

## Project Overview

### Company Background

SingHealth is Singapore's largest public healthcare cluster, providing comprehensive, multi-disciplinary and integrated care through a network of acute hospitals, national specialty centres, community hospitals and polyclinics, offering over 40 clinical specialties.

### Problem Description

SingHealth is planning to build new hospitals in the coming decades to meet future healthcare demands. A decision-support tool is needed to forecast hospital capacity needs, incorporating data visualisation and adjustable parameters to help decision-makers explore different scenarios for long-term planning.

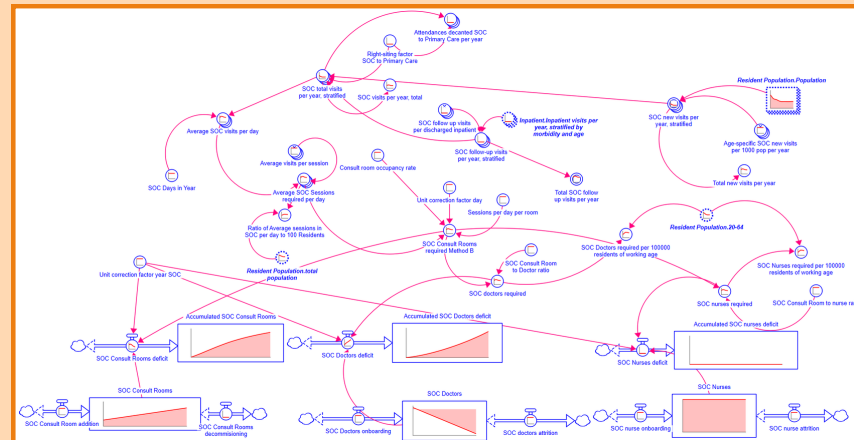
### Objective

Develop a system model to assist decision-makers in planning future hospital capacity, enabling stakeholders to make informed decisions regarding the capacity of future healthcare systems.

### Key Skillsets Acquired

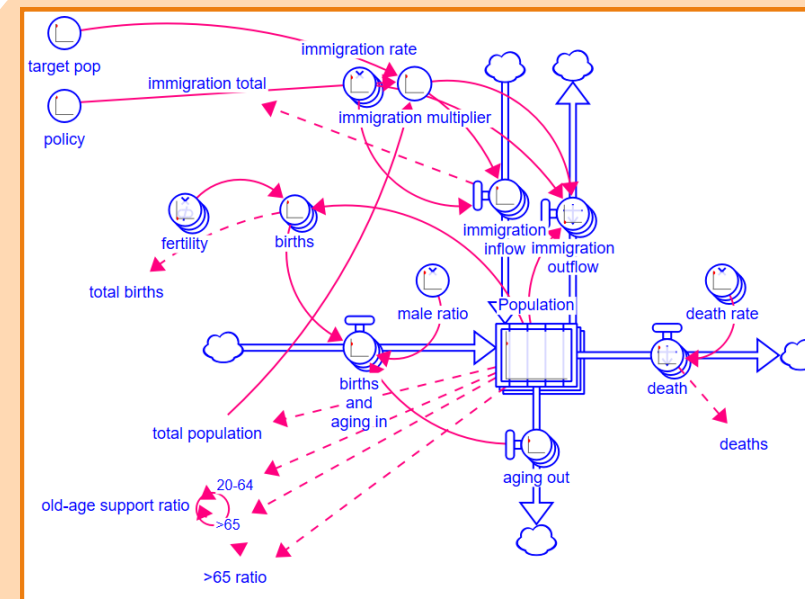
-  Systems Modelling
-  Excel
-  Data Analysis & Visualisation
-  Simulation & Forecasting

## Methodology



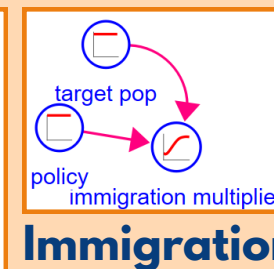
### Specialist Outpatient Clinic Module

SOC attendances consist of new SOC visits from the Resident Population module and follow-up SOC visits from the Inpatient module, both stratified by age. This gives rise to the SOC total visits per year, stratified, which allows for the calculation of Average SOC Sessions required per day as well as Total SOC follow-up visits per year. These variables provide hospital planners with insights into all SOC attendances, generating forecasts for both new and follow-up visits on a daily and yearly level. Like other modules, the most significant factors and variables are displayed in the corresponding dashboard, providing valuable insights for decision-making.



