Automating Capacity Pre-Booking at Physical Internet Warehouse Nodes

Zavitsas K., Kouloumbis M., Sen J.M., Ramirez M.

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OUTBOUND CAPACITY CHALLENGE

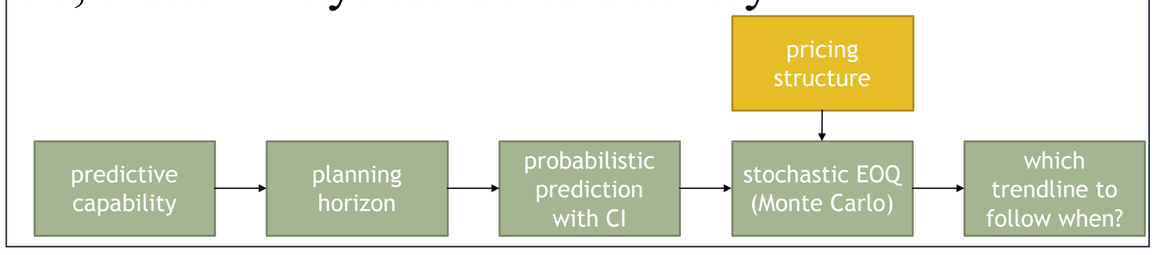
The Physical Internet envisages the automation of the capacity booking process through the introduction of smart contracts. This requires the use of predictive models to determine what is a reasonable quantity to book, which are not well integrated into the decision making process. Currently, most warehouse operators book capacity only one day ahead when more concrete bookings' data are available. The paper proposes the integration of a pre-booking decision support tool to enhance the implementation of the predictive model outputs into smart contracts.

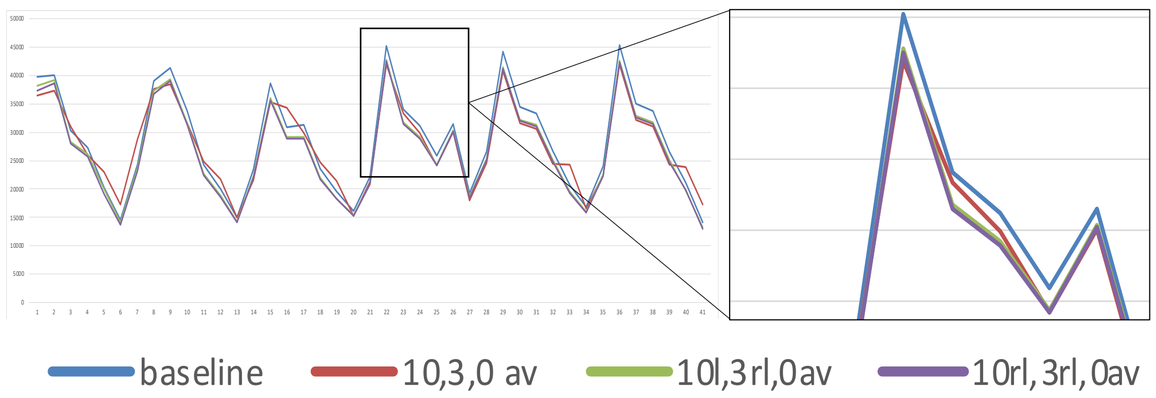
Each delivery route is assumed to have a pricing structure that spans from ten days ahead to the day of delivery and contains early booking and cancellation fees. The aim of the tool is, considering the prediction quantity and pricing structure to determine an optimal strategy for issuing smart contract orders.

SOLUTION ALGORITHM

The algorithm builds on inventory management theory and utilises Monte Carlo simulation to determine an optimal strategy for issuing smart contract orders. A pricing structure is assumed with small discounts for early bookings and cancellations.

The mean and standard deviation are extracted from the predictive model, and converted to confidence intervals. For a 10-day planning horizon capacity booking alterations are allowed 10, 3 and 0 days ahead of delivery.





Scenario	Cost savings (%)
baseline	0
red	2.54
green	5.35
purple	6.39
perfect	8.63

PERFORMANCE

The algorithm produces **reliable** and **cost-efficient** capacity booking actions that consistently outperform current practice.

To validate results a DHL route from Madrid to Barcelona is considered. Two years of historical data were used to train an ARIMA predictive model for a planning horizon for 40-days. Furthermore, a capacity booking cost and cancellation fee structure are assumed.

Smart contract actions are compared for the following strategies over the 40-day planning horizon:

- **baseline scenario (blue)**: book all capacity on the day of delivery.
- **red scenario**: book predicated capacity 10-days ahead of delivery. If necessary make adjustments 3-days ahead.
- **green scenario**: book 95% (low) confidence interval 10-days ahead. If necessary make adjustments based on "stochastic order quantity" 3-days ahead.
- **purple scenario**: book the "stochastic order quantity" 10-days ahead. If necessary make adjustments 3-days ahead.
- **perfect scenario**: assumes perfect prediction and booking correct capacity 10-days ahead