**Deliverable - 01: Healthcare Delivery Process**

EEX5362

PERFORMANCE MODELLING

name**: m.z. mohamed anushath**snumber**:** **s22010279**  
Registration no**:** **122517322**

due date**:** **31st October 2025**

### Chosen System: A Queue

### Hospital Outpatient Registration and Consultation Queue System

### Introduction & System Description

The Hospital Outpatient Registration and Consultation Queue System is an essential component of modern healthcare delivery. It manages the flow of patients who visit the hospital for routine checkups, medical consultations, or diagnostic services without being admitted as inpatients. The process typically begins when patients arrive and register at the outpatient counter, after which they wait in a queue for consultation with a doctor. This simple yet critical process determines the overall patient experience and reflects the hospital’s service efficiency.

In many hospitals, especially during peak hours, outpatient departments face significant congestion. Long queues, delays in registration, and extended waiting times for consultation often result in patient dissatisfaction and operational inefficiencies. These issues highlight the need for effective queue management and performance analysis to improve service quality.

The Hospital Outpatient Registration and Consultation Queue System provides a structured way to monitor, analyze, and optimize this flow. By studying measurable performance factors such as waiting time, service time, queue length, and doctor utilization, healthcare institutions can identify bottlenecks and improve throughput. A well-designed system not only enhances patient satisfaction but also supports better decision making in staffing and resource allocation, leading to a more efficient and responsive outpatient service.

### Dataset Description

The following dataset contains five simulated patient records representing a typical morning session (8:00 AM to 11:00 AM). All 100 records are included at the end of this report and are also provided in CSV format within the Git repository. Each record includes the patient’s arrival time, registration time, waiting time, consultation time, assigned doctor, and the queue length at the time of arrival.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Patient ID** | **Arrival Time** | **Registration Time** | **Waiting Time** | **Consultation Time** | **Doctor ID** | **Queue Length** |
| P001 | 09:07 | 3 | 10 | 19 | D02 | 2 |
| P002 | 10:51 | 6 | 20 | 16 | D03 | 13 |
| P003 | 10:11 | 7 | 33 | 12 | D01 | 11 |
| P004 | 09:47 | 6 | 7 | 15 | D03 | 13 |
| P005 | 08:28 | 8 | 24 | 20 | D04 | 8 |

### GitHub Link:

### Full dataset with 100 records in csv format is uploaded to GitHub

### <https://github.com/hamzaanushath/Hospital-Outpatient-Registration-and-Consultation-Queue-System>

**High-Level Problems in the Hospital Outpatient Registration and Consultation Queue System**

The hospital outpatient registration and consultation process involve several interconnected stages patient arrival, registration, waiting, and consultation. Each stage introduces potential performance issues that can affect both patient satisfaction and hospital efficiency. The major high-level problems are as follows:

1. **Long Waiting Times**  
   Patients often experience long queues at registration counters and consultation rooms, especially during peak hours. These delays reduce patient satisfaction and can lead to overcrowding in waiting areas.
2. **Uneven Resource Utilization**  
   Some doctors or registration desks may be overworked while others remain under-utilized. This imbalance results in inefficiency and can increase staff fatigue or idle time.
3. **Poor Queue Management**  
   Without proper queue management or scheduling systems, patients may not be served in the correct order of priority. This leads to confusion, frustration, and occasional conflicts among patients.
4. **Bottlenecks in the Process Flow**  
   Bottlenecks may occur at any stage registration, consultation, or even at diagnostic units. These slow points reduce overall throughput and create ripple delays across the system.
5. **Limited Real-Time Monitoring**  
   Most outpatient systems lack real-time tracking of waiting times or patient flow. Without data visibility, hospital administrators cannot quickly identify or respond to performance issues.
6. **Inadequate Staffing or Scheduling**  
   During peak periods, the number of available staff or doctors may not match patient inflow. Poor scheduling and lack of predictive planning led to congestion and inefficiency.
7. **Data and Process Fragmentation**  
   Registration, consultation, and record-keeping are often managed separately. This fragmentation causes delays in information flow, duplication of work, and possible errors in patient handling.

### Performance Objectives

The main performance objectives for the Hospital Outpatient Registration and Consultation Queue System are as follows:

### Minimize average waiting time at both registration and consultation.

### Reducing the time patients spend waiting to register or meet a doctor is a key indicator of system efficiency. Shorter waiting times lead to higher patient satisfaction and smoother hospital operations.

### Maximize doctor and staff utilization.

### Ensuring that doctors, nurses, and administrative staff are efficiently utilized prevents idle time and improves the productivity of the healthcare workforce. Balanced staff utilization also reduces burnout and supports better quality of care.

