Foodie's
Case Simulation

This Case Simulation was prepared by Edwin Hartnell
(edwin.hartnell@scientificstrategy.com) working with
the Georgia Institute of Technology (www.gatech.edu).

Abstract — Foodie's Urban Market is a small grocery store in Boston's South End that successfully competes against much larger, nearby rivals. Stocking their limited shelf space with a smart product assortment is essential when serving South End's diverse community. This Case Simulation provides both a case study of the changing business environment for grocery stores, and a software simulated model of Foodie's market dynamics. Students are asked to optimize the product assortments presented in the model.

Keywords – Agent-Based Models, AI, Artificial Intelligence, Business, Economics, Microeconomics, MBA, Teaching, Case Simulations, Case Study, Market Simulation, Modeling, Willingness To Pay, WTP, Consumer Surplus, Assortment Optimization, Inventory Management, Consumer Packaged Goods, CPG, Grocery Store, Supermarket

Learning Goals – Students will learn:

1. How to optimize shelf space by consolidating product assortment,
2. How to streamline warehouse inventory levels,
3. How to select new products by their incremental sales contribution, and
4. How to use models to predict customer reaction to change.

Prerequisites:

- Introductory statistics (including regression and correlation)
- Introductory economics (including consumer surplus)

1 ABOUT CASE SIMULATIONS

1.1 Overview

Case Simulations are a combination of Case Studies and Market Simulations.

$$Case\ Simulation = Case\ Study + Market\ Simulation$$

Case Simulations extend business and economics case studies by reproducing key market dynamics in a software simulation. Students can actively explore this simulated environment to analyze the problems presented in the case. Data analytic tools are provided alongside the simulation to answer specific questions. Student solutions can be tested in software before recommendations are made.

1.2 Market Simulation Details

The software simulation runs an Agent-Based Model (ABM) built upon Mainstream Economics. Consumer Agents make Rational Decisions based upon their Willingness To Pay (WTP) and Consumer Surplus for goods and services. Vendor Agents can follow the rules of Game Theory to maximize profitability.

The simulation runs within a free Data Analytics platform called KNIME. This platform, along with the Market Simulation extension, must first be installed by students before the Market Simulation workflow can be explored and analyzed.

2 CASE STUDY

Economies of scale are in short supply at Foodie's.

"Sometimes you feel like it's you against the world, in terms of the economics," said Victor Leon, founder of Foodie's Urban Market in Boston. (Yonan, 2004)

2.1 Background

South End Boston is an eclectic mix of million-dollar lofts, low-income housing, Michelin "star caliber" restaurants[1], and 99 cent stores. Boston's residents on food stamps in South End are poorer than the city's average[2], while those not on food stamps are richer (Statistical Atlas, 2020).

Foodie's opened its doors to South End in 1998 with the goal of serving the whole community. As a result, its organic and super-premium items often sit juxtaposed to its discounted and value items.

"We feel like we need to be just what most stores don't like to be -- and that's all things to all people," said David Erickson, a buyer at Foodie's (Yonan, 2004).

While outsized retailers have taken over most metro areas, small independent stores like Foodie's have prospered in Boston. But their success was improbable. Not only are rival supermarkets getting larger, but the number of alternative food retailers has expanded.

In the decade between 1994 and 2004, the size of supermarkets in the USA grew 30% from 35,000 square feet to more than 45,000 square feet (Food Marketing Industry Speaks, 2020). At 8,500 square feet, Foodie's was only one-fifth the size.

[1] While Boston does not have a Michelin guide, TimeOut believes no less than 3 South End restaurants deserve stars. (Grossman, 2020)

[2] Almost 25% of South End households receive food stamps with median incomes of $13.4K. At the same time, the household incomes of families who do not receive food stamps is 20% higher in South End than the city's average. (Statistical Atlas, 2020)

"Small retailers not only compete with supermarket chains but with everyone who sells food, and that can be drug stores, club stores, convenience stores, sometimes even bookstores," said Michael Sansolo of the Food Marketing Institute (Yonan, 2004).

A friendly attitude, convenient location, and good customer service are acknowledged in South End as important ingredients to success. But a smart product assortment is essential.

2.2 Inventory and Assortment

Product assortments impact both costs and revenue. It drives the retailer's logistics and inventory costs, while influencing the retailer's ability to attract customers (Ruiz-Real, et al., 2017).

Large retailers sometimes offer less variety than traditional retailers. This not only drives down the costs of the large retailer, but can also increase the costs of the traditional retailer seeking differentiation. Greater differences in costs lead to relaxed price competition (Dukes, et al., 2009)

2.3 More Variety

Selecting a product assortment has become significantly more complex.

