Applying Operations Research to Optimize Annual Delivery Program (ADP) in LNG Transport

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Objective

The Liquefied Natural Gas (LNG) industry plays a significant role in the global energy market and is experiencing strong growth. The LNG transport planning typically operates with a horizon of 12 months. Before the beginning of each contract year, LNG supplier agrees with buyers on an annual delivery program (ADP) to ensure efficient delivery and receipt of LNG cargoes. This study looks at optimizing ADP for LNG exporters based on production predictions, fleet characteristics and delivery contracts, and generate smooth and safe cargo lift, berthing and delivery schedules.

Methods, Procedures & Process

Operations Research, being part of Artificial Intelligence in the broad sense, provides modelling and algorithmic methods and techniques to make use of data in providing support to decision making processes.

In this project we propose an optimization model considering LNG production and storage, cargo lift planning and berth and ship scheduling simultaneously. The objective is to minimize logistics costs while respecting all safety and operational constraints, including inventory limitations, berthing time (e.g., tidal) restrictions, delivery contractual frequency and quantities, etc.

This combined optimization model, encompassing fleet composition, ship scheduling, berth scheduling, speed optimization and inventory management, is complex, but provides an integrated and accurate representation of the decision-making problem faced by many operators in the LNG business.

Results, Observations & Conclusions

We present a comprehensive computational study where we optimize realistic LNG ADP optimization problems of various sizes using a state-of-the-art commercial solver. The problem sizes tested range from one typical LNG cargo loads every 1 or 2 days, using 1 to 2 berths, 5 to 8 ships and across 2 to 12 months planning horizon. We show that this ADP optimization problem is challenging for even one of the best solvers in the market, especially when size is increased to a certain level. Therefore, exploration of alternative methods to solve these complicated ADP optimization problems is needed, for example, by incorporating machine learning to provide more accurate prediction of ship voyage duration throughout the year to eliminate the need to explicit model and optimize sailing speed.

The Future of LNG

The integrated ADP optimization model for LNG transport presented in this study is, to the best of our knowledge, the first in the literature to take into account such as multiple berths, time-dependent production rate, speed optimization and continuous time setting. With the rapid growth in global LNG production and export, models without these features, i.e., assuming only one birth is operational, fixed production rate throughout the year, and fixed sailing speed, are increasingly difficult to address realistic business needs in the LNG industry.

However, the computational challenges of solving large-scale OR problems call for more efforts in the exchange and collaboration within the sub-areas in AI to keep creating value for the industry.