iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 9 Issue: VI Month of publication: June 2021

DOI: https://doi.org/10.22214/ijraset.2021.34852

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue VI Jun 2021- Available at www.ijraset.com

Big System Failure: A Queuing Theory Model to provide Oxygen to a COVID Infected Person during COVID- 19 Pandemic

Dr. Umesh Sharma[1], Ritu Singh[2]
[1]*Associate Professor, Sanskriti University, Mathura*
[2]*Research Scholar of Basic and Applied Sciences, Sanskriti University, Mathura*

Abstract: This paper describes the methodology designed to maximize the service of medical system in hospitals. We apply the result of queuing theory to find maximum number of servers served by hospital authorities to provide oxygen. Too much waiting may be fatal to a critical patient and it may leads to increase the mortality rate than expected further a serious situation for Government and Medical authorities.
Keywords: FCFS, SIRO, Queuing theory, Poisson distribution, M/M/n

I. INTRODUCTION

In the hustle and bustle of daily life we always face overcrowding everywhere as a result of this, queue is obvious. The queue is common in restaurant , hospitals ,super markets , bank, ATM and all public places.

India is facing covid crisis due to there is an exponential rise in cases which is pushing health systems to and possibly beyond .An exponential rise is in medical resources is required to make an equilibrium between patient and medical system.

There is extreme shortage of medical oxygen across the world in the second COVID-19 wave. While government and multiple companies are trying their best to ensure the need for medical oxygen ,to save severe COVID-19 infected patients. In INDIA daily requirement of medical oxygen cylinder is 19,32,297 to save COVID patients (MAY 04, 2021).

Hospitals are increasing their servers to meet the daily demand of patients arrival.

The three basic components of queuing theory are arrival pattern, the actual waiting line and service facilities. In medical facilities customers word is replaced by patients. Patient arrival is infinite following by a Poisson process. If server is empty patient will be served immediately otherwise a queue will be formed. Service is based on FCFS (first come first serve) basis but depending on patient's condition, emergency or social and economic, it may be SARO (service at random order).

II. METHODOLOGY

Assume that the arrival of patients follow a Poisson distribution and average rate of λ patients per unit of time. The patients are served as First come first served, basis. Let L is expected number of patient in a queue. W is average waiting time for a patient.

A. M/M/1 Queuing Model

We use the following relations to observe the queue

Mean patient arrival rate : λ

Mean service rate : μ

Utilization factor : $P = \frac{\lambda}{\mu}$

Probability of zero patient in the system : $P_O = 1-P$

Probability of having α patients in the system : $P_\alpha = P_O . P^\alpha$

Average number of patients in the system : $L_s = \frac{P}{1-P} = \frac{\lambda}{\mu-\lambda}$

Average number of patients in the queue : $L_q = L \times P = \frac{P \,.\, P}{1-P} = \frac{P\lambda}{\mu-\lambda}$

Average waiting time in the queue $W_q = \frac{L_q}{\lambda} = \frac{P}{\mu-\lambda}$

Average time spent in the system including waiting time : $W_S = \frac{L}{\lambda} = \frac{1}{\mu-\lambda}$

B. Discuss the Same for M/M/n Model

All patients arriving in the queue are served in equal service time in an order of FCFS. Patients may choose the queue according as per their interest. There may be infinite number of patients in a queue or in a system. Now if we introduce 3 servers i.e n= 3

Mean patient arrival rate : λ

Mean service rate : μ

Utilization factor : $P = \frac{\lambda}{n\mu}$

Probability of k patients in the hospital : $P_k = P_0 P^k$

The average number of patients in the hospital : $L_n = L_q + \frac{\lambda}{\mu}$

The average number of patients in the queue : $L_q = P_n \frac{P}{(1-P)^2}$

The average waiting time in the queue : $W_q = \frac{L_q}{\lambda} = P_n \frac{1}{n\mu(1-P)^2}$

The average time spent in hospital queue $W_s = \frac{L_s}{\lambda} = W_q + \frac{1}{\mu}$

III. METHOD

In this study data was collected from XYZ hospital by personal interview with patients or their relatives and hospital staff for two weeks.

A. Arrival of patients follow the Poisson distribution at an average rate of λ patients per unit of time .
B. Queue discipline is FCFS (First-come first-serve) but for emergency cases it is SARO (Service at random order).
C. Service time is distributed exponentially at an average of μ patients per unit of time.
D. Length of queue is infinite.
E. The hospital staff are working at their full capacity.
F. Server represents doctors, nursing staff, ICU beds, medical equipments.

