ISSUES IN SURGICAL SCHEDULING PROBLEM: UNCERTAINTY, CAPACITY PLANNING, REQUEST AND DEMAND

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ABSTRACT

The surgical scheduling problem in healthcare is one of the most crucial problems that get attention from many researchers. However, less concern is given to understand the issue in the surgical scheduling problem. The purpose of this review is to reveal the crucial issues in a surgical scheduling problem. We organise the issues into three categories: (1) Uncertainty; (2) Capacity Planning; and (3) Request and Demand. In the uncertainty issue, we discussed the issue that may cause uncertainty that happens in surgical procedure, and for capacity planning issue, we concentrate on resources planning such as human and material resources. The request and demand issue are related to the surgical case criteria and surgical team preferences. At the end of the review, we determine the important issue that arises inside the surgical scheduling problem requires further attention.

1 INTRODUCTION

The surgical scheduling problem is described as the selection of procedures to be performed, the allocation of resource time to those procedures, and the sequencing of those procedures within the time allotted (May et al. 2011). (Xiang et al. 2015; Belkhamsa et al. 2018) state that pre-operative, intra-operative, and post-operative phases are stages in a surgical procedure. The surgery would require both material and human resources to complete the procedures. Pre-operative Holding Units (PHU) beds and nurses were required during pre-operative. Next, the intra-operative stage needs to consider the Operating Room (OR), surgeons, anaesthetists, and nurses. Finally, services such as Incentive Care Unit (ICU) beds and nurses are required for the post-operative phase.

There are two types of surgery: elective and emergency surgery (Silva & de Souza 2020). Under elective surgery, three types of surgery schedule strategy can be used either block scheduling, open scheduling and modified block scheduling (Patterson 1996). Although there is guidance for the surgery procedure and various type of surgery schedule strategy to be used, there are still issues that may cause the surgical scheduling disruption. (May et al. 2011), state that disruptions that happen in surgical scheduling are mainly due to the uncertainty issue from

the procedure duration and capacity planning issue. The unbalanced scheduling of the OR department also often causes demand fluctuation in other departments such as surgical wards and intensive care units (van Oostrum et al. 2008). (van Oostrum et al. 2009) propose Master Surgical Scheduling (MSS) to deal with this issue. The MSS implementation improved coordination among hospital staff members and solve the issue of long-term forecasting and capacity planning. Another advantage is that it boosts OR performance and eliminates the problem of confusion. (Silva & de Souza 2020) proposed an optimization method for the ambiguity problem in surgical scheduling by incorporating approximate dynamic programming. Their method has the potential to make a big difference in practice. Resource constraints in Surgical Department also may lead to the issue in surgical scheduling. As example, (Wang & Xu 2017) proposed an evolutionary algorithm to deal with the issue of multiple resources constraints in their study. Figure 1 show the surgical procedure phase (Belkhamsa et al. 2018). We illustrate the part the surgical scheduling problem may happen that relate to an issue that already states previously.

