Application of Operational Research as a Management Tool in Hospitals- A Systemic Review

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ABSTRACT

Purpose: The purpose of this study is to understand the significance of Operational research techniques in making the optimum utilization of limited resources. There is the need to apply operational research techniques in Indian health sector esp. hospitals.

Data source: Relevant studies were identified through searches in the following databases: springer, pubmed, google scholar from 1968-2009.

Study selection: The reviews were selected on the basis of various operational research techniques in hospitals worldwide and methodological design was judgmental and convenience.

Result: The result could be shown that operational research techniques played very significant role in decreasing cost, increasing profit and was helpful in making critical decision.

Keywords--- Hospitals, operational research, Techniques, health sector, Managers

I. INTRODUCTION

The Indian health system contains both Public health system as well as Private health system. The aim of the hospital is to serve the ill patients, to promote awareness among the society. An ideal hospital contains specialized staff and equipment which aids in providing proper treatment to the patient. Nowadays there is increase in demands of health care services. Patients believe in quality services, but the resources available are limited in number and in such case operational research and its techniques play significant role in making the available resources utilized to its optimum level. The concept of operational research as a science had been in existence since 1930’s but the true attention given to operational research was during world war-2 by the efforts of military planners. Decades after the successful application of operational research these techniques were applied in the problems of businesses, societies and various industries. Since that duration these techniques have been widely used in petro-chemical, airlines, finances, logistics government etc.

II. LITERATURE REVIEW

B. Satheeshkumar, S. Nareshkumar, S. Kumaragharu (2014) gave an illustration of how much a hospital need appropriate number of nursing staff to manage the continuous service to the patient. The scheduling and planning of nursing staff is essential to avoid any additional cost in a hospital. The study states the use of linear programming techniques to solve the nurse scheduling problem and proved that this technique was useful in nurses scheduling at a multi-specialty hospital.

Manmohan Patidar, Sanjay Choudhary felt the need to solve the complex scheduling problems which plays the significant role of linear programming techniques. Nursing scheduling is one of the most necessary tasks to balance the workload of the nurses and to ensure all tasks done efficiently. This study shows how linear programming played significant role in nurse scheduling in a multi-specialty hospital.

Murphy Choy Michelle Cheong (2012) developed a nurse scheduling model with the help of mixed integer programming model. The best part of this model if that it optimizes both hospital’s requirement as
well as nurses preferences and had allowed various flexibility. This is an improvement over the old time manual approach which is costly in terms of man power as well as inefficient in producing a good schedule. The models were built using AIMMS which solves the problem in very less time. The modeling and simulation problem is prepared in a linear integer programming form which can be easily solved using MOSEK, and from the results, the problem was successful to be solved within 0.89 seconds which is extremely fast.

Isken MW, Hancock WM (1991) applied a simple rounding heuristic along with simulated annealing algorithm to obtain an optimal solution of nursing staffing problem. The staffing problems in hospital is the most challenging task because of the variations in staffing requirements between different shifts, within the day, between different days and the most difficult task is to maintain the service level all the time. This model helps to obtain solutions in less time on a computer. This model is designed keeping in mind the possible commercial constraints.

Woolf et al., (1968) applied PERT to a medical research project at the Hospital situated in Toronto. In order to use PERT, the project was broken down into the individual tasks that must be performed. A network was drawn showing the start to end sequence of activities, thus defining the work to be done. Time estimates were given to each of these activities and entered into an IBM computing system together. The computer defines the “critical path” and produces a report showing an estimated duration of the project and a proper schedule for completing each of the activities. Whenever each activity was completed, an IBM card is sent to the project director who compared the actual completion date with respect to the date on the schedule report. In this way it was possible to determine whether the project was on time, behind or ahead of schedule. The PERT technique significantly helped to organize the project and maintain progress toward its conclusion. The researchers suggested the use of PERT technique in complex medical research work.

Kwak et al., (1976) applied PERT techniques for the National Center for Drug Analysis (United States Food and Drug Administration). This Center is a pharmaceutical-chemistry laboratory Specialized for the development of analytical chemical procedures. The model was developed on the basis of the empirical data at the national center for 5 year period. The model was statistically tested and interpreted. The model was used to help the management of the center in development of a whole work-planning process as well as in controlling the project’s tasks, hence achieving the effective utilization of human and physical resources.

V.R. girja, M.S. Bhat studies a paper which states that the emergency department in known as the most critical part in a hospital. And any delay in the service provided to the patient at this time can be life threatening and can result serious consequences. They conducted a study in the emergency department of a tertiary care hospital to analyses the different types of process flow in the department with respect to PERT technique. The study state that operational research can be an important tool to improve quality reduces cost and is essential at the time of decision making. This study aimed to find the critical path estimated completion time and any variation in path in the emergency care unit. The study contained an exploratory research with random sample of 100 patients within the sample of 460 in duration of 2 months. The time event was calculated with the stop watch. On application of PERT the expected time of project completion was 84.89 minutes whereas the variance time was found to be 253.1 minutes. Those too, with zero and positive float value which signifies that the emergency processes were on/ ahead of scheduled time duration.

Jones (2009) proposed PERT as a potent technique for Hospital pharmacists in integration of their departmental planning process with strategic planning for the institution. Which will necessitate the development of more complex and sophisticated procedures in planning, managing in order to meet deadlines as according to the master plan. Researcher further says that PERT and CPM proves to be a valuable planning tool. It assists the pharmacists in the following points. Firstly it envisage the continuity of activities and events (network) in the development of some new services; secondly, assesses the activity times; and lastly it determine those activities which are critical in completion of the plan and finally applying statistical analysis in the completion date. A PERT/CPM network analysis is described in a structure which helps the reader to envisage the efficient applicability of this technique in making strategic planning processes. The case study was carried out in a 203 bedded hospital. The project completion date was in 10 days at probability equals to 0.05.

Lee et al. (1999) developed an effective clinical pathway for patients with lobectomy conditions. The team met on monthly basis and proposed a clinical path on lobectomy. A total of 24 discharged patients were reviewed retrospectively. Based on these findings a critical pathway was found and initiated and the PERT/CPM was applied in 6 case. The result showed early discharge and significant reduction was found.

Sam Afrane Alex Appah investigates the application of queuing theory and modeling techniques to the queuing problem at the out-patient department at AngloGold Ashanti hospital in Obuasi, Ghana. They used a descriptive, observational as well as ex-post facto case study approach. The essential data was generated then analyzed and finally used to model five capacity scenarios for the outpatient department of the hospital. The finally came to the conclusion that the optimum system performance can be achieved with the help of eight doctors effectively at post from contrast to the prevailing five doctors that were effectively at post. Sum it up, the study says that if we apply queuing theory and modelling technique to out- patient challenges, it can enhance optimal performance.
Samuel Fomundam, Jeffrey Herrmann (2007) surveys the contributions and applications of queuing theory in the health care sector. The paper presents a range of queuing theory results in the waiting time, utilization analysis and appointment systems analysis. The paper also contains the results for systems at different level of scales, which incorporates the individual departments (or units), health facilities, regional healthcare systems etc. The main motive of this study was to provide sufficient information who is interested in using queuing theory in healthcare process.

Somayeh Ghazalbash Mohammad, et.all (2011)presented a mixed integer programming model to minimize Cmax as well as idle time of operating room in hospitals. The paper considers that operating room scheduling important operational challenges in most hospitals. This model determines the allocation of resources including operation theatre, surgeons, and assistant surgeons to surgeries, also the sequence of surgeries within operating rooms and the starting time for them. The main feature of the model includes the systematic curriculum plan for training residents and then the real-life constraints were observed in teaching hospitals. The numerical results and the gap evaluations for the instances show satisfactory results.

Abdulrahim Shamayleh (2013) presented a simulation model to analyse a surgical theater of a local hospital in KSA. The focus was to analyze the performance of the surgical theater (generally) and Post Anesthesia Care Unit (PACU) (mainly) so as to assist making decisions regarding PACU staffing. The surgical theater consists of ten operation theatre rooms and the PACU unit with a bed capacity of fifteen beds. The results can be applied by the manager as a tool to plan and manage the Operating room and PACU.

Rafat Mohebbifar , Edris Hasanpoor, et.all (2013) did systematic analyzing of outpatient waiting time. The paper used descriptive cross sectional study in the hospital of one of the medical universities located in the north west of Iran. The sampling stage was used in which 160 outpatients were studied and the data analysis was with SPSS software. The result reveals reduction in waiting time from 245 minutes to 161 minutes. By applying such models, one can reduce the waiting time especially before the admission to the examination room. The models include the Electronic visit systems, six sigma model, and queuing theory.Model, FIFO model etc. that reduces the outpatient waiting time.

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Various processes in hospital

External Process

- Patient flow in Out-patient
- Walk-in-patients
- Appointment based patients
- Patient gets appointment
- Patient waits for his/her turn
- Doctor decides whether patient needs hospital admission or not
- Investigation suggested by doctor
- Investigation billing done
- Investigation procedure done
- Patients collect reports
- Patient goes back to doctor and gets consultation
- Patient purchases medicine
- Patient leaves hospital
- Patient comes back for follow-up

Internal Process
III. CHALLENGES AND ISSUES IN PROCESSES

While working in a hospital, a hospital administrator faces different types of day to day issues which are as follows:

- In a hospital there are staffs with different credentials and skills (from a super specialty doctor to a house keeping staff) and in such scenario there are chances of conflict in between the staff.
- The major peculiarity of a hospital is that it is emergent in nature i.e. and hospital has to be ready with emergency measures to cope up in case demand increases.
- The operation theatre timings are divided into various slots according to elective surgeries and non-elective surgeries, any mis scheduling in these slot may lead to loss to hospital.
- In a particular hospital there are different departments working at the same time so departmental issues may happen in hospital.
- A doctor sitting in opd may have to leave suddenly if any emergency case arrives and in that case the opd patients suffer
- Overload of work to nurses may lead to poor nursing care of patients
- Lack of maintenance of data by the staff.
- Staff inhibitions of doing so many mathematical calculations.

