Project Report

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Modeling and Simulation



Problem 1

# Problem Formulation

## Environment

The environment in this problem is a Multiple-channel Queue represented in a banking system that serves customers in two queues. The first queue, is the drive-in teller queue which serves customers in their cars, this queue has a maximum capacity of 2 customers. When full, newly arriving customers are served instead in a queue inside the bank (Inside queue) this queue has no maximum capacity. It is also assumed that the servers of both queues have the same performance.

## Objectives

Estimate the average serving times of both queues.  
Estimate how often customers would wait in both queues.  
Estimate the maximum congestion (Queue length) in the inside queue.  
Estimate how often will a customer go to the inside queue.  
Estimate the idle time of the inside queue server.

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# Model Conceptualization

## System Components

|  |  |  |  |
| --- | --- | --- | --- |
| Entity | Attribute | Event | Relations |
| Customer |  | Arrival, Departure |  |
| Teller | Time of serving customer | Begin serving customer, End serving customer, |  |

## System Analysis

Inter-arrival Time Probability Tabl

|  |  |  |  |
| --- | --- | --- | --- |
| Arrival time | Probability | Cumulative | Range |
| 0 | 0.09 | 0.09 | 01-09 |
| 1 | 0.17 | 0.26 | 10-26 |
| 2 | 0.27 | 0.53 | 27-53 |
| 3 | 0.20 | 0.73 | 54-73 |
| 4 | 0.15 | 0.88 | 74-88 |
| 5 | 0.12 | 1 | 89-00 |

Service Time Probability Table

|  |  |  |  |
| --- | --- | --- | --- |
| Service Time | Probability | Cumulative | Range |
| 1 | 0.2 | 0.20 | 01-20 |
| 2 | 0.4 | 0.60 | 21-60 |
| 3 | 0.28 | 0.88 | 61-88 |
| 4 | 0.12 | 1 | 89-00 |

Calendar Table

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Number and Queue | Rand Interarrival Time | Rand Service Time | Interarrival Time | Arrival Time | Service Time | Service Begin | Waiting | Service End | Time spent | Idle Time |
| 1 (D) | 19 | 18 | - | 0 | 1 | 0 | 0 | 1 | 1 | 0 |
| 2 (D) | 88 | 7 | 4 | 4 | 1 | 4 | 0 | 5 | 1 | 3 |
| 3 (D) | 64 | 63 | 3 | 7 | 3 | 7 | 0 | 10 | 3 | 2 |
| 4 (D) | 34 | 25 | 2 | 9 | 2 | 10 | 1 | 12 | 3 | 0 |
| 5 (I) | 13 | 80 | 1 | 10 | 3 | 10 | 0 | 13 | 3 | 10 |
| 6 (I) | 5 | 92 | 0 | 10 | 4 | 13 | 1 | 17 | 7 | 0 |
| 7 (D) | 44 | 27 | 2 | 12 | 2 | 12 | 0 | 14 | 2 | 0 |
| 8 (D) | 77 | 16 | 4 | 16 | 1 | 16 | 0 | 17 | 1 | 2 |
| 9 (D) | 40 | 4 | 2 | 18 | 1 | 18 | 0 | 19 | 1 | 1 |
| 10 (D) | 74 | 12 | 4 | 22 | 1 | 22 | 0 | 23 | 1 | 3 |

# Experimental Design

The simulation is done with 100 Runs on 100 Customers

# Result analysis and Conclusion

## Results

|  |  |  |
| --- | --- | --- |
| Criteria | Value | Histogram |
| Avg Service Time (ALL) | 1.9 |  |
| Avg Interarrival Time (ALL) | 2.29 |  |
| Avg Service Time Drive-in | 2.34 |  |
| Avg Service Time Inside | 2.32 |  |
| Avg Waiting Time Drive-in | 0.59 |  |
| Avg Waiting Time Inside | 0.48 |  |
| Maximum Inside Queue Length | 2 |  |
| Probability to Go Inside | 17.16% |  |
| Portion of Idle Time Inside | 196 |  |
| Avg Waiting Drive-in (Two Cars) | 1.43 |  |
| Avg Waiting Inside (Two Cars) | 0.40 |  |

**Analysis**