QUESTION 1

**The steps I followed to simulate the checkout process in Excel to solve the given assignment .**

**Step 1: Setup the Spreadsheets**

1. **Create Column Headers**:
   * **A1**: Customer
   * **B1**: Arrival Time
   * **C1**: Interarrival Time
   * **D1**: Service Start Time
   * **E1**: Service Time
   * **F1**: Service End Time
   * **G1**: Time in System (W)
   * **H1**: Idle Time

**Step 2: Simulating the Process**

1. **Simulated Interarrival Times**:
   * In **C2**,I generated the interarrival time using the formula: **=ROUND(RANDBETWEEN(1,15),0).**
   * Drag this formula down for all 20 customers.
2. **Calculated Arrival Times**:
   * In **B2**, I did set the arrival time for the first customer to 0 .
   * For **B3** (second customer),I used the formula =B2+C3.then dragged this formula down to simulate the arrival times for all customers.
3. **Simulated Service Times**:
   * In **E2**,I generate the service time using the formula: **=ROUND(RANDBETWEEN(1,8),0**).
   * Then dragged this formula down for all 20 customers.
4. **Determined Service Start Time**:
   * In **D2**,I set the service start time for the first customer equal to their arrival time (=B2).
   * For **D3** (second customer),I used the formula =MAX(B3,F2). This ensures that the service starts either when the customer arrives or when the previous customer finishes, whichever is later.
   * Then I dragged this formula down for all customers.
5. **Calculated Service End Time**:
   * In **F2**,I calculate the service end time using the formula: =D2+E2.
   * Dragged this formula down for all customers.
6. **Calculated Time in System (W)**:
   * In **G2**, I calculated the time in the system using the formula: =F2-B2.
   * Dragged this formula down for all customers.
7. **Calculated Idle Time**:
   * In **H2**, I calculated the idle time using the formula: =MAX(0,D2-F1) (this is the time between when the previous customer was serviced and the current customer starts being serviced).
   * Dragged this formula down for all customers.

**Step 3: Aggregate Results for a Single Simulation**

1. **Calculated Average Time in System**:
   * Used the formula =AVERAGE(G2:G21) to calculate the average time customers spend in the system.
2. **Calculated Proportion of Time Idle**:
   * Calculated the total idle time using =SUM(H2:H21).
   * Calculated the total simulation time (time the last customer finishes service) using =F21.
   * Calculated the proportion of idle time using =Total Idle Time / Total Simulation Time.

**Step 4: Running 50 Replications Using Data Table**

1. **Prepared Data Table for Replications**:
   * Copied the outputs (Average Time in System and Proportion of Idle Time) into a different area of the spreadsheet, that **I1** and **J1**.
   * Created a list of 50 different numbers (1, 2, 3, ..., 50) in a column, say in **M2**

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1. **Used Data Table to Generate 50 Replications**:
   * Selected a 2-column range .
   * Go to **Data > What-If Analysis > Data Table**.
   * For **Row Input Cell**, left it blank.
   * For **Column Input Cell**, selected empty cell (e.g., **S1**).
   * Clicked OK. This generated 50 replications of the average time in the system and idle time proportions.

**Step 5: Analyze Results**

1. **Analyzed the Data**:

* Calculated the average, minimum, maximum, and standard deviation of the 50 replications to understand the variation in the results.
* Used **AVERAGE**, **MIN**, **MAX**, and **STDEV.P** functions in Excel.

 **Average**: =AVERAGE(N2:N51) for the average time in the system and =AVERAGE(O2:O51) for the proportion of idle time.

 **Minimum**: =MIN(N2:N51) for the average time in the system and =MIN(O2:O51) for the proportion of idle time.

 **Maximum**: =MAX(N2:N51) for the average time in the system and =MAX(O2:O51) for the proportion of idle time.

*  **Standard Deviation**: =STDEV.P(N2:N51) for the average time in the system and =STDEV.P(O2:O51) for the proportion of idle time.

**THE RESULTS OF THE ANALYSIS**

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| **AVERAGE TIME IN STSTEM FOR THE 50 REPICATIONS** |  |
|  |  |
| **MAX ( AVG TIME IN SYSTEM OF REP)** | 8.7 |  | |
|  | 4 |  | |
| **MIN ( AVG TIME IN SYSTEM OF REP)** |  |  |
|  |  |  | |
| **STDEV.P ( AVG TIME IN SYSTEM OF REP**) | 1.028287897 |  | |
|  |  |  | |
| **AVG( AVG TIME IN SYSTEM OF REP)** | 5.668 |  |
| **PROPORTION OF TIME IDLE FOR THE 50 REPLICATIONS** |  |  | |
| **MAX( PRO OF IDLE TIME REPLICATIONS)** | 0.579545455 |  | |
|  |  |
| **MIN ( PRO OF IDLE TIME OF REPLICATIONS)** | 0.579545455 |
|  |  |
| **AVG ( PRO OF IDLE TIME OF REPLICATIONS)** | 0.417660765 |
|  |  |
| **STDEV.P ( PRO OF IDLE TIME OF REPLICATIONS)** | 0.083568203 |
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