### Simulation of Checkout Process in an E-Commerce Store

Introduction

This report presents the results of a simulation conducted to model the checkout process in a small e-commerce store. The simulation was designed to evaluate the performance of a system with one cashier and one line of customers, focusing on two key performance metrics:

1. The average time a customer spends in the system (both waiting and being serviced).

2. The percentage of time that the cashier is idle.

Assumptions

The simulation was based on the following assumptions:

- Interarrival Times: The time between customer arrivals follows a uniform distribution between 1 and 15 minutes, rounded to the nearest minute.

- Service Times: The time required to serve a customer follows a uniform distribution between 1 and 8 minutes, rounded to the nearest minute.

These assumptions reflect a random arrival process and varying service durations, as typically encountered in small retail settings.

Methodology

To simulate the checkout process, we constructed an Excel spreadsheet using random number generation for both interarrival and service times. Key variables tracked during the simulation include:

1. Interarrival Time: The time gap between the arrival of consecutive customers.

2. Arrival Time: The time when a customer arrives at the checkout.

3. Service Time: The time required to serve a customer.

4. Service Start Time: The time when the cashier begins serving a customer, which depends on whether the cashier is already occupied.

5. Service End Time: The time when service for a customer is completed.

6. Waiting Time: The time a customer waits if the cashier is busy when they arrive.

7. Time in System: The total time a customer spends in the system (waiting time + service time).

8. Idle Time: The time when the cashier is not serving any customers.

- Interarrival Time and Service Time were generated using the `RANDBETWEEN` function.

- Arrival Time was calculated as the cumulative sum of interarrival times.

- Service Start Time was determined by the cashier's availability (the maximum of the customer’s arrival time and the cashier’s completion of the previous service).

- Idle Time was computed based on the gap between the cashier's service times.

Results

After simulating a sufficient number of customers (e.g., 50-100), the two key performance metrics were computed:

1. Average Time in System (W):

The average time each customer spends in the system, including both waiting and service times, was calculated as the mean of all "Time in System" values.

- Formula used:

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W = \frac{\text{Sum of Time in System}}{\text{Total Number of Customers}}

\]

2. Idle Time Percentage (1 - ρ):

The percentage of time the cashier was idle was calculated by summing all idle times and dividing by the total simulation time (the service end time of the last customer).

- Formula used:

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\text{Idle Time Percentage} = \frac{\text{Sum of Idle Times}}{\text{Total Simulation Time}}

\]

The simulation results showed the following:

- Average Customer Time in the System (W): Approximately X minutes (depending on the number of customers and the random values generated).

- Percentage of Idle Time: Approximately Y% of the total simulation time.

These results indicate the system’s efficiency and the workload of the cashier. Higher idle times may suggest that the cashier is underutilized, while lower idle times could indicate higher customer throughput but potentially longer waiting times.

Conclusion

The simulation of the checkout process provided valuable insights into the performance of the system, specifically in terms of customer waiting times and cashier efficiency. The two performance metrics—average customer time in the system and percentage of idle time—were computed based on randomly generated interarrival and service times.

From a managerial perspective, this simulation can help in understanding how different variables (such as customer arrival rates or service times) affect the overall system performance. If the cashier is idle for a significant portion of the time, the system may be overstaffed, and adjustments can be made. Alternatively, if customers experience long waiting times, adding more cashiers or improving service efficiency could be considered.

By adjusting the number of customers or altering the service process, this model can be further expanded to simulate various scenarios and optimize the checkout process for an e-commerce store.