

Company Background

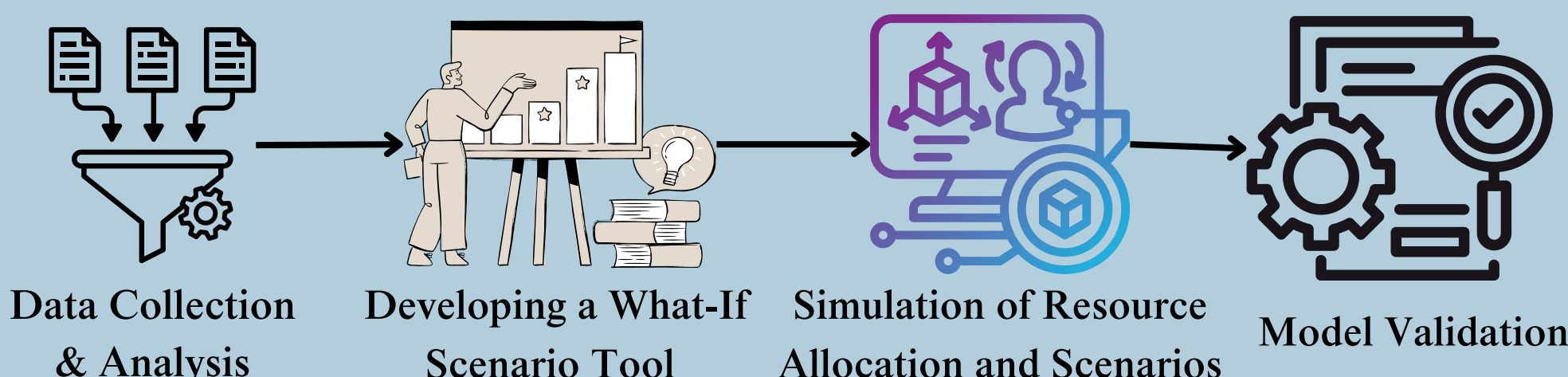
KK Women's and Children's Hospital (KKH) is Singapore's largest and leading specialist hospital, managing high-risk conditions in women and children, and delivering approximately 12,000 babies annually. KKH continues to harness the latest medical innovations and technology to provide patients with safe, seamless care.

Problem Statement & Objectives

An ageing workforce facing a shortage of trained midwives, compounded by the unpredictable nature of childbirth, has created operational challenges at KKH's Delivery Suite. Unplanned admissions and less-than-ideal resource management exacerbated the problems further, causing extended waiting times and suboptimal patient flow, which could potentially compromise safety if care is delayed.

