The SM Superstore

You have just been hired as a consultant by Sue Model of Sue's Markets. Although Sue has been in the grocery business for many years with a large chain of small stores, she just recently opened the first of a new type of store called The SM Superstore. The idea behind this new concept is to provide a huge store with numerous types of brands available and fast, friendly service. This first store is being used to test the layout and operating procedures for a large chain of superstores that Sue expects to build.

The first store has been open for six months, and Sue is still having a problem staffing the checkout counters during peak times, which occur from 2 PM to 10 PM. She has received many customer complaints about the long lines in front of the checkout counters. She has 20 checkouts that she can use, but has not been able to develop an adequate staffing plan to eliminate the long waits. Your consulting firm has been asked to develop an economical staffing plan that will meet Sue's requirements.

Prior to requesting your services, Sue hired a group of IE students from a local university to collect and analyze data. Some of those data are summarized in this document. No additional information is available. After reading your report, she may decide to ask for additional work.

An informal survey was conducted to determine what wait times customers expect—the time customers wait in line before reaching the cashier. Most customers would prefer at most a 2- or 3-minute wait time, but are willing to wait as long as 10 or 12 minutes if the store is very busy. Customers with only a few items normally expect a shorter waiting time. Customers did indicate that if they had to wait longer than 15 or 20 minutes, they might go to another store the next time. In addition, if the number of customers exceeds 4 or 5 per lane, the congestion starts to interrupt the other shoppers.

Although the customer arrival rate has a great degree of variability, the IE students have provided average arrival rates at the checkout lines (in customers per hour) for each half hour of the times under consideration. These rates are as follows:

Time	Rate	Time	Rate
2:00 - 2:30	95	6:00 - 6:30	105
2:30 - 3:00	100	6:30 - 7:00	95
3:00 - 3:30	120	7:00 - 7:30	125
3:30 - 4:00	150	7:30 - 8:00	150
4:00 - 4:30	160	8:00 - 8:30	155
4:30 - 5:00	150	8:30 - 9:00	95
5:00 - 5:30	160	9:00 - 9:30	70
5:30 - 6:00	110	9:30 - 10:00	60

During the data collection phase, it was assumed that all days were identical so data were only collected on Monday through Thursday. It now appears that the overall demand on Friday increases about 15%, and the weekend demand is very different. Thus, you should only be concerned with the weekday staffing.

Actual shopping time has a great degree of variability. Customers purchasing fewer than 10 items generally average about 42 seconds per item, although it takes a minimum of 3 minutes just to travel through the store. Customers who purchase more items average about 34 seconds per item.

The number of items per customer is quite variable, but appears to be consistent over time. A large sample of items per customer was obtained from cash register receipts and can be found in file `IIE_SM_1.dat`. The average checkout time per item is about 3 seconds, but can vary as much as 25%. About 1.3% of the time a price check will be needed on an item or a damaged item will need to be replaced. Although the store uses scanners for checkout, customers sometimes request that the price list at the item display be checked. The time for this activity is highly variable, but averages about 2.2 minutes.

The form of payment depends on the number of items that a customer purchases. For purchases of 20 or fewer items, 45% of the customers pay cash, 30% pay by check, and 25% pay with a credit card. For purchases of greater than 20 items, the values for those categories are 20%, 45%, and 35%, respectively. All payment transaction times appear to follow a normal distribution, but vary by payment type. Cash payments average 0.95 minute, with a standard deviation of 0.17. Check payments for customers with a check cashing card average 1.45 minutes, with a standard deviation of 0.35. With no check cashing card (27% of the time), the supervisor must approve the check, which requires another 0.95 minute, with a standard deviation of 0.15. Credit card payments average 1.24 minutes, with a standard deviation of 0.21.

Bagging times average about 1.25 seconds per item, but can vary as much as 20%. Customers have a greater preference, 63%, for plastic bags rather than paper. If a bagger is not available, the cashier will bag the groceries after payment is made. About 30% of the time the customer will help. The time does not appear to be dependent upon who is doing the bagging. Baggers may be assigned to a single aisle, to multiple aisles, or may simply move among all aisles as required.

Sue's employees for cashier and bagging activities are mostly part-time people. Cashiers are paid an average of $7.25 per hour, and baggers are paid an average of $5.50 per hour. There are several rules that must be followed in staffing with part-time employees. Any part-time person must be scheduled for a minimum of 3 hours and a maximum of 5 hours. Cashiers are generally not asked to work as baggers, and baggers are not allowed to work as cashiers.

Clearly, one can make all customers happy almost all the time by keeping all the checkouts completely staffed all the time. However, the cost to implement this strategy would be prohibitive. Ideally, a staffing schedule would provide minimal waiting time at a minimum cost. Although Sue is expecting a single schedule, she did note at the last meeting that she expects demand to change over time. So, she might be interested in how and when to adjust her schedule as the demand changes.

Sue is looking forward to receiving your recommendations.