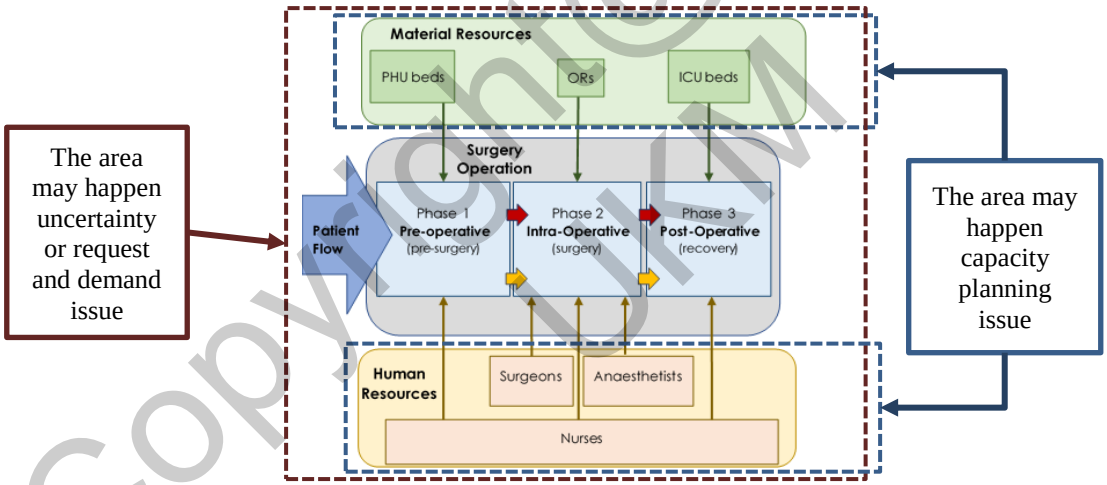

Figure 1 Surgical procedure phase

2 ISSUE REPRESENTATION

From the analysis of previous studies, we categories the issue in surgical scheduling problem into three types which are: (1) Uncertainty; (2) Capacity Planning; and (3) Request and Demand. In this section, we discuss the uncertainty issue that commonly arises in surgical scheduling. We then address the capacity issue that relates to resources planning, and subsequently, the problems of request and demand related to the surgical case criteria and surgical team preference.

2.1 Uncertainty

Uncertainty is the most crucial issue that arises in surgical scheduling. Surgery duration is one of the reasons that cause the uncertainty issue (van Oostrum et al. 2008). The surgery's duration is unknown due to the procedure's unforeseen start time and leads to an increase in overtime (Zhang et al. 2020). Overtime is a frequent occurrence in surgery units, resulting in increasing surgery team or patient stress or dissatisfaction and financial loss for hospitals (Zhang et al. 2020). (Silva & de Souza 2020) discussed the uncertainty on when emergency and urgent surgery will arrive. When emergency and urgent surgery occurs without warning or intervention, the confusion about its arrival will be exposed.

Furthermore, the uncertainty issue also may happen due to the recovery time for the patient. For example, (Zhu et al. 2015) state uncertainty may arise due to the patient's recovery time by the anaesthesia after the surgery. (Wiyartanti et al. 2015) stated that when many surgical cases need immediate changes in data, such as when surgery delays or cancellation occurs on the same day, confusion can arise from the patient or the surgical procedure itself.

2.2 Capacity Planning

(Chow et al. 2011) study the way to improve the surgical scheduling caused by the high surgical bed utilisation. Because of the capacity problem, this situation is challenging to be handled. The issue occurs due to the demand peaks, insufficient space, a lack of capacity in speciality-specific surgical wards, and available beds in surgical wards. Another capacity issue that should be considered is recovery bed capacity in the surgical department. (Astaraky & Patrick 2015) state that the recovery bed capacity should be assured such that the available beds of recovery is adequate.

The limitation of human and material resources, such as nurses, auxiliary personnel, medical equipment, or places in intensive care units, is also a factor in the capacity problem (Silva et al. 2015). Another capacity issue is related to the limitation of the operating room (Liu et al. 2019).

2.2 Request and Demand

Request and demand are common in open scheduling, which allows the surgeon to select their favourite surgical day (Dexter et al. 2003). When the patient requests the surgery date, another request and demand will occur (Silva & de Souza 2020). The request often occurs when a surgical request is sent from the hospital's waiting list (Banditori et al. 2013). Frequent request and demand change certainly cause the surgical scheduling problem.

(Yang et al. 2015) studied surgeon demand in surgical scheduling based on allocating the right surgeon in the operation room with the matching time resources. Also, the demand issue that may relate to the surgical scheduling problem is the demand for resources. (Wang & Xu 2017) stated that resource demand is the resources required to complete a surgical procedure. For example, in the intra-operative phase resources such as material and human resources is needed to perform this phase. Besides that, (Guda et al. 2016) stated that the surgeon may sometimes request the patient arrive earlier than the scheduled surgery time.

3 CONCLUSION

This work reviews the issue of a surgical scheduling problem and categorises the issues into three types which are (1) Uncertainty; (2) Capacity Planning; and (3) Request and Demand. Based on the review, we can conclude that all these issues are interrelated and need to be considered in order to cope with the disruption in the surgical schedule. This ambiguity problem extends beyond the surgical scheduling process and should be considered in designing a good quality surgical schedule that can cope with disruptions. For future work, we would like to investigate other issues in scheduling that relates to the surgery procedure. An example is an issue in scheduling in human resource in surgical procedures such as nurse scheduling, surgeon scheduling, and anaesthetist scheduling.

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