Optimized Production Scheduling Through Advanced Planning Techniques

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ABSTRACT

Figure 1: Exterior view of Omega Motor’s production facility.

This project aimed to address inefficiencies related to inventory by minimizing holding and setup costs while ensuring optimum inventory levels for Omega Motor. Ineffective inventory management usually causes unnecessary costs, higher lead times, and missed opportunities for operational efficiency. The study also emphasized the trade-off between cost reduction and maintaining sufficient inventory levels to meet production demands effectively. Also, the critical methodology and algorithm of this project were linear integer programming using Gurobi optimization and Python-based applications.

Our approach included an optimization model for Omega Motor’s critical production and inventory needs. We formulated a mathematical model/algorithm to minimize the total costs associated with inventory holding and production setup by using Gurobi Python. The model reviewed critical parameters such as demand forecast data for 2025, which the company provided based on previous years’ sales data, production constraints, and lead times. This allowed for more accurate and efficient inventory planning, thus determining an optimal batch size.

OBJECTIVES

1. Determination and analysis of setup and holding costs.
2. Address the trade-off between cost reduction and sufficient inventory levels for efficient production processes.
3. Stock optimization: Minimizing setup and holding costs by improving stock management strategies.

PROJECT DETAILS

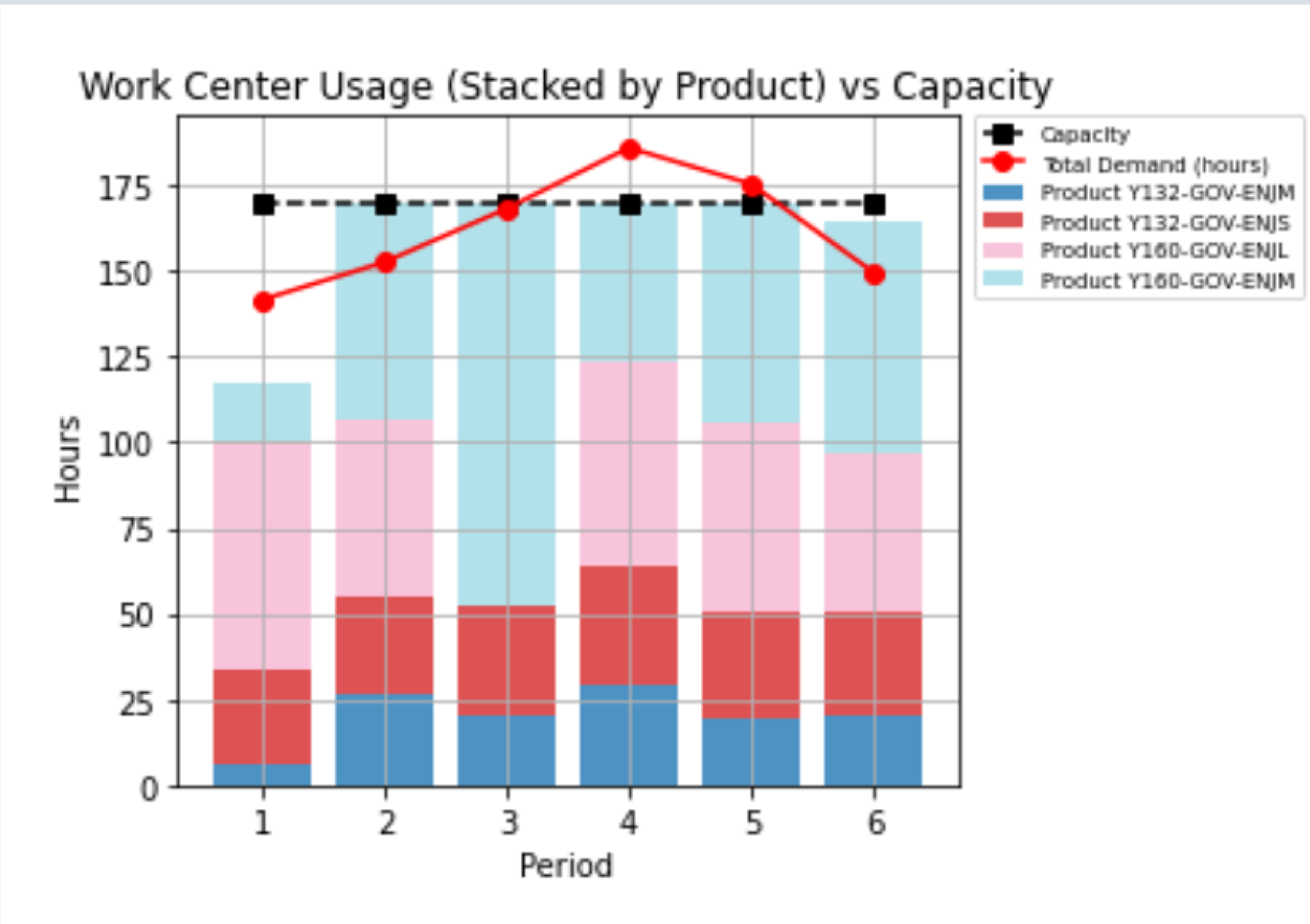

Figure 2: Work center capacity usage versus demand graph

The optimization model focused on balancing production schedules with capacity and demand. Critical factors such as demand forecasts, production constraints, and machine occupancy times were input to the model to determine efficient batch sizes and understand bottleneck points.

- On the graph, the space between the stacked bars and the red line usually reflects setup overhead or strategic overproduction to minimize future costs.
- The solver allocated the gap between capacity and demand in the chart to slower periods and accounted for inventory costs.
- This strategy ultimately optimized total costs based on the provided input data.

