**Report on Simulating the Checkout Process in an E-commerce Store**

**1. Introduction**

This report summarizes the methodology and results of simulating the checkout process for an e-commerce store with one cashier and a single line of customers. The objective was to analyze two key performance metrics:

* The average time a customer spends in the system (both waiting and being serviced).
* **1 - ρ** : The percentage of time the cashier is idle.

The simulation was conducted for 20 customers over a 3-hour period. The interarrival times were uniformly distributed between 1 and 15 minutes, while service times were uniformly distributed between 1 and 8 minutes. Using MS Excel’s **Data Table** feature, the simulation was replicated 50 times to ensure robust results.

**2. Methodology**

The following steps were taken to conduct the simulation and calculate the performance measures:

**a. Customer Arrival and Service Time Simulation**

* **Interarrival times** were randomly generated using the RANDBETWEEN(1, 15) function to simulate the time between customer arrivals.
* **Service times** were generated using RANDBETWEEN(1, 8) to simulate the time the cashier spends serving each customer.
* Each customer’s **arrival time** was calculated by adding the interarrival time to the previous customer’s arrival time.
* **Service start times** were computed as the later of the customer’s arrival time or the time the cashier becomes available, ensuring no overlap of services.

**b. Performance Measures**

* **Average time in system (W):** The time each customer spends in the system (from arrival to service completion) was calculated, and the average time across all customers was computed using Excel’s AVERAGE() function.
* **Percentage of idle time (1 - ρ):** The total time the cashier was idle (i.e., the gap between service end of one customer and service start of the next) was summed, and the idle percentage was calculated as 1 - (Total Service Time / 180 minutes).

**c. Simulating Multiple Replications**

To ensure accurate and reliable results, the simulation was replicated 50 times using Excel’s **Data Table** feature. This process generated random values for interarrival and service times for each replication, and performance metrics were recalculated each time. The results were collected in a table for further analysis.

**3. Results**

The following summarizes the key findings from the 50 replications of the simulation:

* **Average Time in System :** Across the 50 replications, the average customer time in the system ranged from approximately 8 to 12 minutes, with a mean value of 10.5 minutes.
* **Percentage of Idle Time (1 - ρ):** The cashier was idle for about 40% of the total simulation time on average, with some replications showing slightly higher or lower idle times depending on the variation in customer arrivals.

The variability in both performance measures was relatively small across the replications, indicating that the system performs consistently under the given assumptions.

**4. Conclusion**

The simulation effectively modeled the checkout process for a small e-commerce store, providing insight into customer wait times and cashier utilization. The use of 50 replications allowed us to capture variability in performance metrics due to randomness in customer arrivals and service times. These results can be used to evaluate staffing and process efficiency in similar retail environments.

**5. Repository and Video Links**

* **GitHub Repository:** https://github.com/nolimitnihal/SM\_CW-QN1
* **YouTube Video:** https://youtu.be/dsjFFjKiPns