

Pioneer Model for Cost Optimization - OT

“Correct case at correct place to Correct person in Correct time for Correct cost”

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ABSTRACT

Background

Rapidly urbanizing (31.6%) and ageing (6.8%) population of India, with improving access to healthcare facilities has lead to significant growth in surgical procedure volumes. An estimated annual growth rate of about 14% in surgical procedures has made operation theatres as the most vital and imperative facility both for hospitals and patients. For hospital, operation theatres are the major cost centre not only involving the maximum expenditure but also huge revenue generation. For Patients, operation theatre is place where life saving or life improving procedures are performed justifying their major concern for safety and quality of services.

Rationale

Escalating cost is generally accounted to the increasing quality of care. Providers believe in an inherent tradeoff between Quality and Cost efficiency which is not factual. This trade off can be cast off by achieving **Operational Efficiency** in processes. This paper highlights that adhering to quality decreases variability's in process, eliminates wastes and errors leading to increased efficiency paving way to decreased cost with expression of sustainability.

Methodology

This descriptive study was conducted prospectively for a period of two months in a tertiary care hospital. A total of 584 surgical (elective) procedures were included with **process mapping, defining various critical to quality parameters of surgical pathway and measuring the Operational Efficiency by quantifying them using Efficiency Metrics which included 8 parameters viz. Utilisation, first case delay, starting tardiness, turnaround delays, cancellations, scheduling efficiency, prediction bias and one subjective parameter of satisfaction** . Reasons for the variations found were analysed by **Pareto Chart using Minitab**. The data was analysed with descriptive statistics using SPSS analysis (SPSS16.0). A self administered questionnaire was also designed to evaluate Subjective perspective of OT's team including Anesthesiologists, Surgeons, Nurses and Technicians.

Available literatures on utilisation and operational efficiency of operation theatres were reviewed.

Analysis and discussion

Out of total time only 66% was spent on actual surgery, the **utilization** of the OTs was found to be suboptimal with **raw utilisation** of only 53.56% and **adjusted utilisation** of 61.76%. Other influencing efficiency metric parameters like delay in **first case start** (33mins), **mean start time tardiness** (34mins), **Higher case cancellation rate** (9.8%) indicating lost valuable opportunity cost and wasted OT time in delayed turnovers (31% cases) and prediction bias of more than 85 mins. /day. Effective utilisation is directly proportional to **efficient scheduling** of OT which was found to be only 70-80% effective.

Suggestions

Increasing the utilisation, maintaining proper scheduling and decreasing the turnaround time gives opportunity to add more cases, distributing the cost to more procedures. Identifying the **non operating time (KNOT)** and reducing it. Several approaches like use of **OT-MIS for visual management** and escalating further to use of **OPTIMISATION MODELS** and **SIMULATION** which transforms real time problem of scheduling by choice driven variable for optimum resource allocation ensuring **Correct case at Correct place to Correct person in Correct time for Correct cost**.

Applying a holistic approach to process of OT functioning. Introduction of **OT allocation initial amount** controls cancellation and delayed reporting by surgeons. Change of **patient surgical pathway** with effective pre-surgical counselling and separate **anesthesia induction room** increases compliance and productivity.

Key Words

Cost Optimization, Operational Efficiency, Patient Surgical Pathway, Simulations, Utilizations

INTRODUCTION

Rapidly urbanizing (31.16%) and ageing (6.8%) population of India, with improving access to healthcare facilities and rising lifestyle diseases along with mounting cancer cases have lead to significant growth in surgical procedure volumes. An estimated annual growth rate of about 14% in surgical procedures has made operation theatres as the most vital and imperative facility both for hospitals and patients. For hospital, operation theatres are the major cost centre not only involving the maximum expenditure but also huge revenue generation. For Patients, operation theatre is place where life saving or life improving procedures are performed justifying their major concern for safety and quality of services. It is the heart of any hospital where all the surgical procedures are performed. There has been transformation of operation theatres as the place where surgical procedures are conducted to operation theatre complex where not only surgical procedures are performed but also the quality care and safety are of essence.