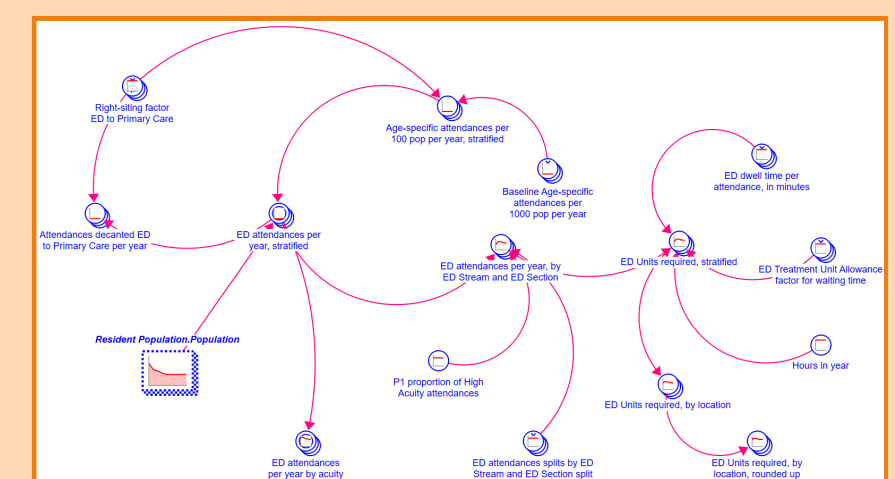
### Population Module

The population model aims to accurately model both resident population trends and the effects of immigration; stratified into gender and age, to provide a greater degree of precision for the outputs. The model takes into account key parameters such as fertility, death rates and initial population, with data obtained from Singapore Department of Statistics.



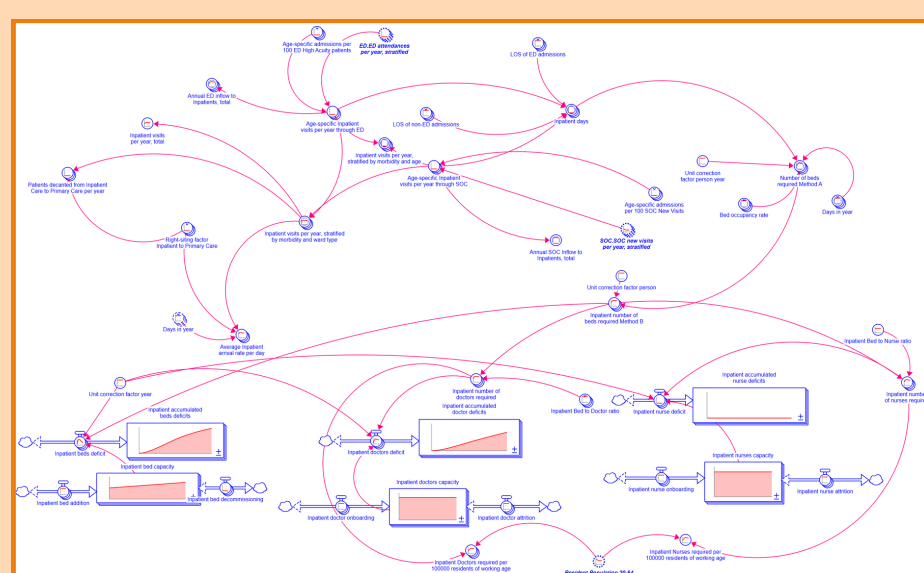
### Immigration

Immigration multiplier adjusts net immigration number into Singapore by a dynamic approach, taking into considerations of socioeconomic and policy influences, which can be adjusted by users from the dashboard.



