



Simio 2020 December Student Competition

Service Industry Problem



Overview

The Simio BBQ Smoke Pit is an up-and-coming local restaurant. It features a variety of BBQ smoked meats and classic sides. This makeshift cookout is nestled in an older, renovated building in a bustling downtown block. Due to size constraints, this is a carry-out only establishment. However, as Simio BBQ Smoke Pit continues to grow in popularity, customers are facing longer wait times due to product outages and a constrained labor force. To keep up with demand, the restaurant needs help determining what new policies to enact to resolve their service bottlenecks.

Due to the long smoking time required for the BBQ meats and lengthy cook time for some sides, the restaurant is struggling to keep a reasonable level of cooked food available. Having too little inventory will affect customer satisfaction. If food shortages occur too often, wait times could increase, causing customers to leave and losing potential business for the restaurant. On the other hand, creating excess inventory could accrue extra costs. The meat is expensive and excess uneaten food must be disposed of at the end of the day.

The challenge is to balance staffing and food production to maximize profits and customer satisfaction. The restaurant is looking to investigate customer arrivals and ordering patterns, resource requirements, and food production rates. Simio BBQ Smoke Pit desires the best strategy to replenish each of the different food items on their menu. This replenishment strategy not only affects when and how much food to cook, but also how to allocate the cooked portions between the meal assembly stations and the holding cabinets. Additionally, Simio BBQ would also like to know if the potential improvement of changing staffing levels or adding equipment would be worth the investment.

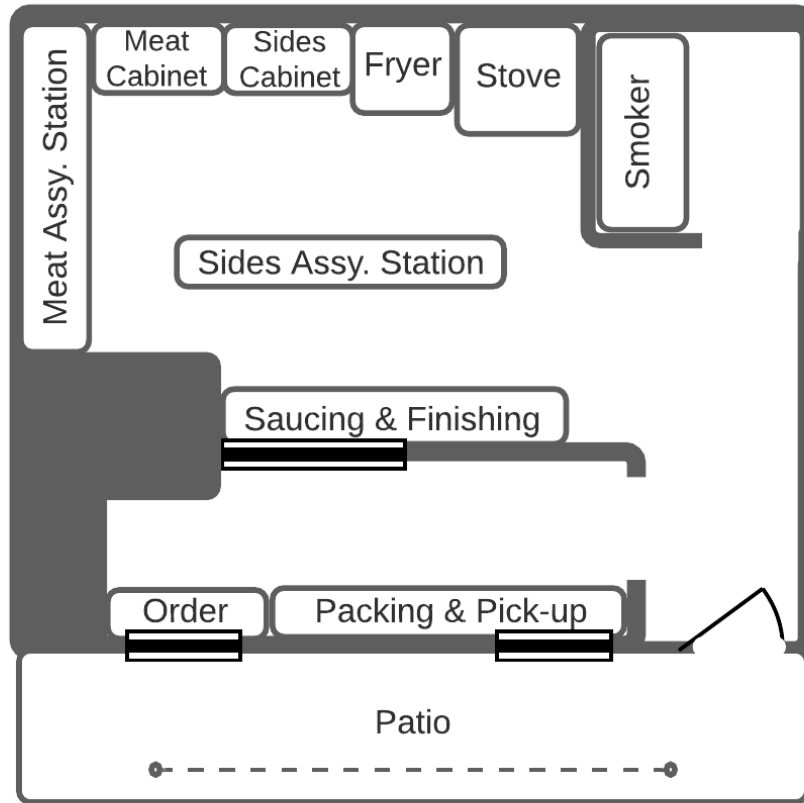
Problem Description

Restaurant Layout

The restaurant's entire property is approximately a 27ft by 27ft square including a small concrete patio in the front, as shown in Figure 1. Customers will not enter the Simio BBQ Smoke Pit building; all orders are taken through a window at the order counter. The customers will line up starting on the patio, but that line can continue as long as necessary down the sidewalk. After they order, customers will move into the patio pick-up space; this area is blocked off with two stanchions and a rope. When a customer's order is completed, the food will be handed through another window at the pick-up counter and the customer will exit the patio space, as there is no seating here.