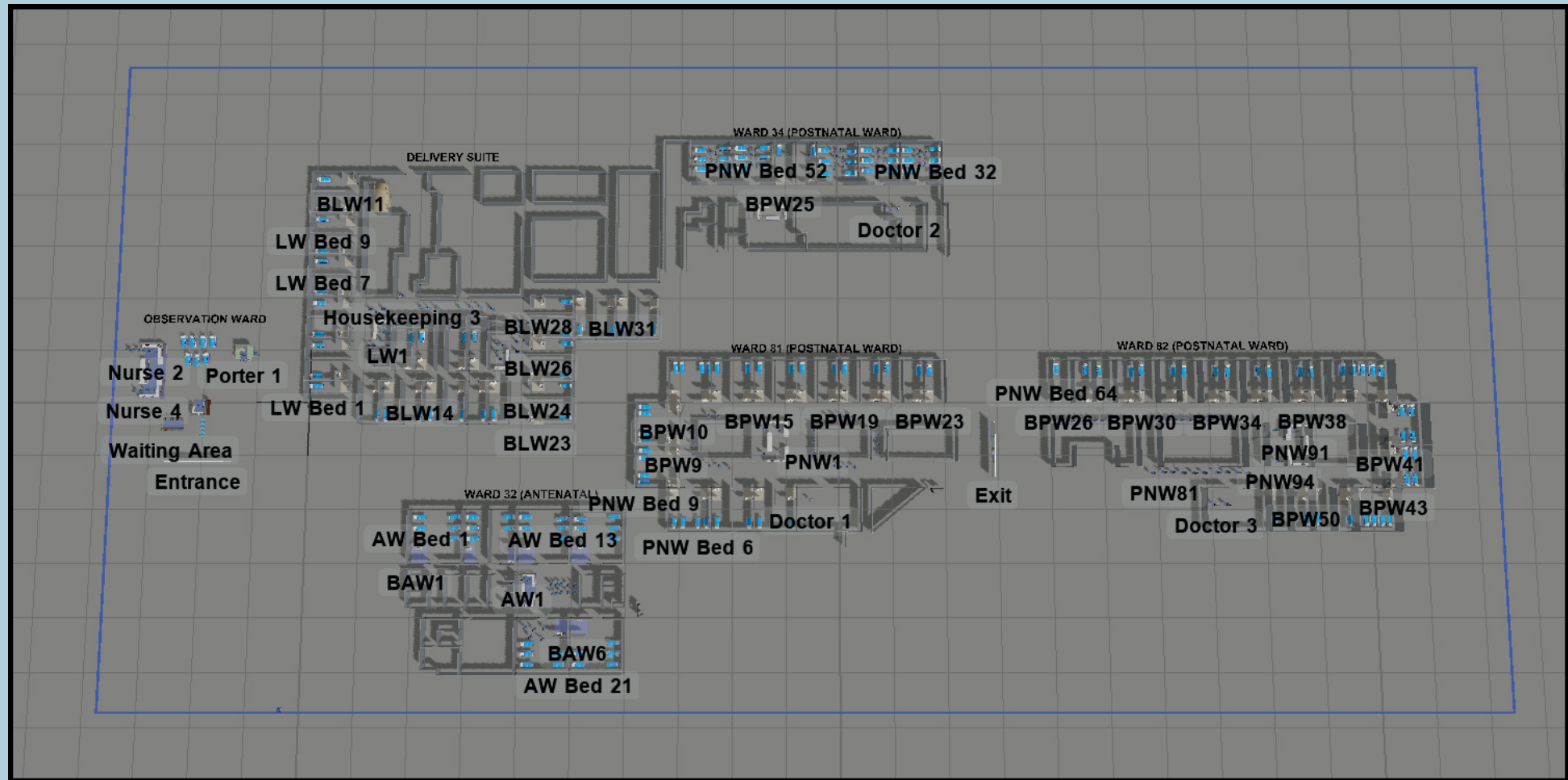
This project seeks to optimise resource allocation, streamline patient flow, and improve efficiency in the KKH Delivery Suite to reduce waiting times, alleviate overcrowding and enhance patient care through developing a digital twin based on historical data.

Methodologies



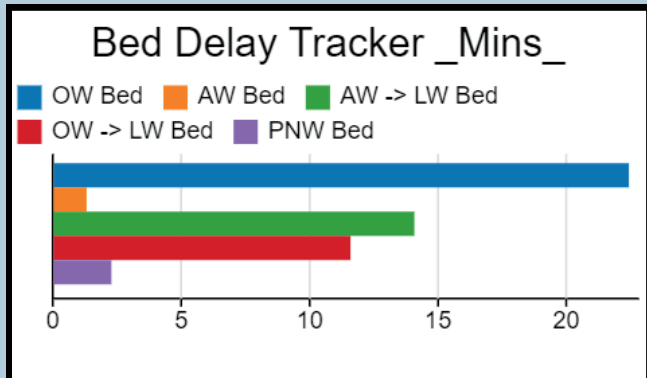
Flexsim Model

FlexSim Model layout

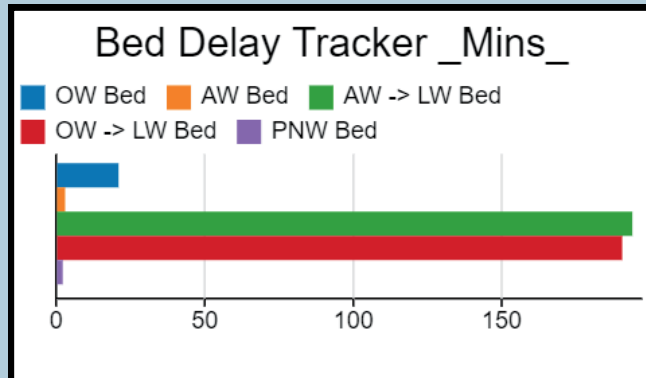


Scenario: Closing 4 Delivery Suites

Base Model



What-if Model



One common scenario in KKH is the closing of delivery suites. Reducing the number of active delivery suites from 14 to 10 led to significant delays.