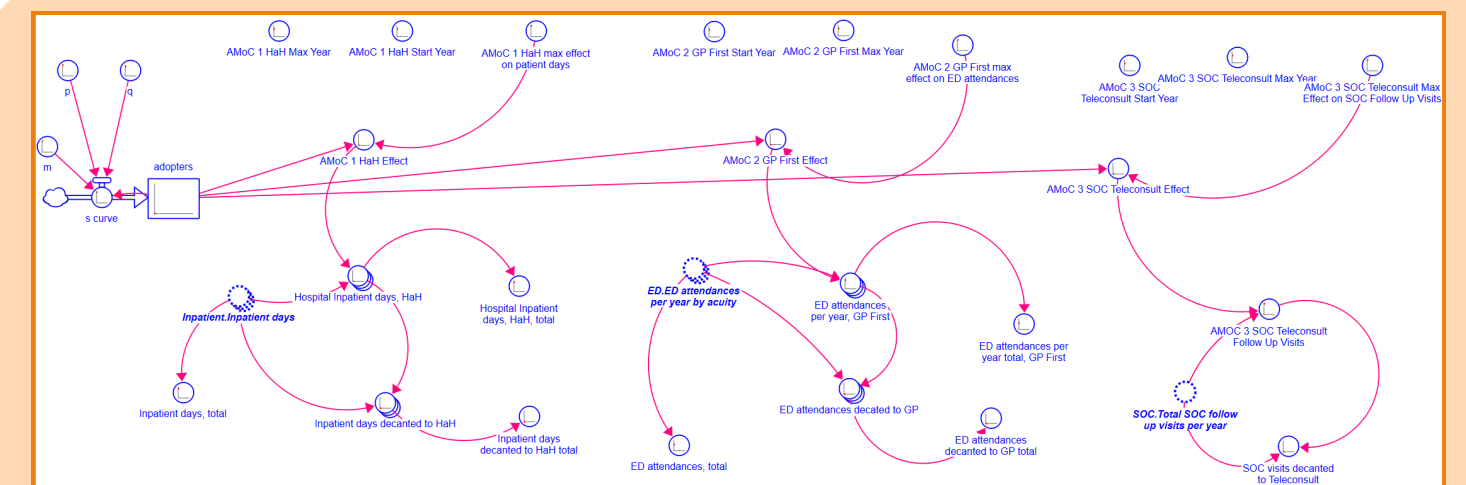
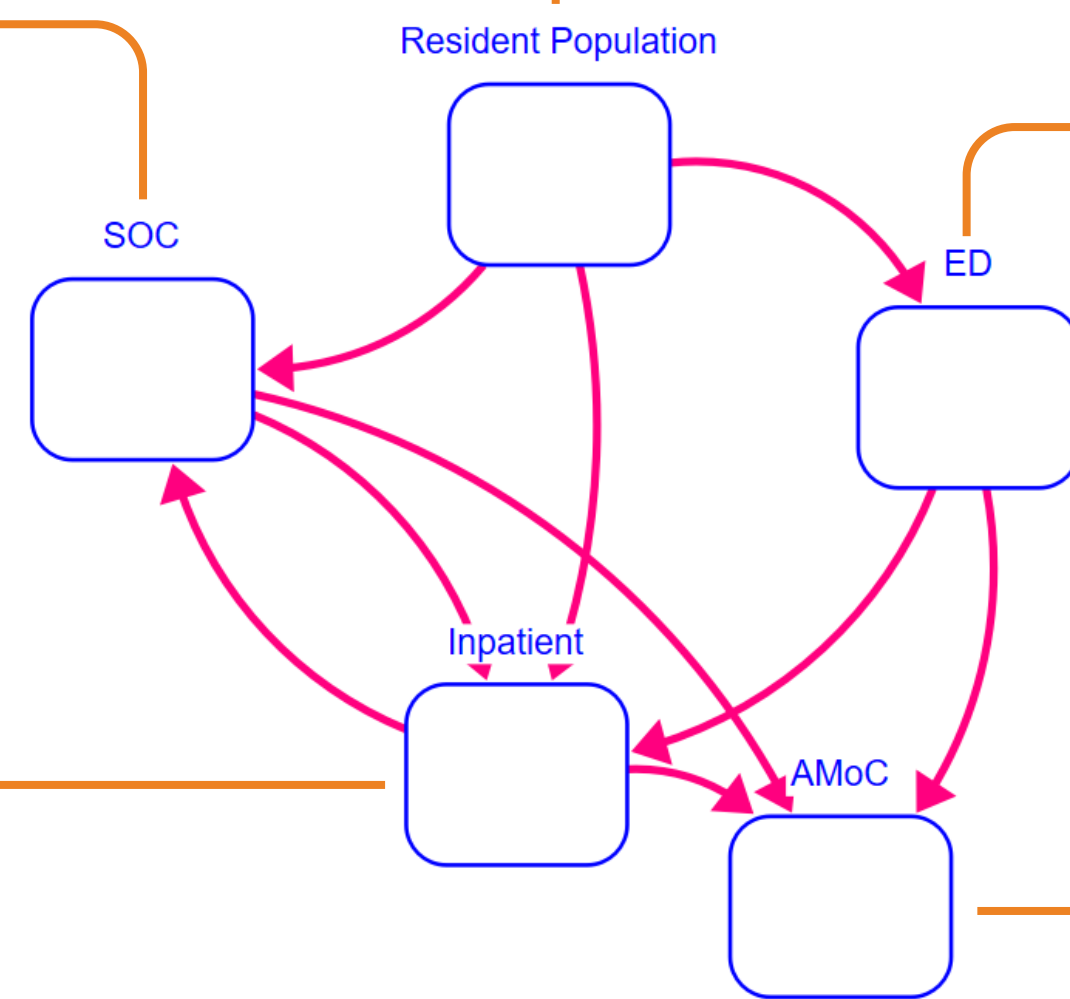
### Emergency Department Module