IV. RESEARCH METHODOLOGY

A questionnaire was sent to administrative departments of 5 Indian Hospitals. The overall survey response rate was 5 REPUTED Indian Hospitals in Chandigarh. The data received was collected and analysed to evaluate the results and responses. The primary focus of this questionnaire is on the day to day challenges in a hospital, application of any administrative strategies esp. operational research techniques, the succession rate of these techniques and if not, then the reasons for not using it.
What is the ownership type of this hospital?

- 75% Not for profit type
- 25% Other

How many bedded hospital your Hospital is?

- 40% less than 50
- 40% 50-100
- 20% above 100

“There are lots of chances when a hospital face challenges because of their emergent in nature".

- 40% Strongly agree
- 20% agree
- 40% neutral
- 20% disagree
- 20% strongly disagree
On a scale of 1-10 how often does the hospital face challenges in your hospital.

Does your hospital apply administrative strategies in case of challenges?

Do you have an operational researcher in your hospital?
Does your hospital apply operational management techniques?

- Yes: 2 (40%)
- No: 3 (60%)

How often does your hospital apply operational management techniques?

- Always: 50%
- Often: 50%

Which of the following techniques of operational research have you applied in your hospital? (Check all that applied)

- Transportation: 0 (0%)
- Sequencing: 1 (50%)
- Job assignment: 1 (50%)
- PERT: 2 (100%)
- Game theory: 0 (0%)
- CPM: 1 (50%)
- Other: 0 (0%)
V. RESULTS

The result could be shown that every hospital accepted that they face day-to-day challenges in hospitals and all of them apply administrative strategies to cope up with these challenges but only 40% of them applied operational research techniques as a strategy. Out of all the hospitals using operational research techniques-PERT, CPM, Job assignment and sequencing...
techniques were the most commonly used techniques. The frequency of application of OR techniques was often. While the hospitals which were not applying OR techniques was because of its complex calculation and inhibition of staff to do such calculations. 60% of hospitals would prefer to use OR techniques if it comes in an easy to use software.

VI. OBSTACLE IN USING OPERATIONAL RESEARCH

1) Lack of Information and data
2) Lack of operational researchers in hospitals
3) Inhibition of medical staff in calculating long data.

VII. USE OF OPERATIONS RESEARCH TO TACKLE THE CHALLENGES

Operational research techniques gives the guidance to a hospital about the techniques which can be applied and such a manner so that the overall performance of hospital increases. There are certain techniques which have been applied in the past and proved to be significant aid for hospitals. But the application of operational research needs hard methodology to provide quantitative information so as to propose actions and enabling them to allocate the available resources more effectively.

-In decision making- the operational research helps the hospital to solve the business operating issues with the help of mathematical modelling like transportation, sequencing, job assignment etc.
- Critical path- a hospital is full of complex processes which need multi-tasking. For example a patient getting an appointment to getting out of the hospital has an n number of tasks such as getting lab test, x-ray done, paying bills, taking medicines from pharmacy etc. In such scenario the PERT and CPM techniques helps the manager to manage the process by finding the loop holes.
- Improves productivity- the OR techniques helps in inventory management, it helps in forecasting manpower planning, future expansion planning.

VIII. CONCLUSION

The current body of evidence regarding the application of operational research techniques by Hospital managers varies significantly. In the era where there is growing demand of health care services due to increase in footfalls of older patients and chronic diseases due to lifestyle problems In the current scenario there is increase in need to use the resources as efficiently as possible so as to make hospitals work smoothly and hassle free All such challenges make the hospitals to apply some strategies like operational research techniques to go far in the future.

Currently, we did not found enough published studies that support this systemic review focusing on operational research techniques. Hospitals need to use the resources as efficiently and effectively and as possible to continue to assure that their hospital survive and prosper. To handle these situations more efficiently a manager must be aware of his/ her hospitals operational as well as performance data. The growing use of health care IT software will help the manager to collect, organize and interpret the data. Hence, it would be easy to implement Operational research methods on that data.

REFERENCES

[10] Sam Afrane Alex Appah Queuing theory and the management of Waiting-time in Hospitals: The case of Anglo Gold Ashanti Hospital in Ghana