IMPROVEMENT OF PATIENT FLOW IN A CARDIOLOGY CLINIC

Department of Industrial Systems Engineering & Management
IE3100M Systems Design Project

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Overview

Company background

Changi General Hospital (CGH) is Singapore's first general hospital which caters mostly to patients in the East region of Singapore. The population of patients CGH caters to has increased drastically throughout the years. As a result, more staff have been hired, and more specialist clinics have been set up. CGH also continuously finds ways to push the standards of care and service for their patients, such as through the adoption of technology.

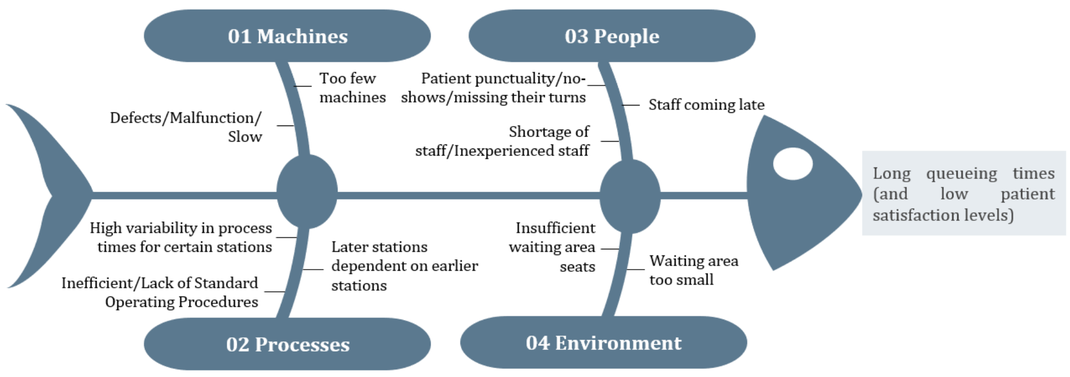
Problem description

Being a Specialist Outpatient Clinic (SOC), the Cardiology Centre of CGH requires patients to make appointments before visiting the clinic. However, even with appointments, patients often have long queueing times, leading to low patient satisfaction levels. In a recent survey, CGH was ranked 6th among 8 hospitals in the SOC category on overall patient satisfaction level. There is hence a need to address this problem to ensure CGH remains competitive.

Objectives

1. *Understand causes of long queueing time in CGH Cardiology Centre*
2. *Improve overall patient satisfaction level by reducing queueing time*

Problem analysis



Key Skillsets

Data analysis | *Critical thinking & reading*
Systems thinking | *Project management*
Simulation | *Optimisation*

Methodology

Data cleaning & analysis → Determining bottleneck station → Confirming key factors contributing to long queue times → Creating simulation model → Implementing solutions → Analysing effectiveness of solutions

Data Cleaning & Analysis

- **Missing, incomplete, and erroneous data**

This required us to look more closely into the dataset to determine what could be kept and what had to be removed. E.g. removal of records where service time = 0 seconds

- **Clinic not having a fixed daily schedule**

Analysis of the dataset thus had to be split by days

- **Many different types of patients visiting the clinic**

Pathways of the different patient types had to be mapped out to better understand the patient flow in the clinic. Analyses of service time and queueing time also had to be split by the various patient types. Patient type can differ by payment class, subspecialty, stations they are required to visit, etc

Determining Bottleneck Station

Stations in the clinic include: Registration, ECG, BP/BMI taking, Treatment, Await Result, Counselling Room, Counselling Appointment, Consultation, and Payment

Consultation station

Among these stations, the consultation station was found to have the longest queueing time that we could address directly. Using data across the whole year as a general gauge, median queueing time ~19min, and 95th percentile of queueing time ~1hr21min. Targets set by the Ministry of Health (MOH) for queueing time are a median of 30min and a 95th percentile of 60min.

Median

Target achieved

95th percentile

Target NOT achieved

Calculation of queueing time

Reported queueing time

1. First call time < Revised appointment time, reported queueing time = 0
2. Transferred on < Revised appointment time, reported queueing time = First call time – Revised appointment time
3. Reported queueing time = First call time – Transferred on

Actual queueing time

Actual queueing time = First call time – Transferred on

In our project, we **focused** on **REPORTED Queuing Time** as it was deemed the more important metric

Confirming Key Factors

From our analysis, key factors contributing to long queueing times were established to be:

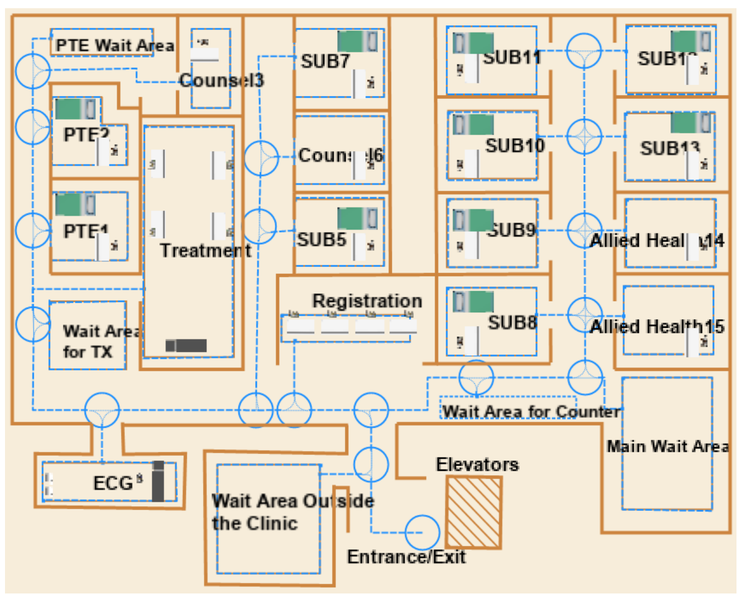
1. Uneven arrival pattern of patients due to their punctuality and appointment time scheduling
2. Some doctors starting their consultation sessions late
3. Absence of a priority system for calling patients at the consultation station
4. Long service times and high variance in service time at some stations

Creating Simulation Model

Data input

Data used in simulation model:

- *Revised appointment time* of patients
- Punctuality of patients
- Punctuality of some doctors
- Service time at various stations
- Different types of rooms
- Different pathways patients might take
- Proportion of different types of patients
- Proportion of patients going to each station



Layout of clinic in the simulation software, AnyLogic

Model validation

Metrics used in model validation:

- Reported queueing time at consultation
- Queueing time at other stations
- Turnaround time of patients
- Arrival pattern of patients to clinic
- Number of patients visiting clinic
- Time last patient leaves the clinic

Summary of key metrics used in model validation

	Actual	Simulation	Percentage error
Actual queuing time	59	53.77	8.9%
Reported queueing time	155	158.01	1.9%
Turnaround time	128	125.52	2.1%

Small percentage error achieved, indicating accuracy of simulation model

Implementing Solutions

Solution 1

Give priority to patients with reported queueing time above a certain threshold at the consultation station

❖ Sensitivity analysis was used to find the optimal threshold

Solution 2

Reschedule the appointment times of patients so that arrival rate is more uniform throughout the day

❖ Different scheduling patterns were tested to find the optimal schedule

Analysing Effectiveness of Solutions

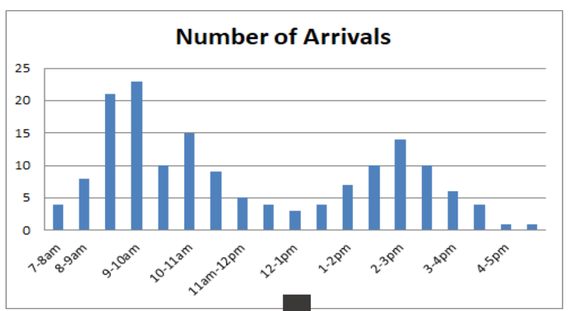
Results of Solution 1

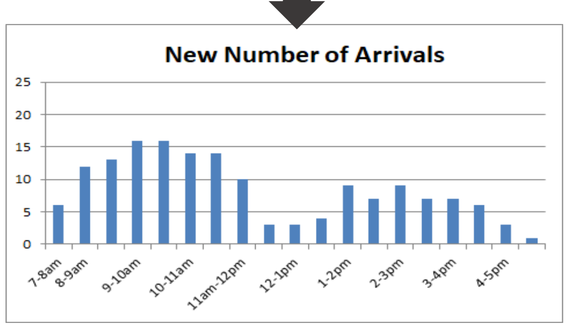
Optimal threshold: Patients with reported queueing time ≥ 40 minutes

Reported Queuing Time	Base model	Solution 1	Difference
Mean	31.02	29.45	5.1%
Median	18.15	18.46	-1.7%
95th percentile	86.97	75.56	13.1%

13.1% reduction in 95th percentile of reported queueing time

Results of Solution 2





Reported Queuing Time	Base model	Solution 2	Difference
Mean	31.02	24.69	20.4%
Median	18.15	12.64	30.4%
95th percentile	86.97	68.1	21.7%

21.7% reduction in 95th percentile of reported queueing time