### Maximize patient throughput (patients served per hour).

### Throughput refers to the total number of patients successfully registered and consulted within a specific period. Increasing throughput helps the hospital serve more patients without compromising quality, especially during peak hours.

### Identify bottlenecks in the registration or consultation process.

### Performance analysis helps detect areas where queues build up or delays occur, such as at registration counters or in waiting areas. Recognizing these bottlenecks allows management to take corrective action and improve system flow.

### Optimize resource allocation and evaluate trade-offs (e.g., number of doctors vs. registration counters).

### Allocating resources effectively is vital for maintaining a balance between service quality and operational cost. An optimized system ensures that additional resources are deployed only where they provide significant improvement to performance outcomes.

### Modeling Scope & Use Case

The dataset can be used for performance modeling using queuing theory or discrete event simulation example with Python SimPy. It supports the analysis of how changes in arrival rate, service time, or staff availability impact waiting times and system throughput.

### The Dataset (100 records)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Patient ID** | **Arrival Time** | **Registration Time** | **Waiting Time** | **Consultation Time** | **Doctor ID** | **Queue Length** |
| P001 | 9:07 | 3 | 10 | 19 | D02 | 2 |
| P002 | 10:51 | 6 | 20 | 16 | D03 | 13 |
| P003 | 10:11 | 7 | 33 | 12 | D01 | 11 |
| P004 | 9:47 | 6 | 7 | 15 | D03 | 13 |
| P005 | 8:28 | 8 | 24 | 20 | D04 | 8 |
| P006 | 8:28 | 7 | 40 | 8 | D02 | 4 |
| P007 | 8:10 | 7 | 23 | 12 | D02 | 9 |
| P008 | 10:35 | 5 | 30 | 10 | D05 | 5 |
| P009 | 9:48 | 7 | 7 | 19 | D02 | 13 |
| P010 | 10:07 | 6 | 23 | 8 | D05 | 9 |
| P011 | 8:03 | 7 | 24 | 11 | D01 | 4 |
| P012 | 10:54 | 5 | 36 | 20 | D04 | 10 |
| P013 | 10:29 | 5 | 11 | 12 | D05 | 5 |
| P014 | 8:38 | 8 | 45 | 14 | D01 | 9 |
| P015 | 8:32 | 6 | 37 | 8 | D02 | 8 |
| P016 | 8:33 | 4 | 44 | 10 | D02 | 3 |
| P017 | 8:54 | 4 | 43 | 9 | D01 | 1 |
| P018 | 9:34 | 7 | 22 | 16 | D02 | 3 |
| P019 | 9:17 | 8 | 44 | 17 | D01 | 4 |
| P020 | 8:52 | 3 | 5 | 13 | D05 | 2 |
| P021 | 9:50 | 7 | 15 | 17 | D05 | 1 |
| P022 | 8:25 | 8 | 32 | 10 | D01 | 7 |
| P023 | 8:52 | 6 | 29 | 15 | D05 | 8 |
| P024 | 9:05 | 6 | 27 | 15 | D05 | 7 |
| P025 | 9:22 | 6 | 35 | 9 | D05 | 14 |
| P026 | 10:21 | 6 | 34 | 13 | D03 | 5 |
| P027 | 8:35 | 6 | 39 | 14 | D04 | 12 |
| P028 | 9:32 | 8 | 11 | 9 | D02 | 1 |
| P029 | 9:46 | 8 | 20 | 18 | D03 | 7 |
| P030 | 8:08 | 5 | 30 | 17 | D05 | 13 |
| P031 | 9:49 | 4 | 6 | 9 | D01 | 7 |
| P032 | 8:30 | 6 | 5 | 17 | D05 | 9 |
