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SIMULATION AND OPTIMIZATION IN COMPLEX EMERGENCY DEPARTMENT FOLLOWING THE EMERGENY SEVERITY INDEX AND TAKING INTO CONSIDERATION SOME DECISIONS BASED IN AGENTS TO CONTINUOUS IMPROVEMENT

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ABSTRACT

In this case study, we are considering the use of Discrete Event Simulation (DES) and Agent Based Simulation (ABS) with our Flexible Healthcare Simulation Optimization (FHSO) algorithm in Emergency Department (EMD) following the Emergency Severity Index (ESI) with a lot of patient tracks, to optimize staff assignment, and better determinate the number of resources that could share tasks between the EMD and surgery room taking into consideration the indirect tasks executed by the resources. The main purpose of this study was understand the capacity of the EMD, patient's cycle time or Length of Stay (LOS) and staff assignment for different demands of patients using simulation & optimization inside FlexSim due to its multi method modeling capability (DES and ABS) and high flexibility. The project was handled inside the major Latin America's hospital.

1 INTRODUCTION

Privates hospitals have readjusted expenses and investment plans, which explains the improvement in income and net margins in 2016, after decreases of 11.67% in 2014 to 10.66% in 2015, going up to 11.10% in 2016 (even though still lower than the amounts observe before the economic crisis). Net income per patient-day increased 18.1% in 2016, whereas total expenses per patient-day increased 15.4% in the same period.Net income per hospital discharge increased 10.2% in 2016, whereas total expenses per hospital discharge increased 10.1% in the same period. Discounting the effects of the increase in prices of health and personal care, there was a real drop of 0.8% in net income per hospital discharge. So, hospitals have worked hard to curb the increased expenses.

2 PROPOSED METHODOLOGY

- Conceptual Modeling in Modeling & Simulation (M&S)
- Modeling & Simulation (M & S)
- Agent-based model of the emergency department
- Optimization

3 RESULTS AND ANALYSIS

First, to understand the more likely patient's demand scenario, we run the model with three different demands of patients. Based on the results, we gotten from the output that the EMD has the maximum capacity of 420 patients/day, after stress the model. Implementing the FHSO (Flexible Healthcare Simulation Optimization) algorithm inside our simulation model with the surgeries room, which was not considered in the previous results, we can compare: a) the simulation model with the surgery room and

without the algorithm (we call "rigid model") and b) the simulation model with the surgery room and with the algorithm (we call "flexible model") For the purpose of that research, elective surgery is not been considering in the analysis.

ER Discharge of Patients:

- Rigid No-Heuristic Simulation : 117
- Flexible Heuristic Simulation : 124

With 124 patients admitted in the area selected (both models), in a 7 days simulation run, the "Rigid Model" is capable of processing only 94% of the volume, unlike the "Flexible Model" which is able to discharge the totality of admitted patients in the area. The FHSO algorithm in the "Flexible Model" allows to balance physician and nurses workload as we can see in the figure 1. As we can see, there are improvements on the same % of the utilization for the Provider C and D1 (which are doctors).

3.1 Waiting Room Census vs Time

The "Census vs Time" results in the figure 2 show the evolution of patients waiting for medical evaluation in the main waiting room that provides patients to the area. The "Rigid Model" presents up to 57 patients (peak) and a minimum of 20 patients (likely tendency). It is relevant observe how the heuristic impacts the waiting room census during the low-demand hours (1-7 a.m.), where in the "Rigid Model" the area presents more patients than the "Flexible Model" at its peak (mean).

3.2 Maximum Length of Stay

Along with mean values, when heuristic is use, patient's maximum length of stay in decrease in 34%, from 16.4 to 10.8 hours in medicine patients track, due to the access to staff and fix resources accomplish by the build-in heuristic. Once the patient are in the surgery track, using our flexible heuristic, we've gotten 7% of improvement on patient's maximum length of stay.

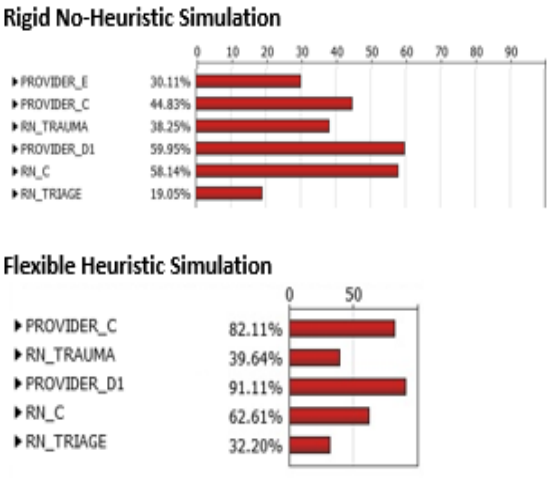

Figure 1: Staff's utilization inside the 'Rigid' 'Flexible' model.

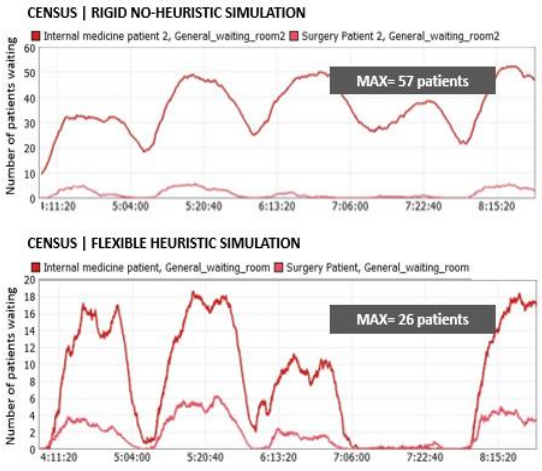

Figure 2: Census of patients in the 'Rigid' & 'Flexible' model.