Research Paper

A Case of Number of Severs Determination through Queuing Model Application in a Clinic of Udaipur

Dr. Ashish Adholiya
Assistant Professor (IT/ Marketing)
Pacific Business School, Udaipur (Rajasthan)

Dr. Shilpa Adholiya
Researcher and Data Analyst,
Freelancer, Udaipur (Raj.)

ABSTRACT

Waiting for own turn in a line is an exceptionally frenzied circumstance for everyone, especially in the case when someone is looking for medical treatment. Commonly it can be observed in general situation people are hanging tight in line for their turn for the service is become the part of their life, especially places such as shopping center, railway reservation counter, tourist leisure activity points, restaurants etc we have seen that the individuals spent a good percent of their valuable working hours. In pursuance to get the medical treatment if someone spent a certain time in the queue his/ her critical state may get worse, so it is very crucial to manage the waiting time in clinics, hospitals and any other medical unit. Waiting lines or queue is one of the critical challenges for the medicinal services everywhere throughout the globe especially in the countries with dense population. This study tests the use of waiting line model / queuing theory and displaying the waiting line issue at the outdoor patients at a selected clinic of Udaipur, Rajasthan. In this research work queuing model would be assessed to determine the number of serving points (medical staff) required according to the number of patients so that patient scan get prompt treatment. Number of doctors which recommend for offering clinical services at the selected clinic for better service and reducing the patient waiting time is 4 in its place of 3 doctors right now offering their specialty services at clinic.

Keywords: Waiting Line Model, Queuing Model, Medical Services, Outdoor Patients

INTRODUCTION

A typical and common occasion situation in the common peoples' regular daily life is waiting in a line or in a queue for particular service. A queue or waiting line is the result of difference between the demand and supply of the service. Time in a queue to get the service or a waiting line depends on several factors such as number of people in the queue, number of the servers, type of the service, proportion time for service etc.

Because of unmanaged or poor clinical services at any hospital or clinic, patients and their attendants experiences the lot of time delays to get treated[1-2]. Commonly it is also identified that long waiting lines are the result of absence of coordination, poor administration and inadequate management of resources etc, which influences the efficiency and efficacy of services in hospitals and clinics and resultantly affects patients' satisfaction[3]. For the particular research work the people are patients in the queue and number of patients, numbers of doctors, type of criticality of the patient, average time for the regular checkup of the patient and many more factors may influence the waiting time of a patient in waiting line or queue. If a patient is not satisfied with the hospital services, then it may affect the economic status of the hospital by not assuring the revisit of the patient and his/her positive word of mouth. So, just to improve the efficiency

of the service time in a clinic or a hospital OPD, waiting lines should be properly organized by the hospital administration. For this purpose in order to diminish the holding up time of patient in a line proper and accurate application of waiting line or queuing model can be performed. Queuing model is a mathematical study model of waiting lines so its application and utility in a clinic or hospital can give some fruitful results. Queuing theory helps to build a hypothetical model though which length of the waiting line or queue and waiting time can be anticipated in accurate way. The application of waiting line model or queuing theory has been used in health care units such as hospitals since year 1952.

But, even after that this one very effective predictive tool to get the approx idea about the use of number of servers, it is lamentably negligibly utilized in most medicinal services framework in world. Proper and accurate utilization and implementation of waiting line model or queuing model has been improving various administrative services in different hospitality areas especially in the medical clinic, or hospital backgrounds and also decreasing the undesirable expenditure by offering several servers (doctors) and other facilities. Long and unorganized waiting lines or crowd of the patients in waiting rooms of a hospital indicates the ineffectiveness and inefficacy of the hospital administration, and this can be identified very commonly in several hospitals and clinics in India. In order to maintain the aforementioned state of overcrowding the decisions of administration is based on their experience rather than on the basis of a strategic model based outputs. For the present research work a well known clinic of the Udaipur district of Rajasthan was chosen for the study purpose, which is a multi-specialty clinic and offer clinical and medical services gets various patients consistently and this for the most part brings about long patient waiting up times. In light of this test this research paper presents the queuing model arrangement for the OPD patients of selected clinic so as to build up a model that can help lessen the waiting time of patients. One of the significant factors in order to improve the productivity in the delivery of medical and health care services is the flow of patients and discharging them with great extent of satisfaction, especially in OPD managing their delays to get treatment. Great patient flow implies that patient queue of waiting line is less and poor patient flow implies that patients endure from waiting line delays and other time mismanagement. So, in totality waiting line model and theory can be valuable tool for the hospital administrators in now days for improving their basic decision making instances pertaining to capacity, servers and resourcing.