The ED module captures the behaviour of ED attendances by acuity and section. This module functions on the logic of the baseline ED attendances per year (which can be updated via the input file if new data becomes available) and stratifies it by various metrics (age, section, acuity) to generate accurate statistics. The dwell time for each patient type is also input into the module such that the time spent in the ED by different patients can be accurately tracked and accounted for.



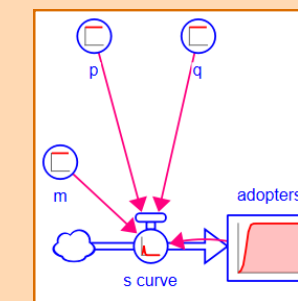
### Inpatient Module

The attendances to the inpatient module are derived from the ED and SOC modules to obtain the total inpatient visits per year, stratified by morbidity and age. Similar to the ED module, the inpatient module also tracks patient dwell time to generate accurate results. Additionally, the required resources are determined by manpower-to-demand ratios. This module provides hospital planners with further insights of the overall demand within the inpatient sector of the hospital.



### Alternative Models of Care Module

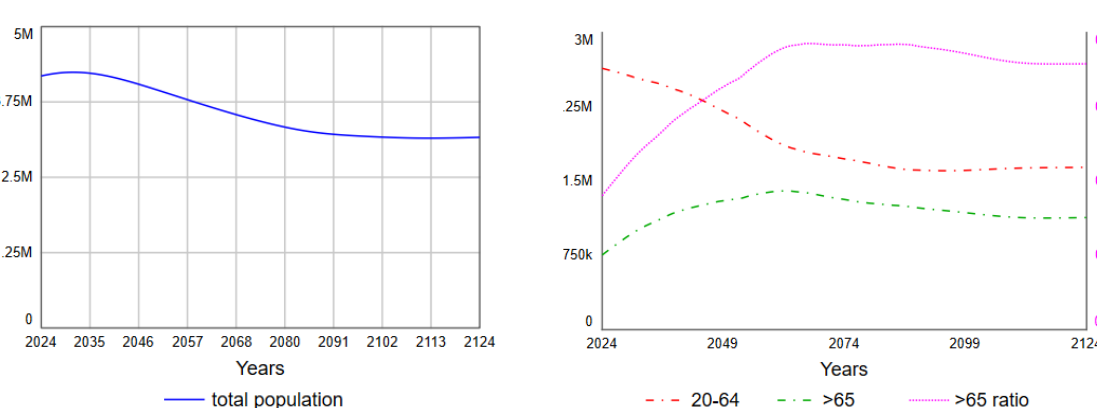
At the core of the AMoC module is the S-curve function, which models the adoption behaviour of new technology or practices based on the Bass diffusion model developed by Frank Bass in 1969, and aims to simulate the behaviour and interaction of potential adopters with a new product. In this case, the S-curve aims to simulate the adoption of the AMoCs by Singapore residents in the coming decades. Overall, the AMoC module aims to accurately model the effect of AMoCs in alleviating the strain on the rest of the hospital system.