The quality of care in surgical unit is usually a measure of timely, safe and best care to patients. Maintenance of the quality indicators of operation theatre and striving for total quality management of the processes of Operation theatre is mandatory. Assurance of quality also reduces the variability in outcome of the operation

theatre. It evaluates the efficiency of operations and also ensuring reduction of waste processes. But the quality is also often accounted to the rise in cost of services. Quality is maximum efficiency and effectiveness which is best possible outcome with the minimum resources. Never the less some approaches for quality may employ some additional cost but its investment which reduces discrepancies in outcome causing waste elimination. Thus the cost including all opportunity cost of services i.e. monetary, time, resources etc is reduced with quality assurance.

For maximising the cost benefit ratio of operation theatre complex, hospitals needs to utilise operation rooms in most efficient manner possible. Operational efficiency of theatres decreases the loss of valuable resources and also increase productivity distributes the cost of resource use to more users of the facility.

Rationale

Escalating cost is generally accounted to the increasing quality of care. Providers believe in an inherent trade off between Quality and Cost efficiency which is not factual. This trade off can be cast off by achieving **OPERATIONAL EFFICIENCY** in processes. This paper highlights that adhering to quality decreases variability's in process, eliminates wastes and errors leading to increased efficiency paving way to decreased cost with expression of sustainability.

Methodology

❖ Study design and approach

This study was performed prospectively in operation theatre complex of a multispecialty hospital with focus on Multispecialty operation theatre that alone accounts for 70% of the surgeries. The approach was descriptive with analysis of the situation.

❖ Time frame

This study was conducted for a period of two months which included 50 working days for Multispecialty operation theatre.

❖ Data source

This includes collection of primary data from the hospital OT records to describe and interpret the utilisation pattern of multispecialty operation theatre. The data regarding the scheduling and utilisation pattern was collected.

❖ Sample size

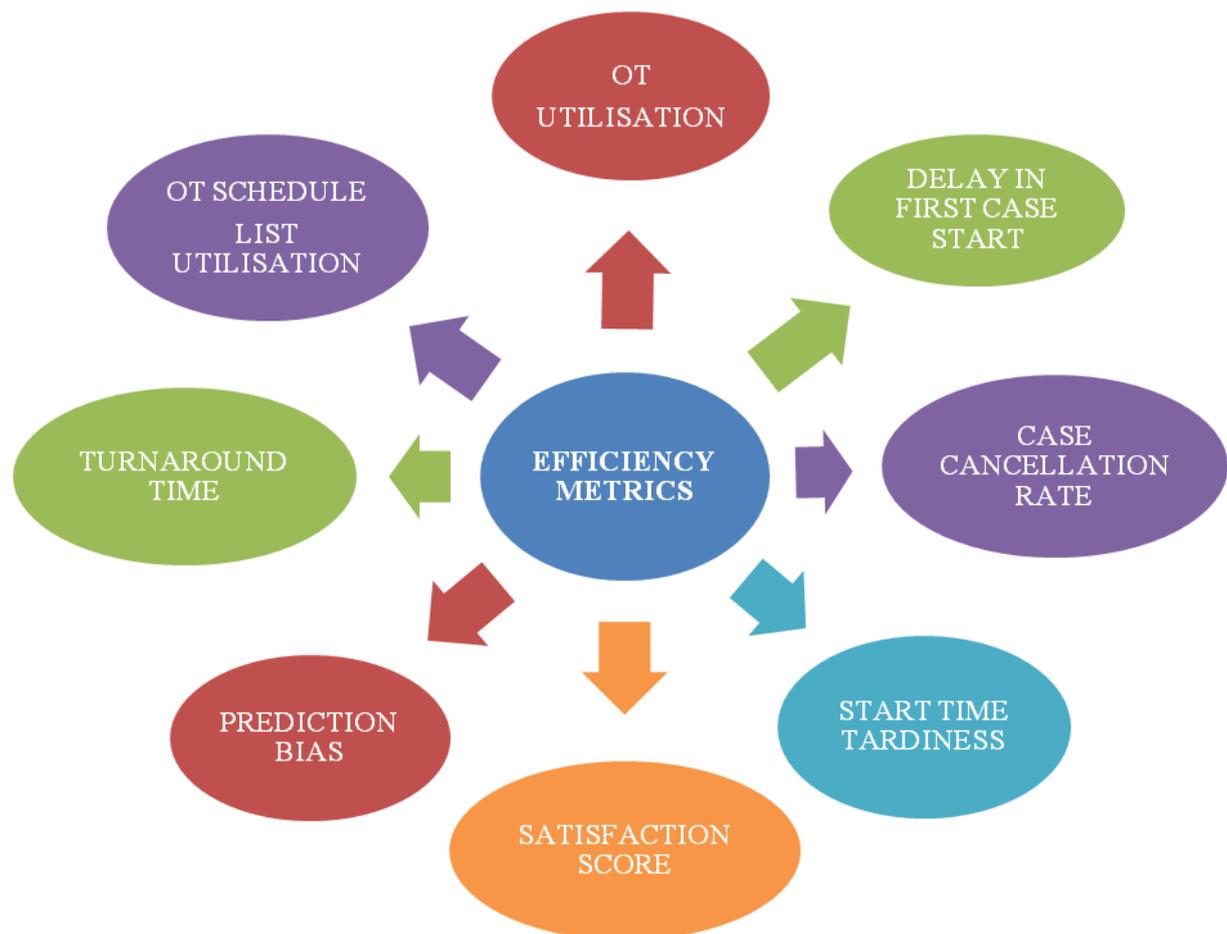
A total of 584 surgeries were included in the study.

