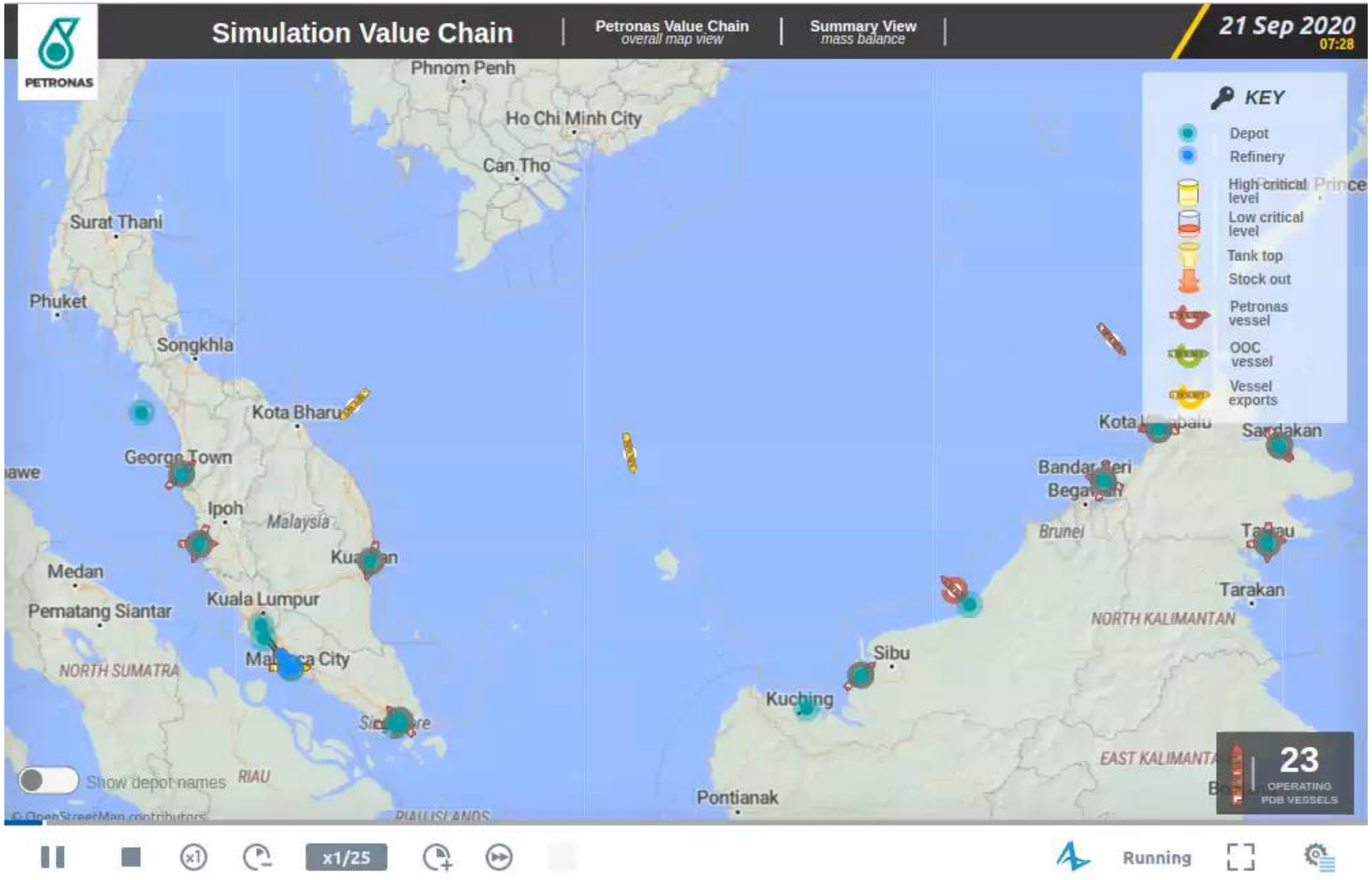
Data is collected automatically *from all sources and formatted into a user-friendly Excel that can be edited easily by user for scenario experimentation.*

