

General Description

This model represents a small Emergency Department (ED) consisting of a waiting area, a registration desk, a triage room, a radiology station, a billing area, 6 beds and 6 rooms that are used for patients that are admitted into the hospital.

Patients enter the ED through the front door entrance and go directly to the registration desk. After they are registered, they wait in the waiting area to be sent to the triage room. After they are seen in the triage room, they wait in the waiting area for an available bed. When a bed and a nurse are both available, the nurse greets the patient and walks them to the bed. The patient waits in the bed for an available doctor, who is accompanied by a nurse. They finish treating the patient and the patient either visits billing before exiting the ED or is sent to the Radiology room. If a patient is seen at Radiology, they are either sent to billing and then sent home, or they are admitted into a room for a longer stay. Once admitted into a room, the patient is again visited by a doctor and a nurse and then released to billing and then home.

Patients also enter the ED from an ambulance. The ambulance can carry up to 2 patients. They arrive at the emergency entrance and are greeted by a nurse who will walk them directly into a room. After being treated by a doctor, an emergency patient will either visit billing or the Radiology department.

There are several statistics collected in this model. The details of these statistics are discussed below. The Facility window contains two different floor labels with statistics and the Console window (Definitions tab, Console panel) contains floor labels, status pie charts and status plots.

A small experiment can be used to vary the number of nurses, the number of doctors and the number of radiologists to see the impact on Average Wait Time for Doctor, Number of Patients in System and Average Length of Stay.

Detailed Description

System Initialization

The system does not begin empty. It is initialized so that there are patients in the system at the beginning of the model run. This is controlled by a process called "OnInitialization" which is executed when the main model is first initialized. This process searches a Data Table called 'Initialization' and uses the content of this table to create a set number of patients, with certain priorities and place them in a specific location (station) within the model. This is done with the combination of a Search step, Create step, Assign step and Transfer step.

Patient Arrivals

The large main door is the Source of the main arrivals of patients. This Source uses a Rate Table to determine the rate of arrivals into the system. The Source also references a Data table named 'PatientPriority' which determines the type of patient to create and therefore which symbol to display for the entity.

Arrivals are created for the Emergency entrance from a Source that can be found off on the “road” to the side of the ED near the ambulance. This Source also references the PatientPriority table to assign a priority to a patient. There is an Add-On Process on this Source that checks to see if all the Rooms are full after the patient is created. If there is no room in this Emergency Department for this patient, a state variable is incremented to keep track of the number of Diversions from this hospital and then this patient is destroyed and not sent into the ED. But for most patients created, they request a ride on the ambulance vehicle and are dropped off at the emergency entrance where they are met by a nurse who walks them to a room.

Registration, Waiting Area and Triage

The registration desk is a standard Server with *Initial Capacity* of ‘3’. After the patients are registered, they visit the Server named ‘WaitingAreaBeforeTriaged’, which has the symbol of a set of waiting rooms chairs. They visit Triage when it is available and then sit at the Server named ‘WaitingArea_PostTriaged’ until a bed and nurse are available. The nurse arrives to walk the patient to the bed. The nurse is a standard Worker object that is requested in the TransferNode ‘ToBeds’, by a patient.

Beds, Rooms, Radiology and Billing

A Bed is an object that is part of the Project Library. It is a subclassed version of the standard Simio Server object. A patient will arrive at a bed and lay down using the assignment of *State Variable Name* ‘ModelEntity.Animation’ with a *New Value* of ‘Sleep’. Each instance of the Bed requests a Doctor to visit using the *Resource For Processing* section of the *Secondary Resources* properties. The *Before Processing* property in the *Other Resource Seizes* properties requests a Nurse to visit this bed. Once the Doctor and the Nurse arrive, the processing begins at this Bed and then both the Doctor and Nurse are released. Link Weights on the Paths leaving the output node of each Bed determine the percentage of patients that visit Radiology vs Billing.

A Room object is very similar to a Bed object. Patients are only routed to a Room if they are sent there after visiting Radiology or if they arrive through the Emergency entrance.

The Radiology department is a standard Server object, with the capacity of ‘1’. The Billing desk is also a standard Server object. All patients leaving the Billing desk travel to the front door and exit the system.

Statistics

The following statistics are collected and displayed in the Facility window. Utilization statistics, status charts and plots can be found in the Console window. The Math.Round function is used within the floor labels to truncate display of real numbers to a single decimal point.

Average Wait Time to See Doctor: The wait time is calculated with a Tally Statistic on the Bed object and this overall value is found by taking an average of the wait times of all the beds.

Number of Patients Admitted: This is calculated with a Tally Statistic that records the number of patients that are admitted into a Room.

Percentage of Beds and Rooms Occupied: This is calculated with a State variable that tracks the number of Beds and Rooms occupied at the current time.

Number of Diversions From Hospital: This is calculated with a State variable that tracks the number of times that a patient wanted to enter the ED through the Emergency entrance but could not visit this hospital because all the Rooms were full.

