

such a design, customers would enter any of the register areas that were staffed and form a line at each such facility. When it became the customer's turn to pay for the acquired merchandise, the cashier would process the transaction and bag the merchandise. Unfortunately, the multiple-line approach did not work out too well with the expanded checkout area, since, if a customer got into a line that was not moving as fast as another, it was difficult for the customer to quickly switch lines, particularly, when Registers 4 and 5, the primary registers, were the only ones being staffed.

In an attempt to alleviate this problem, the store switched to a *single-line, multiple-channel, single-phase* approach, as shown in Figure 1. Customers would form a single line (see blue arrows in Figure 1) before moving to an available register. Movable sign-standards were placed at the point where customers were to start forming a line (see red circle in Figure 1). However, for many customers, this was a confusing approach, particularly for customers who were new to the store. This latter group would often bypass the line and go directly to a staffed register. If such behaviour was seen by a cashier, the customer was often asked to go to the end of the single line that had formed.

While the identified checkout approach might appear fair to most customers (i.e., first-come, first-served), a major issue with the design is the resulting inefficiency of staff utilization. Once a cashier completes a transaction with a customer, the cashier then calls out "next in line," thereby indicating that the next customer in line can move forward to the open register. This process means that the cashier is in a "down-time" state by having to page the next customer and by having to wait until the customer moves from the "waiting area" (see red circle in Figure 1) to the open register area (see green stars in Figure 1)

An informal time-study analysis was carried out to determine the amount of "down-time" resulting from the current checkout area setup and procedure. The distance from the "waiting area" to Register 1 is 22 ft. It takes the average "next-in-line" customer 5 seconds to reach Register 1, once the customer is aware that he or she is being paged. The time it takes a cashier to call out "next in line" and the time it takes for a customer to realize that he or she is being paged by a particular cashier takes an average of 2 seconds.

Just because a customer is waiting in line does not mean that the customer is continuously scanning the checkout area to determine which register is available [e.g., customer may be talking to someone else in line, examining items selected, looking for money to pay for the items, or looking at display areas (i.e., orange areas in Figure 1)]. The display area to the left of where the waiting line forms is stocked with chocolate bars and similar candy; the display area to the right is stocked with single-unit, cold beverages. The display area in front of Registers 4 and 5 contain more single-unit, packaged candy and magazines. The display area along the far wall in front of Registers 4 and 5 is stalked with various sale merchandise. The customer has direct access to all of these display areas. However, the display area behind Registers 1, 2, and 3 contains merchandise that is of higher value

or is of such a nature that direct customer access is not allowed; customers need to ask for staff assistance to examine or to acquire the merchandise located in this area.

Focus: Store layout, employee productivity.

Questions:

1. Determine the shortest distance a customer must walk from the “next-in-line” waiting position to each register, using the Euclidean and/or rectilinear distance, as is appropriate. Registers 3, 4, 5, and 6 are lined up horizontally. Assume the customer follows the paths shown in Figure 1 to reach a given register.
2. How long does it take the average customer to walk from the “next-in-line” waiting position to each register?
3. For each register, how much time is required to deal with each customer (i.e., sum of “next-in-line” awareness time, travel time, and transaction processing time)? The average transaction time, once a customer reaches a register area and the transaction is completed, is 2 minutes.
4. Given the following information: (1) all registers are staffed during all hours of operation, (2) the store is open 365 days a year, (3) the store is open 16 hours each day, and (4) there is a continuous line of customers waiting to check out throughout the day. The average transaction time, once a customer reaches a register area and the transaction is completed, is 2 minutes. Assume that all customers are waiting in line at the start of the waiting area when they are called by a cashier and that each cashier follows the “next-in-line” procedure.
 - [a] If there was no “down-time” for each cashier (i.e., the first customer is at the register and there is no waiting time between servicing customers - once one customer is served, servicing of the next customer begins immediately), what is the maximum number of transactions that each cashier could process on an hourly, daily, weekly, and yearly basis? What are the totals for the store (i.e., for 6 registers operating at full capacity)?
 - [b] Taking into account the “next-in-line” awareness time, the travel time, and the transaction time, how many customers can be processed at each register on an hourly, daily, weekly, and yearly basis?
 - [c] What is the total “down time” for each register on an hourly, daily, weekly, and yearly basis?

- [d] Assuming that the labour cost for each cashier is \$10 per hour (includes all wage, tax, and benefit costs), what is the yearly cost to the store for “down time” for each register?
5. Based on your answers to the previous questions, can you determine a way to reduce the “down-time” cost to the store. What are your specific recommendations? What is the value of the savings?
 6. What is the total “down time” if, for an entire year, Registers 4 and 5 only need to be staffed for 70% of the time, Registers 1 to 3 only need to be staffed for 40% of the time, and Register 6 only needs to be staffed for 20% of the time?

[Reference: Krajewski, L. J., & Ritzman, L. P. (2005). *Operations Management* (7th ed.). Upper Saddle River, NJ: Pearson Education.]