Product variety exploded in the last decades of the twentieth century. According to the Harvard Business Review (1994), the number of products increased by 16% *per year* during the 1980's and 1990's, while shelf space was only expanding by 1.5% (Quelch & Kenny, 1994).

For grocery stores, the Food Marketing Institute (1993) reported that the number of stock-keeping units held by a typical store increased from 6,000 to 30,000 SKUs within a single generation.

"I don't think the SKU proliferation game is going to slow down anytime soon," says Lonnie Watkins, a manager at the materials handling company Dematic North America (Jacobsen, 2012).

But periods of consolidation typically followed the explosions.

One reason for this is private labels. When a new niche proves itself, retailers will often "delist" the niche brands which pioneered the category with their own labels, then trim back on the variety offered by the niche brand (Ruiz-Real, et al., 2017).

But consolidation is often not so easy.

"Anybody who's tried to rationalize their product line has found they lose sales because consumers don't want to give up their niche products," says Bill Leber, a director at the logistics automation company Swisslog North America. "They're not willing to give up the product to save money" (Jacobsen, 2012).

Empty shelves give retailers opportunities to experiment with new products. But assortments can also shrink rapidly despite the reluctance of retailers. This happens both in booming economies, when shelf space is limited, and during deep recessions, when cost saving is paramount (Knoke, 2017).

Dairy is a category under consolidation pressure in all economies. Its chilled shelf space is desirable during both periods of expansion and consolidation.

One category that has shown resilience against consolidation is non-alcoholic beverages. According to IRI, when European assortments were shrinking by up to 10%, beverage assortments were growing at 6%. IRI noted some of the reasons: the category added new flavors, offered greater convenience with ready-to-drink mixes, and innovated new premium products (Knoke, 2017).

But overall demand within a category is rarely driven by the mere proliferation of products. Costs to the retailer's limited inventory and shelf space is easy to assess. But the impact to legacy product lines can be difficult to unravel (Quelch & Kenny, 1994).

2.4 Wise Consolidation

Retailers need to consider the *incremental* value new products bring to their categories by assessing how customers react to a changing assortment.

“It seems obvious that focusing on range and reducing assortments need to be done wisely,” says Christoph Knoke, a managing director at IRI. “Simple decisions to cut assortment could put revenue at risk, since they do not take product interactions and reasons for shopping trips into account” (Knoke, 2017).

2.5 Adjusting Assortments

Further south of Foodie’s in Jamaica Plain, Boston, David Warner explains how his small City Feed and Supply grocery store adjusts its product assortment.

“We'll try carrying anything,” said Warner. “We'll buy a case of it, try to sell it, see how it goes over”.

“Almost anything,” retorts Kristine Cortese, his wife and co-owner of the store. “We didn't get that slushy machine” (Yonan, 2004).

3 DISCUSSION QUESTIONS

These questions can be prepared by students after reading the case and before an instructor-led class discussion.

1. The case stated that large retailers sometimes offer less variety than traditional retailers. Have you personally experienced this? What are some examples of categories where a large retailer would have less variety than a traditional retailer?
2. Which categories would you expect variety to proliferate the most as stores got bigger? Consider cola, cereal, ground coffee, toothpaste, and any other categories that come to mind.
3. How can delivery and warehousing services respond to the need of supermarkets to stock a greater variety of niche products at lower cost? Think about how, for example, the shipping pallet would need to adjust.
4. Chilled food is another category which has been resilient to assortment consolidation, with SKU counts continuing to grow while counts shrunk in other categories. Why do you think this is?
5. If there are between 100 and 500 unique products within any given consumer packaged goods (CPG) category, how many possible assortment compositions are there to evaluate? What are some ways to efficiently do this analysis? Hint: there are 2^{263} atoms in the universe.
6. The case states that retailers need to consider the incremental value new products bring. What does this mean? How do you calculate the incremental value of a new product? What about of an existing product?
7. What are all the costs of stocking additional items? Why does the case state that many of these costs are difficult to unravel?
8. If you were a store manager, how would you decide which sub-set of products should never be out-of-stock?
9. If you were a category manager tasked with consolidating the SKUs in a particular category, what metrics would you consider before deciding?
10. If you were a brand manager at a CPG manufacturer, what criteria would you consider when planning new product innovation?
11. Brands sometimes argue that product proliferation is needed even when new products fail to drive incremental sales as the new SKUs protect their shelf space from hungry competitors. Is this a good argument?

12. If you were a manager at Foodie's and the South End city government offered you a way to improve your business, what would you wish for?
13. If you lived in South End, would you do your shopping by walking two blocks to Foodie's or by driving 2 miles to a much bigger grocery store?

4 SIMULATION QUESTIONS

A Market Simulation has been prepared that mimics the market dynamics of several categories sold by Foodie's. The simulation is an Agent-Based Model (ABM) comprising of many shopper agents (called "customers" in the simulation) buying groceries over a 3-month period.

