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Study of Different Parameters for the Electricity Bills Cash Counter Queuing Model

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Abstract- ***The purpose of this paper is to study the waiting time of customer to deposit electricity bill at a cash counter. To analyze the different parameters, arrival rate ,service rate ,utilization factor, the average number of customers in the system , average number of customer in the queue, average time spent by the customer in the system ,average time spent by the customer in the queue.***

Keywords: Arrival rate, Service rate, Utilization factor, first come first served (FCFS)

I. INTRODUCTION

Queuing Theory deals with the study of waiting lines. It is one of the unpleasant part of life. It is common experience in day to day life. Every person is facing this problem of waiting line to get service during his routine life. Queuing theory is also called as a branch of Operations Research as the results of Queuing models are often used in the Business Planning. The problem of waiting line caused because of increase in demand of facilities and if the service facilities are not working up to the mark, waiting time of customer increases requires too much time to get service from service mechanism, result in the formation of long queue. To reduce the waiting time of customer it is necessary to improve the service facility. Some times in other case if service facility stands idle and no customer in the queue may increase the cost of service facilities. In both the cases there is imbalance results. To get optimum level we have to minimize the sum of cost of customers waiting time and cost of service facilities. In this paper we collect data from electricity bill paid counter New Nandanvan layout, Nagpur to study the different parameters in queuing theory and analyze the results.

Basic Features of Queuing System

1. Arriving customers: It is a process of entering the customer into the system. Arrival of customer in this case is finite and standing in a single queue.

2. Queue Discipline: It is a rule applied for the customer to enter the system for the service. The rule implemented for the service is First- Come First-Served (FCFS).

3. Service mechanism: The service mechanism 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/FCFS)

Little's Theorem:

$L=\lambda T$

It describes the relationship between throughput rates. By using this theorem expected number of customers in the system can be determined. Here λ is average arrival rate of customer and T is the average service time for a customer.

For the analysis of the different parameters for electricity bills cash counter queuing model 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

Time in minutes	No. of customers in queue
Start of peak hours(0 min)	3
After 10 min	8
After 20 min	12
After 30 min	18
After 60 min	30

Calculations:

$$\lambda_1 = \frac{8-3}{10} = 0.5, \lambda_2 = \frac{12-8}{10} = 0.4$$
$$\lambda_3 = \frac{18-12}{10} = 0.6, \lambda_4 = \frac{30-18}{30} = 0.4$$

Avg. arrival rate= $\lambda = 0.475$ customer/min

On an average server takes 2 minutes for one customer

$L = \lambda T = 0.475 \times 2 = 0.95$ customers

$\mu = \frac{\lambda(1+L)}{L} = 0.975$ c.p.m.

$$\rho = \frac{0.475}{0.975} = 0.4872$$

$$P_0 = 1 - 0.4872 = 0.5128$$

$$P_n = (0.5128)(0.4872)^n$$

$$L_q = 0.4629,\ W_q = 0.9746, W = 2$$

Percentage of idle workstation= 51.28%

Conclusion:

The percentage of idle workstation is approximately 50% utilization factor and probability of no customer in the system are near about equivalent .The system may accommodate more customers for the service.

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