The key parameters are  $q$ , the coefficient of imitation, and  $p$ , the coefficient of innovation.  $m$  represents the total market size.

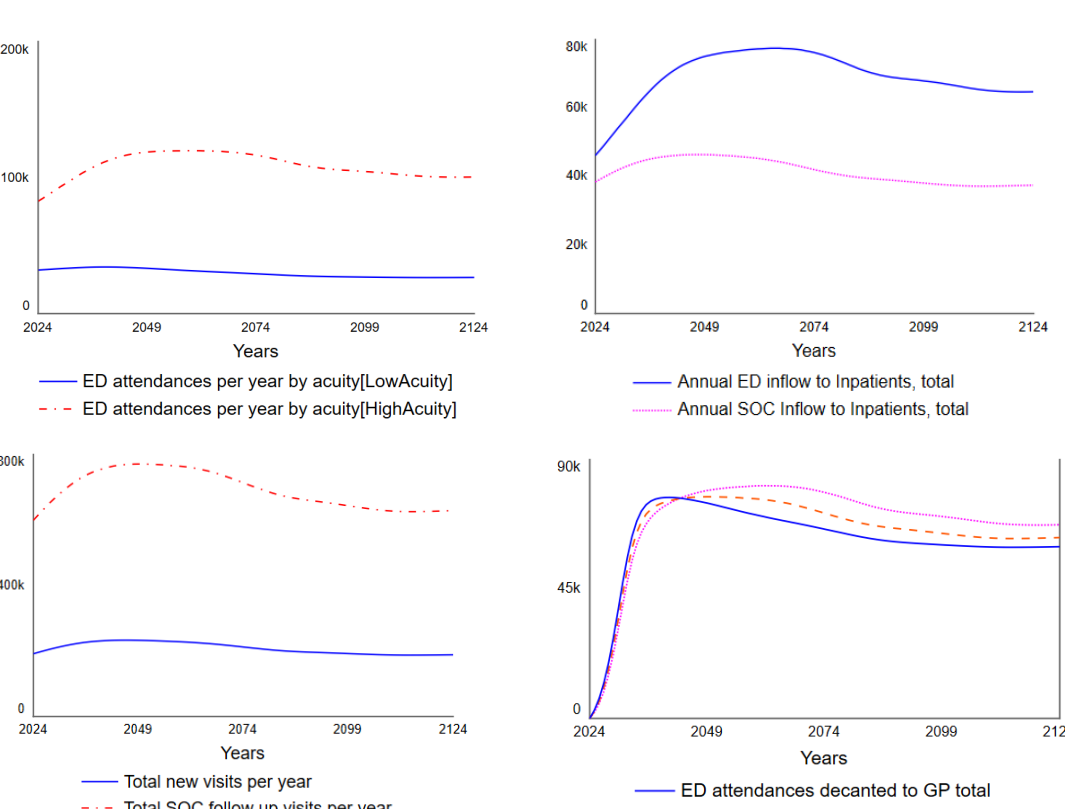
## Results

### Population Trends



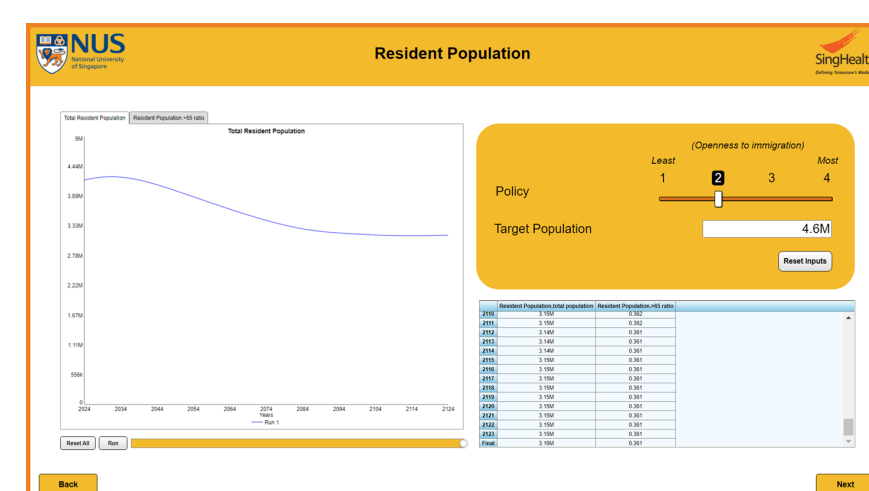
An overall decrease in population is observed after peaking in 2030, with an increase in the >65 age ratio due to the rapidly ageing population. Singapore will need to consider how to care for its ageing population in the years to come. Our model's detailed breakdown of population by age allows a more in-depth analysis for age-specific patient demand.

