Project Maths Modelling Project 1

Prashanth Guntal (18200537)
Surbhi Grover (18200126)

1) PROBLEM STATEMENT:

In the given problem statement, we are modeling a Fine Fast Food restaurant. Restaurant management is interested in their staffing for lunch period running from 10 am to 2 pm. Customers arrive at a restaurant in three ways, namely: by Foot, by Bus or by Car. Currently, they have six staff working in order section and two staff working at food pickup section. However, they are looking for an alternative plan to change the staffing by 3 staff at the ordering section and 1 staff at the food section during no peak hour or before arrival and departure of Bus i.e.; at 10am to 11am and 1pm to 2pm and 9 staff at ordering section and 3 staff at food pick up section during peak hours i.e., 11am to 1pm. Aim of this simulation is to analysis will changing the staff during peak hours is reducing the wait time of people.

ARENA MODEL:

First three entities are for the arrival of customers by Foot, by Bus or by Car. The second entity is the customer arrival to order/Pay section. In this staff takes the order and then makes the payment, i.e., these two operations are sequential. After that, each customer goes to the food pickup section and waits unit food is ready. Then they collect the food and move towards the seating section where there are only 30 seats available. After eating the customer walks out of the restaurant via the exit door. In the current model, the order/pay section is TRIA(1,3,4) + TRIA(1,2,3) minutes distributed, as two sequential steps are happening. Food pickup section is UNIF(0.5,2) minutes distributed and in seating area consuming food is TRIA(11, 20, 31) minutes distributed. In the alternate model, we are just changing the staff allocation; however, the time taken by each server remains the same. Since the customer is taking some time to walk from one server to another server, therefore a delay is there in both models between customer arrival to order/payment, order/payment to food pickup entity and food pickup entity to seating location which is EXPO(30) sec distributed. There is more delay between seating area to exit door, which is EXPO(1) minute as people move more slowly after having food and moving towards the exit door. Seating area allocation is done in random order as people are willing to sit anywhere, not just with their group. We have also scheduled at 10:50, 11:50, 12:50 and 1:50 that one server from each station goes on a 10-minute break. Even the plots (i) of the queue to get into order/pay, pick up food and the seating area is drawn.

RESULTS:

On simulation, current/initial model(*Fig-1*) for 4hrs customers served and out are 213 on average out of 236 customers in, and alternative model(*Fig-2*) for 4hrs customers served and out are 195 out of 212 customers in.

Model	Average time in Order/pay queue(hours)	Average time in Food Pickup queue(hours)	Average time in Seating area queue(hours)	Maximum time in Order/pay queue(hours)	Maximum time in Food Pickup queue(hours)	Maximum time in Seating area(hours)
Current Model	0.0055	0.058	0.011	0.065	0.2737	0.1045
Alternative Model	0.00118	0.0065	0.0124	0.033	0.1165	0.2028

Table-1

Model	Average Length of Order/pay queue (hours)	Average Length of Food Pickup queue (hours)	Average Length of Seating area queue (hours)	Maximum Length of Order/pay queue (hours)	Maximum Length of Food Pickup queue (hours)	Maximum Length of Seating area (hours)
Current Model	0.3246	3.4	0.67	24	25	11
Alternative Model	0.062	0.34	0.6516	13	17	14

Table-2

PLOTS:

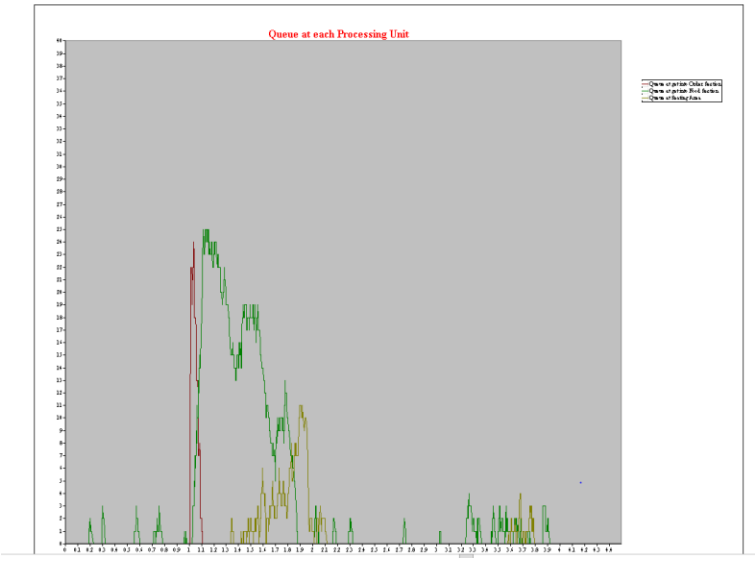

Fig – 1

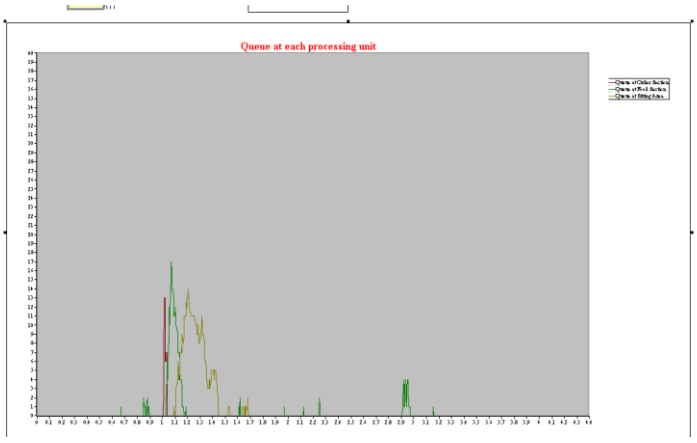

Fig-2

- Queue at order/pay – Red Colored
- Queue at food pickup – Green Colored
- Queue at Seating Area – Brown Colored

CONCLUSION:

Considering the waiting times and length at each section and ratio of number of customers served out, going with alternative plan would be better.

2) PROBLEM STATEMENT:

In the given problem statement, we need to simulate the simple clinic operation. The hospital staffed by one assistant and Doctor on the premises. However, the clinic is thinking to add one more assistant to assist separately. Through this simulation, the main aim is to analyse if the addition of one assistant is efficient for the clinic or not.

ARENA MODEL:

The first entity to the model is the "Patient Arrival" which generates the incoming of the Patient entities. The patients are arriving on average once every 20 minutes. Therefore, patient arrival is according to the exponential distribution with mean 20 minutes. After the arrival, the patient's entity goes to the check-in process, which is staffed by one medical assistant. This process takes from 30 seconds to 2 minutes, therefore modelled using Uniform distribution. From registration if the Doctor is available, i.e., doctor resource is idle, then the patient will directly go to the Doctor else he will go to the waiting room. The patient in the waiting room will be served in a FIFO manner.

The Doctor takes an average 15 minutes with a standard deviation of 3 minutes for a check-up, therefore, configured using Normal distribution. After the check-up, only 50% of patients need a prescription which is decided by 50-50 chance. If the patient requires a prescription, then the Doctor is occupied for an average 1 minute more which is modelled using exponential distribution. From Doctor, all the patient directly go to the check out to the same medical assistant who was in check-in, which usually takes the 45 seconds modelled using exponential distribution. Another model with the same processes formulated with one more resource attached at the check-out process instead of using the same resource as check-in.

RESULT:

On simulation, the model for ten replications of 8 hours the model with one medical assistant resource has treated, on average, 24 patients, whereas the model with two medical assistants has treated 23 patients. The max. waiting time and average time of the patient in the office for ten replications is shown in below table:

Replications	Maximum time in the waiting room when one assistant available (hours)	Maximum time in the waiting room when two assistant available (hours)	Average Total time spent in office when one assistant available (hours)	Average Total time spent in office when two assistant available (hours)
1	0.6655	0.6655	0.5163	0.5230
2	0.7804	1.1354	0.6130	0.8062
3	1.4319	0.7441	0.9776	0.5829
4	1.1578	1.2249	0.9553	0.9698
5	0.9144	1.0202	0.6024	0.5992
6	0.7748	0.7748	0.6081	0.6081
7	0.3088	0.3088	0.3654	0.3654
8	0.4539	0.4539	0.3993	0.3993
9	1.6716	1.6739	1.0280	1.0270
10	0.8795	0.3797	0.5310	0.3781

Therefore, the maximum time spent in the waiting room in the model with one assistant is 1.6716 hours whereas in model with two assistant is 1.6739 hours. The average total time spent in the clinic by the patient in the model with one assistant is 0.65964 hours whereas with two assistant is 0.6259 hours.

CONCLUSION:

Adding one more medical assistant hasn't drastically changed any waiting time or average total time. Therefore adding one more medical assistant will not be preferable.