Inclusion criteria and exclusion criteria

- ✚ All the surgical procedures performed in Multispecialty OT were included.
- ✚ Only elective surgeries were included for evaluation of performance.
- ✚ Cases performed in the Labor room were excluded.
- ✚ Neurosurgery and Orthopedic surgeries were excluded from MS-OT schedule list.

❖ Method of data analysis

A total of 584 surgical (elective) procedures were included with **process mapping, defining various critical to quality parameters of surgical pathway and measuring the Operational Efficiency by quantifying them using EFFICIENCY METRICS** which included following 8 parameters.



A qualitative approach was also adopted by administering written questionnaires to OT staff, Anesthesiologist and Surgeons for getting the perspectives of all concerned persons with functioning of operation theatre. These self administered questionnaires were used to analyse the satisfaction of all OT users with various parameters. It was conducted to get illuminating insight into various aspects of operation theatre functioning.

All the data collected during study was used to compute efficiency of operation theatre using efficiency metrics. The data was analysed with **descriptive statistics using SPSS analysis (SPSS 16.0)**. The factors were computed using averages, percentages, frequency and descriptive statistics. Reasons for the variations found were analysed by **Pareto Chart using Minitab**.

Available literatures on utilisation and operational efficiency of operation theatres were reviewed.

Review of literature

In a study conducted by Farooq Ahmed Jan, Sayed A Tabish, it was found that out of total utilisation time 66% was spent on actual surgery, 21% on supportive services and 13% on making room ready for surgery. The result of this study suggests that utilisation of theatre can be increased by avoiding delay starts, avoiding cancellation of cases, proper scheduling of surgeries and induction room.

According to Shakti Gupta and Sunil Kant OR utilisation essentially means “The use of the equipments to full potential.” Utilisation index or coefficient is one of the important parameter to monitor the functional status of the equipments. It is also a parameter to assess the productivity of service or equipment. OR utilisation measures the use of an OR that is properly staffed with people needed to successfully deliver a surgical procedure to a patient.

Analysis and discussion

1. OT UTILISATION

Efficiency of any operating theatre is most commonly expressed by terms of theatre utilisation. It is the most important Performance indicator of operating rooms sought by managers to ensure that the patients are getting good value for their money spent. Theatre utilisation is most descriptive parameter for efficiency, represented by a ratio of theatre used time upon the theatre allocated time.

