Innovative Approaches to Reducing Waiting Time in Queuing Systems: A New Methodology

James R. Thompson[1], Laura A. Mitchell[2], Robert K. Davis[3]
[1]Department of Mechanical Engineering, University of Chicago, USA
[2]Department of Computer Science, Stanford University, USA
[3]Department of Electrical Engineering, Massachusetts Institute of Technology, USA

ABSTRACT

The aim of this paper is to study the effect of new methodology applied to reduce the waiting time of customer coming to the book shop to purchase the books. For this purpose the different parameters of queuing theory has been measured before and after the new methodology applied to the queuing model

Keywords: *Mean arrival time, Mean service time, Waiting time, Utilization factor, Idle workstation.*

I. INTRODUCTION

As we know that every human being facing a problem of waiting lines to avail the facilities during day to day life. As there is increasing in population growth very rapidly and life style of human being diverted towards easy going life, every person is demanding facility. So at every counter of facility there is forming a long queue to avail facility. Here we discuss the problem of forming a queue of customers coming to purchase the books at Shiv Book Store, New Nandanvan, Nagpur. The different parameters of queuing model has been calculated before and after the application of new methodology applied to reduce the waiting time of customer at book store.

II. PARAMETERS TO 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 customer in the system.
5. Percentage of idle workstation $= (1-\rho)100\%$
6. Little's Formula: Expected number of customers in the system $L = \lambda T$, T is average service time of a customer.
7. Expected number of customers in the queue waiting for service $L_q = \frac{\lambda^2}{\mu(\mu-\lambda)}$
8. Expected waiting time a customer spends in the queue $W_q = \frac{L_q}{\lambda} = \frac{\rho}{\mu-\lambda}$
9. Expected waiting time in system (time in queue plus service time) the queue

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

III. METHODOLOGY

The data was collected during peak hours from 6.00pm to 8.00pm. The different parameters of queuing model are calculated. To reduce the waiting time of customer a new methodology was implemented. In this methodology a printed form was given to the customer to placed the order of books which was collected during morning hours from 9.00am to 2.00pm and the order was ready to issue after 6.00pm.

IV. OBSERVATIONS

1. Old Methodology: [21],[22]

Time recorded in minutes	Waiting No. of customers in queue
Start of peak hours(0 min)	5
After 30 min	12
After 60 min	15
After 90 min	20
After 120 min	25

Calculations: **[21], [22]**

$\lambda_1 = \frac{12-5}{30} = 0.23, \lambda_2 = \frac{15-12}{30} = 0.1\ \lambda_3 = \frac{20-15}{30} = 0.17,$ $\lambda_4 = \frac{25-20}{30} = 0.17$

Avg. arrival rate= $\lambda = 0.17$ customer/min

On an average it takes 5 minutes service time for one customer

$L = \lambda T = 0.17 \times 5 = 0.85$ customers

$\mu = \frac{\lambda(1+L)}{L} = 0.37$ c.p.m.

$\rho = \frac{0.17}{0.37} = 0.46$

$P_0 = 1 - 0.46 = 0.54$

$L_q = 0.39,\ W_q = 2.29, W = 4.99$

Percentage of idle workstation= 54.00%

2. New Methodology: [21], [22]

Time recorded in minutes	Waiting No. of customers in queue
Start of peak hours(0 min)	2
After 30 min	6
After 60 min	8
After 90 min	10
After 120 min	15

Calculations: **[21], [22]**

$$\lambda_1 = \frac{6-2}{30} = 0.13, \lambda_2 = \frac{8-6}{30} = 0.07\ \lambda_3 = \frac{10-8}{30} = 0.07, \quad \lambda_4 = \frac{15-10}{30} = 0.17$$

Avg. arrival rate= $\lambda = 0.11$ customer/min

On an average it takes 2 minutes service time for one customer

$L = \lambda T = 0.11 \times 2 = 0.22$ customers

$$\mu = \frac{\lambda(1+L)}{L} = 0.61 \text{ c.p.m.}$$

$$\rho = \frac{0.11}{0.61} = 0.18$$

$P_0 = 1 - 0.18 = 0.82$

$L_q = 0.04,\ W_q = 0.36, W = 1.99$

Percentage of idle workstation= 82.00%

V. CONCLUSION

From the above results it has been observed that in old methodology the utilization factor as compared to the new methodology is very high which indicates that the server is more busy and waiting time of customer increases in old method. By implementing the new method, the number of customer, their waiting time in queue and waiting time in the system was reduced. Finally percentage of idle work station increases which increases the satisfaction level of customer.

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