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Application of Queuing Theory to Minimize the Waiting Time of Customer at Bill Paying Counter of Supermarket

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Abstract: The purpose of this paper is to study how the Queuing theory is applied to minimize the waiting time of customer at bill paying counter of supermarket. By measuring the different parameters of existing Queuing model, a new model has been suggested here to minimize the waiting time of customers. After analysing the parameters of Queuing model it has been observed that the new suggested model gives better result than the existing model.

Keywords: Average arrival rate, Average service rate, Utilization factor, Percentage of idle workstation.

I. INTRODUCTION

In today's life each and every person is facing a problem of Queuing. This problem is very much common in many of fields for example marketing, business management, information technology, reservation of tickets, library management, traffic control, paying various bills etc. Queuing theory is applied to such problems to analyze it and apply it to improve and modify the system to minimize the waiting time of customers, minimize the service cost to optimum level. This theory was first introduced in 1909 by Agner Krarup Erlang. In this paper we analyze the different parameter of Queuing model of bill paying counters at Vikas Mega Mart Supermarket, Nagpur and suggested a new Queuing model to reduce the waiting time of customers. Here the Queuing model is multi server and infinite population. It gives the idea about the improvement of customer's satisfaction rate.

A. Methodology

We collect the data from Vikas Mega Mart Supermarket, Nagpur at peak hours from 7.00 pm to 8.00 pm. Number of arriving customers at every 10 minutes has been noted and from this information different parameters of Queuing models were calculated to analyse the efficiency of the system. From the data it has been observed that many of the customers purchase very few material required less time for bill preparation, but because of others they have to wait for bill paying in the queue. There are two bill paying counters in the supermarket. We suggest here a Queuing model that customers purchasing minimum materials clear their bills at counter-1 and rest of the customers at counter-2.

1) Different Parameters of Queuing model:

a) Average arrival rate of customer, λ 2. Average service rate of server, μ

b) $\rho = \frac{\lambda}{\mu}$ Utilization factor, 4. $P_0 = \left(1 - \frac{\lambda}{\mu}\right)$ is the probability of no units in the system,

c) Percentage of idle workstation = $(1 - \rho)100\%$

2) 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 the value of L we can calculate $\mu = \frac{\lambda(1 + L)}{L}$

3) Observations of counter -1

Time in Min	Number of customers in queue	Arrival rate	Avg. arrival rate
Start time 0 min	10		
After 10 min	18	0.8	

After 20 min	25	0.7	0.88
After 30 min	30	0.5	
After 40 min	42	1.2	
After 50 min	55	1.3	
After 60 min	63	0.8	

4) Observations of counter -2

Time in min	Number of customers in queue	Arrival rate	Avg. arrival rate
Start time 0 min	8		0.82
After 10 min	15	0.7	
After 20 min	22	0.7	
After 30 min	33	1.1	
After 40 min	39	0.6	
After 50 min	48	0.9	
After 60 min	57	0.9	

B. Calculations

It is to be noted that on an average each customer spend 5 min to pay bill.

$$\text{Average arrival rate of counter-1 and counter-2 } \lambda = \frac{0.88 + 0.82}{2} = 0.85$$

$$L = \lambda T = 0.85 \times 5 = 4.25 \text{ customers}$$

$$\mu = \frac{\lambda(1 + L)}{L} = 1.05 \text{ c.p.m.}$$

$$\rho = \frac{0.85}{1.05} = 0.8095$$

$$P_0 = 1 - 0.8095 = 0.1905$$

Percentage of idle workstation= 19.05%

C. For the new suggested model

For counter-1: On an average each customer spend 2 min to pay bill

$$L = \lambda T = 0.88 \times 2 = 1.76 \text{ customers}$$

$$\mu = \frac{\lambda(1 + L)}{L} = 1.38 \text{ c.p.m.}$$

$$\rho = \frac{0.88}{1.38} = 0.6377$$

$$P_0 = 1 - 0.6377 = 0.3623$$

For counter-2: On an average each customer spend 7 min to pay bill

$$L = \lambda T = 0.82 \times 7 = 5.74 \text{ customers}$$

$$\mu = \frac{\lambda(1 + L)}{L} = 0.9629 \text{ c.p.m.}$$

$$\rho = \frac{0.82}{0.9629} = 0.8516$$

$$P_0 = 1 - 0.8516 = 0.1484$$

$$\text{Average of utilization factor } \rho = \frac{0.6377 + 0.8516}{2} = 0.7447$$

Percentage of idle workstation= 25.53%

II. CONCLUSION

From the above results it has been observed that the utilization factor decreases and percentage of idle workstation has been increase in new suggested Queuing model as compared to the existing model .This will definitely reduce the waiting time of customer and will increase the customer satisfaction level.

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