Theatre utilisation = $\frac{\text{Theatre used time}}{\text{Theatre allocated time}}$

Theatre allocated time

Based on the settings of this study, the PAH model of theatre utilisation was used for calculation which uses the occupancy definition of utilised time.

Utilisation = $\frac{\sum (\text{patient out OR} - \text{Patient in OR})}{\text{Scheduled time}} * 100$

Scheduled time here includes all the operating time and not just the session allocated time.

Raw utilisation of operation theatre is the total hours of elective cases performed within the OR time divided by the hours of allocated time.

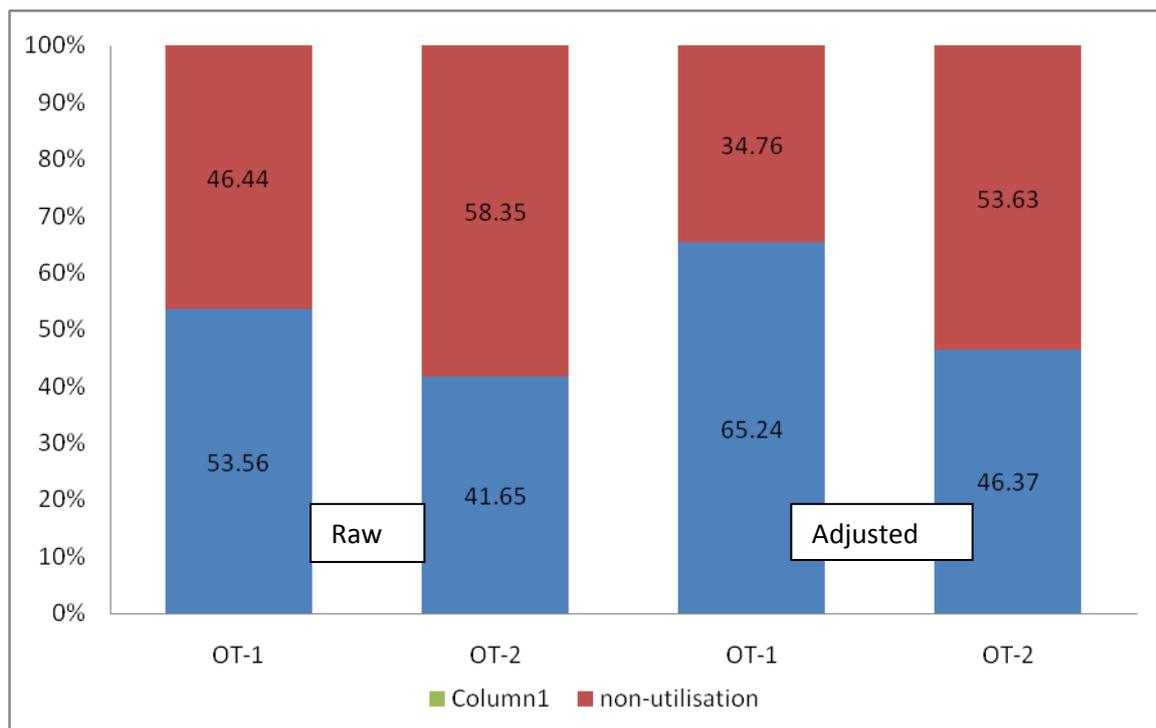
Raw utilisation = Total hours of cases performed / Total resource hours of allocated OR

But surgical procedures require preparation of OR and some special requirements before operation, thus a significant time should also be allocated to such activities or also called the ‘credit’ time for turnover. Thus we calculate the adjusted utilisation of OR.

Adjusted utilisation of operation theatre uses the total hours of hours of the elective cases performed within OR time allocated including the credit for the turnover time necessary to set up and clean the ORs.

Adjusted utilisation = Total hours of cases + “credit” time / Total resource hours of allocated Operation theatre.