- Average transfer delay from the AW and OW to a delivery suite bed escalated from **13 minutes to 190 minutes**
- Due to the long bed delay, average time spent in OW and AW extended from **2.5 hours to 5 hours**

Impact

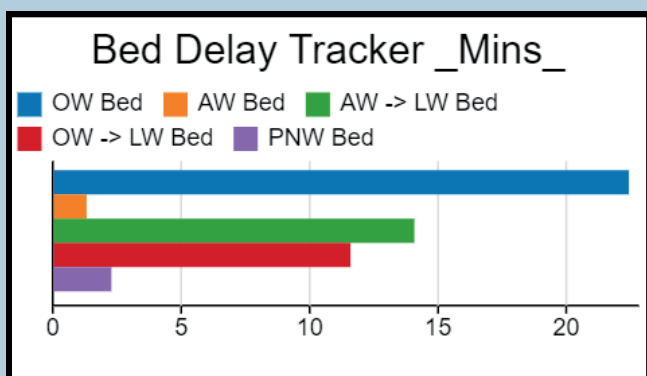
- Congestion in observation and antenatal wards
- Diminishing patient experience and workflow efficiency

Recommendation

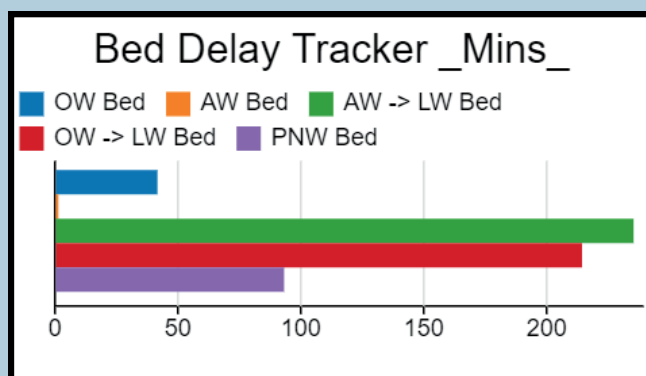
- Utilize simulation modeling to evaluate and optimize staffing and bed allocation strategies before implementation

Scenario: Morning Influx of Patients

Base Model



What-if Model



Another common scenarios in KKH is the morning influx of patients. An increase in patient arrivals during the morning hours, from 30 to 40 led to significant delays.

- Average transfer delay from the AW and OW to a delivery suite bed escalated from **13 minutes to 215 minutes**
- As a result of the increased transfer delays, bed delays PNW beds also escalated from **2 minutes to 90 minutes**
- Extended stay in postnatal ward to **over 65 hours**

Impact

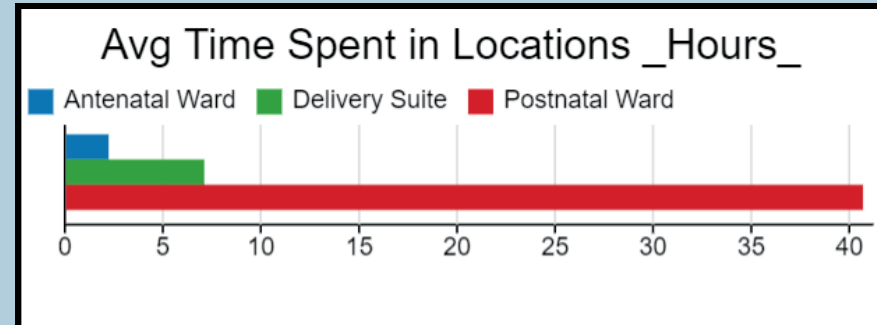
- Downstream effect led to major delays across the system
- Diminishing patient experience and workflow efficiency

Recommendation

- Increase staffing during peak morning periods by allocating more nurses and midwives to morning shifts to better manage patient load and minimize delays

Model Validation

Simulated Data



Sample Data

Antenatal	Delivery Suite	Postnatal
Min. :0.2833	Min. :1.067	Min. :21.38
1st Qu.:0.5833	1st Qu.:4.833	1st Qu.:25.65
Median :1.2000	Median :11.933	Median :31.05
Mean :2.0465	Mean :13.778	Mean :31.30
3rd Qu.:2.9667	3rd Qu.:22.483	3rd Qu.:34.82
Max. :8.2500	Max. :53.100	Max. :54.57

Model Validation: Simulated vs. Actual Data

Key Differences

- Delivery Suite: Model underestimated time by 30%
- Postnatal Ward: Model overestimated stays by 20%

