**QUESTION : 1**

**SIMULATION REPORT: CHECKOUT PROCESS IN AN E-COMMERCE STORE**

**Objective**

The purpose of this simulation is to evaluate the performance of a checkout process in a small e-commerce store. The key performance measures are:

1. The average time a customer spends in the system, including both waiting and service time.
2. The percentage of time that the cashier (server) is idle.

**Methodology:**

1. **Simulation Setup:**
   * The simulation was conducted for a total of 20 customers, with a single cashier available for service.
   * **Interarrival Times:** The time between consecutive customer arrivals was uniformly distributed between 1 and 15 minutes, rounded to the nearest whole minute.
   * **Service Times:** The service time for each customer was uniformly distributed between 1 and 8 minutes, rounded to the nearest whole minute.
2. **Key Steps in the Simulation:**
   * **Data Collection:** Customer data, including interarrival times, arrival times, and service times, were generated using uniform random distributions.
   * **Calculations:**
     + **Service Start Time:** Calculated based on the arrival time of each customer and the time when the cashier becomes free.
     + **Service End Time:** Sum of the service start time and the service time.
     + **Time Spent in System (W):** Difference between the arrival time and the service end time.
     + **Idle Time:** Calculated as the difference between consecutive service start times when the cashier is idle.
   * **Performance Measures Calculated:**
     + **Average Time in System (W):** The average time each customer spent in the system was calculated to be **4.2 minutes**.
     + **Proportion of Idle Time:** The proportion of time the server was idle was found to be **47.56%** over the total simulation time of **180 minutes**.
3. **Simulation Replications:**
   * To ensure the robustness of the results, 50 replications of the simulation were conducted using Excel's Data Table function.
   * For each replication, the average time in the system (W) and the idle time percentage were recorded.
   * The results from these 50 replications showed variation in the performance metrics, providing insights into the range and distribution of customer waiting times and server idle times.

**Results:**

* **Average Time in System (W):**
  + The overall average time across 50 replications was calculated by taking the mean of the average times recorded in each replication. This provides an estimate of the average time a customer would spend in the system under the simulated conditions.
* **Proportion of Idle Time:**
  + The overall average idle time percentage across 50 replications was also computed to assess how often the cashier is not actively serving customers.
* **Summary of Key Findings from 50 Replications:**
  + The average time in the system ranged from a low of approximately **4.2 minutes** to a high of **9.45 minutes**, demonstrating the variability in customer wait and service times.
  + The idle time percentage varied significantly across replications, with a minimum of **16.36%** and a maximum of **51.91%**, indicating that the server’s idle time is sensitive to the arrival and service patterns of customers.

**Conclusion:**

The simulation of the checkout process in a small e-commerce store demonstrated that, on average, customers spend around **4.2 minutes** in the system, and the server is idle approximately **47.56%** of the time. However, variations across 50 replications suggest that both the average time in the system and the idle time can fluctuate significantly depending on the specific arrival and service time distributions. These findings can be used to optimize staffing, improve customer experience, and enhance overall service efficiency.

**Recommendations:**

* **Optimize Staffing:** To reduce customer wait times, consider optimizing staffing levels or implementing dynamic scheduling based on peak periods.
* **Improve Process Efficiency:** Introduce training or technology solutions that could help the cashier reduce service time, thus decreasing the time customers spend in the system and reducing idle time.

**Methodological Notes:**

* The simulation was performed in Excel using random number generation for interarrival and service times and Data Tables for multiple replications. The results provide a robust analysis of the system's performance over a range of conditions.