

**Department of Electrical and Computer Engineering**

**Bachelor of Software Engineering Honours**

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**Performance Modelling**

**MINI PROJECT – TASK 01**

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# **Performance Analysis of a Public Transportation Network**

## **System Details and Performance Objectives**

### **1. High-Level Problem Statement**

Urban public transportation systems play a critical role in daily commuting. However, city bus networks often experience operational challenges such as long passenger waiting times, overcrowded buses, and uneven service utilization. These problems arise due to stochastic passenger arrivals, limited bus capacity, variable travel times, and fixed bus schedules.

This study analyzes a **city bus network using discrete-event simulation** to evaluate its performance. The simulation focuses on identifying congestion points, measuring passenger waiting times, and assessing bus utilization. The goal is to provide insights that can help improve service efficiency, reliability, and passenger satisfaction.

### **2. Dataset: Sample Bus Network Data**

The dataset used in this analysis is generated through simulation rather than collected from real-world observations. The network consists of two routes and six bus stops, with parameters defined as follows.

#### **Route and Stop Configuration**

Route	Stops	Headway (min)	Number of Buses	Mean Travel Time (min)
A	A1, A2, A3	15	2	6
B	B1, B2, B3	12	2	5

#### **Passenger Arrival Rates**

Passenger arrivals follow a Poisson process, with the following arrival rates (per minute):

Stop	Arrival Rate (passengers/min)
A1	0.35
A2	0.25
A3	0.20
B1	0.40
B2	0.30
B3	0.22

## Bus Parameters

Parameter	Value
Bus Capacity	40 passengers
Boarding Time	3 seconds per passenger
Alighting Time	2 seconds per passenger
Minimum Dwell Time	0.1 minutes
Simulation Duration	8 hours (480 minutes)

## 3. Complex System Identification

### System Description

The system under study is a city bus transportation network operating on multiple routes with multiple stops. Passengers arrive randomly at stops and wait in queues until a bus arrives.

### Sources of Complexity

- Random passenger arrivals
- Limited bus capacity
- Variable travel times between stops
- Fixed bus schedules (headway-based dispatching)

## System Components and Performance Characteristics

Component	Description	Measurable Performance Metrics
System	City bus network	Throughput, Waiting Time, Utilization
Passengers	Random arrivals at stops	Queue length, Waiting time
Buses	Capacity-limited service units	Occupancy, Trips completed
Stops	Passenger queues	Queue size over time

## 4. Performance Objectives

The objectives of this performance analysis are:

### 1. Reduce Average Waiting Time

Evaluate passenger waiting times at each stop.

## **2. Maximize System Throughput**

Measure the total number of passengers transported.

## **3. Identify Bottlenecks**

Detect stops with long queues and high congestion.

## **4. Optimize Resource Utilization**

Assess bus seat usage and utilization percentage.

## **5. Improve Operational Efficiency**

Analyze bus trip completion and service regularity.

## **6. Enhance Passenger Satisfaction**

Reduce overcrowding and long waiting periods.

## **5. Simulation Methodology**

The system is modeled using SimPy, a discrete-event simulation framework.

Key modeling assumptions include:

- Passenger arrivals follow an exponential distribution.
- Buses operate continuously along predefined routes.
- Boarding and alighting consumes time proportional to the number of passengers.
- Performance metrics are collected dynamically during the simulation.

### **Git Repository URL Link:**

<https://github.com/NAJMA845/miniproject-EEX5362-public-transport-performance-analysis.git>