RESEARCH METHODOLOGY

The nature of the research work is observational and diagnostic, means study will describe the use of the waiting line model in the hostel and its mathematical analysis, and diagnoses the significance of the best suitable form of waiting line model for the selected clinic of Udaipur. Primary data and required information for the analysis purpose were gathered with in the period of 45 days, and the major time to collect the data was spent in the waiting rooms and lobbies of OPD department of clinic. Primary and essential data was accumulated from the direct contact with the respondents and the observations, direct meetings with the administrative heads of the clinic, doctors, nursing staff and managerial staff. All the other secondary information was collected through the appointment records and by posing questions to the patients and other visitors.

The research method deployed for the present research work was to assess the efficiency and efficacy of queuing systems or waiting line model and practices, inclusive of the advancement of queuing or waiting line model for the investigating the queuing method as a effective method of solving the problem of patient waiting time for treatment or other medicinal services. The model will help to find that the genuine time it takes to serve the patient through estimating the actually required serving/ treatment points (doctors) in the clinic according to the flow of patients. The model created was utilized to investigation the waiting line or queuing model against the number of servers and patients rate of arrival within the clinic for the treatment. Moreover, in the wake of looking at the issue systematically and applying the waiting line or queuing model, the corrective measures can be proposed to improve the delay and make the OPD increasingly productive to improve the rate of patient satisfaction too.

DATA ANALYSIS AND RESULT DISCUSSION

The (Multi Server) MMS waiting line / queuing model first in first out is used in the present research work for estimating the accurate and effective number of serving points in the clinic for proper management of the waiting time of patients. In waiting line or queuing framework inflow of the visitors for particular this research work patients pursues Poisson probability to estimate the average patients within per unit of time frame. The model likewise follows the first in first out serving model for all the serving units (doctors, care units, specialists etc.) at clinic. The time for treatment or medicinal service are disseminated exponentially according to the number of average patients per unit of time and the servers' numeric count.

Table 1: Patient(s) Arrival in the Clinic (Month November 2019)

Day	1	2	3	4	5	6	7	8
N	140	89	96	132	92	96	101	85
Day	9	10	11	12	13	14	15	16
N	132	112	106	110	94	90	96	87
Day	17	18	19	20	21	22	23	24
N	136	108	115	99	97	106	103	114
Day	25	26	27	28	29	30	-	-
N	124	123	112	84	97	103		

Source: Appointment Book Register of Hospital

From the data given in Table 1 related to Patient(s) Arrival in the Clinic (Month November 2019) it could interpret that the total patients visited to the clinic within the period of 30 days of month November 2019 are 3179. Consequently, the average rate of patients coming to the clinic on per day basis would be 3179/30 =105.97 106 patients on per day basis and on the basis of total visiting hours of the doctors i.e. 180 hrs, per hour = 17.66 18 patients are visiting to the clinic for medicinal services or treatment. From the personal observation and on the basis of doctors response on an average in order to check the patient properly and suggest him the care or treatment an amount of 7-10 minutes is required as in the clinic total care is the primary aim and doctor himself is responsible to noting down some basic details of patients such as blood pressure, weight, etc. This implies that within the period of 60 minutes/1 hour a doctor can offer the treatment to 9 patients. In this one hour service rate of a doctor some other breaks such as checking of reports of already visited patients, attending the patients revisited with some confusion in the mind, other calls from the medical staff of clinic etc. So, in totality an average (μ) of 7 new patients can consult the doctor within the period of 60 minutes/ 1 hour. In the selected clinic of the study, 3 specialty doctors offer their consulting services in OPD. Doctors' visiting hours incorporates both the morning and evening visiting hours. So, on approx 6 hours in a day 3 specialty doctors offer their consulting services at the clinic, excluding their other hours which they spend in clinic for other medicinal services.