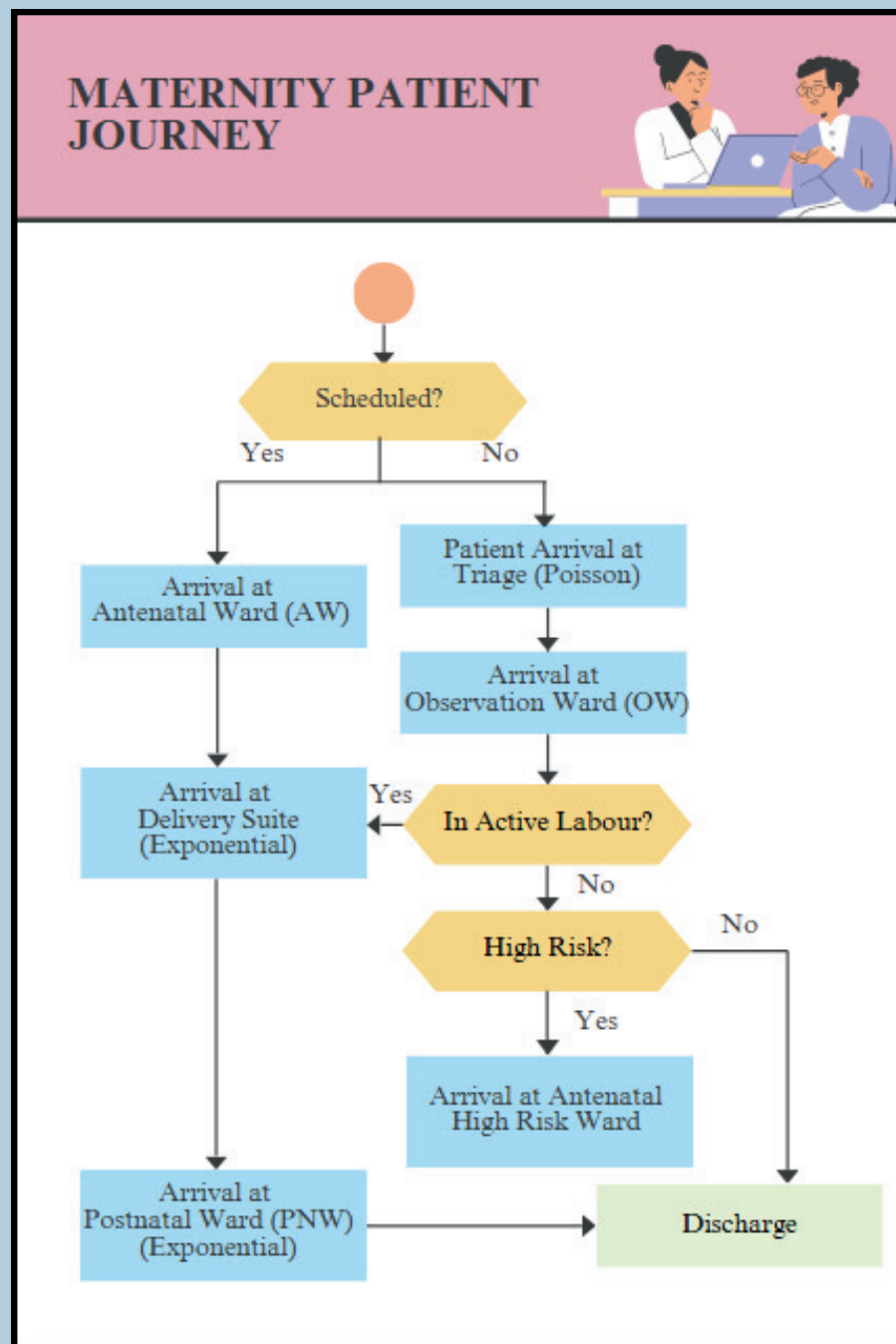
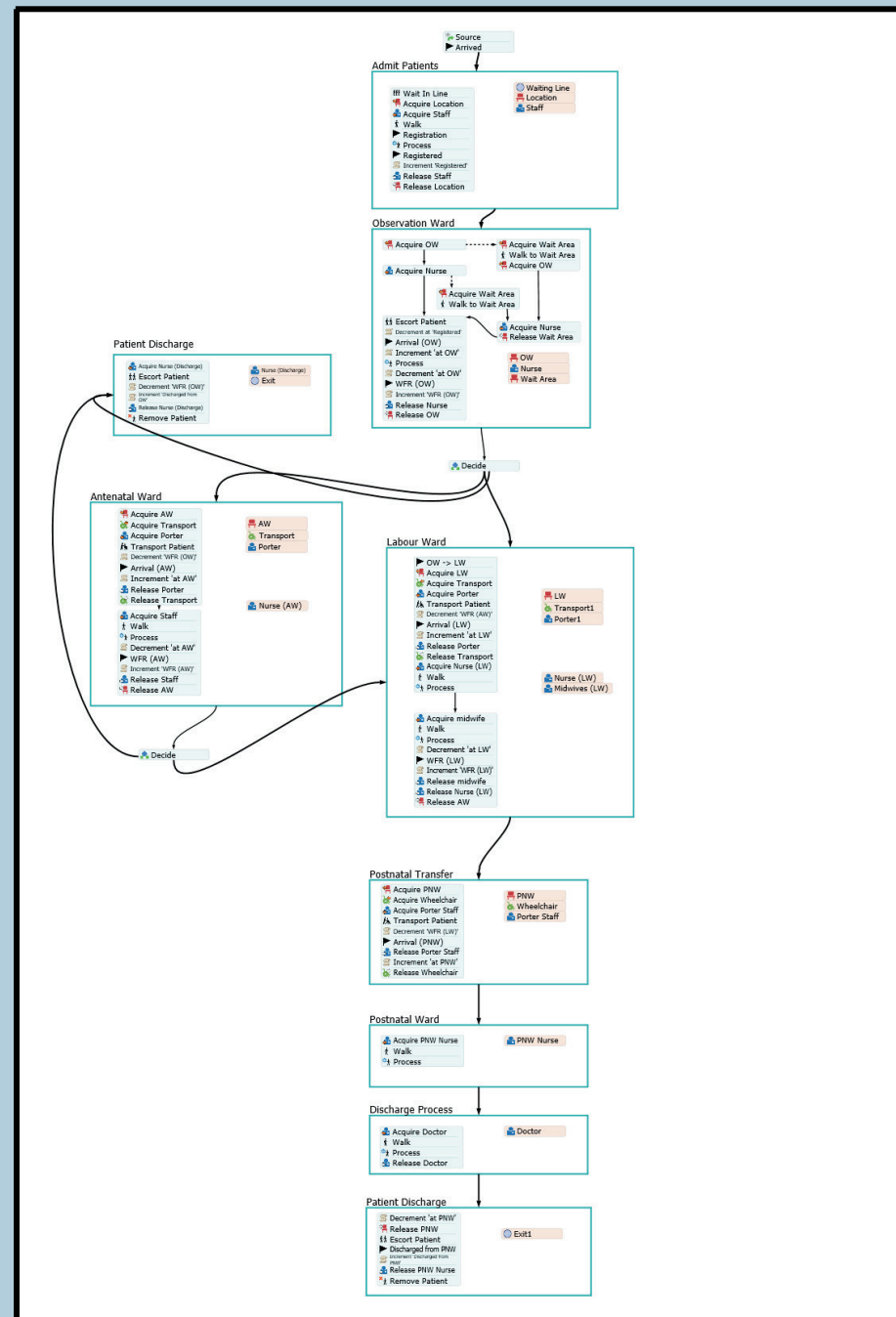
Key Similarity