### Hospital Trends

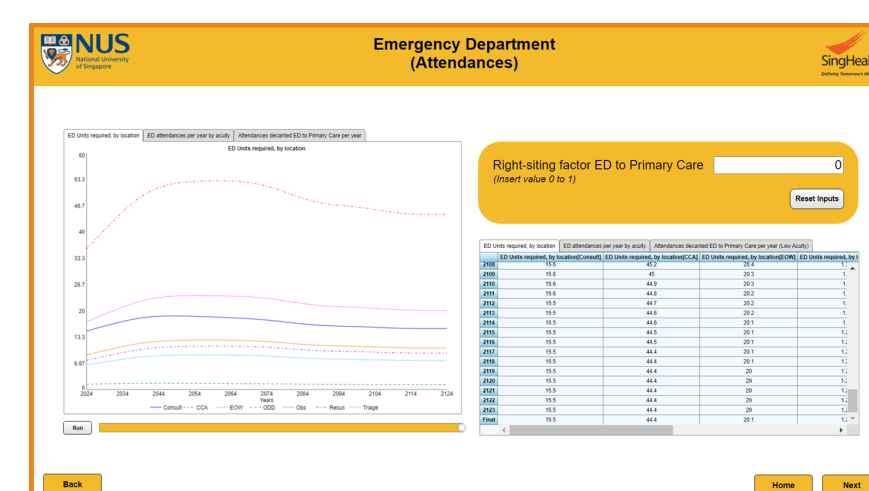


Additionally, we generated results for each hospital system to analyse key trends from ED, Inpatient, SOC and AMoC effects. Hospital demand generally follows population trends, with the exception of AMoC where the S-curve function influences the overall adoption rate and its impact on other hospital systems. These results are generated from baseline input parameters that can be updated as hospital planners see fit.

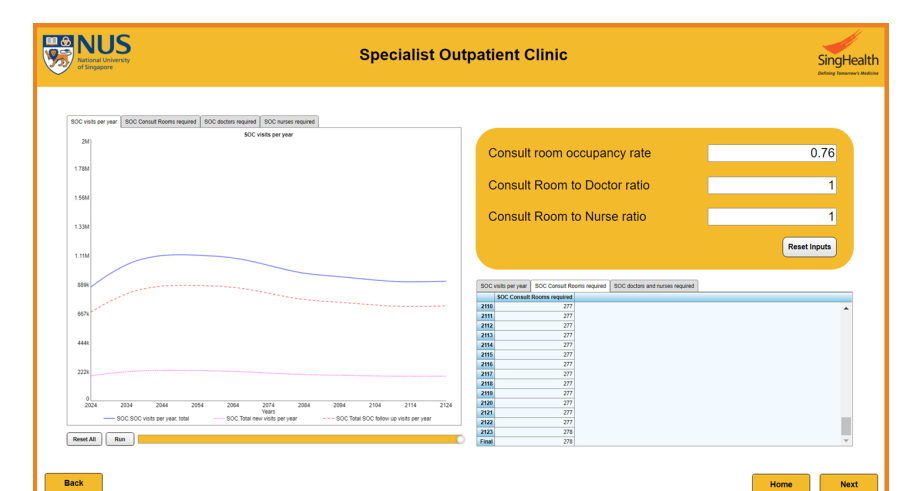
## Data Visualisation Dashboard



On the Resident Population page, users can adjust input parameters to compare various population scenarios regarding immigration policy and target population.

