Faculty of Engineering Technology

Department of Electrical and Computer Engineering

Bachelor of Software Engineering Honors

EEX5362 Performance Modelling

Healthcare Delivery Process: Patient Check-in to Discharge

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1. High-level problem

Hospitals often experience delays, overcrowding, and inefficient resource use during patient flow from check-in to discharge. This project models a Patient Flow Management System to measure and optimize performance metrics such as waiting time, throughput, resource utilization, and bottlenecks in an outpatient or hospital ward setting.

Purpose:

To identify bottlenecks, optimize resource allocation, and reduce patient waiting times, ultimately improving hospital efficiency and patient satisfaction.

2. System description (high level)

Scope:

From patient arrival (reception) to final discharge or completion of an appointment.

Main Components / Stages:

- Patient Arrival & Triage: Reception desk processes arrival and assigns priority.
- Registration & Record Retrieval: EMR lookup and patient registration.
- Vital Signs & Initial Assessment: Conducted by nurses.
- Doctor Consultation: Diagnosis and prescription.
- Diagnostics (Lab/Radiology): Optional per patient based on doctor's recommendation.
- Treatment / Prescription: Medication dispensing at pharmacy.
- Billing & Discharge: Payment processing and patient exit.

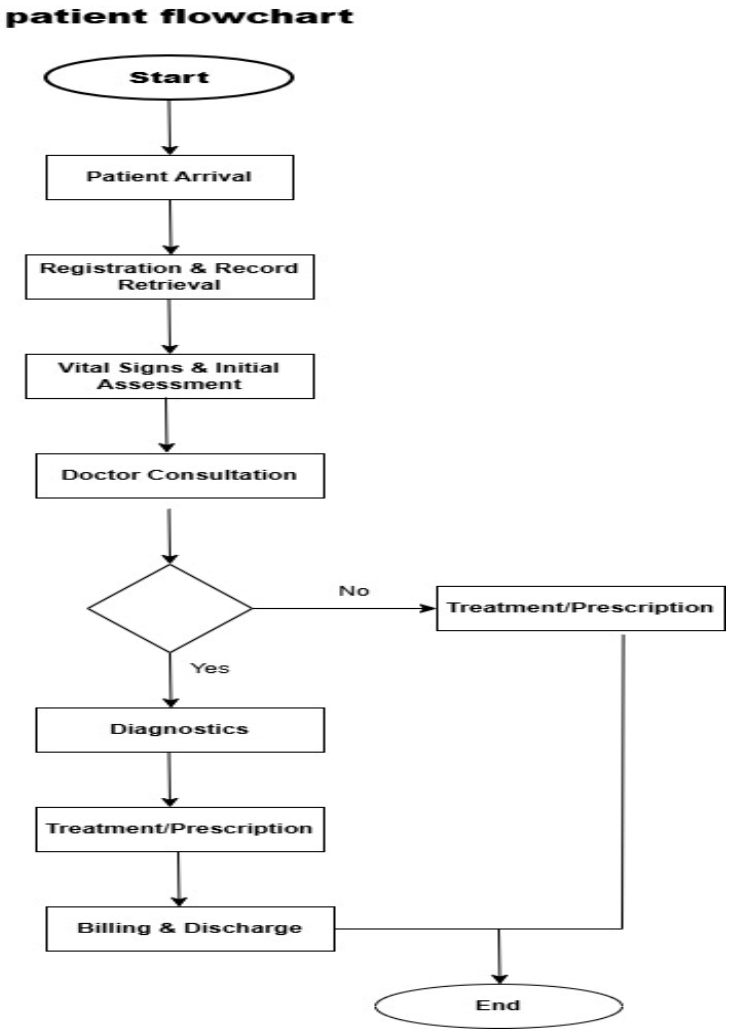
Actors / External Systems:

- Actors: Patient, Receptionist, Nurse, Doctor, Lab Technician, Pharmacist, Billing Staff.

- External Systems: Electronic Medical Record (EMR) database, Appointment system, SMS/Notification service.

Key Performance Metrics:

- Average waiting time per stage (minutes).
- Total time in system (arrival → discharge).
- Throughput (patients/hour).
- Resource utilization (doctors, nurses, lab equipment).
- Queue lengths & bottleneck identification.
- Percentage of patients exceeding target time thresholds.