Table no. 1: Raw and Adjusted utilisation of OT-1 and OT-2



As the table depicts that only half of the available time (46.37 percent for OT-2, 65.24 percent for OT-1) was actually utilised for surgery. It indicates the functioning of surgical suite much below its designed capacity necessitating measures.

The Operation Theatre (OT) is being the primary source of revenue generation with around 50-60 per cent of revenue earned just by this area. This is more so for surgical specialities. The OT complex in a hospital is one of the most complex and expensive functional unit demanding maximum utilisation to ensure optimum cost-benefit. Thus this is also indicative of value for performance. Optimum utilisation level helps to ensure that patients are getting good value for their elective surgery out of pocket expenditure.

2. DELAY IN STARTING FIRST CASES

The delay in start of first cases is of utmost importance as this delay has a ripple effect over the whole OT schedule throughout the day. In the study it was found that average mean delay per first case was 32.82 minutes with a standard deviation of 23.93 minutes. Most common reasons for delays in start of first cases were delay in admission process of day care patients, or late reporting of patients. Second only to these reasons

were delays due to surgeons reporting late. On the contrary the operating rooms were always found ready before time.

3. ON-TIME START TARDINESS

Tardiness in start of every case was computed and it was found to be increasing the time that patients have to wait for their surgeries once they arrive at the hospital, especially if the preceding case runs late. Facilities with long workdays will have more tardiness because the longer the day, the more uncertainty about case start times. Tardiness does not necessarily depends on the durations of preceding cases or on the relative numbers of long and short cases. Rather, tardiness per case grows larger as the day progresses because the total duration of preceding cases increases. In the study it was found that average delay of 33.50 minutes with a standard deviation of 23.67 minutes per case.

In well-functioning OR suites, the cumulative tardiness of the start of scheduled cases should be less than 45 minutes per 8-hour OR day. To achieve this, the OR manager should properly determine when patients should be told to arrive (not too early or late), and sequence each surgeon's list of cases in the same OR on the same day with the most predictable case first and the least predictable (often the longest) case last.

4. TURNOVER (TURNAROUND) TIME

The time between two surgeries should be optimised such that there should be adequate time for cleaning and preparing OR for next procedure and should be small enough to avoid delay in taking up next surgery. Despite this, turnover time also receives much attention from OR managers because it is a key satisfier for surgeons and patients waiting for surgery. In the qualitative analysis of surgeons' satisfaction done in the study, the surgeons reported dissatisfaction with the turnover times between two cases as third most disagreeable factor.

Prolonged turnovers (delays). A length of time between cases that is longer than a defined interval (i.e. 45 minutes) should be considered a delay, not a turnover. Prolonged turnover times peak in the middle of the workday because that is when most turnovers occur. The turnover time of above 45 minutes in MS-OT was found in 31% of cases which necessitates the rectification action.

5. PREDICTION BIAS

Prediction bias is the bias in case-duration estimates per 8 hours of OR operating time. Prediction bias indicates whether the estimate of case times is consistently too high or too low in schedule list. The mean prediction bias for the study period was found to be 89.44 minutes per 8 hours of scheduled OR time with a standard deviation of 40.25 minutes. Such a large variation in estimation of case duration also indicates less utility of OT schedule list.

Some surgeons consistently shorten their case-duration estimates because they have too little OR time allocated and need to "fit" their list of cases into the OR time that they do have. In contrast, other surgeons purposely overestimate case durations to maintain control and access of their allocated OR time, so that if a new case appears, their OR time is not given away.

An accurate or near accurate prediction of case duration is important in scheduling the operation theatre list effectively. Usual overruns leads to delay in successive cases and usual under runs leads to under utilisation of operation theatre.

A major cause of variation for case duration is the fact that each surgery is unique in its own Correct and the duration of each operation cannot be exactly forecasted. But our constant effort should be that forecasting the duration of surgeries should be accurate at least eighty percent of the time.

Efficient OR suites should aim for bias in case-duration estimates of less than 15 minutes per 8 hours of OR time.

