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FIVE GUYS

MENU MATH

CRUNCHING COST & QUALITY

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Problem Statement

- 5 Guys needs to **minimize** ingredient purchasing costs while ensuring **enough stock** to meet demand.

- Challenges include managing **limited** storage space, **fluctuating** demand, varying ingredient **costs**, and supplier **reliability**.

Case Overview & Importance

CASE DESCRIPTION

Analyzing 5 Guys' ingredient purchasing optimization, **focusing** on sales data, storage constraints, and supplier costs to ensure **efficient operations** and **minimize costs**.

IMPORTANCE

Optimization balances cost and supply for **profitability**, ensures consistent **availability** and **quality** for customers, and provides suppliers with **reliable** purchasing patterns.

Stakeholders

MANAGEMENT

Needs to balance cost and supply to ensure profitability and efficiency.

CUSTOMERS

Expect consistent product availability and quality.

SUPPLIERS

Interested in maintaining reliable business relationships and understanding purchasing patterns.

Mathematical Model

Variables:

Xi: Quantity of ingredient i to be ordered. (2 brands for each)
eg: Ball Park Buns, Pepperridge farm Buns

Objective:

Minimizing the sum of the cost of goods with discounts included
Minimize $z=\sum(Ci \cdot Xi)$
Where **Ci** is the cost of ingredient i
In addition to that apply tiered discounts

Constraints:

12 Nutritional Constraints
12 Demand Constraints
24 Supplier Constraints
1 Storage Constraint

Mathematical Model

Nutrition Constraints:

Find combination of ingredients for menu and then constrain protein, fat, and calories for that menu item

Supplier Constraints:

Spend over $100 from each supplier and at most $5000 at any one supplier.

$$100 <= (X * Xprice) <= 500$$

Scenarios

MODEL 1

All constraints

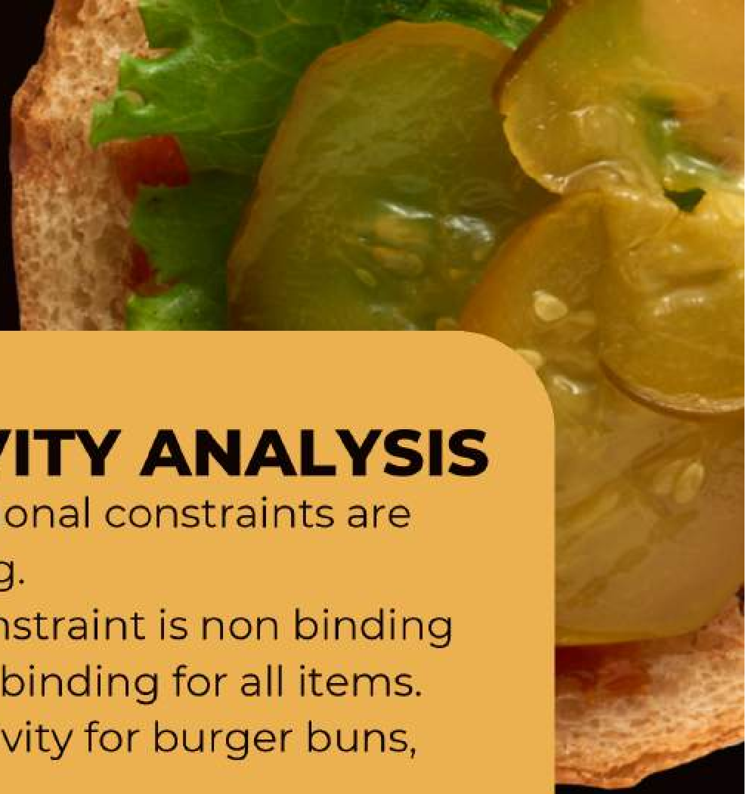
MODEL 2

No nutrition constraints

MODEL 3

No supplier constraints

Model 1



OPTIMAL SOLUTION

- Total cost: $23,417
- Balanced mix of ingredients from various suppliers
- Meets all nutritional, demand, storage, and supplier constraints