- Total hospital stay duration matched well between simulated and actual data

Limitations & Next Steps

- Current model could not account for real world complexities, such as a shortage of porters, prolonged induction times and birth complexities
- Current dataset (n≈50) limits model accuracy
- Future iterations require comprehensive data collection to refine and enhance model accuracy and robustness

Patient Flow Design



Potential Impact & Future Applications

Scalability to Other Hospital Departments

With this simulation model in place, future expansions can support other complex hospital areas, such as the Operating Theatre and Children's Emergency, improving patient flow and resource management hospital-wide.

Data-Driven Resource Allocation

The model's predictive capabilities enable KKH to optimize resource allocation through inferential and predictive analysis. For example, For example, deploying mid-wifery trained nurses from the antenatal and postnatal wards during predicted high-demand periods can quickly address staffing shortages and reduce delivery suite wait times.

“What-If” Scenario Testing for Operational Adjustments

The model's scenario testing feature provides valuable insights for both daily operations and large-scale changes. It will be useful to assess the impact of operational changes, such as ward renovations pre-implementation Minimising disruptions and improving planning.

Systemic Change and Continuous Refinement

The model supports systemic improvements by eliminating inefficiencies such as bed reservations and adapts to real-world challenges, including delays arising from complicated deliveries, through continuous refinement, ensuring it remains an accurate digital twin

Skillsets Acquired

- FlexSim Healthcare Simulation
- FlexScript
- Healthcare (Delivery Suite) Optimization
- Operations Research
- Stochastic Modelling
- Data Analytics & Visualization
- Project Management

