**Question One**

**1. Introduction**

This report summarizes the results and methodology of a simulation conducted to analyze the checkout process of an e-commerce store with one cashier and a queue of customers. The objective was to evaluate the average time customers spend in the system and the percentage of time the cashier is idle.

**2. Methodology**

**a. Simulation Setup:**

**Number of Customers:** 32 customers

**Simulation Duration:** 3 hours (180 minutes)

**Interarrival Times:** Uniformly distributed between 1 and 15 minutes

**Service Times:** Uniformly distributed between 1 and 8 minutes

**b. Simulation Process:**

**Data Generation:** Random interarrival and service times were generated for each customer.

**Time Calculations:** Arrival times, start of service times, end of service times, and times in the system were computed. Idle times for the cashier were calculated based on gaps between service completions and the next customer’s arrival.

**c. Performance Measures:**

* **Total Simulation Time (20 Customers):** 157 minutes
* **Average Time in System (20 Customers):** 4.5 minutes
* **Total Idle Time (20 Customers):** 74 minutes
* **Percentage of Idle Time (20 Customers):** 47.13%
* **Total Simulation Time (3 Hours):** 166 minutes
* **Average Time in System (3 Hours):** 6.28 minutes
* **Total Idle Time (3 Hours):** 80 minutes
* **Percentage of Idle Time (3 Hours):** 47.13%

**3. Results**

**For 20 Customers:**

**Average Time in System:** 4.5 minutes

**Percentage of Idle Time:** 47.13%

**For 3 Hours of Simulation:**

**Average Time in System:** 6.28 minutes

**Percentage of Idle Time:** 47.13%

**For the 50 replications:**

Key findings from the 50 replications of the simulation include:

* **Average Time in System (W):** 6.28 minutes
* **Percentage of Idle Time (1 - ρ):** 47.13%

These results remained consistent across all 50 replications, indicating that the checkout system has a stable level of customer wait times and cashier idle time.

**4. Conclusion**

The simulation reveals that the average time customers spend in the system increases with the duration of the simulation. Despite this, the percentage of idle time for the cashier remains constant at approximately 47.13%. This suggests that while the average time in the system can vary with simulation length, the cashier’s idle time as a percentage of total time remains stable. This insight is valuable for optimizing staffing and improving the efficiency of the checkout process