

Job Shop Capacity Expansion: A Site Stand-Up Framework and Simulation-Based Policy Evaluation

BUSINESS PROBLEM

With growing customer demand, job shops opening a second production site face two new challenges: how to accelerate the new site stand-up and how to determine which site produces which order. Company X, a made-to-order machining and fabrication supplier, encountered this firsthand when opening a second facility to support double-digit revenue growth. As order volume was expected to continue growing, the company sought to move beyond intuition-based execution and routing toward systematic methods that could sustain its delivery performance and cost efficiency standards.

DATA SOURCES

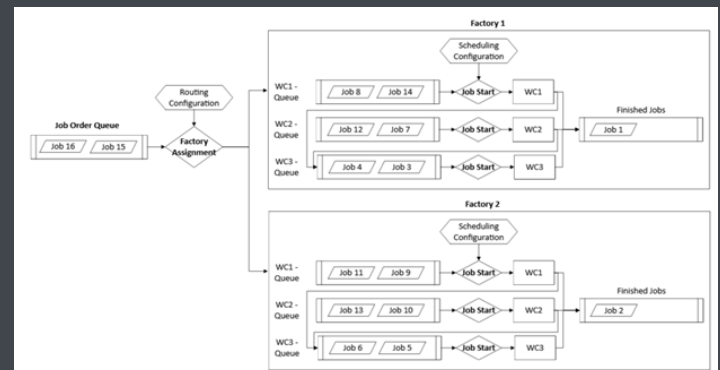
- Sales Order Dataset – ERP extract containing order confirmation dates, due dates, and customer delivery requirements
- Manufacturing Order Dataset – ERP extract with job routings, required work centers, estimated processing times, and actual operator labor times
- Synthetic Job Dataset – Workload-scaled demand set generated via lognormal distribution fitting and nearest-neighbor mapping

Data Types and Format

Numeric

APPROACH

A five-stage capacity expansion framework spanning planning, installation, verification, adaptation, and ramp-up was proposed based on lessons learned from executing the site stand-up. A weighted-sum routing heuristic scored each site across four criteria (capability, capacity, utilization, and cost), and three scheduling rules (EDD, SPT, CR) were evaluated using a custom Python discrete-event simulation. Pareto front analysis identified efficient tradeoffs across delivery and cost metrics under both base and scaled demand scenarios.



IMPACT

On the operational side, the new production cell advanced from near-zero equipment installation to 61% of planned equipment commissioned or in commissioning, with a further 33% actively in installation, culminating in successful shipment of the first customer orders from the new facility. Tuning the weighted-sum routing model reduced late-job tardiness by 13% and late-job count by 10% versus the average configuration under the recommended EDD scheduling policy. Across 3,780 simulations under scaled demand, EDD emerged as the most robust scheduling policy, and a routing weight configuration of 0.4 cost / 0.4 utilization / 0.2 capacity captured the majority of available cost savings without materially degrading delivery performance. Results also indicated Company X is more labor-constrained than equipment-constrained, informing future investment priorities.

 DRIVERS	Company X had experienced sustained double-digit revenue growth and opened a second production facility to support continued expansion and improve geographic service coverage. The new site required structured execution to bring online and introduced a new routing decision for every customer order.
 ENABLERS	Company X's pre-existing ERP system provided rich, linked sales and manufacturing data across all organizational levels. Embedding the investigator on the shop floor surfaced constraints not captured digitally. The host division provided established maintenance, HR, and supplier relationships that accelerated stand-up. The modular Python simulation allowed flexible configuration across factories and scheduling policies.
 ACTIONS	• Executed new production site stand-up and codified lessons learned into a proposed five-stage expansion framework • Defined four routing criteria (capability, capacity, utilization, cost) aligned to Company X's operational priorities • Formulated a weighted-sum routing heuristic and adapted EDD, SPT, and CR scheduling rules for a multi-site environment • Built and baselined a custom Python discrete-event simulation against real delivery performance
 INNOVATION	Capital project execution literature focuses on large-scale projects, offering limited guidance for smaller manufacturers. This work proposes a job shop-focused framework emphasizing lean execution and long-term operational value and jointly analyzes routing and scheduling using real ERP data, providing insights grounded in actual system behavior rather than hypothetical assumptions.
 OTHER APPLICATIONS	This framework applies to job shops expanding beyond a single site, especially in high-mix, made-to-order environments such as aerospace, custom fabrication, and medical devices. It also supports staffing and capital planning, and the five-stage stand-up approach is transferable to other capital equipment installations.