Inside the building, the front of the restaurant has counters for order-taking, packing, and pick-up and is open to the patio via two windows. There is an internal wall with a window used to communicate with the food production team and collect the finished meals. Behind this wall, the food is cooked and assembled. The main room includes the meat assembly station, the sides assembly station, and the saucing and finishing station. There is also the sides cooking equipment, such as a fryer to cook fries and a stove to cook an assortment of other sides. Additionally, there are two different food holding cabinets: one for sides and one for meat. The BBQ meat smoker equipment sits in a room off to the side since it needs special ventilation.

Figure 1: The layout of Simio BBQ Smoke Pit restaurant.



Customers

The Simio BBQ Smoke Pit is a popular establishment for both solo and group diners. Historically, the restaurant hosts group sizes as small as one and as large as six people.

Due to its fame around town and simple menu, customers come knowing what they want to order, so they head directly to the order counter line. Based on past observations, management has noticed that customer groups have varying tolerances for how long they will wait in line at the order counter before deciding to leave the restaurant. This tolerance time is approximately between 10 and 30 minutes.

Simio Smoke Pit currently has one cash register where orders are placed. Each person in a group will order one meal, consisting of an entrée and one or two sides. After each member of the group places their order, the group will move to the pick-up counter waiting area. Due to current safety regulations, groups are required to social distance while waiting for their food on the patio area. The patio space is limited to 5 groups, regardless of group size. If the waiting area is full, the cashier stops taking new orders until a group receives their entire order and leaves the restaurant. A sample of customer arrivals and order information is given in the Customer Arrivals data sheet.

Meals and Ordering

The BBQ Pit offers three different meal types: a sandwich, a small platter, and a large platter. The platter meal types can be ordered with any of the BBQ Pit's smoked meats: pulled pork, brisket, or ribs. A sandwich is only available with pulled pork or brisket. Sandwiches and small platters come with one side and use a small portion of meat, while a large platter comes with two sides and uses a large portion of meat. Side options include fries, mac and cheese, green beans, and baked beans. The price of the meal depends on the type and the meat chosen. The sides also vary in price as shown below.

Table 1: Base meal price per meat type and the portion of meat per meal.

Meal Type	Meat Type	Portion	Price
Small Platter	Brisket	4 oz	\$4.50
	Pulled Pork	4 oz	\$3.80
	Ribs	1 half rack (½ full rack)	\$5.30
Large Platter	Brisket	8 oz	\$7.00
	Pulled Pork	8 oz	\$6.00
	Ribs	1 full rack	\$7.50
Sandwich	Brisket	4 oz	\$5.30
	Pulled Pork	4 oz	\$4.50

Table 2: Price per each type of side.

Sides Type	Price
Fries	\$1.00
Mac and Cheese	\$2.00
Green Beans	\$1.50
Baked Beans	\$1.50

Sides do not have any unit of measurement associated with their portion size. One side is one portion of that side's inventory. Customers can order two sides of the same type and no meals will be served without any side.

Cooked inventory might not always be readily available when customers place their meal orders. Since sides have a shorter cook time, it is observed that a customer will wait for sides, no matter how long. A customer will not change their side order, even if their side is not readily available; they will wait for a new batch to be cooked. However, the Simio BBQ's meat is cooked overnight due to the long smoke time. Whatever is produced overnight is the only inventory available for that type of meat the next day. Therefore, there are instances where a certain type of meat might run out during the day. If this occurs, the meal option will be removed from the menu and customers will no longer be able to order that meal type.

The workers at the order counter are updated on the meat quantity to prevent selling meals that cannot be fulfilled. If the meat for their original order entrée is not available, the customer will select another entrée based on what is currently available. Most customers come in knowing what they want before seeing an updated menu, so management has asked that prior to taking the new order the customer's original order is recorded. This will assist in recording customer satisfaction and could help in future restocking policies.

When all meat inventory is low, if there is only enough meat for some group members' orders, then the orders that can be fulfilled will be taken. Because there are not enough entrées to fulfil the other party members' orders, they will not order anything, but will remain with their group. Once there is no meat inventory in stock no more orders will be taken that day.

Assembly Process

As a group is ordering, tickets corresponding to their meals are printed back at the meat assembly station; one ticket is printed per meal. In the current system, an assembler will grab one ticket slip, move down the line, and complete the assembly of that one customer's meal. Management is open to exploring other task deployment options, for example, having a dedicated worker at each station.

