



Review Article

## How to Assess the Productivity of Operating Rooms?

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### ABSTRACT

Productivity assessment is a prerequisite for improving productivity. Productivity is generally defined as the ratio of units of outputs to units of inputs. Multiple factors should be measured if we what calculate the productivity of operation theatre depend on the performance of both operation theatre itself and the teamwork. Overall, the productivity measurement is an important means to an end. It provides valuable information on how an operation theatre is performing, where it would like to be, and how it can achieve its goals. Productivity measures are only useful if they reflect the goals and objectives of the operation theatre and used to bring about action and productivity improvements.

**Key words:** Productivity, Operating Rooms (ORs), Performance Measures

### INTRODUCTION

Productivity assessment is a prerequisite for improving productivity. 'You can't manage what you can't measure' said Peter Drucker who is widely regarded as the pioneer of modern management theory, also he said: "Without productivity objectives, a business does not have direction. So, without productivity measurement, a business does not have control." <sup>(1)</sup> and 'If you don't know where you are going, chances are you will end up somewhere else' - said Yogi Berra. <sup>(2)</sup>

Regardless of the types of patients, purpose and level of urgency for surgery, most present-day surgical procedures are carried out in operating rooms (ORs) which are designed and equipped to provide care to patients during surgical procedures. ORs are critical assets to all modern tertiary

hospitals. This is because ORs contribute to almost two-thirds of a hospital's total revenue. <sup>(3)</sup>

Moreover, ORs also account for about 40%of the hospital's total expenses which include manpower costs (i.e. salaries of surgeons, anaesthetists, nurses, etc.). <sup>(4)</sup>

Thus, many hospitals that offer surgical services seek to improve the design and operations of their ORs to establish restore and boost profitability, while retaining the quality of surgical care. <sup>(5)</sup>

#### **What is Productivity?**

Productivity is generally defined as the ratio of units of outputs to units of inputs. <sup>(1)</sup>

Hollingsworth et al. <sup>(6)</sup> that calculating the productivity ratio is simple in the case of a single-input, single-output firm. For a single-input, single-output firm

productivity (P) can be defined as:  $(P= Y/X)$  where, Y is the number of units of the firm's single output, and X is the number of units of the firm's single input.

However, for the more realistic case of a multiple-input, multiple-output firm, calculating the productivity ratio is significantly more difficult and less objective. This is because the inputs and outputs cannot be simply summed; they must be aggregated into a single index representing total output and a single index representing total input. This can be achieved by weighting the outputs and inputs before summation. Deciding the values of the weights can be a subjective and difficult process. Therefore, for a multiple-input, multiple-output firm productivity is defined as:  $(P= \sum_s U_r * Y_r / \sum_m V_i * X_i)$  where,  $U_r$  is the weighting for output,  $Y_r$  is the number of units of output,  $V_i$  is the weighting for input,  $X_i$  is the number of units of input, S is the total number of outputs, and M is the total number of inputs. (1)

All hospitals are multiple-input, multiple-output firms. Inputs would include number of doctors, nurses, beds, pharmaceuticals, equipment and facilities. Outputs would include number of treated patients, inpatient days, outpatient cases and surgical procedures. When compared with the manufacturing industry, outputs in a service industry, such as the hospital industry, are more difficult to define

This aspect of the hospital service, especially the operation theatre, introduces additional complications when we deal with matters of efficiency.

### ***Operating Room Productivity***

Multiple factors should be measured if we what calculate the productivity of operation theatre depend on the performance of both operation theatre itself and the team work.

#### ***1. Operating Room itself***

Despite the technological breakthroughs and their applications in ORs to improve the OR performance, it is interesting to note that there is still no consensus in the literature on measure(s) to be used for monitoring OR performance. (7)

To compound the non-consensus situation, a number of measures are available for OR performance assessment as accounted in a review article on OR planning and scheduling where Cardoen et al (8) identified several OR performance measures that have been reported in more than 100 papers published.

