Use of a Novel Patient-Flow Model to Optimize Hospital Bed Capacity for Medical Patients

Online Appendix: User Guide to the Excel Toolkit

In this online appendix we provide guidance to use the Excel toolkit. The toolkit is accessible as an online supplement to the paper, or through the link https://github.com/YueHu-CU/Implementation-of-a-patient-flow-model-to-optimize-inpatient-hospital-capacity.

Input parameters

The model requires the following input parameters: (a) Choose Unit Type in cells A4 – B4: General Medicine, Cardiology, or Observation cohort, (b) Choose Day-of-Week Type in cell C4: weekday or weekend, (c) Choose Year in cell D4: number of years ahead (Year 0 – 5) for capacity planning, (d) Request Rate (number/hour) in cells B8 – B31: number of bed requests during each hour on a typical weekday/weekend (assuming that the hourly count is distributed uniformly throughout all minutes of the hour), (e) Discharge Density (percentage/hour) in cells C8 – C31: proportion of patient departures during each hour on a typical weekday/weekend (i.e., number of patient departures during each hour / number of all patient departures throughout the day), (f) Number of Beds in cell D8: number of beds to test performance, (g) % Compound Annual Increase in Bed Request Rate in cell D13: projected annual increase in inpatient demand, (h) Average LOS (days) in cell D16: average patient LOS in the selected cohort.

Outputs

The model provides the following outputs: (a) Occupancy Level in cell F9: average occupancy in the cohort throughout the day, (b) Average Delay (min) in cell G9: average waiting time for bed requests on a typical weekday/weekend, (c) Peak-Hour Delay (min) in cell G12: average waiting time for bed requests made during the busiest hour on a typical weekday/weekend, (d) Daily

Maximum Delay (min) in cell G15: maximum waiting time for bed requests on a typical weekday/weekend, (e) Delayed Patients (%) in cell H9: proportion of patients waiting for > 0 hours on a typical weekday/weekend, (f) Patients Waiting > 1 hr (%) in cell H12: proportion of patients waiting for > 1 hour on a typical weekday/weekend, (g) Patients Waiting > 2 hr (%) in cell H15: proportion of patients waiting for > 2 hours on a typical weekday/weekend, (h) The yellow diamond in the four output plots marks the (performance measure vs. occupancy level) couple resulting from the current input parameters with respect to all possible (performance measure vs. occupancy level) spectrum for the cohort.

Instructions

1. Enable all the content, mainly Macro, when the Excel file is open. The toolkit is coded using Visual Basic for Applications (VBA), a Microsoft's event-driven programming language, and can be supported by both Microsoft Windows (recommended) and Mac OS systems. (Nevertheless, VBA has been found to be incompatible with many versions of Mac OS systems.) For Microsoft Windows users, instructions to enable Macro can be found here: https://support.microsoft.com/en-us/office/enable-or-disable-macros-in-office-files-12b036fd-d140-4e74-b45e-16fed1a7e5c6.
Please note that the toolbox cannot be run properly if Macro is not supported by the application.

2. In the Model tab, enter all the input parameters by either selecting from the dropdown menus or typing in the numbers.

3. For any experiment, the discharge densities entered in cells C8 – C31 must sum up to 1. In addition, no positive discharge density is allowed before 10 am, because the model assumes that patients start leaving wards as early as 10am after/during the morning inspection round. Violation of either point will result in an error message.

4. For any experiment, if the bed request rate is so high that the tested number of beds cannot meet all demand, the toolkit will output the message “System is not stable.”

5. Run the model by clicking the Run Model Button and view performance measures.

6. Click the Reset Button to clear all the experiments and recover the default input parameters derived from the hospital census data.