In each category, a representative sub-set of products have been included in the model. Some product names are fictious, and product prices and costs have been approximated. The Willingness To Pay (WTP) customers have for each product has already been determined.

Students are asked to use the simulation to optimize the product assortment in each category. Some of this analysis can be performed in a spreadsheet but most needs to be performed in the simulated environment. Your instructor may demonstrate how to get started.

Create a spreadsheet to collect your answers.

Education (ED-231) - Foodie's

Foodie's Urban Market successfully competes against much larger, nearby rivals. A smart product assortment is essential to serving South End Boston's diverse community. This Case Simulation provides a software simulated model of Foodie's market dynamics. Students are asked to optimize the product assortments presented in the model.

Section 1: Consolidate the Milk Category

This section requires you to consolidate the Milk Category by eliminating one of the Milk Products from the Assortment.

Section 2: Manage the Cola Category

This section requires you to manage the Cola Category by determining which products should never drop out-of-stock and selecting products that can be removed from the assortment.

Section 3: Define the Chilled Food Category

This section requires you to define the Product Assortment for the Chilled Food Category.

4.1 Consolidate the Milk Category

This section requires you to analyze sales of the milk category in the market simulation. You are then required to consolidate the category by eliminating a single milk product from the selection. The Willingness To Pay (WTP) each customer has for each of the products in the category has already been determined.

1. Find the list of milk products in the Input Product Array table within the Market Simulation. Answer the following questions. Hint: The GroupBy node can be used to count and average.

    a. How many milk products (SKUs) does Foodies currently sell?
    b. How has milk been sub-divided into families?
    c. How many products in each family?
    d. What is the average price of each family?

2. Using the Input Product Array, calculate the margin and margin percentage of each product. Fill in the following table. Sort the table and highlight the product that has the highest and lowest margin percentage.

Product	Margin	Margin Percent

3. Find the Input WTP Matrix table. How many customers have been included in the model? Verify the products in the Input WTP Matrix are the same products found in the Input Product Array. Fill in the table.

How many Customers in the WTP Matrix?	
How many Products in the WTP Matrix?	

4. Using the Input WTP Matrix, generate a scatterplot showing the relationship between the customers Willingness To Pay (WTP) for Fuller Farms branded milk versus their WTP for Creamy Cows milk.

5. Repeat the exercise by generating a scatterplot between customer WTP for Fuller Farms and Skinny Stalks branded milk. Compare the two scatterplots. Explain your findings and their implications.

6. Use the Market Simulation to analyze the number of customers who buy each milk product. Connect the Input Product Array and the Input WTP Matrix to a "Simulate Market" node and run it. Find the "Output Product Array" and fill in the table.

Product	Quantity	Revenue	Profit
Fuller Farms			
Creamy Cows			
Skinny Stalks			

7. Using these Output Product Array results, highlight the product with the lowest quantity, revenue, and profit. Is this the same product that has the lowest Margin Percentage (calculated in question 1.2 above)?

8. Calculate the total quantity, revenue, and profit of the milk category for Foodie's. Hint: this can be done with the GroupBy node. Do not forget to first filter out the 'No Sale' product as these are customers that Foodie's *did not* sell to. Fill in the following table.

Foodie's Totals	Sum Quantity	Revenue	Profit
Original Milk Sales			

9. Try eliminating Fuller Farms from the Product Assortment. This can be done by either filtering the Fuller Farms row from the Input Product Array, or by adding $1000 to the price of Fuller Farms (no customer would pay that much for milk). Sum the total quantity, revenue, and profit of Foodie's milk category. Fill in the table.

Foodie's Totals	Sum Quantity	Revenue	Profit
After Fuller Farms Eliminated			

10. Restore the Fuller Farms product and price, then eliminate the Creamy Cows product. Next restore Creamy Cows and eliminate Skinny Stalks (only one product should ever be eliminated at a time). Concatenate all the results into the following table.

Foodie's Totals	Quantity	Revenue	Profit
Original Milk Sales			
After Fuller Farms Eliminated			
After Creamy Cows Eliminated			
After Skinny Stalks Eliminated			

11. Which product should Foodies eliminate first from the milk category? Why? Is this the same product that had the highest margin percentage and second highest sales? Are you keeping the product that had the lowest sales? How would you justify this decision?

4.2 Manage the Cola Category

This section requires you to manage the Cola Category. Determine which products should never drop out-of-stock and identify those products whose inventory can be streamlined or removed from the assortment.

Connect the Input Product Array and the Input WTP Matrix to a "Simulate Market" node and run it. Find the "Output Product Array" and answer the following questions.