3. Performance Objectives

- Minimize average total patient time in the system.
- Keep average waiting time before doctor consultation below 30 minutes.
- Maximize throughput during peak hours (9:00–12:00) — target to be determined.
- Identify bottlenecks (e.g., lab turnaround time) and propose improvements (e.g., add staff, increase parallel capacity).
- Maintain resource utilization between 60–85% to avoid idle staff and prevent overload.

4. Dataset Description

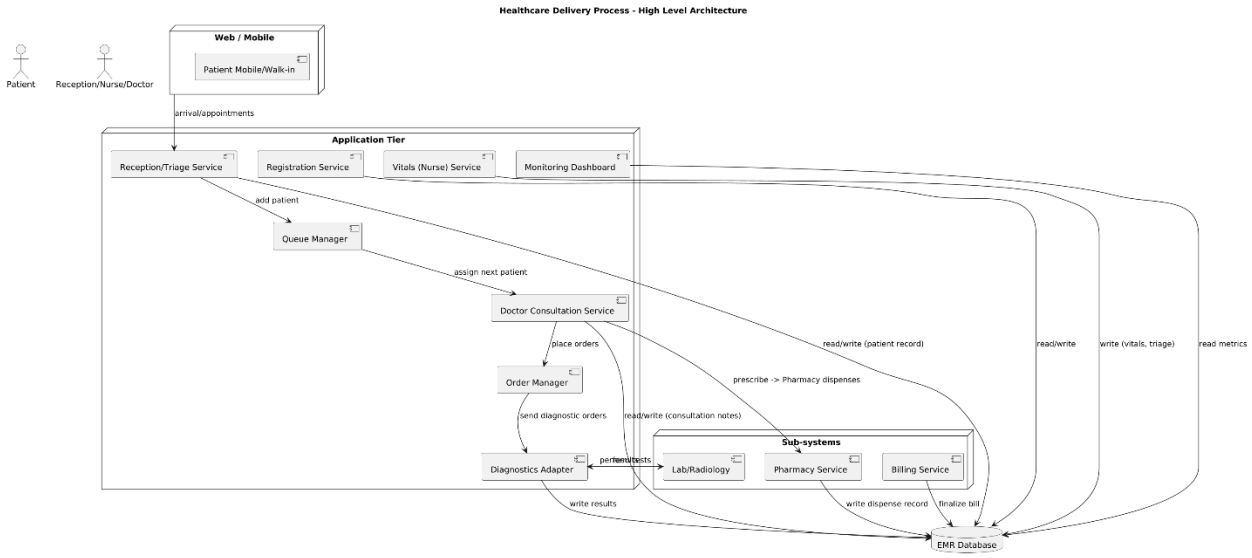
Schema (Columns):

- patient_id (string/integer)
- arrival_time (datetime)
- triage_time (datetime)
- registration_complete_time (datetime)
- vitals_complete_time (datetime)
- doctor_start_time (datetime)
- doctor_end_time (datetime)
- diagnostics_required (boolean)
- diagnostics_start_time (datetime, nullable)
- diagnostics_end_time (datetime, nullable)
- pharmacy_start_time (datetime, nullable)
- pharmacy_end_time (datetime, nullable)
- billing_time (datetime)

- discharge_time (datetime)
- doctor_id (string)
- nurse_id (string)
- diagnosis_code (string)
- priority_level (1 = emergency, 5 = low priority)
- outcome (discharged / admitted)

5. Modelling & Analysis Approach

- Descriptive Statistics: Calculate mean, median, percentiles for waiting times and total time.
- Queueing Analysis: Model as a network of queues to study waiting times and resource utilization.
- Discrete Event Simulation (DES): Simulate patient flows under different staffing and scheduling scenarios.
- Bottleneck Detection: Identify resources with high utilization or growing queues.
- What-if Scenarios: Add doctors, lab machines, adjust triage policies, or implement prioritized queues.
- Success Criteria: Waiting times below thresholds, throughput maximized, and resource utilization within target range.



Deployment Diagram – Patient Check-in to Discharge System