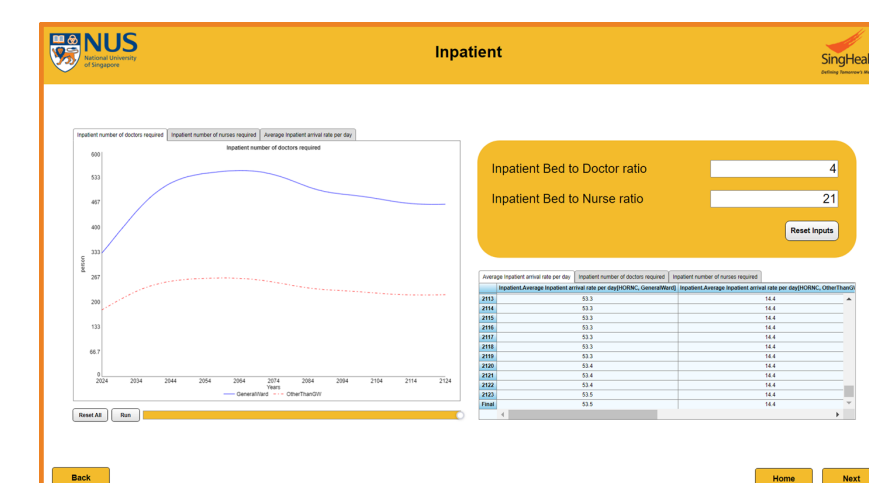


On the ED Attendances page, users can modify the right-siting factor parameter to observe how attendances for each ED pathway change.

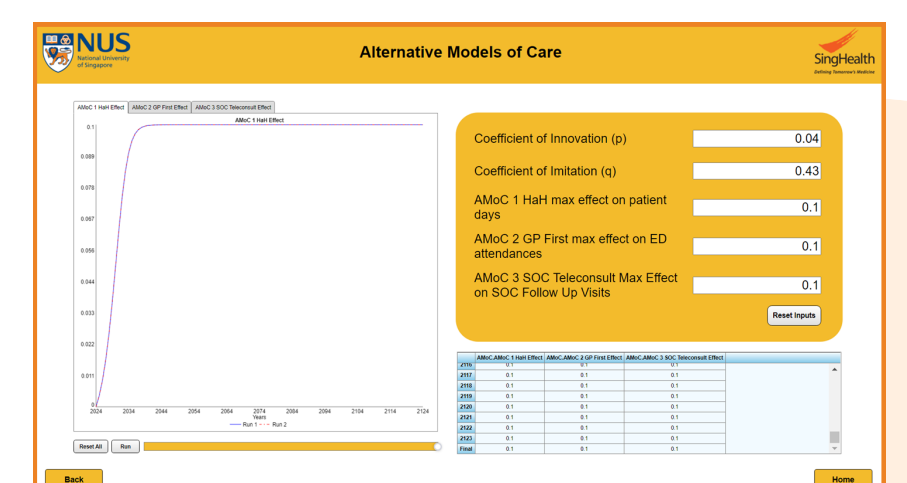


On the SOC page, users can adjust the room occupancy rate, room-to-doctor and nurse ratios to observe how visits and resource requirements change.

This dashboard is created using STELLA Architect to assist the planning team in visualising data trends for each module. In addition, it allows users to **edit parameters based on potential what-if scenarios to help them with making key decisions** in their planning. Users can run the data after modifying the parameters and easily reset inputs to default values without affecting the model's values.



Similar to the SOC page, users can adjust the ratios on the Inpatient Attendances page to estimate the required number of doctors and nurses.



On the AMoC page, users can modify these parameters and view the data values in the table at the bottom right after running the simulation.

## Future Directions

Based on the user needs of the project team:

- More editable input parameters for both the population and hospital models.
  - Enable analysis of differences between possible future scenarios with varying parameter sets and the current model's baseline values to enhance forecasting capability.
- Reverse-engineer the S-curve equation for AMoC adoption rate.
  - Input the desired year for maximum adoption and receive the required  $p$  and  $q$  parameters as output.
  - Planners can gauge the necessary resources required to achieve this specific level of adoption.