Analysis of Different Parameters of Queuing Theory for the Waiting Time of Patients in Hospital

Damodhar F Shastrakar [1], Sharad S Pokley[2]
Department of Mathematics,
Smt Radhikatai Pandav College of Engineering,
KITS, Ramtek.
Nagpur.
dfshastrakar@yahoo.com, sharadpokley@gmail.com

Abstract: The purpose of this paper is to study the waiting time of patient coming for the checkup by the doctor in the clinic. To analyze the different parameters, arrival rate ,service rate ,utilization factor, the average number of patient in the system , average number of patient in the queue, average time spent by the patient in the system ,average time spent by the patient in the queue.

Keywords: *Arrival time, Service time, Utilization factor, First in first out (FIFO), Priority service.*

*****

I. Introduction

Queuing Theory described a system having the customers arriving for the service, waiting for the service if the number of customers are more in numbers and leave the system after getting the service. It is commonly unwanted part of our life .In our day to day life everyone is facing this problem to stand in a queue for the service. Queuing theory is also called as a branch of Operations Research because the results of Queuing models are often used in the Business decisions. Queue theory is a mathematical approach for analyzing waiting lines. Unfortunately queuing is common in most of the fields. Some of the common examples of queuing are customers waiting at a supermarket checkout counter, waiting at ticket purchasing counter, waiting for a bus or train , waiting at the telephone booth or a barber's saloon, waiting for service in banks and banks ATM counters, waiting at Toll paying counter, waiting at electric bill paying counter etc.

In day to day life it has been observed that there is increase in demand of facilities and if the service facilities are not up to the mark to satisfy the customer in a specific time, customer requires too much time to get service from service mechanism, result in the formation of queue. To solve the problem of the waiting time of customer it is essential to modify the service facility. To get optimum level there should be maintain a balance condition to minimize the sum of cost of customers waiting time and cost of service facilities. In this paper we collect data from a Dhanashree clinic of Dr. Aniruddha Deuskar Nandanvan layout Nagpur to study the different parameters in queuing theory and analyze the results.

Characteristics of Queuing System

1. Arriving characteristics: It is a input source of entering the customer into the system. Pattern of customers arriving in this case is finite and waiting for the service in a single queue.

2. Queue Discipline: A specific discipline is to be maintain while availing service facility. It is a process of rules and regulation followed by the customer to enter the system for the service. The rule implemented for the service in this case are First- Come First-Served (FCFS) and Priority service.

3. Service mechanism: It is a process and pattern of giving service to the customer. It is based on the policy decided for the service facility in which customers are serviced and leave the service system. Here Service mechanism follows single channel-single phase.

Probabilistic Queuing Models

Poisson-Exponential, Single server-Finite population model (M/M/1: N/FIFO, Priority)

Little's Formula:

$L=\lambda T$

Where L is expected number of customers in the system, λ is average arrival rate of customer and T is the average service time for a customer.

By using this theorem expected number of customers in the system can be determined.

For the analysis of the different parameters of queue theory following variables will be investigated:

1. Mean arrival time of customer, λ
2. Mean service time of server, μ
3. $\rho = \frac{\lambda}{\mu}$ utilization factor,
4. $P_0 = \left(1 - \frac{\lambda}{\mu}\right)$ is the probability of no units in the system
5. Probability of having exactly n customers in the system $P_n = (\rho)^n P_0$, for any value of n
6. Percentage of idle workstation $= (1-\rho)100\%$
7. Expected number of units in the system $L = \frac{\lambda}{\mu - \lambda}$
8. Expected number of units in the queue waiting for service $L_q = \frac{\lambda^2}{\mu(\mu - \lambda)}$
9. Expected waiting time a unit spends in the queue $W_q = \frac{L_q}{\lambda} = \frac{\rho}{\mu - \lambda}$
10. Expected waiting time in system (time in queue plus service time) the queue

$$W = W_q + \frac{1}{\mu} = \frac{1}{\mu - \lambda}$$

Observations:

Data was collected during peak hours 7.00 pm to 8.00 pm

Time in minutes	No. of patients counted in queue
Start of peak hours(0 min)	5
After 15 min	15
After 30 min	24
After 45 min	35
After 60 min	48

Calculations:

$$\lambda_1 = \frac{15-5}{15} = 0.67, \lambda_2 = \frac{24-15}{15} = 0.6$$

$$\lambda_3 = \frac{35-24}{15} = 0.73, \lambda_4 = \frac{48-35}{15} = 0.87$$

Avg. arrival rate= $\lambda = 0.718$ patient/min

On an average each patient spends 15 minutes in clinic.

