The Effect of Operating Characteristics on Managerial Decisions

Now let us consider the operating characteristics of our example as they relate to management decisions. The arrival rate of 24 customers per hour means that, on the average, a customer arrives every 2.5 minutes (i.e., $1/24 \times 60$ minutes). This indicates that the store is very busy. Because of the nature of the store, customers purchase few items and expect quick service. Customers expect to spend a relatively large amount of time in a supermarket, since typically they make larger purchases. But customers who shop at a drive-in market do so, at least in part, because it is quicker than a supermarket.

Given customers' expectations, the store's manager believes that it is unacceptable for a customer to wait 8 minutes and spend a total of 10 minutes in the queuing system (not including the actual shopping time). The manager wants to test several alternatives for reducing customer waiting time: (1) the addition of another employee to pack up the purchases and (2) the addition of an additional checkout counter.

Alternative I: The Addition of an Employee

The addition of an extra employee will cost the store manager $150 per week. With the help of the national office's marketing research group, the manager has determined that for each minute that customer waiting time is reduced, the store avoids a loss in sales of $75 per week. (That is, the store loses money when customers leave prior to shopping because of the long line, or when customers do not return.)

If a new employee is hired, customers can be served in less time. In other words, the service rate, which is the number of customers served per time period, will *increase*. The previous service rate was

$$\mu = 30 \text{ customers served per hour}$$

The addition of a new employee will increase the service rate to

$$\mu = 40 \text{ customers served per hour}$$

It will be assumed that the arrival rate will remain the same ($\lambda = 24$ per hour), since the increased service rate will not increase arrivals but instead will minimize the loss of customers. (However, it is not illogical to assume that an increase in service might increase arrivals.)

Alternative II: The Addition of a New Checkout Counter

Next we will consider the manager's alternative of constructing a new checkout counter. The total cost of this project would be $6,000, plus an extra $200 per week for an additional cashier.

The new checkout counter would be opposite the present counter (so that the servers would have their backs to each other in an enclosed counter area). There would be several display cases and racks between the two lines so that customers waiting in line would not move back and forth between the lines. (Such movement, called *jockeying*, would invalidate the queuing formulas we already developed.) We will assume that the customers would divide themselves equally between both lines, so the arrival rate for each line would be half of the prior arrival rate for a single checkout counter. Thus, the new arrival rate for each checkout counter is

$$\lambda = 12 \text{ customers per hour}$$

and the service rate remains the same for each of the counters,

$$\mu = 30 \text{ customers served per hour}$$