RESOURCE OPTIMIZATION: FORECASTING ENGINEERING CAPACITY AND PLANNING MATERIAL AVAILABILITY

Capstone Project Summary

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Project Overview

This capstone project addresses a high-impact operational challenge faced in the execution of complex infrastructure projects in the construction industry, involving a system known as the Free Cantilever Traveller (CFT). These projects are technically demanding and require careful planning of engineering manpower and specialized material stock, both of which are often limited in availability and tied to long lead times.

The core objective was to develop a predictive, dashboard-driven decision-support tool that improves the visibility of engineering capacity and material availability several months ahead of project delivery. By doing so, the solution helps planners proactively identify resource shortfalls and take early corrective action, such as hiring or procurement, before bottlenecks affect delivery timelines.

Methodology and Work Done

The project involved the integration of multiple datasets related to engineering logs, planned project timelines, and material needs. These were initially provided as manually updated spreadsheets. Data cleaning and preprocessing were performed using Power BI's Power Query interface, including date standardization, monthly aggregation, and the construction of a custom calendar table to ensure temporal alignment across all datasets.

Two main dashboards were built:

Engineering Capacity Dashboard – This visualizes the monthly engineering hours available against hours required by upcoming projects. A key feature is its predictive layer, which estimates future engineer availability using historical time logs and a machine learning time-

series algorithm (Prophet). Capacity flags are triggered when future project demands exceed engineer availability or when too many projects overlap simultaneously.

Material Stock Dashboard – This models the monthly inflow and outflow of critical components (specifically longitudinal frames used in CFT builds). It computes a running stock balance and raises alerts when the projected inventory drops below safe thresholds. Users can simulate different starting stock values and delivery timelines to assess risk.

A key innovation in the project is the use of forecasting algorithms to replace static assumptions. Engineering hours were predicted per individual using Prophet, accounting for seasonality and working hour caps, resulting in a more realistic view of future workforce availability. These forecasts were then integrated into Power BI and used alongside DAX logic to drive automated alerting and scenario-based analysis.

Benefits and Impact

The solution delivers clear and actionable value to project planning teams by shifting decision-making from reactive coordination to proactive resource management. With a 5–6 month predictive window, stakeholders can now anticipate capacity gaps or material shortfalls well in advance of project delivery. The use of automated flags in the dashboard enables timely actions, such as initiating procurement processes or adjusting engineering assignments, thereby minimizing disruption. Furthermore, the solution is built on a modular and scalable Power BI platform that allows for future expansion to other materials, project types, or even real-time data sources. By increasing visibility and forecast accuracy, the tool significantly reduces the risk of last-minute delays, engineer overload, or unexpected stockouts, challenges that are particularly costly in large-scale infrastructure operations.

Learning Outcomes and Reflections

This project was a deeply rewarding and challenging journey in applied business analytics. One key learning was the importance of balancing technical rigor with user usability, designing not just a functional model but one that stakeholders could understand, trust, and act upon. Building a data model that translated business rules into DAX logic, while ensuring a smooth visual experience in Power BI, taught valuable lessons in communication between analytics and operations.

The integration of machine learning forecasts was another highlight. Working with Prophet in Python pushed me to consider how predictive models can be designed not just for accuracy, but for interpretability, an essential feature in operational tools.

Finally, I gained firsthand experience in the challenges of data quality and pipeline automation. While the project currently relies on manually maintained spreadsheets, designing it with future integration in mind (via CRM or ERP systems) taught me to think modularly and plan for long-term maintainability, a key concern in real-world analytics deployments.

Final Thoughts

This project demonstrates how analytics, forecasting, and visualization can combine to address a niche but mission-critical problem in engineering project management. While some limitations remain, including data manuality and scenario simplification, the resulting tool provides a strong foundation for data-driven decision-making. It is my hope that this work will continue to evolve and contribute to more efficient and intelligent planning for CFT and similar projects in the future.