**QUESTION ONE**

You have been selected to simulate the checkout process in an e-commerce store (such as a small gift shop). The setup includes one cashier and one line of customers waiting for service. The objective is to determine two key performance measures:

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

§ The percentage of time that the checkout clerk is idle.

**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.

**Required**

(i) Create an MS Excel spreadsheet to simulate the checkout process.

(ii) The simulation should calculate two measures of performance:

§ Average customer time in the system (W).

§ Proportion (or %) of time the server is idle (1-ρ).

**Instruction**

(i) Simulate 20 customers.

(ii) Simulate for 3 hours.

(iii) Use MS Excel’s Data Table to generate 50 replications of the simulation.

(iv) Write a brief report summarizing your results and the methodology used to conduct the simulation.

(v) Use your GitHub account to create a new repository titled “SM\_CW-QN1.” Upload your Excel file and a summary/overview of your results, including how you arrived at these results (in Word or PDF format).

(vi) Use Screen Pal Screen Recorder to record the process of conducting the simulation in Excel.

(vii) Save and provide the URLs/Links for both your GitHub repository and the YouTube video showing the simulation process.

(viii) In your COURSEWORK ANSWER BOOKLET, submit the URLs/Links of the GitHub repository and the YouTube link as your answer for this question.

**SOLUTION:**

### **Step 1: Set Up Your Spreadsheet**

1. **Create Columns for Data:**
   * **Column A:** Customer Number
   * **Column B:** Interarrival Time (minutes)
   * **Column C:** Arrival Time (minutes)
   * **Column D:** Service Time (minutes)
   * **Column E:** Service Start Time (minutes)
   * **Column F:** Service End Time (minutes)
   * **Column G:** Time in System (minutes)
   * **Column H:** Clerk Idle Time (minutes)

### **Step 2: Generate Random Interarrival and Service Times**

1. **Generate Random Interarrival Times:**
   * In **Column B**, use the formula =RANDBETWEEN(1, 15) to generate random interarrival times between 1 and 15 minutes.
2. **Generate Random Service Times:**
   * In **Column D**, use the formula =RANDBETWEEN(1, 8) to generate random service times between 1 and 8 minutes.

### **Step 3: Calculate Arrival Times**

1. **Calculate Arrival Times:**
   * In **Cell C2**, set the first arrival time to 0 (assuming the first customer arrives at time 0).
   * In **Cell C3**, use the formula =C2 + B3 to calculate the arrival time for subsequent customers. Drag this formula down the column.

### **Step 4: Calculate Service Start and End Times**

1. **Calculate Service Start Times:**
   * In **Cell E2**, set the first service start time to the first arrival time (i.e., =C2).
   * In **Cell E3**, use the formula =MAX(C3, F2) to ensure the service starts either when the customer arrives or when the previous service ends, whichever is later. Drag this formula down the column.
2. **Calculate Service End Times:**
   * In **Cell F2**, use the formula =E2 + D2 to calculate the service end time for the first customer.
   * In **Cell F3**, use the formula =E3 + D3 to calculate the service end time for subsequent customers. Drag this formula down the column.

### **Step 5: Calculate Time in System and Clerk Idle Time**

1. **Calculate Time in System:**
   * In **Cell G2**, use the formula =F2 - C2 to calculate the total time the first customer spends in the system.
   * Drag this formula down the column.
2. **Calculate Clerk Idle Time:**
   * In **Cell H2**, set the first idle time to 0 (assuming the clerk starts working immediately).
   * In **Cell H3**, use the formula =E3 - F2 to calculate the idle time between customers. Drag this formula down the column.

### **Step 6: Calculate Performance Measures**

1. **Average Time a Customer Spends in the System:**
   * Use the formula =AVERAGE(G2:G[n]) where [n] is the number of customers.
2. **Percentage of Time the Clerk is Idle:**
   * Use the formula =SUM(H2:H[n]) / F[n] where [n] is the number of customers.

### **Example Spreadsheet**

Here’s a small example with 5 customers:

| **Customer** | **Interarrival Time** | **Arrival Time** | **Service Time** | **Service Start Time** | **Service End Time** | **Time in System** | **Clerk Idle Time** |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 0 | 0 | 5 | 0 | 5 | 5 | 0 |
| 2 | 3 | 3 | 4 | 5 | 9 | 6 | 0 |
| 3 | 7 | 10 | 6 | 10 | 16 | 6 | 1 |
| 4 | 2 | 12 | 3 | 16 | 19 | 7 | 0 |
| 5 | 5 | 17 | 2 | 19 | 21 | 4 | 0 |

Feel free to adjust the number of customers and run the simulation multiple times to get a more accurate measure of the performance metrics. If you need further assistance or have any questions, let me know!