Applications of Operations research tools to Public Healthcare Management: A Perspective

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Abstract: A brief over view on the basis of secondary Research on the applications of Operations research tools and techniques to the management of public sector hospitals. The paper attempts to bring forth the fact that O.R as a subject which has largely remained confined to the management textbooks has so far found very limited applications in healthcare. Through this paper, the author also attempts bring forward the various researches worldwide on application of O.R to public sector healthcare and the possibility of further research on the same.

Key Words: Operations research, Longevity, Health Equity, Simulation, Markov's model, Pulmonary Evaluation equipment, Data envelopment Analysis. Multi Integer Linear programming model.

Current healthcare scenario in Public sector hospitals in India:

Demographic changes the world over are leading to an increasing shift in the delivery of healthcare services. Increasing Longevity and availability of knowledge at the fingertips is leading and ever increasing demand for better healthcare as the patient today is much more better informed about his health than ever before. Hospitals in the world are becoming larger and larger due to the scale in the economy but simultaneously getting more and more complex to manage. While the economies of scale have lead to larger hospitals with a high patient turnout ratio and an increasing cost of healthcare has also led to a larger no. of organizations with deeper pockets leading to investments in the healthcare sector. While the increasing demography has intensified the pressure on the heavily burdened public sector hospitals, the medium sized private sector hospitals and the private nursing homes; the onus still remains on these institutions to deliver quality healthcare while maintaining their healthy bottom lines. In order to do the same; the fingers point to the following areas: Cost cutting (without compromising the cost) increased efficiency in terms of better services. The increased efficiency can be delivered by better or optimum utilization of resources.

Many communities such as O.R society and Industrial Engineering have been very active in healthcare management research. **(International Journal of Production Research, 2015 Vol. 53, No.24,7173–7176, http://dx.doi.org/10.1080/00207543.2015.1102356)**

O.R applications in Public sector hospitals

As per Mobin Ahmed, O.R application in healthcare will balance the information sources in projects and quantify the changes in terms of yields or results. It is this property of OR that sets it different from other researches. Practical utilities of O.R can be with scientific and factual strategies in tandem with a computer system. The interdisciplinary approach of O.R deals with the applicable part of the given circumstances helps in giving a model solution which deals with different choices in the approaches. Groups of academicians, strategy creators, program directors, disease transmission experts, biostatisticians, group health specialists, and health economist's ought to hold hands to execute quality OR to answer public health system pertinent issues and illuminate them opportune. **(IOSR Journal of Mathematics (IOSR-JM) e-ISSN: 2278-5728, p-ISSN: 2319-765X. Volume 13, Issue 3 Ver. IV (May - June 2017), PP 29-34)**

The public sector hospitals which are preconceived to be inefficient have been effectively known to

deliver healthcare to the bottom of the pyramid sector while producing the best doctors from the medical colleges attached to them (**Operations Research and Health Care, A Handbook of Methods and Applications) Margaret Brandeau.**

Overview of global studies of O.R applications in Public sector Healthcare

As per Bradley, Tiffany Et Al, global health refer the the research of health issues placing priority on achieving equity in health world wide. While health equity has been largely achieved in advanced countries; health disparities continue to plague the lower middle income (LMIC) and the lower income (LIC) countries. O.R as a discipline provides better understanding of complex methods using advanced analytical tools. The modelling methods of O.R can useful and inexpensive when working on complex data where decision making has to be done to choose a health policy 1 or health policy 2. It can also be useful to frame complex financial evaluations like implementing the most optimal solutions with a limited budget across multiple needs.

Health equity being an integral part of global health; O.R can be analytically used to find solutions to maximise equity. Data envelopment analysis set up in India and Kenya have helped to identify inefficiencies in the healthcare delivery systems as well as better utilization of resources. Other studies have utilized the simulation model to optimize utilization of resources in an emergency department in Malaysia.

One important area of health care which has not been studied is application of O.R techniques to medical equipment and healthcare technology management. A cost utility analysis was however in a Pulmonary Evaluation equipment for lung cancer diagnosis in Iran and a decision theory model was developed in Brazil in a Mammography clinic to account for equipment failure and maintenance. A queuing model was developed to effectively manage the turn around time and the repair time of equipment. A simulation model was used to study the impact of treating sexually transmitted diseases in the sub Saharan region. In Thailand, Markov's model was used to study the cost utility in terms of adjusted life years for four different types of Lung Cancer treatments. Provac, an American Health Organization used the decision analysis model for assessing the cost effectiveness of adding vaccines to the child immunization schedules in Latin American Countries. (**Operations research in global health: a scoping review with a focus on the themes of health equity and impact Beverly D. Bradley**)