IV. ANALYSIS OF DATA

A. Present Scenario

It was observed in an XYZ hospital that the arrival rate was λ = 400 patients per day and number of oxygen beds (service rate) = 375 beds
Performance measures are :
Utilization factor = 1.07
Utilization factor is greater than 1 which shows that our system fails.

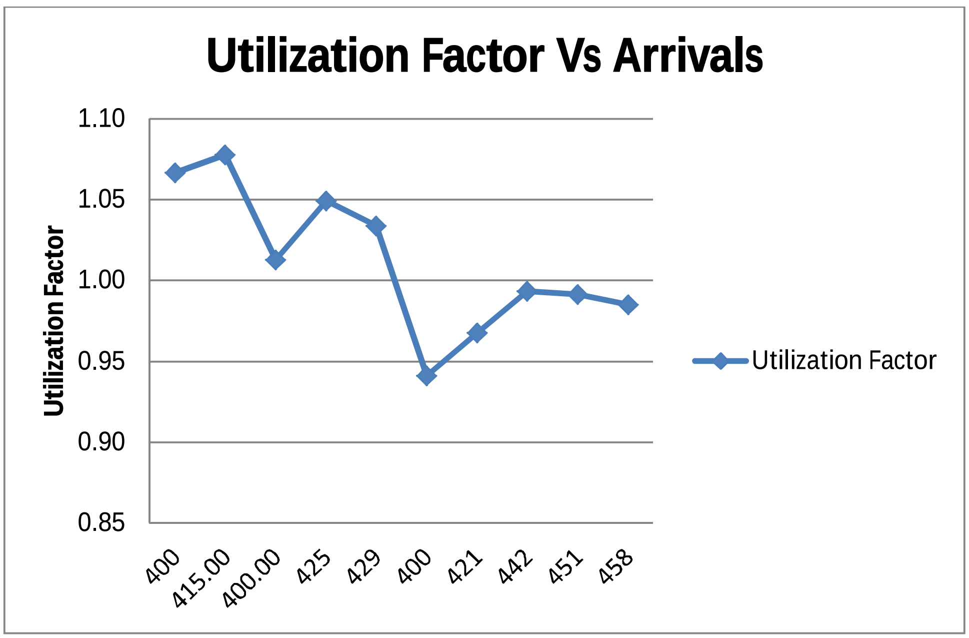
B. Proposing Model

On the basis of previous week patients records we suggested a model to the hospital to increase their utilization service. The model proposed that "Increase the number of ICU Beds by 10 /per day until we get the desired service rate." According to this model the hospital authorities will get the time and staff to manage the increased number of beds. The hospital may appoint daily wages staff to handle new beds.
Assume that a covid infected patient will occupy the bed for 10 days. The bed is supposed to be vacant if a patient die or he/she survived and go back to home with medical supports designed to support at home.
The hospital has bed strength 375 beds and if we increase it 10 /day it will be 385, 395,405,………….. 465.

V. DATA ANALYSIS

The following table is used to represents the increased service rate based on number of arrival per day and number of beds increased.

Arrival per day	Service provided	λ	μ	P	Ls	Lq
400	375	0.28	0.26	1.07	-16.00	-17.07
415	385	0.29	0.27	1.08	-13.83	-14.91
400	395	0.28	0.27	1.01	-80.00	-81.01
425	405	0.30	0.28	1.05	-21.25	-22.30
429	415	0.30	0.29	1.03	-30.64	-31.68
400	425	0.28	0.30	0.94	16.00	15.06
421	435	0.29	0.30	0.97	30.07	29.10
442	445	0.31	0.31	0.99	147.33	146.34
451	455	0.31	0.32	0.99	112.75	111.76
458	465	0.32	0.32	0.98	65.43	64.44



VI. RESULTS AND DISCUSSION

The above table and graph shows that we get the desired utilization factor after applying our proposed model but still the server (ICU BEDS) are busy and medical staff are working at their full strength.

VII. CONCLUSION

This model is proposed to improve the service quality of Hospital after a complete failure of the system due to second wave of COVID-19. It reduces the length of queue to improve patients satisfaction and to save the life of serious covid patients.

VIII. CONFLICT OF INTEREST

The authors declare no conflict of interest.

