**Healthcare Delivery Process**

**System Details and Performance Objectives**

**EEX5362 Performance Modelling**

**A.M.F.N.SHAHANI**

**S92077349**

**1. Introduction**

The healthcare delivery process plays a crucial role in ensuring that patients receive timely and effective medical care. However, healthcare systems often face challenges such as long waiting times, inefficient scheduling, limited medical resources, and uneven workload distribution among healthcare professionals.

This project focuses on modelling and analysing the **Outpatient Department (OPD)** process as a complex system with measurable performance characteristics. The objective is to evaluate and improve system performance in terms of patient waiting time, resource utilization, and throughput using data-driven methods.

**2. System Description**

**2.1 Overview**

The selected system is the **Outpatient Department (OPD) healthcare delivery process**. This process begins when a patient registers at the hospital and ends after consultation and prescription are completed. The flow typically includes several stages:

1. **Patient Registration**
2. **Waiting for Consultation**
3. **Doctor Consultation**
4. **Medical Test (if required)**
5. **Billing and Pharmacy**

Each stage introduces delays due to limited resources or high demand. The interaction between patients, doctors, nurses, and administrative staff creates a **complex and dynamic system** that can be modelled to identify performance bottlenecks and optimize efficiency.

**3. High-Level Problem Definition**

Many hospitals and clinics face inefficiencies in managing patient flow through their healthcare delivery process. Patients experience long waiting times, while doctors may be underutilized or overbooked. The current system often lacks dynamic scheduling and data-driven decision-making capabilities, resulting in suboptimal use of hospital resources.

This study aims to analyse and model the OPD workflow to:

* Identify bottlenecks in patient flow
* Quantify waiting time and consultation delays
* Evaluate doctor utilization
* Recommend improvements for better throughput and reduced latency

By developing a simulation or analytical model of this process, it becomes possible to evaluate performance and propose optimization strategies that improve both patient satisfaction and operational efficiency.

**4. Dataset Description**

**4.1 Dataset Overview**

The dataset represents the flow of patients through the OPD over a given day or week. It can be collected from hospital information systems or simulated using queue-based modelling.

Each record captures details of patient arrival, consultation start/end times, and the resources used.

|  |  |  |
| --- | --- | --- |
| **Field Name** | **Description** | **Example** |
| Patient\_ID | Unique patient identifier | P001 |
| Arrival\_Time | Time of registration | 08:15 |
| Consultation Start | Time consultation begins | 09:00 |
| Consultation End | Time consultation ends | 09:20 |
| Doctor\_ID | Identifier for attending doctor | D003 |
| Department | Department visited | General Medicine |
| Waiting Time (mins) | Time between arrival and consultation start | 45 |
| Treatment Duration (mins) | Duration of consultation | 20 |
| Satisfaction Score | Feedback from patient (1–5) | 4 |

**4.2 Data Source**

* **Option 1:** Real hospital data from patient management systems (with anonymized records)
* **Option 2:** **Simulated data** generated using statistical distributions for arrival rate, service time, and doctor availability
* **Option 3:** Public datasets such as Hospital Waiting Time datasets available on Kaggle

**4.3 Data Usage**

This dataset will be used to:

* Calculate average waiting time and service time
* Measure throughput (patients served per hour)
* Identify peak demand hours
* Evaluate resource utilization for doctors and consultation rooms

**5. Performance Objectives**

The primary goal is to evaluate and improve the efficiency of the healthcare delivery process.  
The following **performance objectives** have been defined:

1. **Minimize Average Patient Waiting Time**  
   Reduce the time patients spend waiting for consultation after registration.
2. **Maximize Doctor Utilization Rate**  
   Ensure that available doctors are optimally utilized without overloading them.
3. **Identify System Bottlenecks**  
   Detect points in the workflow where delays are most frequent (e.g., registration desk, waiting area).
4. **Optimize Resource Allocation**  
   Dynamically assign staff or adjust schedules based on patient load to reduce idle time and improve service rates.
5. **Increase Overall Throughput**  
   Enhance the number of patients successfully served per time unit (e.g., per hour or per day).
6. **Improve Patient Satisfaction**  
   Ensure reduced waiting times and balanced workloads contribute to a better overall healthcare experience.

**6. Expected Outcomes**

By analyzing the system based on the above objectives, this study expects to achieve:

* A data-driven understanding of how different factors (arrival rate, consultation time, staff availability) affect performance.
* Identification of key bottlenecks causing inefficiency.
* Recommendations for optimized scheduling and resource management.
* Improved throughput, reduced latency, and enhanced patient satisfaction.

**7. Conclusion**

The healthcare delivery process is a complex, multi-stage system with measurable performance indicators. Modelling and analysing this system allows healthcare institutions to identify inefficiencies, optimize patient flow, and improve service quality.

Through this study, performance evaluation based on waiting time, resource utilization, and throughput can lead to a more efficient, responsive, and patient-cantered healthcare system.

**8. References**

1. Green, L. V. (2006). Queueing analysis in healthcare. Patient Flow: Reducing Delay in Healthcare Delivery.
2. Gupta, D., & Denton, B. (2008). Appointment scheduling in health care: Challenges and opportunities. IIE Transactions, 40(9), 800–819.
3. Vissers, J., & Beech, R. (2005). Health Operations Management: Patient Flow Logistics in Health Care.
4. Public healthcare datasets – [Kaggle.com](https://www.kaggle.com)