Essentially, all reported OR performance measures can be broadly classified into 2 key groups, namely hospital-centric metrics and patient-centric metrics, depending on whether the quality of patient experience is considered or not. (7)

#### ***a) Hospital Metrics***

There are several performance measures of ORs, which are of special interest to the hospital involved due to their impact on productivity or revenue. Since these measures do not take into consideration the experience of patients who have undergone surgeries, was collectively define them as hospital-centric metrics. (7)

The duration of an operation is the time from the start of anaesthesia to the time the anaesthetist completes handover to recovery staff. The gap time is the sum of the 'idle times' between completions of handover of one patient to recovery staff to the start of anaesthesia in the next patient. The actual duration of a list is the time from the start of anaesthesia in the first patient on the list to the arrival of the last patient in recovery (minus any established breaks, if any, for rest/lunch). The scheduled duration of a list is the time available for the list (for example, lists are usually scheduled for a half day, 4 h, or a full day, 8 h). A list overrun occurs when the actual duration of the list exceeds its scheduled duration. A list

under-run occurs when the actual duration of the list is less than its scheduled duration. <sup>(9)</sup>

An over-booked list is one in where the sum of estimated durations of individual operations (plus any expected gap time) on that list exceeds the scheduled duration of the list. An under-booked list is one where this sum of estimated durations is smaller than the scheduled duration of the list. Efficiency as used throughout this paper specifically refers to the notion of a team utilising its scheduled list duration fully, without over-running or cancellation. <sup>(2)</sup>

Hospital factors include OR utilisation which is the ratio of time spent by patients in OR to total OR time available, <sup>(10)</sup> waiting time of surgeons which is the length of time spent by surgeons waiting prior to the start of their scheduled surgeries, <sup>(11)</sup> overtime costs which is the additional costs incurred due to performance of surgeries beyond the standard operating hours (8 to 12 hours per day) of Ors, <sup>(12)</sup> throughput which is the number of surgical cases per unit time, <sup>(13)</sup> Contribution margin is typically computed in terms of dollar per unit OR time and is the revenue generated by a surgical case less all the hospitalisation variable labour and supply costs, <sup>(14)</sup> and makes pan which is the time at which the last patient of a day leaves the OR.

#### **b) Patient factors**

Patient patient-centric metrics define as OR performance measures which depend on the experience of patients who have undergone surgeries and have a direct impact on both patient satisfaction and safety. <sup>(7)</sup>

Essentially, there are 2 main customer-centric metrics, namely waiting time of patients and number of cancelled surgeries. Similar to the waiting time of surgeons, waiting time of patient refers to the length of time spent by patients waiting prior to the start of their scheduled or urgent surgeries. <sup>(15)</sup> Cancelled surgeries refer to

scheduled surgeries that have been cancelled due to non-clinical reasons like non-availability of ORs, surgeons or manpower. <sup>(16)</sup>

## **2. The team work Performance Measures**

### **a) Surgical skills Performance Measures**

Speed, quality of product and patient outcomes are the three outcomes indicators, while not formalised assessment processes, have been explored for use as surrogate measures of surgical skill. Efficiency in operating time is important to maximise service delivery, which is increasingly pressured under the current policies for patient management pathways and waiting list times. However, such efficiency requires large numbers of procedures, which trainees could not usually expect to, obtain, and is therefore a more appropriate aspiration for newly appointed consultants. <sup>(17)</sup> Although attractive, measurement of the performance of surgeons based upon patient outcomes is fraught with difficulty owing to variation in case mix and the large numbers required for reliability. <sup>(18)</sup>

Patient outcomes reflect the performance of the whole surgical team, both within the operating theatre and during the postoperative period, and therefore do not provide a reliable assessment of an individual surgeon. <sup>(19)</sup> Additionally, patient outcome is usually a multi-factor criterion requiring long term follow-up. Even if outcome-based metrics are straightforward to use, they are not objective enough and they do not study the differences in the surgical procedure in detail. Another approach uses human grading techniques. The underlying idea is to ask to a senior surgeon to provide an evaluation rating scale using dedicated check-lists during the observation of an intervention.

The Surgical Processes using Dynamic Time Warping has focused on motion pattern analysis, for instance using

time series analysis of the different motions. The main drawback of such approaches is their low level of granularity, which does not give insight into the surgical scenario followed. <sup>(20)</sup>

**b) Non- Surgical skills Performance Measures**

The NOTSS system is a behavioural rating system developed using a multidisciplinary group of surgeons, psychologists and an anaesthetist from the Royal College of Surgeons of Edinburgh, in collaboration with the University of Aberdeen. This produced the NOTSS taxonomy version 1.2as shown in table 1.

Observational Teamwork Assessment for Surgery introduced by Hull et al. <sup>(22)</sup> and a collection of others performance studied collected by Sevdalis et al. <sup>(23)</sup> as in table 2.

Table 1: NOTSS taxonomy (adapted from Yule et al. <sup>(21)</sup>)

Category	Element
Situation Awareness	Gathering information, Understanding information and Projecting and anticipating future state
Decision-making	Considering options, Selecting and communicating option and Implementing and reviewing decisions
Communication and Teamwork	Exchanging information, Establishing a shared understanding and Coordinating team
Leadership	Setting and maintaining standards ,Supporting others and Coping with pressure

Table 2: Non-technical skills and teamwork assessment tools (adapted from Sevdalis et al. <sup>(23)</sup>).

