**THE OPEN UNIVERSITY OF SRI LANKA**

**FACULTY OF ENGINEERING TECHNOLOGY**

**DEPARTMENT OF ELECTRICAL & COMPUTER ENGINEERING**

**BACHELOR OF SOFTWARE ENGINEERING (HONOURS)**

**EEX5362 –PERFORMANCE MODELLING**

**Mini Project – Deliverable 01**

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**High-Level Problem Description**

Modern customer service operations depend heavily on Call Centers, which act as the main communication channel between organizations and customers. A key challenge in such systems is to ensure high service quality (low waiting time and high satisfaction) while maintaining operational efficiency (optimal staffing and cost control).

In this project, we analyze a Call Center System where customers call randomly, agents handle calls, and waiting customers are queued following a First-Come, First-Served (FCFS) policy. Because the system operates under limited agent resources, performance can vary significantly based on the number of agents, call arrival rate, and service time distribution.

The objective of this project is to model, simulate, and analyze the system to identify performance bottlenecks and optimal staffing configurations that balance efficiency with customer satisfaction.

**System Overview**

The call center system consists of three key components

* Callers (Customers) - Randomly arriving customers requesting service.
* Agents (Servers) - Limited resources who attend to calls one at a time.
* Queue - Waiting line for customers when all agents are busy.

The system’s behavior is governed by

* Arrival Rate - Random call arrivals following a Poisson process.
* Service Time - Time taken per call, following an exponential distribution.
* Queue Discipline - FCFS (First-Come, First-Served).

**Simulation Parameters**

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Description** | **Value** |
| SIMULATION\_TIME | Total duration | 3600 seconds (1 hour) |
| CALL\_ARRIVAL\_RATE | Probability of a call per second | 0.2 |
| SERVICE\_TIME\_MEAN | Average service time per call | 30 seconds |
| NUM\_AGENTS | Variable per scenario | 3, 5, 7, 9 |

**Identification of the System as a Complex System**

The call center qualifies as a complex system because,

* It involves multiple interacting entities (agents, customers, queues).
* It exhibits stochastic behavior due to random call arrivals and service durations.
* It must balance competing performance objectives minimizing waiting times versus maximizing agent utilization.
* Small parameter changes (like number of agents) can cause non-linear performance impacts, typical of complex adaptive systems.

These characteristics make it suitable for performance modeling and simulation.

**Dataset / Simulation Input**

The simulation uses synthetic random data generated from statistical distributions

* Poisson-distributed arrival times
* Exponentially distributed service durations

**Dataset Format**

For this simulation, the results data set are saved in CSV (comma-separated values) files. This format makes it easy to open, analyze and visualize the data using tools like Excel Python. A separate CSV file is generated for each staffing level in the call center (for 3 agents, 5 agents, 7 agents and 9 agents).

|  |  |
| --- | --- |
| **Field Name** | **Description** |
| Call\_ID | A unique number given to each call |
| Arrival\_Time | The time (in seconds) when the call entered the system |
| Service\_Start\_Time | The time when an agent started handling the call |
| Service\_End\_Time | The time when the call was completed |
| Waiting\_Time | The time spent in the queue before the call was answered |
| Service\_Duration | The length of the call (in seconds) |
| Agent\_ID | The agent who handled the call |
| Queue\_Length\_On\_Arrival | Number of calls in the queue when this call arrived |

**Performance Objectives**

The project focuses on evaluating and optimizing the following measurable performance metrics,

|  |  |  |
| --- | --- | --- |
| **Metric** | **Description** | **Objective** |
| Average Waiting Time | Time customers spend in the queue before being served. | Minimize |
| Peak Queue Length | Maximum number of waiting calls at any point. | Minimize |
| Agent Utilization | Percentage of time agents are busy. | Maintain optimal (80–90%) |
| System Throughput | Total number of calls successfully completed. | Maximize |

Performance Focus and Optimization Goals,

The simulation’s primary performance objectives are,

1. Minimize customer waiting time to improve service quality.
2. Maximize throughput without overloading the system.
3. Identify optimal staffing level that balances cost and performance.
4. Maintain efficient agent utilization avoid both overwork and idleness.
5. Detect performance bottlenecks under varying workloads.

* Git Hub Repo link - <https://github.com/s92083362/call-center-performance-simulation>