A Sequential Solution for the Operating Room Scheduling Problems Based on Enterprise Ontology and Operations Research

by

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SUMMARY

Healthcare is becoming one of the fast growing industries all over the world. Hospitals in the developing countries have faced multiple challenges in the past decade. Consequently, hospitals are more and more aware of the need to use their resources as efficiently as possible, which urges healthcare organizations to increase emphasis on process optimization.

One of the most important problems in hospital management is the operating rooms scheduling problem. The problem of Operating Rooms (OR) scheduling can be divided into three different and related sub-problems namely: (i) the Case-Mix Problem (CMP); (ii) the Master Surgery Scheduling Problem (MSSP); and (iii) the Surgery Scheduling Problem (SSP). The CMP refers to the amount of ORs time allocated to each patient category in order to maximize the total benefits. The MSSP is addressed at the tactical level and it is concerned with the development of the Master Surgery Schedule (MSS), which is cyclically constructed for a given planning period (usually 3-months to 1-year). An MSS defines the allocated time blocks of each OR to the patient categories/surgeons. Finally, at the operational level, the SSP refers to assigning each surgical case a start time, a day, and an OR with the target of minimizing the waiting lists and maximizing resources utilization and ORs' throughput.

In this dissertation; first, and in order to describe the ORs scheduling problem, a set of DEMO (Design and Engineering Methodology for Organizations) models for the operating theatre system is proposed. The four-aspect DEMO models are developed for the operating rooms scheduling problem, which help in understanding the business process from different perspectives.The DEMO models enable to understand the core and the stable part of the enterprise. Second, a hierarchical approach based solution for the ORs scheduling problems is proposed. The hierarchical approach based solution is developed by solving the three ORs scheduling problems sequentially.

First: a stochastic mathematical model is developed for the stochastic CMP. A sample average approximation approach is applied to solve the proposed model. The objective is to find the best case-mix plan that maximizes the throughput. Experimental analysis is conducted at different levels of ORs and nurses capacity. Furthermore, a comparison between the deterministic and stochastic solutions is conducted.

Second: A new mixed integer formulation for the MSSP is introduced with the objective to minimize the weighted sum of peaks in the daily bed occupancy and nurse daily workloads. The model considers nurses capacity and surgeon preferences constraints. Comparisons between the current and two proposed MSS are conducted. Furthermore, the model is solved under three scenarios for the objective function. The solution of the CMP is considered as input for this level.

After that, a DEMO-based simulation model is developed in order to tackle the SSP. The proposed simulation model combines simulation and the enterprise engineering approach by applying DEMO++ approach. The proposed model is applied to evaluate and analyze the operational performance of the case-mix and master surgery plans that are obtained at the higher decision levels: CMP and MSSP under the dynamic, variability and uncertainty properties of the Operating Theatre System (OTS). Additional analysis is conducted to test the performance under different levels of daily nurses' capacity.

In order to examine the applicability of the proposed approaches, the proposed methods are applied using a real case study. Data from Karmoze hospital, a non-profit hospital located in Alexandria, Egypt, are used. Applying the proposed methodology to the hospital could help in improving the hospital operating room plans and the resource utilization. The proposed case-mix plan could increase the served surgery cases by 30 cases per week. The proposed master surgery plans could provide a more smoothed and leveled beds occupancy level and nurses workloads. The simulation model tested the proposed plans under a stochastic and dynamic environment and results emphasized that the proposed plans could increase the number of surgery cases by around 2% per year. Furthermore, the average waiting lists and the average beds mis-match could be decreased by around 50% and 75%, respectively.