DECISION MAKING

• Model tends to choose cheaper ingredients more (Ball Park over Pepperridge buns)
• Uses a mix of both brands, likely to meet other constraints like nutrition or storage

SENSITIVITY ANALYSIS

- Most nutritional constraints are non binding.
- Storage constraint is non binding
- Demand is binding for all items. high sensitivity for burger buns, patties
- Many supplier constraints are binding (buns, Kraft cheese)
- Reduced gradient is 0 for all vars

TAKEAWAYS

- Balanced optimization of menu
- High-demand items critical to manage
- Nutritional guidelines met without tight restrictions

RECOMMENDATIONS

• Renegotiate supplier contracts
• Focus on securing favorable contracts for high-impact items (e.g., patties, buns)

Model 2

OPTIMAL SOLUTION

- Total cost: $20,318
- Model does not include nutritional constraints. Still includes storage, demand, and supplier constraints.

DECISION MAKING

• Model chooses cheapest ingredients that work with supplier constraints. Order minimal amount of expensive items, then order rest of demand of cheap item

SENSITIVITY ANALYSIS

- Demand and supplier constraints are binding.
- Storage Constraint is not binding
- High sensitivity to Burger demand
- Unnecessary costs due to supplier constraints

TAKEAWAYS

- Removing nutritional guidlines would allow for slightly cheaper costs
- Nutritional constraints only effect burgers

RECOMMENDATIONS

- Renegotiate supplier contracts
- Nutritional constraints do not reduce costs by a great margin, nor do they change the order quantities by much
- Benefit of having nutritional constraints may outweigh cost savings

MODEL 3

OPTIMAL SOLUTION

- Total cost: $23,290
- Model does not include supplier constraints, but still contains nutrition, demand, and storage constraints

DECISION MAKING

- Model only chooses one supplier for each ingredient
- Chooses cheapest that also fulfills nutritional need

SENSITIVITY ANALYSIS

- Demand constraints are binding
- Storage Constraint is not binding
- High sensitivity to most demand constraints

TAKEAWAYS

- Restaurant does not need to complicate supply to meet nutritional demands
- Cost savings is minimal, meaning prices are fairly even between suppliers

RECOMMENDATIONS

- Nutritional constraints raise costs more than supplier constraints
- If cost savings are needed, nutritional constraints should be first to be improved

Results Summary

COSTS

- 1st model more expensive
- 3rd slightly cheaper than 1st
- 2nd most affordable

TAKEWAYS

- Get rid of nutrition constraints before the supplier constraint.
- Increase demand as storage is non binding

Challenges

DATA

- Most Five Guys data not publicly available
- Took inspiration from menu for ingredients and got nutritional data from public datasets and ingredients' costs from online grocery stores
- Estimated demand from Five Guys annual sales

LINEARITY

- Discounts are tiered and apply at different spending levels.
- This makes the cost function piecewise and nonlinear.
- Had to use the non linear solver and learn about it

SENSITIVITY

- Had a different sensitivity report by using GRG solver.
- Learned the terminology
- Tried to find values analogous to shadow prices and reduced cost

Key Lessons Learned

- Exploring multiple scenarios (with different constraints) helps in understanding the impact of various factors on the overall cost and feasibility.

- Successfully balancing demand, supplier, storage, and nutritional constraints illustrates the complexity of real-world business operations

Real-World Applications

Cost Minimization in Retail:
Retail businesses can use these optimization techniques to minimize costs by strategically ordering products to benefit from supplier discounts.

Supply Chain Optimization:
The methods used can be adapted for broader supply chain optimization in any industry where multiple suppliers and storage constraints are involved.

Inventory Management:
This project's approach can be applied to manage inventory in restaurants or any other industry, ensuring they order the right quantities from suppliers while considering discounts and storage limits.

Capacity Planning:
The storage constraint modeling can assist any business with physical storage limitations to optimize their space utilization.

Thank you