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EVALUATION OF POOLING STRATEGIES IN THE MANAGEMENT OF OPERATING THEATRES – A SIMULATION BASED APPROACH

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ABSTRACT

This study reports the development of a discrete event simulation (DES) model improving the operational performance of Operating Theatres (OTs) with respect to the dual outcome measures of OT utilization and the waiting times to surgeries. The model is validated with high fidelity using historical data from 2016-07-01 to 2016-12-31. The model considers 2 emergency OTs and 23 elective OTs spanning across 18 surgical disciplines from a large public hospital in Singapore. The utility of the DES model is demonstrated in the design of a form of the Modified Block Scheduling Strategy, defined as the Open Access policy.

1 INTRODUCTION

We developed a high-fidelity DES model based on the actual scheduling process of a large tertiary hospital in Singapore in order to evaluate the effects of scheduling policies on the two performance measures, OTU and WTS using Python 2.7 for the design and evaluation of the Open Access (OA) (Lam et al. 2017) scheduling policy. The model uses historical process data in order to account for the system dynamics involved in the OT scheduling process. The computational studies demonstrate the applicability of DES models for the design of effective OA policies as well as the evaluation of its downstream impact on the surgical case assignment problem (Guerriero and Guido 2011; Fei et al. 2010).

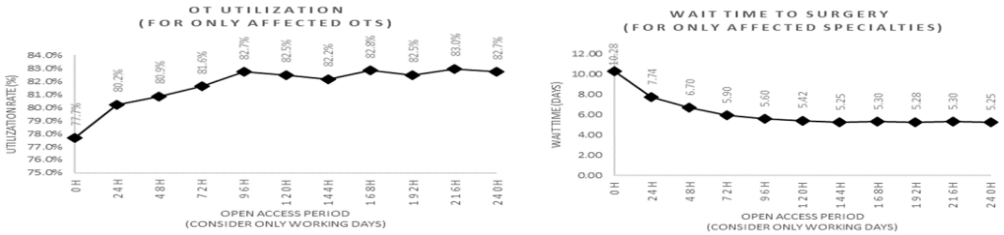
2 DATA AND METHODS

The study data included all surgical procedures performed, surgery duration and the utilized OT. The Master Surgical Schedules from the same period was used for the allocation of medical disciplines and surgeons to OTs in the base case. Surgeon and OT allocation schedules from the same period were also used to develop the operational constraints of the simulation model. The OT listing process for all the 23 elective OTs and 2 emergency OTs were modelled. Patient demographics and surgery information were also incorporated to develop a stratification model for urgent surgical cases. The simulation model captures the detailed processes from the point of the first listing till after the patient exits the OT facility. In a block scheduling system, unutilized OT slots which have been allocated under the master surgical schedule cannot

be released prior to the day of surgery, with the exception of mutually agreeable swaps. This can lead to an underutilization of OT resources. Under the OA policy, unused OT slots can be made available for an expanded pool of surgeons and departments to list their surgery cases at pre-specified time-intervals (defined as OA periods) prior to the actual day of the surgery. To facilitate the implementation of this policy, these OA periods may be specified in multiples of 24H. The key considerations when designing OA policies are: (1) the period of open access; (2) the OT-discipline combinations in functional groupings, and; (3) the strategy in the assigning cases.

3 RESULTS AND DISCUSSION

Two restricted OA scenarios were evaluated. The mean OT utilization (OTU) rates for the affected OTs increased from 77.7% at baseline to 82.7% at 240 hours while mean waiting time to surgery (WTS) decreased from 10.3 days to 5.3 days respectively. A second scenario reveals that similar increases were observed. Mean OT utilization increased from 81.7% to 86.9% and mean waiting time decreased from 9.5 days to 7.9 days. The results from the evaluation of these policies shows an increasing trend as the length of the OA period is increased. However, the marginal improvements in the outcomes measures decrease with the length of the OA period, where near maximal improvements are already observed at OA period of 120-144 hours. Results on the impact of OA periods on the OTU and the WTS for scenario 1, Figure 1.



(a) (b)

Figure 1: Impact of varying OA periods on OTU and WTS for Scenario 1.

Extended OA periods can result in implementation difficulties and resistance in adoption, since the OA policy requires the release of a priori assigned slots to more surgeons and surgical disciplines. The costs of longer OA periods may not commensurate with the potential improvements in OTU and WTS. The restricted implementations of the OA policies showed significant improvements in both OT utilization and waiting time to surgery for the affected OTs and medical disciplines respectively. The simulation model allows the decision maker to choose an optimal OA period whilst ensuring that functional groupings are reasonably assigned. The computational studies also lend insights on the possibility of deriving an optimal combination of surgical disciplines, OTs and length of OA period through a rigorous mathematical model.

4 CONCLUSIONS

This study reports the development of a high-fidelity DES model for the operational management of OTs. The DES model demonstrates the significant improvement in OT utilization rates and the waiting times to surgeries through the implementation of the OA policy.

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