REAL-TIME WATER LEVEL MONITORING & FORECASTING

Using continual deep learning models on historical data & real-time water level sensors to elevate Adaro's mining logistical operations
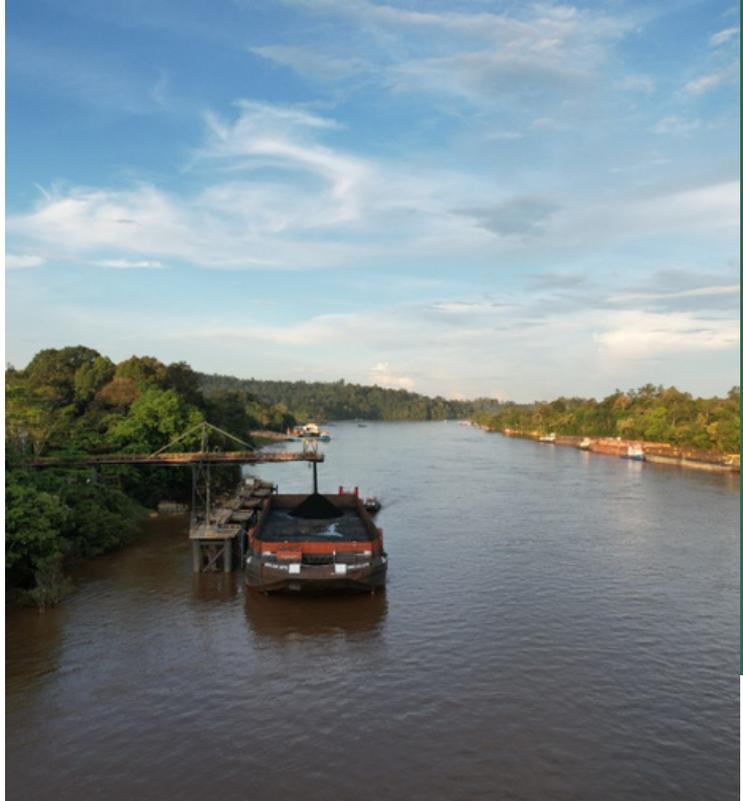
AT A GLANCE

Challenges

- Multiple key locations along the river with varying degrees of water level fluctuation pose operational challenges in maintaining the transportation fleet all year round
- Chartering team relies on human judgement in hiring barges, leading to excess or shortage in delivery vehicles that are operationally costly and disruptive

Benefits

- A centralized data warehouse tracking the water level of multiple locations, with a queryable API service which **saves 920 hours every month**
- A fine-tuned deep learning model that takes prediction error down to a margin of **±9%**, which translates to cost savings of ~$2 million annually

CHALLENGES

A leading coal operator in the region, Adaro rely on river transportation for their coal mining operations in the Kalimantan province of Indonesia. Its fleet of 40 to 45 barges ferry the coal through the 1,090km long Barito river arriving at the destination port for the seaborne coal trade.

The hourly and seasonal fluctuations can see certain segments of the river completely dry up, resulting in barges being stranded, damaged, and incur a safety risk to its operators. When water level is too high, barges sailing through certain segments of the river are at risk of collision with the canal bridges at different junctures of the Barito river.

Without the combination of data and predictive analytics, operators have limited means of knowing in advance the water level at different points of the river, and sailing on water level that is either too low or too high can have expensive and devastating consequences, from a personnel safety perspective in addition to causing operational and logistical disruption, both of which are extremely costly.

Operations and Logistics Planning department have difficulty in ensuring the right amount of barges are provisioned beforehand if there is no way of forecasting the number of sailable days. Teams on the ground have to rely on gut instincts in deciding on an appropriate load capacity taking into consideration the fluctuating water level along Barito river.

Supertype

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A P P R O A C H

i. Cloud First and Digitalization.

Adaro Mining Technology (AMT), led by Pak Eri Basuki, provided Supertype with up to 13 years of historical water level at key sections of the Barito river. The data are collected manually in spreadsheets. A data pipeline is constructed by our engineers to extract, transform (clean) and load the data into a centralized BigQuery data warehouse.
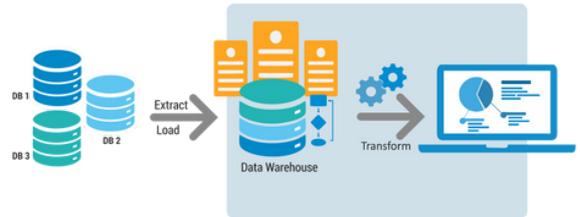
ii. Queryable and Synchronization.

AMT and Supertype work together on the necessary architectural design between how data could be queried and consumed by the various supporting applications within the analytics stack. A queryable interface is created by our engineers to allow for data retrieval, updates and consolidation in real-time.

iii. Predictive Analytics and Continual (Deep) Learning.

We develop a highly tuned model using the latest in neural networks research to predict water level for the days and weeks ahead. In later phases of this project, AMT installed water level sensors for the continuous water measurements of the water level at different spots of Barito river. Our cloud infrastructure along with the data pipelines made it easy to stream these measurements directly to our cloud storage in 10-minute intervals, and the forecast model is continually re-trained on Google's Vertex AI platform to produce up-to-date forecasts using incoming data.

> The Supertype team has demonstrated high capability in understanding our challenges, which were relatively new to them in a relatively short time. The resulting model also has a high degree of accuracy, which we can use to reduce the element of surprise in our dynamic coal supply chain. Currently, it's like having a special ability to predict the very dynamic of natural conditions. We are very satisfied with the work of Supertype.

Eri Basuki
President Director, Adaro Mining Technologies

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KEY DELIVERABLES

- A proper, well thought-out cloud architecture that uses proven, modern data warehousing technology that consolidates:
    - (1) **all 13 years of historical water level** measurement
    - (2) incoming data streams from **multiple water level sensors** installed at various points along the river
    - (3) prediction of water level that is the result of a **continually trained deep learning model**
    - (4) other schematic information
- A REST **API service to enable ad hoc querying** as well as CRUD access to the centralized data warehouse
- Custom-trained deep learning models that are continually trained and deployed on Vertex AI, to return accurate prediction of water level at key checkpoints of the Barito river with upwards of **91% accuracy**
- A **fully automatic** machine learning task that generate predictions for water level daily; as well as a 3-month forecast for the number of loadable days (to be distinguished between half-load, full-load)
- For the business user, Supertype's business intelligence developers create a **Google Data Studio (Looker Studio) dashboard as a business support tool**, aiding in decision-making through visualization, analytical charts, first- and third-party data (such as weather condition in the Barito river basin
- A slick, integrated web application developed with React and modern server-side technologies to help the client acquire key insights on water level, query data, inspect water level forecasts, perform two-way synchronization with the data warehouse and access business intelligence features

Key Benefits

Savings from barges rental and procurement

The three months forecast generated by Supertype produced an MAPE of **~9%**, and is critical at helping Adaro procure just the right amount of barges for the months ahead, producing **up to $1,890,000 in savings** annually from un-utilized barges.

End to end automation reduces labor & error

The EL (Extract - Load) pipeline provides a real-time data streaming mechanism for payloads of sensor data from the installed sensors.
These data packets are streamed and immediately buffered into BigQuery on a 10-minute interval, at a total transfer rate of ~6s, making it available for ad hoc query, exploratory analysis and machine learning procedures.

Along with the automated machine learning inference and retraining pipeline, the data warehousing and automated pipeline save an estimated **920 man-hours every month (~$150,000/year)** in labor cost.

Key Technology

Supertype