Once a customer places an order, the order slip is queued for a food production worker to start work at the assemble stations. There are separate stations for the meat assembly, sides assembly, saucing and finishing, and packing. At the meat station, the time it takes to assemble the meat depends on the meal type. A recent time study revealed the approximate processing times for each station, shown in Table 3.

Table 3: Approximate processing time for each station per item type.

Station	Item	Minimum Time (sec)	Average Time (sec)	Maximum Time (sec)
Meat Assembly	Small Platter	45	50	60
	Large Platter	60	70	90
	Sandwich	50	60	80
Sides Assembly	One Side	10	15	20
Saucing and Finishing	One Meal	5	10	15
Packing	One Meal with side(s)	5	10	15

The maximum number of workers that can be present at one station are as follows: two at the meal assembly station, two at the side assembly station, two at the saucing and finishing station, and three at the packing station. There will only be as many meals assembled at a station as there are workers. There is a landing buffer for two extra meals to sit at each station. This does not account for the two meals workers could be assembling at that station as well. After the saucing and finishing station, there is space for 15 meals to wait at the pass thru window for the customer service workers pick up and take to the packing station.

The meat assembly and side assembly station both have a limit to the amount of cooked product it can hold. Spacing has been allotted at each station to hold a certain number of portions of each food item.

Table 4: The meat and sides assembly station max capacity for each food item.

Food Item	Assembly Station Max Capacity
Brisket	100 oz
Pulled Pork	120 oz
Ribs	12 full racks
Fries	40 portions
Mac and Cheese	10 portions
Green Beans	10 portions
Baked Beans	10 portions

When an assembly station runs out of a food item, a worker replenishes it by getting more food from the holding cabinets. There are two holding cabinets: one for meats and one for sides. These holding cabinets keep the cooked food from spoiling until they are needed at the assembly stations. If any of the food inventory levels in the holding cabinets reach below a certain inventory level, it is time to cook more food. Since the meats are only cooked overnight, the meat cabinet is large enough to hold any meat inventory needed during the day. However, the sides cabinet is limited in capacity and can only hold a certain number of portions. Since fries are a popular item with a quick cook time, they are only held at the sides assembly station and not in the sides holding cabinet. The maximum capacity of the sides cabinet is 120 portions of sides in total. The current policy allocates a maximum amount of space per each side.

Table 5: The allocated maximum space in the sides cabinet per each sides type.

Food Item	Sides Cabinet Max Capacity
Fries	N/A
Mac and Cheese	40 portions
Green Beans	40 portions
Baked Beans	40 portions

Cooking Process and Equipment

Food production requires the use of three types of equipment: smoker, fryer, and stovetop. The smoker is used to cook all three types of meats. The fryer is used to cook fries. The stovetop cooks all other sides: mac and cheese, baked beans, and green beans. Currently, the restaurant owns one of each type of equipment.

Each food item is placed in a unique carrier for cooking. The fryer uses a fry basket. The sides that are cooked on the stove all use a stove pot. The meat heading into the smoker is arranged on a tray. The trays are the same for all meat types, so they take up the same amount of space

in the smoker. However, a tray produces a unique amount depending on the type of meat cooked. The carriers each make a different portion of food as shown in Table 6.

Table 6: The number of portions each carrier produces.

Carrier	Portions
Brisket Tray	200 oz
Pulled Pork Tray	240 oz
Rib Tray	12 full racks
Fry Basket	10 portions
Stove Pot	20 portions

The carriers are unlimitedly available, stay with the food for cooking, and are cleaned during the post cooking clean-up process. The food carriers will always be full; the food production team will never cook a partially filled carrier. The equipment is limited in the number of carriers it can cook at one time. The workers will not prepare to cook a carrier until there is space in the equipment.

Table 7: The maximum carrier capacity of each piece of equipment.

Equipment	Max Carrier Capacity
Smoker	30 trays
Fryer	3 fry baskets
Stovetop	4 stove pots

Each food item has a unique preparation time which includes time to mix ingredients, season the food, heat up the equipment, and prepare the food into the carrier. The cook time for each food item is unique as well. The clean-up time is a cool down time for the food as the worker cleans the equipment or pans for the next use. After clean-up, the newly cooked food is moved into the holding cabinets or directly to the assembly stations. Assume that the raw material for each food item is infinitely available.

Table 8: The preparation time, cook time, clean-up time, and food cost per batch associated with cooking each food item.

Food	Prep Time	Cook Time	Clean-up Time	Food Cost per Carrier
Pulled Pork	6-7 minutes	10 hours	4-5 minutes	\$108.00
Brisket	7-8 minutes	10 hours	4-5 minutes	\$75.00
Ribs	3-4 minutes	10 hours	4-5 minutes	\$54.00
Fries	1-2 minutes	3 minutes	0.5-1 minutes	\$2.50
Mac and Cheese	4-5 minutes	15 minutes	2-3 minutes	\$20.00
Green beans	3-4 minutes	5 minutes	2-3 minutes	\$10.00
Baked beans	3-4 minutes	10 minutes	2-3 minutes	\$10.00

Typically, one worker will operate a piece of equipment at one time and will do all the work at that location. For the smoker, if multiple workers are available, they will collaborate to process the batches of meat. The food production staff at the equipment will prepare each batch that is to be cooked and complete the needed clean-up as well. The times given in Table 8 are per batch, or one carrier, of food. Each piece of equipment works on a timer. The timer will automatically shut off the machine when cooking is completed, therefore a worker does not need to be present during cook time. The food cost is given per carrier of each food item and is only incurred upon cooking the carrier.

Inventory Policies and End of Day Behavior

The current inventory replenishment strategy is as follows: when any of the food item inventories at the assembly stations are empty (0 portions available), the material is then replenished from the corresponding cabinet. The assembly stations will be filled as much as they can hold but might be constrained by what is currently available in the holding cabinets.

Since fries are only held on the assembly station, when their inventory reaches one portion of fries remaining the food production team will cook more fries. The quantity to replenish will be limited by how much the assembly station can hold and the portions a carrier can make.

Generally, an item in the sides cabinet is replenished when the quantity in stock reaches below 25% of the maximum capacity of storage for that side type. The replenishment quantity for any of the sides is limited to the holding space available in the cabinet and the food carrier portions. The food production team will not cook a food carrier if there is not enough space to hold all the portions of food produced and they will not cook a partial carrier. When multiple food items need to be replenished, the food with the lowest inventory should be given cooking priority. Post cooking, the food is moved into the holding cabinets.

Prior to closing for the day, the side food item's replenishment policy changes. A half an hour before closing, 9:30pm, the sides cabinet will stop being filled. The sides assembly station will first deplete the remaining cabinet material. When a side food item is completely out of stock in this time period, then one new batch will be produced. The one batch will be moved into the assembly station straight from the cooker equipment. One batch at a time will be produced as needed.

Preparation of meat for the next day begins as soon as 9:30pm, if the food production team is available. Customer-oriented tasks should take priority. The meat will cook overnight, and the smoker will shut off after 10 hours. Then in the morning the workers will run the smoker clean-up processes. Currently, the restaurant makes the same amount of each type of meat every day; 1,000 ounces of brisket, 1,680 ounces of pulled pork, and 96 racks of ribs.

At the end of day, once all customers have been served and it is past closing time, all inventory is disposed of from the cabinets and assembly stations, as the food will not keep overnight. The only food remaining should be the meat currently cooking in the smoker.

Employees

Simio BBQ Smoke Pit employees two types of workers: Customer Service and Food Production. Customer Service employees oversee taking customer orders, as well as final food packing and handoff. The time to take one customer's order and receive their payment is estimated to be a minimum of 10 seconds, an average of 15 seconds, and a maximum of 25 seconds. This time is estimated per one person's order, and not an entire group's order. Customer Service is also in charge of meal handoffs. Once all meals for an order have been assembled, the Customer Service employee will package the food for the entire order and then deliver it to the waiting customer(s). Orders completed are not always FIFO due to the varying inventory at the assembly stations. The Customer Service employee will pick up the finished meals at the saucing and finishing station window and will take them to the packing station. The workers can carry up to six meals at one time. An order will not be packaged until all meals in that group's order have been completed and brought to the packing station. Once the entire order is packaged, Customer Service will handoff the completed order at the pick-up window. The handoff time includes presentation time and conversation with the group; this time is estimated to be a minimum of 10 seconds, an average of 15 seconds, and a maximum of 20 seconds. The Customer Service employees are paid \$18 per hour.

The Food Production staff oversees cooking preparation for each food item as well as clean-up at the different equipment. These employees also work at the assembly stations to assemble the meals. The Food Production staff is tasked with transferring the food items between locations, whether that is from the cooker equipment to the storage cabinet, or from the cabinet to the assembly station. The Food Production staff uses carts to move product around, so when moving food stock, the Food Production team is always able to carry the amount needed to be moved. When assembling, they will typically only work on and carry one meal at a time. The Food Production employees are paid \$20 per hour.

The restaurant is open for customers from 10:00 am to 10:00 pm, seven days a week. Food Production employees start an hour earlier, 9:00 am, to prep for the day. Additionally, employees will stay past closing to do end of day clean up and preparation for the next day. Staff may need to remain after their scheduled shift time to serve any remaining customers, finish cooking, or do end of day tasks such as starting the smoking process. Any time staff needs to remain past their scheduled shift time will count as overtime. Overtime will be paid 1.5 times their normal pay rate. Workers can take a 30-minute break during their shifts. Management creates a work schedule following the same pattern every day of the week. The only change will be the people working that day; the positions and shift times remain the same. A posting of a work schedule for one day can be found in the Work Schedule data sheet provided.

Other Costs

To operate a restaurant, Simio BBQ Smoke Pit has other overhead costs. Since they have chosen a popular downtown area, they have expensive weekly rent. The rent, utilities, and other support services per week is \$5,000. Additionally, there is a management member staffed to the restaurant. They do not assist in any of the floorwork but do other managerial tasks. The management staff schedule also remains the same each day of the week and is posted in the Work Schedule provided. Management staff are paid \$25 per hour.

Analysis and Project Deliverables

Simio BBQ Smoke Pit's main objectives include maximizing profit and improving customer satisfaction. The restaurant's current profit per week is estimated to be between \$500 to \$5,000. This wide range of profit is due to the fluctuation of customer arrivals each week and the amount of food that is wasted each day. Profit can be increased by reducing food or labor cost and by reducing the number of customers that leave the restaurant. Management is interested in quantifying sales lost due to those dissatisfied customers who leave the restaurant because of long wait times or meat stockouts.

Current customer satisfaction is determined based on the average order-to-delivery (OTD) time, which is the amount of time a customer waits for their food after placing their order. The restaurant's current OTD average is 6-7 minutes, and it should remain at or under 6-7 minutes on average. To expand the customer satisfaction metric, management is interested in the number of times a customer's original order was unavailable. Currently, approximately 6-8% of customers a week are forced to change their order; the goal is to minimize this percentage. Additionally, management has noticed that approximately 20-30% of groups a week leave due to long wait times or meat stockouts, which to increase profit, should be reduced as well.

Simio BBQ Smoke Pit is willing to change current staffing levels and/or the current employee schedules. This change could include hiring new workers or changing the hours of current workers. Management is also looking to experiment with the inventory strategy at all points in the system: cooking, storage, and stations. The inventory strategies should look to improve product availability during service times and reduce product waste at the end of the day.

The restaurant plans one week ahead of time, so the model should represent one typical week of operations based on the current business environment. This week should follow the hourly and daily seasonality from historic data.

Analyze the current state and identify areas to improve profit or customer satisfaction. Model an ideal state and statistically prove the value of each proposed change. As an expert simulationist, your models should include compelling animation.

Metrics that interest management include:

- Revenue
- Food Cost
- Labor Cost
- Profit
- Staff Utilization
- Equipment Utilization
- Ordering Queue Times
- Order to Delivery Times
- Customer Time in System

Questions to answer include:

- What is the biggest service bottleneck in the current system?
- What should the weekly staffing schedule look like?

- What should the inventory management policy be for assembly station and holding cabinets? This can differ per food item.
- Should the cooking procedure follow a different ranking rule for determining what item to cook next?
- How should the food production staff manage processing orders at the assembly stations?

Additional Problems

Through this project, Simio BBQ Smoke Pit has found other related problems they would be interested in investigating. They consider these problems secondary to the main problem but would be keen on hearing any recommendations that could be given.