6. OPERATION THEATRE SCHEDULING LIST UTILISATION

The OT schedule list is the released at 17:00 hours on the day before the surgery containing t all the procedures which have been scheduled to be performed on the next day with the timings for each case. So that surgical team can accordingly plan and be ready at the time of procedure specially the surgeons who have to plan their patient appointments according to the surgery timings. The realistic building of theatre lists start in processes outside of theatre environment, essential validation of how 'lists' are made needs to be undertaken to maintain effective and efficient operating theatres.

OT scheduling efficiency was measured as a parameter of OT schedule list utilisation. Following criteria were used to analyse utility of schedule list:

- ❖ High rate of add-ons
- ❖ Case juggling/shifting frequency

The OT schedule and performance list for the study period was compared for elective cases and the efficiency in scheduling was found to very low with utilisation of schedule list as 12.3% only.

7. CANCELLATION

Cancellation of operations is a significant problem with many undesirable consequences for hospital and patients both. It results in wasted operation theatre time and decreasing efficiency of theatre. Cancellation of scheduled operations has a huge opportunity cost. Operations cancelled by patients on the day of surgery costs a lot to hospital in terms of wasted operation theatres resource hours and logistics spent in preparing for operations. It also costs staff time in preparing instruments, supplies, theatre etc for procedure. Surgeons also lose their valuable time as last minute cancellations disrupt their outpatient time also. An operation cancelled by hospitals cause discomfort both physical and psychological to patients as well as conveys inefficiency in management. Thus on the day of surgery cancellation rate should be as low as possible for efficient operation theatres. Cancellations well before time can be utilised for allotting the theatre for other procedure, thus increasing its utilisation and efficiency. The cancellation rate of 9.8 % was found. This high cancellation jeopardise the efficiency of operation theatre as leads to wasted time of OT if it can't be rescheduled. It

necessitates the decrease in cancellation as well as timely notification of cancellations so that operation theatre can be allotted for other procedures.

8. SATISFACTION SCORE

The perspective of every team member of operation theatre is different in context to the OT efficiency. A surgeon generally looks for on time starts, rapid turnover, first case of the day, easy availability of OR time. Nurses working in the operating room (OR) may understand efficiency as individual knowledge and experience applicable to the care of the patient as well as preventing problems before they occur, whereas managers understand efficiency in terms of production per unit of time or completing assignments as planned.

The hospital administrator may want the highest "throughput" of cases with the least operational cost. A quality manager concerned with quality of care provided to patient and least waiting time for patients. A safety manager views efficiency in surgical safety and interested in knowing the percentage of patients without injury.

Nurse Managers, on the other hand, may focus on disposable supply costs per case; the percentage of cases in compliance with flash sterilization policy; the ready availability of instruments; and other resources, such as imaging equipment, maintaining flexibility to move cases around, and having adequate reserve capacity for add-on or emergency cases.

