Logistics / Distribution | Automobile manufacturing | Transportation optimization | Single Objective

Optimizing automotive production scheduling to reduce finished vehicle inventory

MITLGO

BUSINESS PROBLEM

Automotive manufacturers face challenges managing finished vehicle inventory due to the misalignment between production scheduling and outbound logistics. Traditional production planning methods optimize for assembly efficiency, prioritizing smooth manufacturing workflows and component availability. However, these methods often fail to account for outbound transportation constraints, leading to inefficiencies in vehicle distribution. As a result, vehicles accumulate in storage yards while awaiting shipment, increasing inventory holding costs, reducing cash flows, and delaying dealer deliveries.

APPROACH

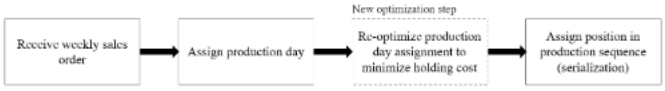
This thesis proposes an optimization-based approach to align production scheduling with outbound logistics. The methodology reorders the daily production sequence to facilitate faster load formation while ensuring compliance with manufacturing constraints. By grouping vehicles into truckloads earlier in the production process, the model minimizes load assembly time, accelerating vehicle shipment.

DATA SOURCES

Data came from three databases: the production, sales, and outbound logistics. The production schedule included vehicle ID, configuration, and assigned day. The sales database provided assigned dealerships, ZIP codes, and holding costs. The outbound system specified delivery mode (only truck was considered). These were merged to identify units that could be grouped into truckloads.

Data Types and Format

Sales and production data was stored in SQL databases. Outbound logistics data was stored in spreadsheets.



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IMPACT

The optimization model significantly reduced finished vehicle inventory. Back-testing showed a 63–65% average reduction in inventory load assembly time across two assembly lines. A real-world pilot confirmed the model's effectiveness, cutting load assembly time by 33% without disrupting manufacturing. This leads to faster cash flow, lower storage costs, and better delivery performance. OEMs also gain visibility into outbound inefficiencies, strengthening supply chain control. Despite scaling challenges when working with more than 600 vehicles, even partial solutions deliver substantial benefits. These results demonstrate that production and logistics integration offers meaningful operational and financial value.

DRIVERS	The automotive industry separates production and outbound logistics planning, which is inefficient. While a large body of literature discusses how production and outbound logistics planning can be combined in practice, discussion of real implementations is non-existent. Not only would solving this problem be academically interesting, but it would help improve cashflows, which was an important objective for the business.
BARRIERS	One major challenge was data fragmentation—logistics, production, and sales systems were separate and had not been integrated before. Computational scalability was another issue: large problem sizes solved more slowly, or not at all. Additionally, outbound carriers were independent and their pickup times couldn't be changed, limiting control to just load assembly.
ENABLERS	Leadership supported innovation and trying new ideas. There was also great support from the production planning team, which sat in a different leadership vertical than me. They were very willing to discuss the planning process and supported me in running a pilot where I adjusted the live production schedule.
ACTIONS	I developed the optimization in Python using real data, validated it through back-testing, and shared results with the planning team. We selected a pilot week and implemented an optimized schedule. After tracking outcomes, we confirmed a 33% inventory reduction during the pilot. I created documentation and training materials to support future use.
INNOVATION	The proposed approach is the first in the literature to discuss real-world testing of an integrated production and outbound distribution model in the automotive sector. The approach used a heuristic to maintain manufacturing feasibility while improving solvability. It also operates within existing systems, requiring no major workflow overhaul.
IMPROVEMENT	The solution reduced inventory of affected vehicles by an average of 63–65% in simulation and 33% in real-world tests. This translates to lower inventory costs, improved cash flow, faster delivery times.
BEST PRACTICES	Limit scope as much as possible to prevent problem from becoming too large to solve. Engage production planning team early to understand relevant constraints of inbound supply chain and manufacturing and work together to identify heuristics that will simplify optimization. Production planning is a challenging and demanding task; it is critical that any new addition to the planning process will create little to no disruption to existing workflows.
OTHER APPLICATIONS	This approach can apply to any manufacturing environment where outbound logistics depends on batch formation.