| P033 | 8:11 | 3 | 16 | 8 | D04 | 3 |
| P034 | 10:50 | 8 | 9 | 15 | D05 | 9 |
| P035 | 10:53 | 3 | 41 | 8 | D01 | 14 |
| P036 | 10:25 | 3 | 36 | 16 | D04 | 1 |
| P037 | 8:54 | 3 | 13 | 18 | D05 | 1 |
| P038 | 8:17 | 5 | 45 | 13 | D04 | 14 |
| P039 | 10:03 | 8 | 39 | 14 | D02 | 4 |
| P040 | 9:19 | 3 | 23 | 20 | D02 | 9 |
| P041 | 8:21 | 6 | 20 | 17 | D05 | 6 |
| P042 | 9:29 | 7 | 7 | 14 | D04 | 13 |
| P043 | 8:06 | 3 | 24 | 17 | D01 | 11 |
| P044 | 10:43 | 5 | 28 | 10 | D05 | 3 |
| P045 | 8:46 | 8 | 37 | 9 | D02 | 1 |
| P046 | 9:59 | 5 | 28 | 16 | D02 | 4 |
| P047 | 8:56 | 3 | 15 | 15 | D05 | 12 |
| P048 | 9:33 | 8 | 12 | 20 | D04 | 13 |
| P049 | 9:38 | 7 | 40 | 19 | D02 | 9 |
| P050 | 8:33 | 3 | 42 | 17 | D04 | 3 |
| P051 | 10:54 | 5 | 44 | 14 | D02 | 12 |
| P052 | 10:19 | 4 | 24 | 16 | D02 | 9 |
| P053 | 10:49 | 6 | 39 | 11 | D03 | 7 |
| P054 | 10:41 | 5 | 29 | 20 | D02 | 12 |
| P055 | 9:47 | 8 | 39 | 11 | D01 | 14 |
| P056 | 10:45 | 3 | 29 | 8 | D05 | 15 |
| P057 | 8:15 | 6 | 33 | 15 | D05 | 4 |
| P058 | 8:35 | 3 | 22 | 19 | D04 | 3 |
| P059 | 8:08 | 8 | 22 | 10 | D02 | 10 |
| P060 | 8:58 | 3 | 6 | 14 | D01 | 15 |
| P061 | 9:09 | 4 | 39 | 19 | D04 | 5 |
| P062 | 8:48 | 6 | 20 | 9 | D03 | 5 |
| P063 | 10:29 | 6 | 45 | 9 | D04 | 3 |
| P064 | 9:04 | 8 | 40 | 14 | D04 | 12 |
| P065 | 8:50 | 4 | 37 | 13 | D02 | 9 |
| P066 | 9:37 | 5 | 8 | 10 | D03 | 4 |
| P067 | 8:25 | 3 | 37 | 16 | D04 | 11 |
| P068 | 10:24 | 7 | 18 | 17 | D01 | 5 |
| P069 | 8:13 | 3 | 25 | 20 | D01 | 4 |
| P070 | 10:57 | 3 | 24 | 13 | D05 | 5 |
| P071 | 10:19 | 5 | 12 | 17 | D03 | 7 |
| P072 | 8:35 | 3 | 11 | 17 | D03 | 9 |
| P073 | 8:00 | 4 | 7 | 13 | D05 | 7 |
| P074 | 10:26 | 4 | 21 | 8 | D04 | 13 |
| P075 | 10:07 | 6 | 37 | 11 | D03 | 5 |
| P076 | 10:11 | 8 | 16 | 17 | D01 | 10 |
| P077 | 10:18 | 7 | 26 | 13 | D01 | 10 |
| P078 | 8:13 | 3 | 26 | 13 | D02 | 7 |
| P079 | 9:04 | 3 | 34 | 18 | D03 | 14 |
| P080 | 8:20 | 5 | 42 | 19 | D04 | 15 |
| P081 | 10:35 | 8 | 42 | 12 | D05 | 10 |
| P082 | 9:52 | 4 | 12 | 8 | D05 | 5 |
| P083 | 8:59 | 7 | 31 | 15 | D04 | 3 |
| P084 | 8:11 | 6 | 31 | 12 | D02 | 7 |
| P085 | 8:55 | 4 | 38 | 19 | D05 | 13 |
| P086 | 8:58 | 8 | 25 | 19 | D03 | 11 |
| P087 | 10:11 | 6 | 34 | 19 | D02 | 11 |
| P088 | 9:54 | 5 | 37 | 12 | D03 | 2 |
| P089 | 10:39 | 5 | 32 | 14 | D01 | 15 |
| P090 | 9:24 | 3 | 37 | 11 | D02 | 12 |
| P091 | 8:21 | 8 | 9 | 13 | D05 | 9 |
| P092 | 10:08 | 7 | 23 | 20 | D02 | 10 |
| P093 | 10:16 | 6 | 8 | 11 | D02 | 10 |
| P094 | 9:41 | 4 | 39 | 10 | D02 | 12 |
| P095 | 10:18 | 8 | 21 | 14 | D02 | 1 |
| P096 | 9:28 | 8 | 32 | 15 | D03 | 13 |
| P097 | 9:34 | 5 | 34 | 11 | D01 | 6 |
| P098 | 9:16 | 3 | 33 | 20 | D04 | 7 |
| P099 | 8:04 | 3 | 10 | 9 | D02 | 14 |
| P100 | 8:19 | 6 | 39 | 19 | D05 | 13 |