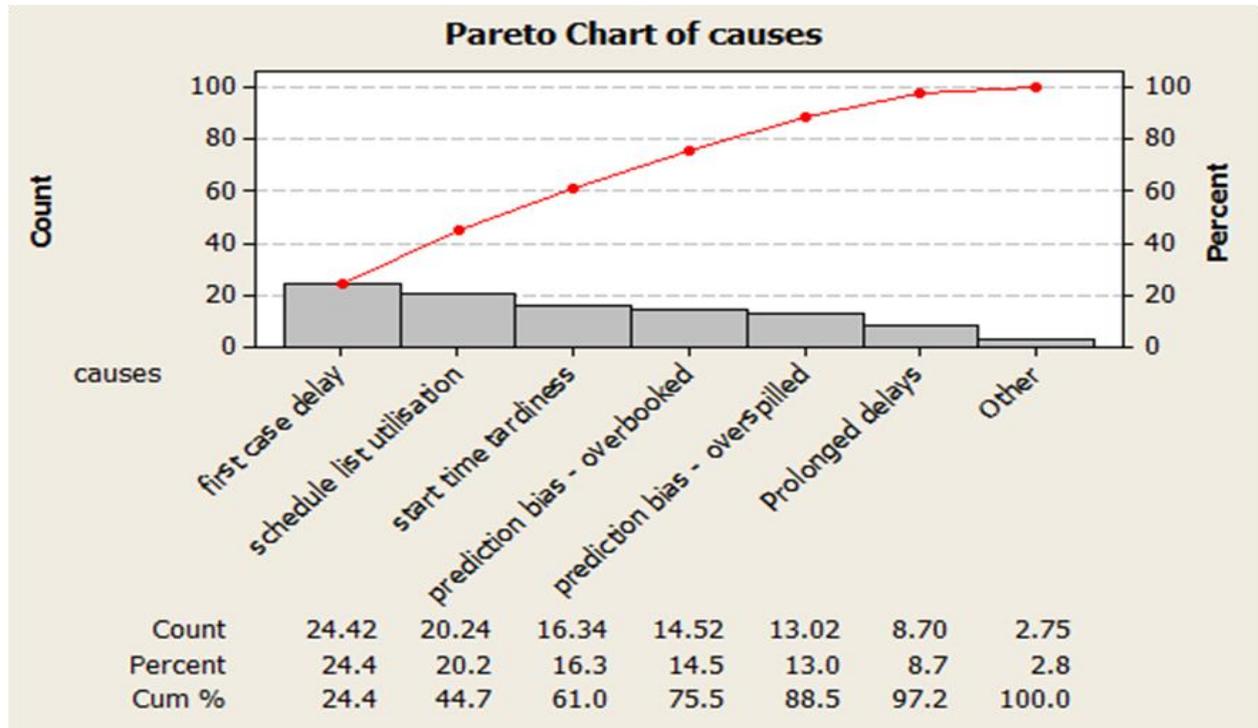
Thus getting the perspective from each type of employee can be illuminating. Conducted satisfaction survey on surgeons, anesthesiologist and OT staff was helpful in identifying the dissatisfaction parameters with the lowest-scoring. More in-depth analysis of these factors may yield opportunities for improvements.

The factors influencing OT functioning were evaluated for satisfaction on a Likert scale and an average score was calculated for each respondent group.

Surgeons	Anesthesiologist	OT staff
Delay due to inefficient Admission process	Delay due to inefficient Admission process	Delay due to inefficient admission process
Delay in start of surgeries on time	Inadequate nursing support	Surgeons do not finish their surgeries on time
Long turnover time btw cases	Delay in start of surgeries	Inadequate housekeeping and helper staff
2.5 (50.4% dissatisfaction)	2.9 (57.2%)	2.2 (43.7%)

PARETO ANALYSIS

Presently the MS-OT functioning seems to be plagued with systemic delays, late starts, prediction bias, prolonged turnovers etc leading to inefficiency and suboptimal utilisation.



Pareto analysis shows that 80% of the problem is due to first case delays followed by ineffective scheduling. Thus concentrating on these vital few factors is bound to solve maximum inefficiency problems.

Suggestions

1. Untie the KNOT (Knowing Non Operative Time)

As most of the valuable OT time is wasted in non- value added activities, it is important to do identify the bottlenecks and wastes of the critical surgical pathway. Increasing the utilisation, maintaining proper scheduling and decreasing the turnaround time gives opportunity to add more cases, distributing the cost to more procedures. Value stream mapping or process mapping should be done identifying all the opportunity areas for improvement i.e. Kaizan burst and the NOT (Non- operating time) should be decreased by doing activities in parallel.

2. VISUAL MANAGEMENT THROUGH OT-MIS

Presently the OT- MIS utilisation is limited, which should be increased with new modules to facilitate the function planning of OT. The OT-MIS use should be increased for the purpose of OT booking, OT scheduling, patient transfer indication, OR functioning status flags and OR delay or over run notifications.

Create a dynamic or auxiliary schedule at the beginning of each day with new start times for each case that are constantly updated after compensating for lateness of first cases and case-duration bias. These revised start times can be used to determine better patient arrival times and to determine the start times of cases for "to follow" surgeons.