PROJECT DETAILS II

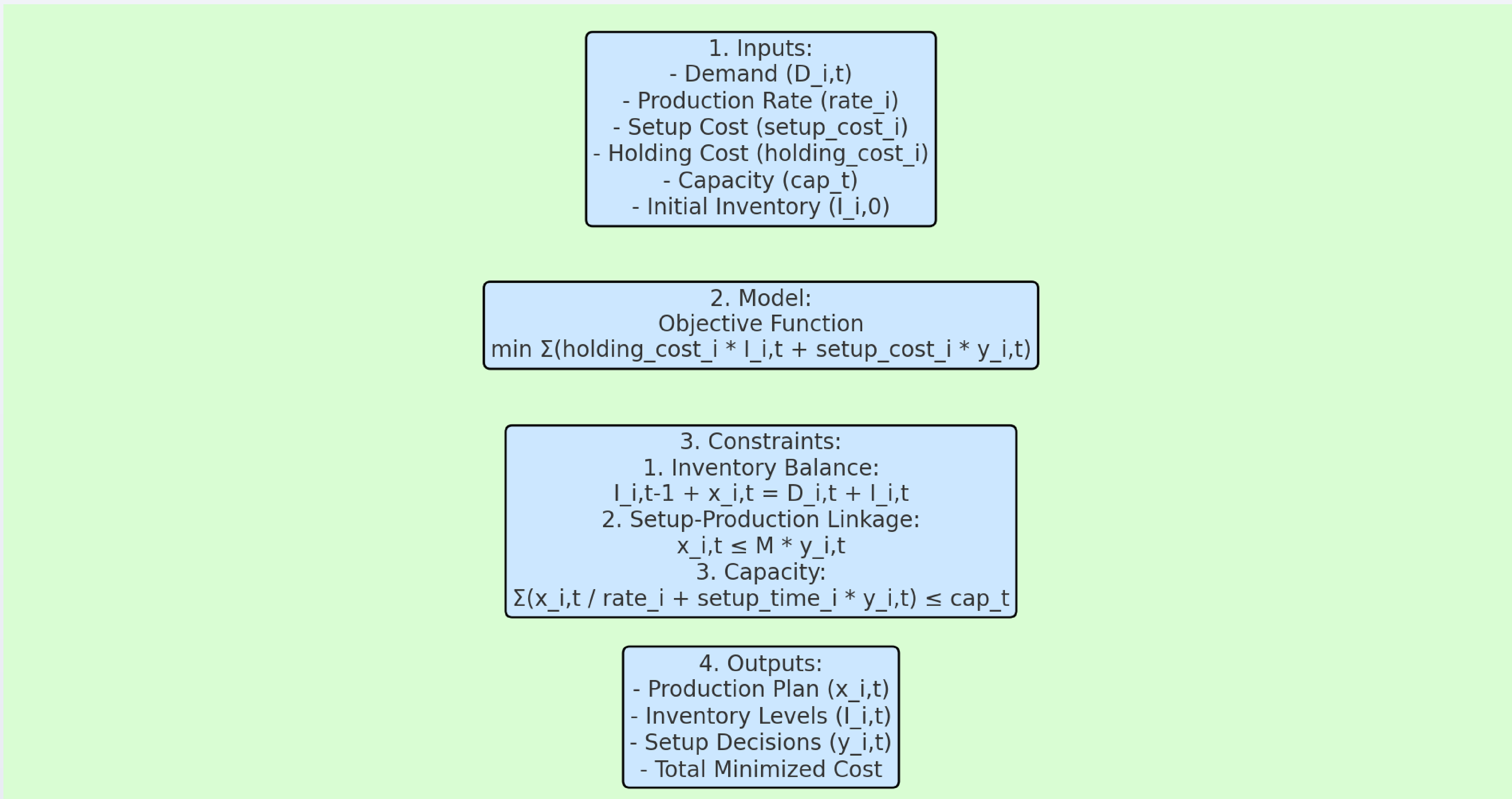

Figure 3: General summary of the algorithm

Calculating holding and setup costs is challenging due to their dependence on dynamic factors. Holding costs include storage expenses such as interest rates, inventory risks, and unit cash flow. For instance, a 2.5% monthly holding rate on a 500 TL unit results in 12.5 TL/unit/month, requiring detailed financial data across products and periods.

Setup costs represent opportunity costs during machine downtime, based on setup time, production rates, cash flow, and profit margins. For example, a 3-hour setup preventing 150 units (at 200 TL/unit with a 25% profit margin) results in a 7,500 TL cost. Accurate estimation requires detailed production data.

Model Constraints:

1.Inventory Balance: Ensures stock levels meet demand while staying non-negative.

2.Setup-Production Dependency: Production is tied to setup decisions (binary).

3.Capacity Constraint: Total production hours, including setup, cannot exceed available capacity.

4.Variable Domains: Production and inventory are non-negative; setup is binary.

These constraints create a Mixed-Integer Linear Programming (MILP) problem, requiring advanced optimization techniques.

CONCLUSIONS

This project greatly improved a linear programming-based optimization model for Omega Motor’s multi-product inventory management challenges. The model effectively addressed the limitations of traditional single-product methods such as EOQ and Wagner-Whitin by allowing simultaneous optimization for multiple products. The implementation reduced holding and setup costs while aligning inventory levels with production demands, resulting in a more efficient and cost-effective stocking strategy.

- The linear programming approach provided a practical and scalable solution for complex and multi-product environments.
- The model's adaptability allowed it to integrate specific constraints of the company such as limited storage capacity and changing demand patterns.
- The proposed model showed measurable cost reductions compared to existing applications through benchmarks, highlighting its potential for broader application in similar industrial contexts. (Other industries cannot use it directly because the constraints and parameters are company-specific, but the linear programming algorithm and logic are applicable within a framework.)

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