IE3100R Systems Design Project AY25/26 Group 22

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Modeling of Oral and Maxillofacial Surgery Patient Journey using Discrete Event Simulation

Problem Overview

The **Oral and Maxillofacial Surgery** (OMS) department at NDCS manages a complex, multi-stage patient journey where patients return for follow-up consultations, procedures, and reviews, increasing scheduling complexity and wait times.Current capacity planning relies on experience-based decision-making, limiting evaluation of staffing and infrastructure changes.

This study develops a **FlexSim Discrete-Event Simulation (DES) model** to replicate real-world OMS scheduling logic and enable rigorous, scenario-based capacity analysis.

Objectives

- Model the **end-to-end OMS patient journey** using DES to replicate **real-world NDCS scheduling and resource allocation practices.**
- Derive **empirical input distributions** from **historical clinic data** for statistical validity.
- Analyse **resource utilisation** and **patient wait times** across varying staffing and infrastructure configurations through a **sensitivity analysis**
- Identify the **optimal configuration** to **minimises patient Wait Time for Appointment (WTA) and system-wide queue length**
- Develop a FlexSim DES model that faithfully captures **rule-based doctor and chair assignment logic, patient routing, and re-entrant follow-up flows**

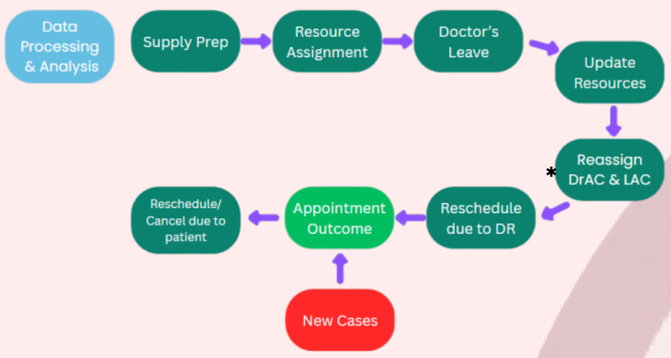
Methodology

Technical Skills

Project Implementation

Process Overview

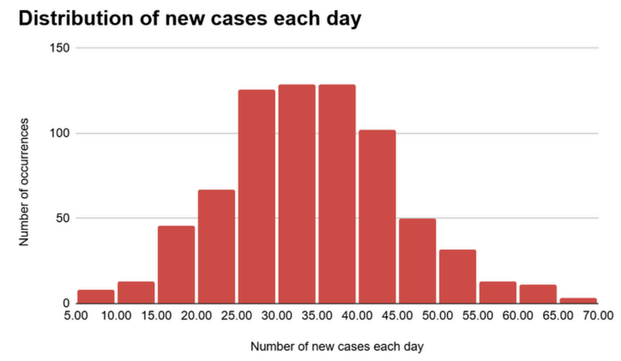
Each module represents a core operational process, collectively defining how the FlexSim model was structured and how tokens flow through the simulation.



**DrAC: Doctor Appointment Calendar*
LAC: Location Appointment Calendar

Model Design and Validity

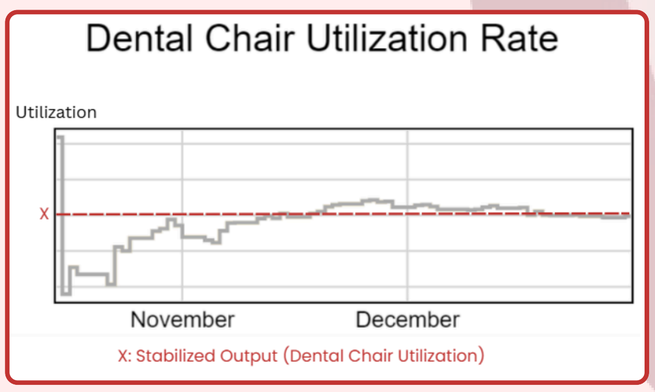
- **Runtime duration of 3 months (Oct-Dec)** - Based on NDCS recommendations, with dashboard graphs confirming a steady state is reached within the first few days, validating the warm-up period
- **Scheduling logic mirrors real-world operations** - The model cross-references each doctor's calendar against available dental chair slots booked in advance, with patients filling these pre-matched resource pair.
- **Comprehensive disruption handling** - The model accounts for patient reschedules and cancellations, as well as doctor absences ranging from same-day medical leave to planned future leave, all of which trigger downstream rescheduling logic.
- **Model outputs** - Closely reflects real-world behaviour, and can be further strengthened by incorporating additional dental services such as operating theatres and follow-up appointments to narrow the remaining gap with actual operations