Visual management by indication of surgery status with colours or functioning status flags saves communication requirement and standardise the process of activities.

Status	Colour coding	
Surgery Ongoing	Blue	
Surgery Running Late	Red	
Next Surgery On Time	Green	
Surgery about to finish (before 30 minutes)	Yellow	
Surgery Done(OR unoccupied)	Violet	

This colour coded flags should be displayed in HMIS and some display boards can be placed at vital locations like surgical waiting area, outside OT suite and surgical wards so that the transfer of patients can be managed. The most essential feature of this visual management would be the **YELLOW light**. When the surgeon indicates closure of patient or approximate completion of surgery within 30 minutes, an indication should be sent and the status flag should be changed to yellow. This yellow indication would save communication and signify start of preparation of next surgery in parallel co-ordinated processes like

- Pre- anesthetic check up review of next patient in pre- operative area
- Shifting of previous patient from post- operative/ recovery area
- Preparation of shifting next to next patient from ward to pre-operative area
- Arranging set and other necessities like blood and blood products for next surgery
- Indication for housekeeping staff to be ready for cleaning OT
- Review of patient file for completeness of consents, report requisitions and records
- Indication for next surgery team to be ready on time etc.

Thus this yellow light would indicate start of various activities for patients in line like production chain where all patients move a step ahead simultaneously decreasing their wait time and also parallel activities in OT preparation to decrease the Turnaround time.

3. SCHEDULING –SIMULATION MODEL OROPTIMISATION MODEL

(OPTIMISATION-ensuring Correct case in Correct place to Correct person in Correct time for Correct cost)

Scheduling of cases is a dependent variable where efficient scheduling can give opportunity to add more cases with same resources. Patient scheduling and operating room planning are complex tasks with a number of influencing factors to consider like, e.g., uncertainty in patient arrival, uncertainty in surgery procedure time and medical prioritisations and diagnosis. Further, several intersected dependencies, e.g. pre- and postoperative care, have to be considered as to prevent bottlenecks and obtain a maximum patient through-put. With an optimisation-based approach we demonstrate how different criteria in patient scheduling and resource allocations can affect various objectives in terms of patient perspectives, staff perspectives and costs.

An optimisation model can be referred to as a mathematical model that represents a real-world problem in which problem choices are represented by decision variables and the problem is solved by finding values of these decision variables that maximises or minimises an objective function. The optimisation models serve as an estimation of the decisions of an operating room manager. The optimisation model is used for modelling the decisions of patient prioritisation and resource allocation considering availability ensuring maximum cost benefit ratio. The intention is to model expected management decisions accurately.

Simulation is used to imitate the real world problem or the possibility of variations and uncertainties. We can use a simulation approach in which we analyse the system actions (patient scheduling and operating room planning) during a limited time period of one year which will help us to formulate the decision variables for optimisation. We use discrete event simulation combined with optimisation to model the system of patient arrival, surgery operations and surgery duration. The rules related to the planning and scheduling of the surgery operations are represented by constraints in an optimisation model.

4. HOLISITIC APPROACH

The key elements in the efficient use of operating theatres are: effective management and good communication, trained staff, appropriate facilities equipment, and operational layout. Foundation of sound operation theatre functioning is team work and good management. OT management is a task where function follows the form of patient surgical pathway.

Thus, Establishing OR policies and standard operating procedures (SOPs), strict adherence to and enforcement of along with continuous monitoring is required as an essential ingredient. Proper documentation of policies for cancellation, postponement and delay should be clearly laid.

Pre- surgical counselling of patients has shown to decrease the psychological anxiety of patients as well as increase the compliance of patients with surgery schedule, instructions and follow-up.

Introducing an early deposit of percentage of approximated total surgical expenditure while booking a surgical theatre would reduce uninformed cancellations.

Studies have shown that separate anesthesia induction room for all operation theatres can increase the patient throughput.

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