D605 – Optimization

Performance Assessment #1 – Analyze a Business Case

Bernard Connelly

Master of Science, Data Analytics, Western Governors University

Dr. Taylor Jensen

May 22, 2025

D605 – Optimization: Analyze a Business Case

A: Business Need and Optimization Type

Scenario 2 highlights G/EF Manufacturing, which specializes in energy-efficient appliances. The company is facing problems meeting the demands of its customers and processing a valid production schedule. They have several decision variables that can be modified to increase efficiency, and multiple constraints that limit their processes. Analyzing these variables as a part of an optimization problem will facilitate more efficient production and delivery while improving overall throughput and reducing costs. The company also wants to evaluate if a just-in-time (JIT) delivery model will meet production demands without overstocking or causing delays.

A1. Benefits of an Optimization Approach

An optimization approach involves maximizing production throughput and minimizing costs under identified constraints. Decision variables can be modified to achieve these goals. For example, the time each of G/EF's 20 machines produces specific parts can be fine-tuned to maximize overlapping parts to yield products that are highest in demand. Delivery schedules can also be modified to ensure delivery frequencies and lead times are optimized to reduce overall costs from gasoline and maintenance of vehicles, while simultaneously minimizing the emissions created by the company, a primary value of G/EF.

A2. Linearity of Optimization Problem

The optimization problem at G/EF Manufacturing is **linear** in nature.

All the relationships between decision variables — such as the number of units produced, the quantity of components ordered, and the time machines are used — can be expressed using **linear equations or inequalities**. For example

- Machine time constraints = sum of processing times ≤ available hours
- Component usage – sum of components per product x units produced

The above are additive or scalar-multiplication relationships. The description has no nonlinear terms such as squares, square roots, or logs. As a result, this is a linear optimization problem.

A3. Optimization Problem Type

The problem described in scenario two best classifies G/EF's problem as a Mixed-Integer Linear Programming (MILP) problem. As described above, this problem is linear in nature. It is mixed-integer because some decision variables, such as emissions, costs, or inventory levels, can be continuous. In contrast, others, such as whether a delivery occurs on a given day, are binary, and others still, such as units produced or ordered, are integer. It is a form of supply chain and production scheduling optimization involving multiple constraints like delivery lead times, shared components, machine capacity, and emissions. MILP is frequently used in operations research to solve problems where time, inventory, and resource constraints must be navigated and addressed.

B: Optimization Objective, Decision Variables, and Constraints

The optimization objective for GE/F is to minimize total cost while maximizing production throughput. The cost includes component delivery, holding inventory, and carbon emissions, which facilitates consumer preference and loyalty.

Decision Variables:

- How many units of each product to produce each day/week/month
- Which machine is used for each job
- How many components to order from each supplier and when
- Binary variables for triggering deliveries which is helpful in a JIT system

Constraints:

1. Machine availability and capacity constraints
2. Delivery lead times and frequencies for each component supplier
3. Inventory holding limits and stockout constraints
4. Component compatibility and usage per product
5. Emissions cap (if sustainability is prioritized)

B1. End Point Considerations

End point considerations define the conditions that must be satisfied after each planning cycle (weekly and monthly) to ensure the production and delivery schedule is both efficient and sustainable. These considerations are critical to the success of the optimization model outlined in A1, which aims to maximize throughput and minimize costs under specific constraints.

First, the model must ensure that all product demand is met by the end of each planning period. This means the optimization model will include demand fulfillment constraints for each product, preventing underproduction and ensuring all customer orders are completed within the specified timeframes.

Second, the model must produce realistic inventory levels by the end of the schedule. The goal is to avoid overstocking (which ties up storage space and increases holding costs) and stockouts (which disrupt the next production cycle). The optimization model can handle this by including minimum and maximum inventory balance constraints for each component and finished good at the end of the period.

Third, machine utilization must be limited to avoid overuse. If machines are scheduled for 100% usage with no buffer, it increases the risk of failure or unplanned downtime. To prevent this, the model will include capacity constraints and optional “downtime buffers” that restrict total machine use to a reasonable percentage of available time.

Finally, supplier delivery schedules must respect realistic lead times and frequency limits. The optimization model accounts for this by constraining when and how often deliveries can occur, ensuring that suppliers are not over-utilized and that deliveries align with production needs in a just-in-time manner.

By incorporating these constraints into the optimization model, the solution will meet short-term goals and support sustainable operations beyond the current planning window.

C: Recommendations for Optimization Method

The recommendation is to use mixed-integer linear programming (MILP) with a solver such as PuLP in Python. A MILP method handles continuous, integer, and binary decision variables as present in GE/F’s variables. It can also model complex constraints and is commonly used in production scheduling and supply chain optimization problems.

Specific Requests by G/EF Manufacturing (per the scenario document):

1. Definition of the problem being addressed

   GE/F Manufacturing must determine the optimal production and delivery schedule that minimizes total operational costs (inventory, delivery, emissions) ensures timely product completion, and potentially supports a JIT delivery strategy to reduce holding costs and increase throughput.

2. Optimization Approach & Defined Components

Objective, Decision Variables &Constraint details discussed in B above.

3. Justification to Business Operations Manager

   To effectively address the rising complexity of G/EF Manufacturing's production and delivery systems, a Mixed-Integer Linear Programming (MILP) model provides the most scalable and cost-effective solution. By simulating various combinations of component delivery schedules and machine utilization, the MILP approach can recommend the most efficient production plan that minimizes total cost while maximizing throughput. Additionally, this model supports just-in-time delivery decisions and ensures components arrive when needed without excessive inventory buildup. Finally, the anticipated outcome is a more agile production system with improved lead times, reduced carrying costs, and enhanced responsiveness to customer demand — key goals for G/EF's eco-conscious business strategy.

References

No other sources were used outside of the WGU course materials provided