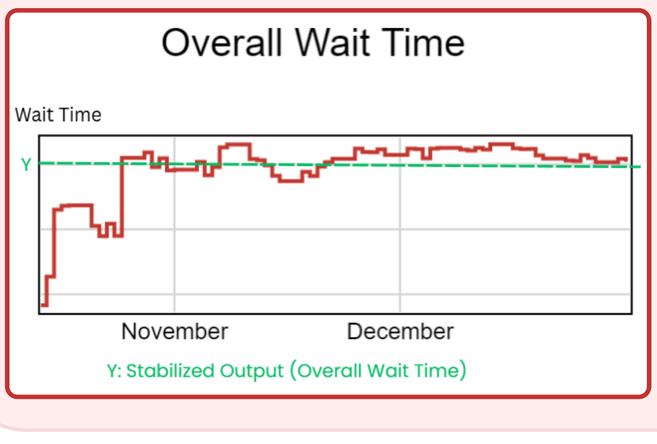
Cleaned data was analysed using a histogram and tested with a chi-squared test ($p > 0.05$), confirming a normal distribution; thus, daily new cases were modelled accordingly.

Flexsim Simulation Output

Variables	Actual	Simulation
Dental Chair Utilization	1.029x %	x %
Average Waiting Time	1.2x days	x days

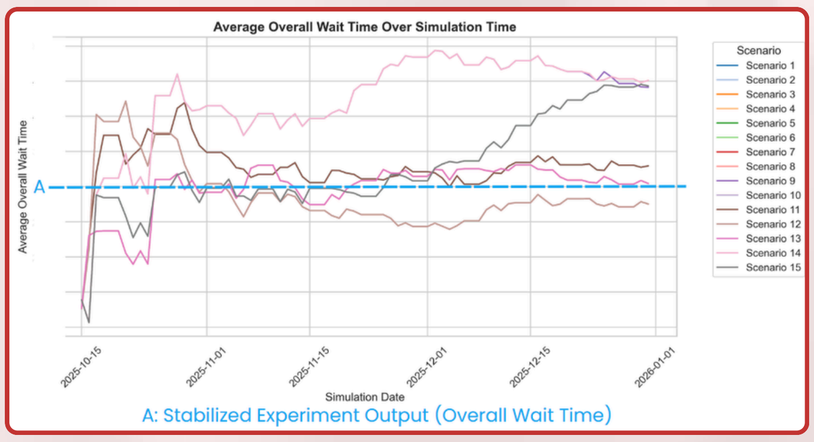


X: Stabilized Output (Dental Chair Utilization)

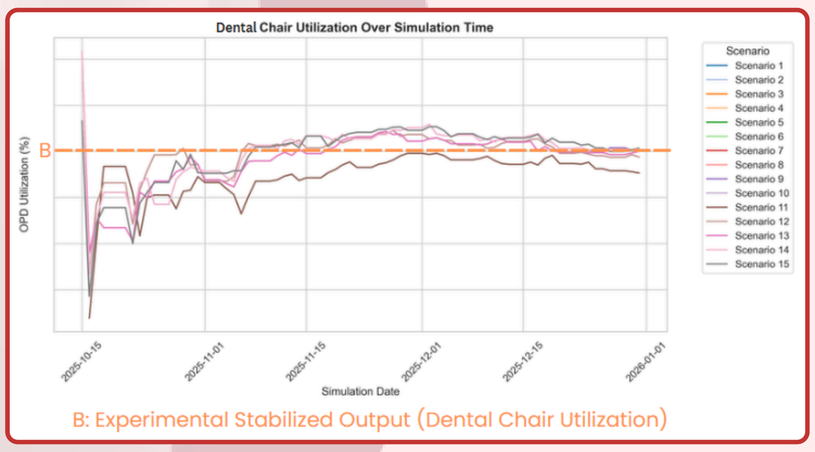


Y: Stabilized Output (Overall Wait Time)

