**Introduction**

This simulation aims to simulate the checkout procedure of a small online store with one cashier and one customer queue. The average amount of time a client spends in the system (waiting and receiving service) and the percentage of time the cashier is not working are the two main performance metrics that this model seeks to ascertain. Through the simulation of interactions between consumers and the cashier, we are able to assess the effectiveness of the checkout procedure and pinpoint possible areas in need of development.

**Assumptions**

**Interarrival Times**: The time between customer arrivals is uniformly distributed between 1 and 15 minutes, rounded to the nearest whole minute.

**Service Times**: The time required to service each customer is uniformly distributed between 1 and 8 minutes, rounded to the nearest whole minute.

**Simulation Period**: The system is simulated for 3 hours (180 minutes) with 20 customers.

**Methodology**

The simulation was conducted using an Excel spreadsheet that models the arrival and service times of customers at the checkout counter. The steps involved in creating the simulation are outlined below:

**Setting Up the Simulation in Excel**:

Columns were created for each customer to capture relevant data, including arrival time, service start time, service time, service end time, waiting time, time spent in the system, and idle time for the cashier.

**Generating Random Interarrival and Service Times**:

Inter arrival times were simulated using the formula =ROUN(RANDBETWEEN(1, 15), 0) producing uniformly distributed random times between 1 and 15 minutes.

Service times were generated with the formula =ROUN(RANDBETWEEN(1, 8),0) representing the time required to service each customer uniformly between 1 and 8 minutes.

**Calculating Key Metrics**:

* **Arrival Time**: Each customer’s arrival time was determined by adding their interarrival time to the previous customer's arrival time.
* **Service Start Time**: Calculated as the later of the cashier’s availability and the customer’s arrival time.
* **Service End Time**: Determined by adding the service time to the service start time.
* **Waiting Time**: Computed as the difference between the service start time and arrival time, reflecting any delay experienced by the customer.
* **Time in System**: The sum of the service time and waiting time.
* **Idle Time for Cashier**: Measured as the time between the end of one service and the start of the next, indicating periods when the cashier was idle.

**Performance Measures**:

**Average Customer Time in the System (W)**: Calculated as the mean of the time each customer spends in the system.

**Percentage of Time the Cashier is Idle (1 - ρ)**: Determined by dividing the total idle time by the total simulation time (180 minutes) and converting it to a percentage.

**Simulation Replications**:

Using Excel’s Data Table feature, 50 replications of the simulation were generated to capture variability in the results and provide a more robust estimate of the performance measures.

**Results**

After conducting 50 replications of the simulation, the following average performance measures were observed:

**Average Time in System (W)**: Customers spent an average of approximately X minutes in the system, including both waiting and service time.

**Percentage of Idle Time (1 - ρ)**: The cashier was idle approximately Y% of the time, indicating that there were periods where the cashier had no customers to serve.

**Conclusion**

The simulation emphasized the harmony between cashier utilization and customer wait times, as well as insights into the efficiency of the checkout process. In order to enhance customer flow, it may be possible to reduce the number of service locations or optimize the workload of the cashier based on the observed idle moments. The findings can be used to guide decisions about hiring and process enhancements in a small e-commerce environment.

**Methodology Reflection**

Excel worked well for our simulation since it made it simple to calculate important indicators and replicate the process of capturing variability. To obtain a more thorough analysis of checkout efficiency, the model might be expanded to incorporate more cashiers or intricate arrival patterns.