A report is generated automatically every day *and results are emailed to planners*





The simulation enables planners to assess and strengthen the resilience of their plans for the upcoming month



Planners follow 3 steps before final plan submission:

- Run simulation with the data extracted.
- Adjust vessels unload date to ensure avoidance of tank critical levels.
- Run Monte-Carlo experiment to validate resilience of proposed plan given a certain failure risk (e.g., 92% success of bottom tank avoidance and full vessel unload)

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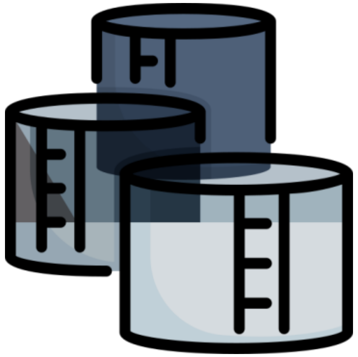
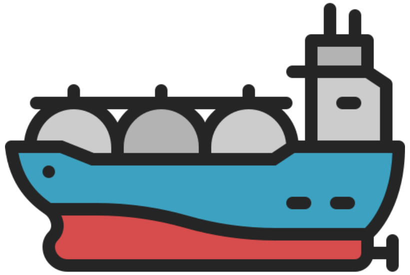
Benefits to stakeholders



Daily automated depot inventory forecast based on opening inventory

~1.5 hours

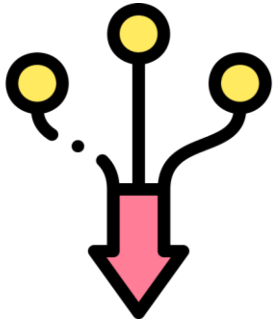
saved compiling data (which was done manually –less error prompt)



Vessel routing plan validation and resilience test given a failure rate tolerance

~35%

more resilient planning (accounts for potential vessel delays and uncertain lifting volumes)



Refinery production plan and vessel discharge plan consolidation

Better integration and communication between units

Average product inventory at each supply chain stage

Better mass balancing metrics

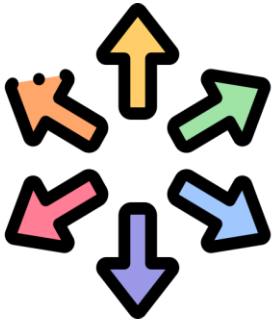
Conclusions

Customer lifting at depot is the most uncertain stage in the supply chain

Develop more accurate predictive models (e.g., machine learning)

Automate vessel adjustment according to critical levels

Optimization engine that minimizes movements and overall cost



Expand model to include other complexities/operations and business in the value chain

Include vessel maintenances, availability and compatibilities

Why we chose AnyLogic?

- It uses **Java** as the core language, which offers great **performance** and a vast community with a diverse ecosystem of **packages**. It is also a great language for **Object-Oriented Programming**.
- **AnyLogic Private Cloud** gives great **scalability**, quick **model sharing** and a customizable **experimentation** platform, custom **web integration** capabilities and a **python API** to be used in reports built in jupyter notebooks, among others.
- It allows a great level of customization to model almost any **business logic** as well as available **built-in libraries** (e.g., fluid library).
- It enables to build useful, beautiful, engaging and dynamic **visualizations**.

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Q&A

- How does the simulation account for unpredictable events such as sudden weather changes or unexpected equipment failures, and how accurate are the resulting forecasts in these scenarios?
- Can you elaborate on the Monte-Carlo experiments used in the simulation? Specifically, how do these experiments validate the resilience of the proposed plans under varying levels of uncertainty?
- Given the multi-destination and multi-product capabilities of the vessels, how does the simulation prioritize or optimize the vessel routing to ensure minimal delays and maximum efficiency across the supply chain?