$$L = \lambda T = 0.718 \times 15 = 10.77 \text{ patients}$$

$$\mu = \frac{\lambda(1+L)}{L} = 0.7847 \text{ c.p.m.}$$

$$\rho = \frac{0.718}{0.7847} = 0.9150$$

$$P_0 = 1 - 0.9150 = 0.0850$$

$$P_n = (0.0850)(0.9150)^n$$

$$L_q = 9.8571,\ W_q = 13.7285, W = 15.0029 \text{ min}$$

Percentage of idle workstation= 8.5%

II. Conclusion:

The percentage of idle workstation is very less and utilization factor is very high so it need some improvement in the service facility .An extra staff should be appointed to assist the doctor so that patient can get service rapidly and reduce the waiting time.

References:

[1] Ahmed S.A. AL-Jumaily, Huda K.T. AL-Jobori (2011), "Automatic Queuing Model For Banking Applications", International Journal of Advanced Computer Science and Applications, Vol. 2,No. 7, pp.11-15.

[2] Anish Amin, Piyush Mehta , Abhilekh Sahay, Pranesh Kumar And Arun Kumar (2014),"Optimal Solution of Real Time Problems Using Queuing Theory", International Journal of Engineering and Innovative Technology,Vol. 3 Issue 10, pp.268-270.

[3] Babes M, Serma GV (1991), "Out-patient Queues at the Ibn-Rochd Health Centre", Journal of the Operations Research 42(10), pp.1086-1087.

[4] Bose K. Sanjay (2002), "An Introduction to Queuing System", Springer US.

[5] Dhari K, Tanzina Rahman (2013), "Case Study For Bank ATM Queuing Models", IOSR Journal of Mathematics, pp.01-05.

[6] Hana Sedlakova (2012), "Priority Queuing Systems M/G/I",Thesis, University of West Bohemia.

[7] Janos Sztrik (2010), "Queuing Theory and Its Application", A Personal View, 8th International Conference on Applied Infomatics, Vol. 1, pp.9-30.

[8] Kantiswarup, Gupta P.K., Manmohan (2012), "Operations Research", Excel Books Private Ltd. New Delhi, pp.215-231.

[9] Manuel Alberto M.Ferreia, Marina Andrade , Jose Antonio Fillpe and Manuel Pacheco Coelho (2011), "Statistical Queuing Theory With Some Applications", International Journal Latest trends Fin.Eco.Sc.pp.190-195.

[10] Mital K.M. (2010), "Queuing Analysis For Out Patient and Inpatient Services: A Case Study" ,Management Decision, Vol. 48, No. 3 , pp.419-439.

[11] Muhammad Imran Qureshi, Mansoor Bhatti, Aamir Khan and Khalid Zaman (2014), "Measuring Queuing System and Time Standards: A Case Study of Student Affairs In Universities", AfricanJournal of Business Management Vol.8(2),pp.80-88.

[12] Muhammad Marsudi, Hani Shafeek (2014), "The Application of Queuing Theory In Multi-stage Production", Line ,International Conference on Industrial Engineering andOperations Management Bali, Indonesia, pp.668-673.

[13] Patel B.,Bhathawala P.(2012), "Case Study for Bank ATM Queuing Model", International Journal of Engineering Research and Application, Vol.2, pp.1278-1284.

[14] Pieter-Tjerk de Boer's (2000), "Analysis And Efficient Simulation of Queuing Models of Telecommunication Systems", ISBN 90-365-1505-X, ISSN 1381-3617, CTIT Ph.D.-Thesis Series No. 00-01.

[15] Pokley S.S.,Gakhare S.S.(2002), "Waiting Line Theory Applied To Adequate Requirement Of Beds In Hospital", "Business Perspectives",Birla Inst.of Management Technology, Vol 4,No.2,pp.77-80.

[16] Prabhu N.U.(1997), "Foundation of Queuing Theory", Dordecht Netherlands; Kluwer Academic Publishers.

[17] Sharma J.K., (2001), "Operations Research Theory and Applications", pp.597-665 Macmillan India Ltd, pp.597-665.

[18] Syed Shujauddin Sameer (2014), "Simulation: Analysis of Single Server Queuing Model", International Journal on Information Theory (IJIT), Vol.3, No.3,pp 47-54.

[19] Taylor S. (1995), "The Effect of Filled Waiting Time and Service provider Control Over the Delay on Evaluation of Service" Journal of Academic Market. Sci.23,pp.33-46.

[20] Worthington D. (1991), "Hospital Waiting List Management Models", Journal of the Operations Research Society 42, pp.833-843.