

IS THERE AN "OPTIMAL" ELECTIVE OPERATING THEATRE UTILISATION TARGET?

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Setting utilisation target: balancing variation and overtime

Operating Theatres (OT) are expensive resources and we often ask "Is there an "optimal" utilisation target?". It depends on many factors: demand, variation in the surgical durations, overtime, proportion of electives/emergency surgeries and specific equipping of theatres. Intuitively we know that departments with a narrower variation in surgical durations can operate at a higher utilisation.

Here we suggest a quantitative approach to set utilisation targets taking into account 2 factors: (1) suitable measure of variation of the department's surgery duration and (2) same probability of overtime for all departments.

Method to calculate target utilisation

OTs record the mean and standard deviation of the surgery durations. Here we introduce "makespan" as the time from start of the first surgery, to the end time of the last surgery whether in a half-day or full-day session. The average (μ) and standard deviation (σ) of the makespan can be computed by using the mean (m) and standard deviation (s) of the surgical durations. This is based on normal approximation

from central limit theorem shown in Fig 1. The probability of overtime (α) is the chance that the makespan exceeds the capacity (c) which can be 4 or 8.5 hours. We relate these parameters to find the number of surgeries (n) and utilisation in Eqn (1) and (2). Eqn (3) shows that the utilisation is approximately proportional to the term s/\sqrt{m} . We will compare this variation measure with standard measures and show that it is more suitable for utilisation planning.

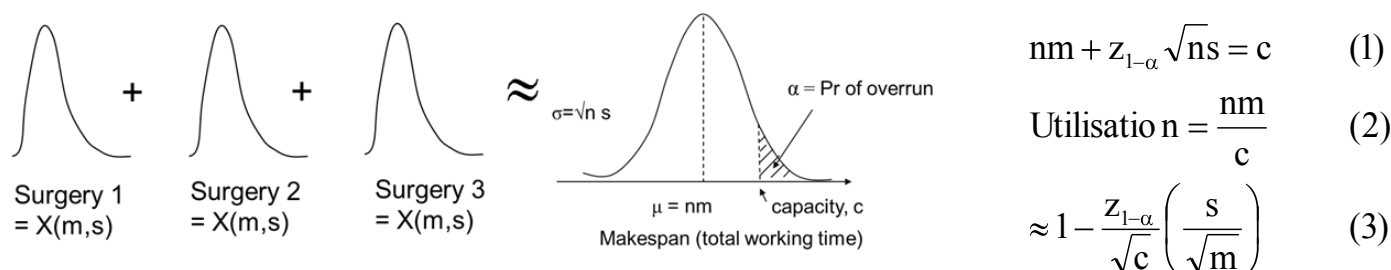


Fig. 1 – Relating capacity, makespan, variation and overtime.

Utilisation targets for major OTs

Table 1 shows the summary statistics of the surgery durations by departments, variation measures and the utilisation targets, given a probability of overrun of 35%. Columns 2 and 3 are the mean (m) and standard deviation (s) of the surgery durations in hours. Columns 3, 4 and 5 are different measures of "variation": the standard deviation, coefficient of variation (standard deviation divided by mean) and a proposed measure of variation (standard deviation divided by square root of mean). Column 6 is the proposed utilisation target.

We see that Pediatric Orthopedics has a lower variation ($s/\sqrt{m}=0.71$) than HRM ($s/\sqrt{m}=1.63$). It explains why it may operate at a higher utilisation than HRM (91% versus 81%), with both having the same probability of overtime. Note that the other variation measures may not correlate just as well with the target utilisation.

While the overall OT utilisation was 86%, we are able to discern individual departments' targets ranging from 81% to 91%. However this range will be smaller if the differences in variations (s/\sqrt{m}) are smaller across the departments, e.g. in DSOT.

The probability of overtime of 35% was empirically chosen. Figure 2 extends that by showing the trade-off relationship between overtime probability and utilisation target, for the 2 departments grouped by the variation measure. Looking at any one curve, clearly higher utilisation comes with a larger chance of overtime. Also HRM (in blue) will have a 'lower' operating curve compared with Pediatric Orthopedics (in red). We therefore think that the variation measure s/\sqrt{m} is a key metric that explains the target utilisation.

Note that we have used historical data to illustrate the approach only, and may not reflect current processes.

(1) Departments	(2) m	Variation measures			(6) Target Util
		(3) s	(4) s/m	(5) s/√m	
Pediatric Orthopedics	2.4	1.1	0.46	0.71	91%
Adult Reconstructive	3.3	1.5	0.45	0.83	90%
CTVS	4.2	2.1	0.50	1.02	87%
Urology	2.7	1.7	0.63	1.03	87%
Colorectal	4.3	2.3	0.53	1.11	86%
Pediatric Surgery	3.0	2.0	0.67	1.15	86%
ENT	2.9	2.0	0.69	1.17	86%
Breast Surgery	5.5	2.8	0.51	1.19	85%
Hepatobiliary	5.0	2.7	0.54	1.21	85%
General Surgery	3.3	2.3	0.70	1.27	85%
HRM	4.6	3.5	0.76	1.63	81%

Table 1 – Utilisation targets for departments

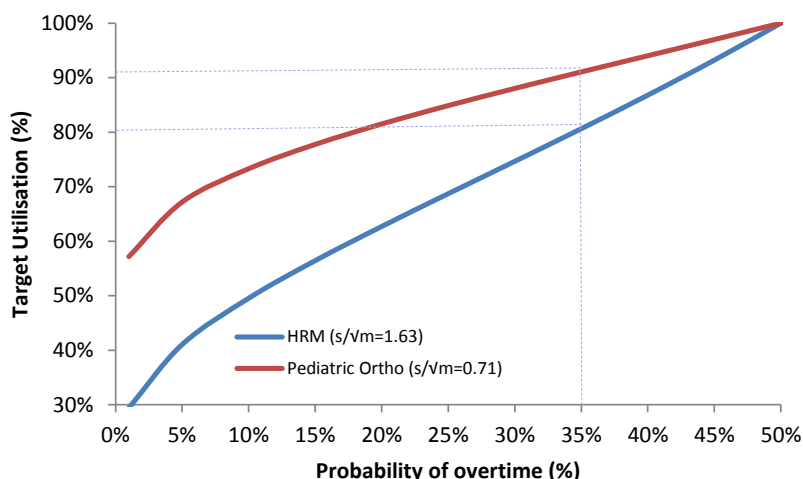


Fig 2 – Target utilisation versus probability of overtime and variation

Conclusions

This is an example of setting utilisation targets in an operational setting, balancing the *natural variation* (surgery duration of departments) and *fairness* (same probability of overtime). The method can also be used to plan the number of half or full day sessions when opening a block of new theatres.

Team

This is the team effort of NUHS and HSOR including Heidi Rafman, Edmund Teo, Tiffany Ang, Ng Bee Ling, Professor Kesavan, Nicky Lau and Palvannan, R.K.