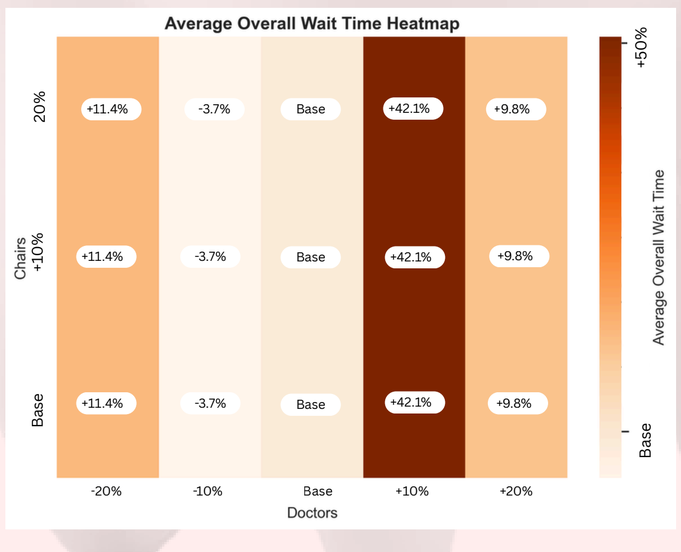
Experimentation Results



A: Stabilized Experiment Output (Overall Wait Time)



B: Experimental Stabilized Output (Dental Chair Utilization)



Chairs \ Doctors	-20%	-10%	Base	+10%	+20%
Base	Run 1	Run 2	Run 3	Run 4	Run 5
+10%	Run 6	Run 7	Run 8	Run 9	Run 10
+20%	Run 11	Run 12	Run 13	Run 14	Run 15

Key Findings & Insights

- Optimal numbers of doctors and chairs
- Optimal number of slots over WTA

SCAN TO SEE OUR SIMULATION

Interactive Demo • Results • Insights

Achievements

1. Successfully built and validated a **DES model** against **real NDCS data**
2. **Experimented** across a range of resource allocation scenarios
3. Identified **optimal configuration for dental chairs resource allocation**

Recommendations

- **Smarter Patient Reminders:** Embed wait times in SMS and add automated reminder calls — proven to cut no-shows by up to 10%.
- **Operational Dashboard:** Track daily operations, consult times, and highlight unused capacity. Enables clinicians to close information gaps, providing them with information for future operations and capacity planning.
- **Educating the Public on Medical Slots:** Highlighting that last-minute cancellations/rescheduling leads to waste slots and strain health resources. This message can be delivered via hospital posters and on social media.

Project Benefits

Scalable Scenario Testing

Enables flexible testing of different scheduling strategies across departments and operating theatres by adjusting key variables.

Better Patient Experience

Reduces waiting time leading to smoother and more convenient patient journeys.

Improved Planning & Decision Making

Provides data-driven insights to support more informed scheduling and resource allocation decisions.

Increased Resource Utilization

Optimises the use of doctors and dental chairs, reducing idle time and improving overall clinic efficiency.

Limitations

- Assumes fixed no-show rates; real variability not captured
- Focused on OMS Department only; excludes cross-specialty resource sharing
- Historical data may not reflect future demand shifts

Future Direction

- Extend model to cover multi-clinic or cross-specialty patient flows
- Validate recommendations through a real-world pilot at NDCS
- Experiment with model backlog realism by replacing scheduling offset with dynamic backlog initialization
- Expand the model to capture all appointment types across the OMS

Mock data is used in this poster. Report will have actual results.