Current Application of O.R in Healthcare:

As per ines Marques; a mixed Integer linear programming model was proposed to manage the surgery schedule of a medium sized hospital in Portugal. Since a huge chunk of patients are admitted to hospitals mainly surgical reasons; surgeries drive ahigh amount and cost and revenues in public as well as private hospitals leaving little room for error and mismanagement. Surgical procedure planning typically happens in three stages; although It may vary from country to country and hospital to hospital. In the first stage that is the strategic planning; the Operation Theater (OT) time is distributed amongst the surgeons fully on board and the surgeons performing the surgeries on-call basis. This allocation is done anticipating the expected year round demand for the OT's and constitutes the hospital budget. At the tactical level the time table or the surgery Schedules are prepared. The schedules are prepared keeping in mind the patients admitted bed occupancy etc. It is often observed in private as well as public hospitals that a patient in need for a surgery cannot be admitted due to a lack of hospital bed. This tactical management calls for a fair bit of researching for efficiency improvement. As per Beliën and Demeulemeester, the time duration of the surgery and the duration of the hospital stay or bed occupancy are random variables depending on the type of surgery which is an independent variable. The purpose of this research is to ease the process of OT allocation and management considering several criteria like urgency of the surgery, bed allocation, the bed availability, the chances of the next patient coming in, sudden emergencies etc. In the mentioned paper the author has proposed mixed Integer linear programming model for the better allocation of the variables. In a typical hospital setup in any developing country the demand for the O.T is usually dependant on the surgeons attached to the hospital and the same surgeon is likely to be attached to more than one hospital. O.T time negotiation with the surgeon is a major challenge for any hospital administrator worldwide. Not allocating the demanded time ay result in the hospital losing a reputed surgeon which will also result in a loss of good will amongst the patients and the loss of revenue in terms of bed allocation and consultation

charges. As per the author, the application of MILP would help minimize the following concerns: Minimize the no rooms assigned to each surgical speciality. Minimize the deviation between the shift assigned and the actual shift for each surgical speciality. Minimize the deviation between the assigned weekly time of each surgeon and the median of the weekly time of the same surgeon (**Optimizing the master surgery schedule in a private hospital InêsMarquesa,∗, M.Eugénia Captivob,c, NaraBarros**)

As per Ehsan Ahmadi, every hospital setup has storage which comprises of a limited space and the associated direct and the indirect costs. Typically the decision of storage is based more on the staff's experience than on any optimization model. This research has developed a stochastic Mixed Integer linear programming model for making the inventory allocation decisions. Every location in the storage area has been given a potential cost associated with it. This model helps the hospital to determine the costs saving done by allocating specific items to specific storage location. Deficiency of inventory during surgeries can result in a wastage of time, process and motion. Moreover it becomes imperative that in order to locate the required inventories the nurse has to keep travelling between the OT and the storage room. This can also result in an increasing level of infection. Apart from Location optimization, this model also helps the hospital to determine the potential costs savings that is achieved on account of that (**A robust stochastic decision-making model for inventory allocation of surgical supplies to reduce logistics costs in hospitals: A case study EhsanAhmadia,DaleT.Masela,*,SethHostetler**)

Healthcare Research Scenario in India:

As per Manoj Mohanan; India's healthcare sector provides a wide range of services acclaiming from the best global hospitals to the worst possible kind of public sector hospital with extremely poor services. There is also a lack of reliable data, the quality of the available data and the difficulties in measuring the same. Structural measures have traditionally received importance from the government like the no.of patients, beds, doctors etc but that data is rarely analysed to improve the quality of healthcare. Measurement of the quality of the healthcare processes is especially challenging as the complex structures and the rigidity of the structures calls for more methods than the traditional statistical ones. (**Quality Of Health Care In India: Challenges, Priorities, And The Road Ahead. Manoj Mohanan**)

Scope for further Research:

While a fair amount of research has been carried out on the applications of O.R to healthcare and the empirical data available is mostly in the journals of the developed world. The healthcare data available from the developing countries is mostly in the form of basic statistics, demographics etc. The scope for primary research for the mentioned topic in the developing countries is vast enough and more likely to be helpful as it provides an inexpensive model which can function as an important management tool.

Conclusion:

While O.R as a subject has been around for a long time and found multiple applications in the industry; in the healthcare industry it has remained on the back burner as an important management tool. The healthcare industry in the developed world has started using advanced and automated management tools, the public sector hospitals in the developing world cannot afford for a long time to come. O.R as an effective management tool will remain to be taken to these institutions by the researcher community soon.

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