Article

A Review on Study of Application of Queueing Models in Hospital Sector

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Abstract

This article provides a review on application of queueing models in Hospital sector. In this article, the methodology for the review is based on a modification of an existing literature review method. In addition, we hope to use the findings of the study to identify possible future projects. This review paper examines research studies attempts to overcome the ambiguity to difficulties of previous problems and tends to suggest an additional scope to enhance the standard of result in comparable condition.

Keywords

Hospital Sector, Patient Flow, Control Chart, Fuzzy Queueing Model

Introduction

Queuing theory is a branch of Operation research, which deals with the study of queues. A queue forms when the current demands for a service exceeds the present capability to offer that service. Queueing theory gives models for predicting the behavior of systems that attempt to serve demand that arises in unpredictable manner. A.K. Erlang's [9], "The Theory of Probabilities and Telephone conversations" is a historically significant paper in this field. Queuing theory plays an important role in health care management. Health care system can be considered as a network of queues with different type of servers where patients arrive in a finite /infinite manner, wait for service (e.g., Treatment, routine checkup

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etc.), get a result i.e., after consultation to doctor either go home or admitted to a hospital. Health care management is facing the problem of allocation of beds, optimal bed's requirement, in distinct wards together with allotment of duties to doctors in different wards of hospital & outdoors and many more.

Objective

The purpose of this review article is:

1. To take a critical look at the literature (facts and views) that already exists and show their relevance with our subject.
2. To recognize new approaches to interpret and try to illuminate gaps (if any) in preceding researches.
3. To enlighten the way ahead for future research.

Methodology

The study of various research articles related to our research question (published in acknowledged portals/Publications) have been done. Facts and information's are gathered from trusted websites which are thoroughly sorted and selected based on their relevance. A concise summary of each review is tried to present in this article.

Review Of Literature

N. M. Eze et al(2019)[5] analyzed the Queuing system experienced at healthcare delivery center in Nigeria by using M/M/2 model. Chi square distribution was used to test for the Goodness of fit of the inter-arrival and service time. The results showed that both were exponentially distributed. In order to ascertain whether the system is efficient, primary data were collected, analyzed, and interpreted. Computationally, the analysis carried out in this work represents that the mean inter-arrival time exceeds the mean service time. To reduce this problem to its barest minimum, the researcher, therefore, recommended that the hospital should have a specific time to run the clinic and ensure that the consulting doctors are readily available so as to avoid cases of patient(s) coming too early and having to wait for hours before they receive service.

Manish Kumar Pandey et al(2021)[4] applied **Gk /Gd/1 Queuing Model to measure Patient movement at** a district hospital of Raipur, India. The arrival process follows exponential distribution and the service process follows Poisson distribution. Data was collected for three departments of hospital for 2 days of a

week by using observation method. Appointment probabilities of waiting time of patients have been derived, and also expected queue length, waiting time for the patients in the model have been shown. On the basis of numerical Illustration of the model the author claimed that the obtained result would be useful for further research in academic, scientific field and also for practitioners.

Hajnal Vass et al(2015)[3] have done a case study on movement of Patient's Flow in Emergency Department(ED) situated in Mures County, Romania for a period of three years January 1,2010 - December 31, 2012 when totally 51.458 patients were registered..The author(s) used M/M/3 queue model to characterize the patient flow in the Emergency Department. The study illustrated how data analysis and queuing models can be used in decision making to find optimal solutions. In this case study it has been considered that the number of human resources is the same with the number of beds. The author(s) recommended to extend the research for the case when the waiting time is not limited only to the number of physicians.

Thanda et al(2019)[1] have done a comparison of different multiserver queueing models for reduction of patient's waiting time in BHAO special clinic, Myanmar for three different departments. The data was calculated for 14 days by observation method. The author(s) calculated different performance measures for three multiserver queueing models M/M/3, M/M/4, M/M/2 which were applied at three different departments. After that they replaced M/M/4 by M/M/5 & M/M/2 by M/M/3 to analyze different performance measures and queueing parameters. As a result of comparison, it has been found that by increasing a server at certain departments the patient's waiting time has been reduced which helps to make the system more efficient.

Adegoke. O. Folake(2020)et al [2] analyzed the use of M/M/s queuing model in Accident and Emergency Department (AED) of a city hospital, North-Central Nigeria for determining the flow of in-patient , optimal bed count in hospital. In the proposed model, the author(s) concentrated on queuing system management, waiting time for patients, and social cognitive approach in AED of a city hospital. In the selected queuing model, the daily admission rates follow Poisson distribution and service times are exponentially distributed. In order to find out the Probability that on arrival a patient will find a bed, the author(s) calculated estimation of arrival rate, service rate and current number of servers. On the basis of the probability of delay, the optimal bed count and the performance measure they concluded that if occupancy level of AED unit remains below 75%, the proportion of delay in patients getting a bed will be very small.

Bhavin patel et al(2012)[7] in their research article used m/m/c queueing model with fixed number of beds for describing the flow of patients, optimal bed counts in a hospital . They demonstrated how to maximize the average cost per day of unoccupied beds versus the cost of delayed patients using a numerical example.

Pinal H Patel et al(2020)[8] proposed M/M/N model to the Lion's Hospital, Mehsana as a particular case study. They collected data of patients over the period

Jan-Dec 2018 and estimated the required number of human resources in Emergency department (ED) and their average waiting time. The result of their analysis helps in management of ED. It also provides the optimal decision to manage the patients flow in future.

Rachna Rathore(2021)[6] used (M/M/C) queue and (M/M/N) model with finite N for the study of bed occupancy management ,patient's movement, optimal bed counts in hospitals and tried to find the probability of a patient to be selected for the bed allotment and the expected occupied beds for a particular time period. The author concluded that as the number of beds increases the bed occupancy decreases ,also the fraction of arrival of patients that is lost from the hospital i.e. B(m, a) reaches to zero. Hence more patients can be admitted to hospital and benefited as per their medical need. Furthermore, as the probability on each day of a week increase, the expectation as well increases.

Discussion And Conclusion

In this paper a review on study of application of queueing models in hospital sector is presented. This paper reviewed various published research articles ,especially case studies, related to our research question.

It has been observed from above reviews that mostly a monotonous pattern of research has been adopted by authors in the concerned topic. The author(s) mostly performed case study in any hospital or healthcare for which they collected data and applied it on queueing models. There is a need of tremendous analytical research in the field of application of queueing models in hospital sector.

Recommendation

For further research following measures may be adopted:

1. Besides the usual and standard mathematical modelling in queueing theory, consideration of customers' behavior, server break down or vacation along with the limitation in arrivals can be introduced to make the model more realistic and challenging.
2. The use of Markov chain models combined with other models like queueing and scheduling may be a good approach.
3. Control chart technique may be applied to analyze the waiting time of the patient in the system to improve the services and the effective performance of the system.
4. Stochastic Queuing Models may also be a good alternative.
5. Since performance measures calculated by Fuzzy queuing model provides much wider information than a simple queuing model. So, Fuzzy queuing model may also be a good alternative for further research.

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