REFERENCES

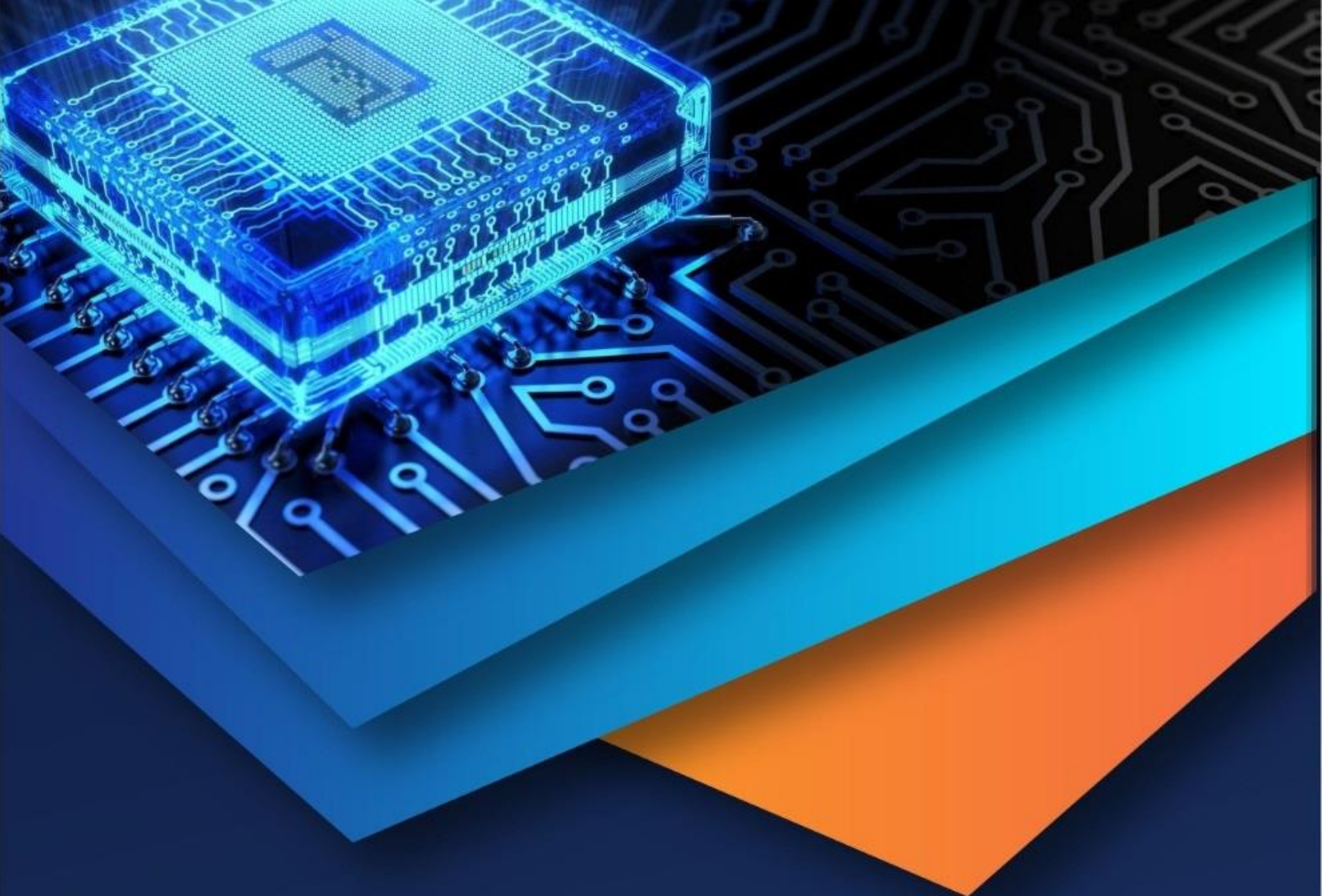
[1] M. S. R. Murthy, M. Pushpa Latha & K.G. R. Deepthi (January-2014),"Minimizing The Waiting Time at Bank ATM for service with Queuing Model,"International Journal of Scientific Research, IJSR, and vol. 3, ISSN: 22277-8179.

[2] Mohammad Shyfur Rahman Chowdhury,"Queuing Theory Model Used to Solve The Waiting Line of a Bank- A Study on Islami Bank Bangladesh Limited, Chawkbazar Branch, Chittagong,"Asian Journal of Social Sciences & Humanities, vol. 2 No. 3 August 2013.

[3] Nityangini Jhala, Praween Bhathawala (March-April . 2016)," Application Of Queuing Theory In Banking sector" IOSR Journal of Mathematics (IOSR-JM) ,vol. 12 ,e-ISSN : 2278-5728s.

[4] T.K Rotich ," Utility Analysis of an Emergency Medical Service Model Using Queuing Theory"British Journal of Mathematics and Computer Science, 19(1): 1-18,2016; Article no. BJMCS.29369.

[5] Quantitative Techniques in Management by N D Vohra Tata McGraw-Hill Publishing Company Limited ; Fifth edition (5 July 2017).



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY