

Modeling and Analysis of a Subway Restaurant

This lab involves developing a Simio model of a Subway® restaurant and using the model to analyze the performance of the system during *lunch rush*. The system works similar to a serial production line with five stages as shown in the figure below (the highlighted stations involve a human worker).



Customers enter and go to the first stage where they select the size and type of bread, meat, and cheese. The second stage is the oven where sandwiches get toasted (if ordered by the customer). The customer (and partially made sandwich) then go to the next stage to add veggies and condiments. Once the sandwich is made, the customer pays at the cash register, the cashier wraps the sandwich and puts it in a bag. Finally, customers go to the drink machine to get their drink and then they leave the system. Each stage has one server and we will assume infinite queues between stages.

During lunch rush, customers arrive according to a Poisson distribution with a rate of 32/hr. Processing times are all triangularly distributed with the following parameters (minutes):

Station	Bread & Meat	Oven	Veggies	Cashier	Drink
(Min, Mode, Max)	(1, 1.5, 2)	(0.5, 1, 1.5)	(1, 1.5, 2)	(0.5, 1, 1.5)	(0.5, 1, 1.5)

Based on the data collected from the restaurant, 70% of the customers want their sandwich toasted while the remaining 30% get cold subs. The current operating policy requires that FIFO (First In First Out) be maintained throughout the system. Therefore, cold sandwiches should also wait in the queue for the oven (if there is one). In other words, the current policy does not allow a customer that wants a cold sandwich to pass a customer that is waiting for his/her sandwich to be toasted.

The manager of this restaurant has hired you to estimate the utilization of the servers, expected number of customers in the system, and the time that customers spend in the system on average. The manager is also interested in evaluating an alternative operating policy that allows “passing” and would like you to perform a comparison between the two policies.

The videos will guide you through:

1. Building the model of the current policy in Simio
2. Verifying the model
3. Defining “Responses” for your experiment and interpret the resulting SMORE plots
4. Modifying the model to allow passing
5. Comparing the two policies

Assignments

1. Using your model of the current operating policy:
 - a. Determine the *minimum* arrival rate that would result in at least 20% of customers spend more than 15 minutes in the system at steady state. Briefly describe your approach and provide any relevant SMORE plots.
 - b. Suppose that the actual arrival rate of customers increases to the rate you determined in Part (a) and you would like to make the maximum improvement to the average time in system by adding one unit of capacity to only one of your servers. Which station will you choose? Explain how you made your decision and provide the relevant SMORE plots.
2. Consider a Subway branch where, besides the toaster oven, there is also a microwave and customers can choose between the two options for having their sandwich heated. Suppose that from those customers that want their sandwich warmed up, 70% will choose the toaster while the remaining 30% will have their sandwich microwaved. The microwave has a processing time that is uniformly distributed between 0.5 and 1.5 minutes.
 - a. Without adding a new *Server* object, modify your models of the current restaurant to include the microwave and evaluate the performance of the system under the “No Passing” operating policy in terms of average and maximum time in system, average and maximum number in system, and server utilizations.
 - b. Explain the problem associated with using a separate *Server* object parallel to the Oven for modeling the microwave under the “No Passing” policy.

Submission Requirements

The deliverables for the lab include the following:

1. A single word document that includes the “solutions” to the assignment problems, i.e., tables/figures of simulation results, analysis of simulation outputs/recommendations, description of your verification analysis, etc. The report is the primary component of your submission that is graded and all other files (such as Excel or Simio models) are just supporting material so make sure your report document is complete by itself and do not simply refer the reader to other files in your submission.
2. All related Simio models developed as part of the assignments.

All of the files should be zipped together and submitted via Canvas. Make sure you do not submit any other file types such as “.rar”.

If you work in a team of 2, make sure that you both submit the exact same zip file and indicate the name of your partner as a comment.