1. What are the top 5 most profitable cola products? Fill in the table.

Cola Product	Quantity	Revenue	Profit
#1			
#2			
#3			
#4			
#5			

2. Aggregate sales by brand. What is the total quantity, revenue, and profit attributable to each brand? Fill in the table. Hint: Do not forget to remove the 'No Sale' product from the quantity total.

Brand	Quantity	Share	Revenue	Profit
Coke				
Pepsi				
Total				

3. Test what happens if any of the 6x330 product packs are out-of-stock. Start with the first 6x330 product by following these steps:

   a) Copy the Input Product Array for the Cola Category
   b) Find the first 6x330 product (CokeDietCan_6x330)
   c) Add $1000 to the price of the CokeDietCan_6x330
   d) Connect the Product Array and WTP Matrix to a Simulate Market
   e) Run the Simulate Market node and find the Output Product Array
   f) Add a new column called "Scenario" using a Constant Value Column
   g) Set the values in the Scenario column to "ColaDietCan_6x330"
   h) Exclude the "No Sale" product using a Row Filter node
   i) Sum up the Cola Category total quantity, revenue, and profit

   Fill in the table.

Out-of-Stock Scenario	Sum Quantity	Revenue	Profit
ColaDietCan_6x330			

4. Repeat the steps above for the other 6x330 products. The Scenario column allows you to concatenate all the results together. Hint: the Concatenate node is helpful. Fill in the table.

Out-of-Stock Scenario	Sum Quantity	Revenue	Profit
ColaDietCan_6x330			
CokeRegularCan_6x330			
CokeZeroCan_6x330			
PepsiRegularCan_6x330			
PepsiMaxCan_6x330			

5. Compare the original results from question 2.2 with these out-of-stock results. Calculate the incremental quantity, revenue, and profit each of these products bring. Fill in the table.

Product	Incremental Quantity	Incremental Revenue	Incremental Profit
ColaDietCan_6x330			
CokeRegularCan_6x330			
CokeZeroCan_6x330			
PepsiRegularCan_6x330			
PepsiMaxCan_6x330			

6. You should notice that some of the above results show that total revenue and profit (but not quantity) will *increase* if a product is out-of-stock. Does this make sense? How would you explain this?

7. Based upon these results, which of the 6x330 products should never be allowed to drop out-of-stock? Which of the 6x330 products are less important to guard against out-of-stock events? Explain.

8. Examine in more detail what happens when the CokeZeroCan_6x330 product is out-of-stock. What do customers buy instead? Does this explain why the CokeZeroCan_6x330 might be allowed to drop out-of-stock?

   Hint: this can be done by comparing the Output Product Array from Question 2.2 with the Output Product Array in Question 2.4. In Excel, these two tables can be compared side-by-side to determine how customers changed their behavior. In the KNIME simulator, this can be done using a Joiner node and a Math Formula node or Column Expressions node.

9. Assume you are the distributor for Coke and that you are measured by revenue. If Foodies told you it wanted to let the CokeZeroCan_6x330 product drop out-of-stock, would you agree? From your perspective, what is the incremental revenue that the CokeZeroCan_6x330 product brings to Foodies?

4.3 Define the Chilled Food Category

In this section, you need to define the product assortment for a new Chilled Food category.

The new Chilled Food category comprises of prepared meals that are ready to heat and eat. The available meal options are combinations of a "Meat" (Beef, Pork, Chicken, Fish, or Vegetarian) and a "Side" (Potato, Steamed Vegetables, or Soup). Both "Spicy" and "Mild" versions of each combination are also available. In all, there are 26 different meal products available for you to choose between.

You have already used market science to calculate the Willingness To Pay (WTP) each customer has for each of the meal product options. But your refrigerator only has enough space to stock 5 of those options.

1. Open the Input Product Array and use the "Include" column to select the first five products (this has already been done for you). Filter these products and connect to a Simulate Market node (along with the Input WTP Matrix). What is your total quantity, revenue, and profit? Fill in the table.

Sale Totals	Sum Quantity	Revenue	Profit
First Five Products			

2. What is the maximum number of 5-product combinations you would need to consider before finding the combination that maximizes profitability?

3. Describe a pragmatic methodology that will allow you to approximately maximize the profitability you can generate from the category.

4. Using the methodology you just proposed, trial-and-error, or any other technique, maximize the profitability you can generate from the Chilled Food category. Boasting rights will be awarded to the student or team that can generate the most profit.

4.4 Consolidate the Cola Category (optional)

In this section, you are required to shrink the same Cola category you analyzed in section 2 (above) down to just 5 products.

1. Can you find a combination of 5 cola products that simultaneously generates at least 60% the quantity and 80% the revenue and profit of the original category?

2. Can you find a combination of 5 cola products that simultaneously generates at least 70% the quantity and 90% the revenue and profit of the original category?

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