Simulation Report

1. Introduction

This report presents the results of a simulation of the checkout process at a small gift shop, aimed at determining two key performance metrics:

* Average time a customer spends in the system (W), including both waiting and service time.
* The proportion of time the checkout clerk is idle (1-ρ), reflecting the efficiency of cashier utilization.

2. Assumptions and Setup

* Interarrival Times: Customer interarrival times were uniformly distributed between 1 and 15 minutes.
* Service Times: The time required to service each customer was uniformly distributed between 1 and 8 minutes.
* Single Server: A single cashier was available, leading to one queue of customers waiting for service.
* Duration: The simulation was carried out for a total of 20 customers, over a 3-hours (180 minutes).

3. Methodology

The checkout process was modeled in Microsoft Excel with the following steps:

* Interarrival times were generated randomly between 1 and 15 minutes using the formula =RANBETWEEN(1,15).
* Service times were randomly generated between 1 and 8 minutes using =RANDBETWEEN(1, 8).
* For each customer, the arrival time was computed as the cumulative sum of interarrival times.
* The service start time was determined by the greater of the customer’s arrival time or the service end time of the previous customer.
* The service end time was calculated by adding the service time to the service start time.
* Time in system (W) was calculated as the difference between the service end time and arrival time.
* Idle time was calculated as the time the cashier was idle between customers.

4. Performance Metrics

Two performance measures were calculated:

* Average time in the system (W): The average time a customer spent in the system was calculated for each replication.
* Proportion of idle time: The percentage of time the server was idle during the simulation was also calculated for each replication.

5. Results

The simulation was replicated 50 times. The key results are summarized as follows:

Average Time in System (W)

Across the 50 replications, the average customer time in the system (W) ranged from 3.40 minutes to 12.20 minutes, with the following statistical summary:

* Minimum (W): 3.40 minutes
* Maximum (W): 12.20 minutes
* Average (W): 5.80 minutes

Proportion of Idle Time

The proportion of time the checkout clerk was idle ranged from 18.33% to 81.11%, with the following statistical summary:

* Minimum Idle Time: 18.33%
* Maximum Idle Time: 81.11%
* Average Idle Time: 48.30%

6. Discussion

The results of the simulation show significant variability in customer wait times and idle time for the server:

* Customer Experience: The average customer time in the system fluctuated based on interarrival and service times. Lower interarrival times combined with longer service times led to increased wait times.
* Server Utilization: The proportion of idle time suggests that, on average, the cashier was idle nearly half of the time (48.30%). However, there were periods where the server was extremely underutilized (up to 81.11%), and other periods where the server was busy for most of the time (18.33%).

The simulation of the checkout process at the small gift shop highlights the variability in customer wait times and server idle times. The insights gained from this analysis can be used to optimize staffing and improve the efficiency of the checkout process.