Problem 1 – New Equipment

Management is considering investing in a new smoker and would like to understand the ROI term of this investment. This new smoker would replace the old smoker as there is currently only enough space for one. This new smoker would cost \$4000 and have a capacity to hold 50 trays. Based on any projected profit increases from your analysis, calculate the number of years it would take the restaurant to recover the original investment of the smoker. Any ROI term longer than three years should not be recommended.

Problem 2 – Restaurant Expansion

As the city continues to renovate its downtown area, an opportunity to acquire a small neighboring plot of land has been presented to Simio BBQ Smoke Pit. Simio BBQ Smoke Pit is planning to purchase this plot but would like expert advice on what way the plot should be used.

This adjacent space will provide different opportunities for the front and back half of the restaurant. In the front customer service area, this expansion could be used in one of two ways: to expand the order window and add another cash register, or to increase the order pick up waiting zone so it will double in size.

In the back half of the restaurant, the space could allow either one new piece of equipment or a new station space. This equipment will be identical to the original equipment in the current state. You could choose to acquire one new smoker and retain the old smoker in this space. Instead of new equipment, this space could be used as a new station space, doubling the worker capacity at any one of the stations.

Data File and Attachments

https://cdn.simio.com/StudentCompetition/2020_Dec_Data.zip

Customer Arrivals

Table 9: Customer Arrival data dictionary

Column Name	Data Description
Arrival Time	The time the customer arrived at the restaurant.
Order ID	The unique numeric identifier for customer group.
Item ID	The menu item's numeric identifier.
Menu Item	The menu item ordered description. This specifies if the order is a sandwich, small platter, or large platter and the meat item.
Side 1	The food item type for the first side provided with sandwiches, small platters, and large platters.
Side 2	The food item type for the second side provided with large platters.

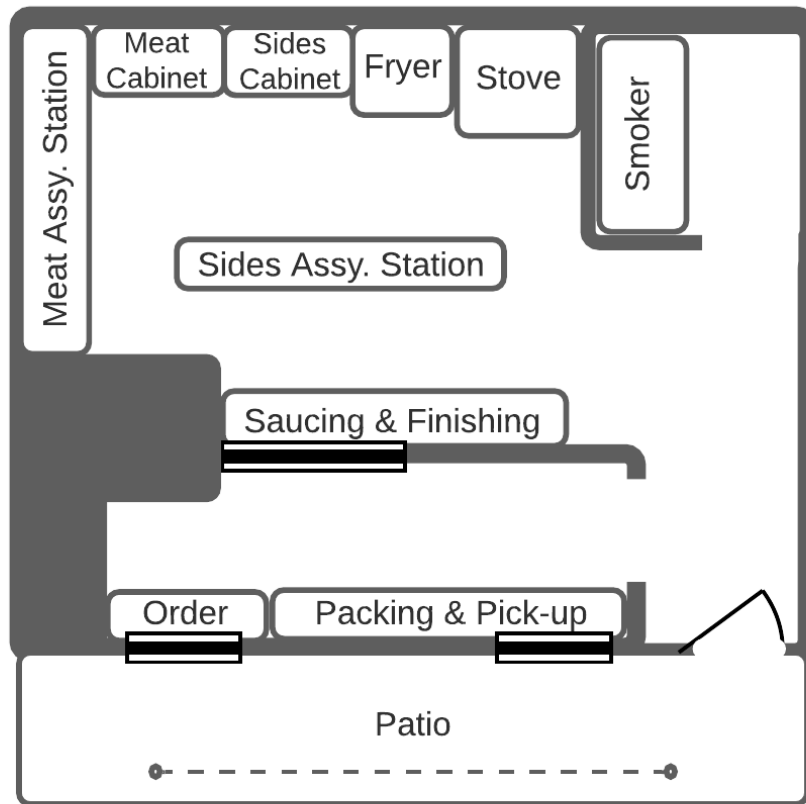
Posted Work Schedule for a Day

Table 10: Work Schedule data dictionary

Column Name	Data Description
Worker Name	The worker scheduled.
Position	The position they are assigned to staff.
Start of Shift	The time the worker's shift starts.
End of Shift	The time the worker's shift ends.

Layout Attachment

Figure 2: The restaurant layout.



The layout is given as an attachment that can be imported into Simio to approximate distances. The entire area is approximately a 27 ft by 27 ft square.