Mathematical Modelling

QuestQ

Initial model & Proposed alternative model

In both inital and alternative models we tracked the following population parameters:

1. Arrival times of customers entering the system. The arrival time of the ith customer is denoted by A_i.

2. Departure times of customers leaving queuing system after collecting order. The departure time of the ith customer is denoted by D_i.

3. Service times for customers in the system. The service time for the ith customer is given by S_i.

4. Total number of customers that have entered/left the system is denoted by n. (Note: We do not account for customers leaving the system, without making an order hence the total number of arrivals = total number of departures)

From the above, we derived the following:

1. Inter-arrival times between customers entering the queuing system. The jth inter-arrival time is given by:

$$A_i - A_{i-1}$$

2. Inter-departure time between customers leaving the system. The jth inter-departure time is given by:

$$D_i - D_{i-1}$$

3. Lead time is traditionally interpreted as the total waiting time prior to making an order for the ith customer:

$$D_i - A_i - S_i$$

4. In our project, we denote lead time as the total waiting time since entering the system, till customers depart from their system after collecting an order. The lead time of the ith customer is thus given by:

$$D_i - A_i$$

5. The total waiting time for all customers:

$$\sum_{i}^{n} D_i - A_i$$

6. Average waiting, during the 45 minute peak period:

$$\frac{\sum_{i}^{n} D_i - A_i}{n}$$

7. Rate of change in queue length (Expected number of people in the queue):

$$\frac{dD}{dt} - \frac{dA}{dt}$$