Average Number of Patients in System: This is a function on the ModelEntity, named Population.NumberInSystem.Average

Average Wait Time for a Bed (min): This is calculated with a Tally Statistic that records the amount of time that a patient waits for a Bed.

Average Length of Stay (min): This is calculated with a Tally Statistic that records the amount of time that a patient is in a Bed or a Room.

Total Leave Without Being Seen (LWBS): This is calculated with a State variable that tracks the number of patients who arrive in the main entrance but leave because the waiting area is too full or the average wait time is too long.

Cost

Each Bed object, Room object, Nurse, Doctor and the Radiologist object have their *Parent Cost Center* property set to 'CostOfStaff'. This will ensure that all the costs associated with these objects will get rolled up to the CostOfStaff cost center. The Nurse, Doctor and Radiologist objects have their *Usage Cost Rate* and *Idle Cost Rate* properties populated with a cost so that the model will calculate the cost of the staff both when they are idle and being utilized. Each time a staff member is used by either a Bed or a Room object, the usage cost of the staff member is rolled up to the cost center of the Bed or Room object, which is why these objects also have their *Parent Cost Center* set to 'CostOfStaff'. The total cost for this cost center can be found in the Results Pivot Grid. CostOfStaff is also used as a Response in the Experiment.

Experiment

An Experiment exists on the main model that varies the input of two Controls; 'Number of Nurses' and 'Number of Doctors'. These controls appear in the experiment because they are properties on the main model. The 'Number of Nurses' property is referenced from the *Initial Capacity* property on the Nurse Worker object. The 'Number of Doctors' property is referenced from the *Initial Capacity* property on the Doctor Worker object.

There are three Responses defined in this experiment. 'CostOfStaff.Cost' indicates the cost that has been associated to the Cost Center named CostOfStaff, while 'Average Length of Stay' contains the expression 'LengthOfStayStatistic.Average * 60', which references the Tally Statistic that tracks this duration. 'Average Leave Without Being Seen' references the State Statistic that references the average number of patients that leave the system because the wait was too long.

Selecting the 'Average Length of Stay' response will show it has an *Upper Bound* is '36'. Notice on the Experiment Properties (right click on experiment in the navigation window), you'll see that the *Objective Type* property is set to 'Multi-Objective Weighted', which will tell the OptQuest Add-In to take into account the three responses when determining the best scenario, based on the objectives and weights of each response.

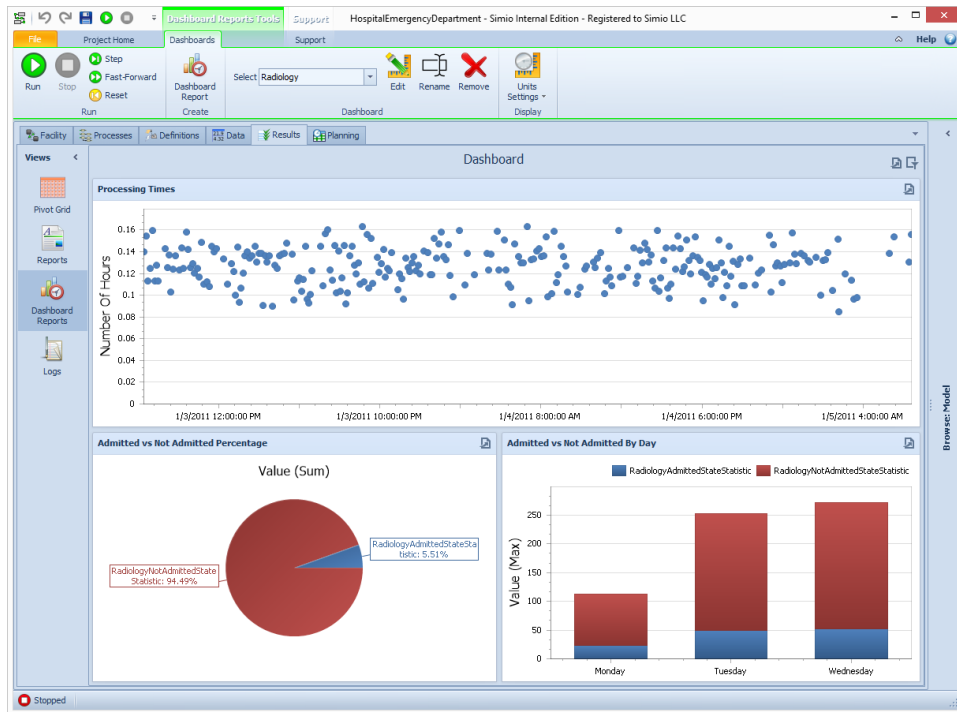
Dashboards

Patients Leave Without Being Seen – Shows patients that leave the hospital over time compared to current waiting times for beds and rooms.



HospitalEmergencyDepartment.spfx

Radiology – Show the time for each patient to be seen in Radiology as well as admitted vs non admitted comparisons.



Number Admitted – Shows the average number of patients admitted in the hospital by day of week and time of day...Also shows the time of day that the patients were admitted.