Tool	Elements assessed	Clinical speciality	Reliability evidence	Validity evidence
Observational Teamwork Assessment for Surgery (OTAS <sup>®</sup> )	Global operating theatre team Performance: 1. Communication 2. Cooperation/back up behaviour 3. Coordination 4. Leadership 5. Team monitoring/situation awareness	It can be used to evaluate individual's skills and behaviour and also global team performance. It captures performance at three stages: before operation, intraoperatively, and after operation	Inter-rater reliability	Content, concurrent, and construct validity
Revised Non-Technical Skills (Revised NOTECHS)	Non-technical skills 1. communication/interaction 2. Situation awareness 3. Cooperation/team skills 4. Leadership/ managerial skills 5. Decision-making	It captures performance Intraoperatively	Internal consistency	Construct validity
Oxford Non-Technical Skills (Oxford NOTECHS)	Non-technical skills 1. Communication/ interaction 2. Situation awareness 3. Cooperation/team skills 4. Leadership/ managerial skills 5. Decision-making	It can be used for surgical, anaesthetic, and nursing personnel. It captures performance Intraoperatively	Inter-rater reliability	Predictive, concurrent, and convergent validity
Trauma Non-Technical Skills (T-OTECHS)	Non-technical skills during trauma calls 1. Communication/ interaction 2. Situation awareness/ coping with stress 3. Cooperation/ resource management. 4. Leadership 5. assessment/ decision-making Assessed skills based	It can be used for any speciality attending a trauma call. It captures performance during the trauma call	Internal consistency	Construct validity

**DISCUSSION**

Quantitative performance is a general term we use to describe the overall 'output' or 'actual productivity' of the surgical list, distinct from quality measures such as patient satisfaction, communication, teamwork, etc (accepting implicitly that these can contribute indirectly to overall performance). Productive potential is a term

used to refer to the activity (speed and degree of active anaesthetic surgical contact with the patient), which 'enables a team to be productive.' <sup>(3)</sup>

From the works of Coelli et al. <sup>(24)</sup> five types of efficiency are identified, namely: Price efficiency, Technical efficiency, Allocative efficiency, Cost efficiency, and Scale efficiency.

According to Heineke,<sup>(25)</sup> organizational performance consists of financial and operational performance, but important to notice is that separating this can have negative consequences. He stated: “it tends to focus managers and the workforce in different directions, producing divergent goals and role conflicts. But in professional service organizations, managers are still most often evaluated in light of financial performance and technical professionals on the basis of their technical output”. With this he means that it is important to see the bigger picture and not just look at either financial or technical facts. To measure the efficiency of patient flows in hospitals, there are several performance measurements.

According to Cayirli and Veralin,<sup>(26)</sup> there are five categories of performance measurements, namely: cost-based measures, time-based measures, congestion measures, fairness measures and other measures.

Each surgical facility needs a clear understanding of its economic structure to ensure the groundwork for an efficient and well-functioning OR suite. At the heart of the question, “How much does OR time cost?” is another question, “How much money is being lost?” when a case is suddenly cancelled, for example. However, many people often confuse the terms “cost” and “charge”, using them interchangeably even when they should know better. It can be dangerous financially since costs and charges are not related linearly.<sup>(9)</sup>

#### ***What are the values of productivity measures?***

Productivity measurement is an important means to an end. It provides valuable information on how an operation theatre is performing, where it would like to be, and how it can achieve its goals. Organisations should monitor and analyse their productivity performance in terms of the productivity level measured by the

various productivity indicators. Productivity levels reflect how efficiently and effectively an organisation’s resources are used. Comparisons of productivity levels must be made between similar entities, such as two companies within the same field.

Productivity growth indicates dynamism and the potential for achieving higher productivity levels in the future. It is expressed as a percentage. Also to know how well your operation theatre is faring; you may compare and evaluate its productivity performance against targets or past performance.

Productivity measures are only useful if they reflect the goals and objectives of the operation theatre and used to bring about action and productivity improvements. This requires commitment from senior management, teamwork and participation from all employees.

#### ***Recommendation***

The productivity in the OR do not depend only on the hospital factors, patient only or the teamwork skill, so it is not easy to be measure, but because the complexity of what we measure and the interaction between them. So I recommend developing of a new scoring and standers top collect them and evaluate them totally.

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