On the basis of MMS (Multi Server) queuing equations some key values such as arrival rate of patients at per unit of time (λ), average rate of service per unit (μ), total number of doctors, probability of zero patients in the queue or waiting line (P_0), number of expected patients in the queue (L_q), number of expected patients in the total medicinal system (L_s), expected time spent by the patient in the queue for medicinal system service/ treatment (W_q), and expected time spent by the patient in the medicinal system of clinic for service/ treatment (W_s) will be calculated mathematically for the 3 serving points (doctors). So, calculations are as below:

λ	μ	**Utilization factor (ρ) = λ / μ**
18	7	18/7 = 2.571 >1

Table 2 presented below showed the mathematical calculation of MMS Queuing System for different number of Servers (Doctors) i.e. 3, 4, 5, and 6 for offering the medicinal services to the patients visiting the clinic.

Table 2: Calculation of MMS Queuing System for different number of Servers (Doctors)

Case	Number of Servers S	Arrival rate (λ)	Service rate (μ)	Probability of No Patient in Queue (Po)	Average Number of Patients in the Queue (Lq)	Average Number Patients in the System (Ls)	Average Time in the Queue (Wq)	Average time in the System (Ws)	System Utilization (ρ)
1	3	18	7	3.743%	4.455	7.027	0.248	0.390	85.714%
2	4	18	7	6.751%	0.620	3.191	0.034	0.177	64.286%
3	5	18	7	7.428%	0.152	2.723	0.008	0.151	51.429%
4	6	18	7	7.591%	0.040	2.611	0.002	0.145	42.857%

Source: Primary Data

From the mathematical calculation outputs presented in the tabular form above revealed that for case 1 where number of servers were 3 server utilization ratio is quite good i.e. 85.714% with 18 patients arrival rate and 7 patients average service offering at per unit of time hour and 64.286% utilization ratio was observed in case 2 with 4 doctors, for this case utilization rate is near about 65% and confirming the lesser time spent by the patient in the queue in comparison to the 3 server (doctors). Among the entire cases highest utilization ration is observed for 3 doctors as the servers. So, from the statistics presented in the above table it could interpret that waiting time in queue accordingly decreases when number of sever (doctors) is increased. But, for case 1 with 3 servers average waiting time in the queue by the patient is Wq= 0.248 hour and average time spend by the patient in the clinic Wq is 0.390, which can be reduced to a certain extent if number of sever increased to 4 as presented in case 2 average waiting time in the queue by the patient Wq would be reduced to 0.034 hour and average time spend by the patient in the clinic Wq would be reduced to 0.177. So, it is recommend that the number of doctors which can be occupied for offering clinical services at the selected clinic for better service and reducing the patient waiting time would be 4. Availing the services from the higher number doctors to reduce or manage the waiting time more specifically would not be cost effective for the selected clinic according to the number of patients visited the clinic on monthly basis.

CONCLUSION

Offering the proper medicinal services to the patients without higher service delays or waiting time or giving the treatment within the certain time frame is a significant factor of any of the hospital and clinic or any other human services organization to improve the visitor satisfaction and to ensure their visits again. Patients and their attendants become disappointed especially with the long waiting time frame and it result into the negative impact on patients and ultimately leads into dissatisfaction or bad word of mouth for the clinic or hospital. So, the present research work confirms that waiting line or queuing model is a viable methodology that can be used to make the right decision over the certain situation on the basis of mathematical outputs for good and effective performance with respect to waiting time problem in the clinics and hospitals. This research work would be useful to understand the usefulness of queuing model in making the decision about number of server determination decision in the hospital and clinic in India in regards to improving the basic leadership with respect to the waiting time difficulties that are looked by medical clinics and hospitals.

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