

# Queueing Model (M/M/C: ∞/FIFO) to Kadathur State Bank of India, Counters

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**Abstract**— In this paper the Queueing model (M/M/C:∞/FIFO) is applied to the counters of the Kadathur State Bank of India station, Dharmapuri District In this research the various characters of that queueing model have been analyzed and concluded.

**Keywords:** Queue, Arrival Rate, Departure Rate

## I. INTRODUCTION

A flow of customers from infinite or finite population towards the service facility forms a queue on account of lack of capability to serve them all at a time. Our main objectives of our research are

- 1) To apply the basic concepts of the selected queueing model to the Kadathur State Bank of India, Tamil Nadu, India.
- 2) To determine the various characteristics of the selected queueing model to the queueing system in the counters at Kadathur State Bank of India, Dharmapuri District.

## II. DATA COLLECTION

We have visited the counters at Kadathur State Bank of India, Dharmapuri district on various days during 11.00a.m to 4p.m and conducted a survey about the arrivals of customers to the counters and about the service rendered to the customers. The data pertaining to the arrival and Departures of customers to the counters of Kadathur State Bank of India, Dharmapuri district are given in this section.

The customers arrive at the kadathur State of India counters under Poisson process and the service is done to the customers in the exponential rate. This queueing model involves three servers. The customers are given service under the FIFO (FIRST IN FIRST OUT) discipline. Thus the queueing model which will fit to our problem is (M/M/C:∞ / FIFO) which is also known as the multi server queueing model.

The details regarding the arrivals and departures of customers obtained in the counters at Kadathur State Bank of India, Dharmapuri district are given in the following table (2.1) and Table (2.2)

Time intervals Per Hour	Arrival Time Interval (Counting for every ten minutes)	Departure Time Interval (Counting for every ten minutes)	No.of arrivals Per Hour	No.of Departure Per Hour
11.00-12.00	1/3/1/2/3/2	4/2/5/1/3/3	12	18
12.00 - 13.00	5/2/4/2/6/3	10/6/4/9/7/4	22	40
13.00 - 14.00	8/6/4/10/8/11	6/5/3/9/10/3	47	36
14.00 - 15.00	2/1/4/3/3/2	3/1/2/6/4/3	15	18
15.00 - 16.00	4/2/5/2/0/4	9/0/5/2/3/2	17	21

Table 1: Arrival and Departure Customers details

## III. EVALUATION OF THE CHARACTERISTICS

From the above table,

- 1) Average number of arrivals to the system per hour ( $\lambda$ ) = 113/5 per hour = 22.6 per hour = 23 per hour (appr.)
- 2) Average number of departure from the system ( $\mu$ ) per hour = 133/5 per hour = 26.6 per hour  $\mu = 27$  (appr.)  
Since  $C = 3$ ,  $\mu = 27/3$ , i.e.,  $\mu = 9$  per queue.
- 3) To find the intensity,  $\rho = \frac{\lambda}{C\mu}$ , Here  $\lambda = 23$ ,  $\mu = 9$  and  $C = 3$ ,  $\rho = \frac{\lambda}{C\mu} = \frac{23}{27} = 0.8518$
- 4)  $P_n P_{-n}$ .  $P_{-n}$  = probability that there are n- customers in the system both Waiting and in service.

$$P_n = \begin{cases} \frac{1}{n!} \left(\frac{\lambda}{\mu}\right)^n P_0 & ; & 1 \leq n \leq C \dots\dots\dots(1) \\ \frac{1}{C^{n-1}C!} \left(\frac{\lambda}{\mu}\right)^n P_0 & ; & n \geq C \end{cases}$$

Where  $P_0 = \left[ \sum_{n=0}^{C-1} \frac{1}{n!} \left(\frac{\lambda}{\mu}\right)^n + \frac{1}{C!} \left(\frac{\lambda}{\mu}\right)^C \frac{C\mu}{C\mu - \lambda} \right]^{-1} \dots\dots\dots(2)$

To find  $P_0 = \left[ 1 + \frac{1}{1!} \left(\frac{23}{9}\right)^1 + \frac{1}{2!} \left(\frac{23}{9}\right)^2 + \frac{1}{3!} \left(\frac{23}{9}\right)^3 \left(\frac{3 \times 9}{27-23}\right) \right]^{-1}$   
 $= [1 + 2.5555 + 3.2654 + 18.7405]^{-1}$   
 $= [25.5614]^{-1}$   
 $P_0 = 0.0391$

The values of  $P_n$  are calculated for  $n = 1, 2, 3, \dots$   
 Using the formulae (1) and (2) These values are given in the Table,

N	0	1	2	3	4	5	6	7	8	9	10
$P_n$	0.0391	0.0999	0.0142	0.0121	0.0103	0.0088	0.0075	0.0064	0.0054	0.0046	0.0039

N	11	12	13	14	15	16	17	18	19	20
P <sub>n</sub>	0.0034	0.0029	0.0024	0.0021	0.0018	0.0015	0.0013	0.0011	0.0009	0.0008

Table 2: The values of P<sub>n</sub>

From the table 2 we can easily see that  $\sum_{n=0}^{C-1} P_n + \sum_{n=C}^{\infty} P_n = 1$

IV. THE RESULTS OF CHARACTERISTICS OF OUR SYSTEM[(M/M/C): (∞/FIFO)]

- 1)  $P(n \geq C)$  = Probability that an arrival has to wait  

$$= \frac{C\mu \left(\frac{\lambda}{\mu}\right)^C}{C!(C\mu - \lambda)} P_0 = \frac{3(9) \left(\frac{23}{9}\right)^3 0.0391}{3!(27-23)} = 0.3372$$
- 2) Probability that an arrival enters the service without wait  

$$= 1 - P(n \geq C) = 1 - 0.3372 = 0.6628$$
- 3) Average queue length, L<sub>q</sub>  

$$L_q = \frac{\lambda \mu \left(\frac{\lambda}{\mu}\right)^C P_0}{(C-1)!(C\mu - \lambda)^2} = \frac{23(9) \left(\frac{23}{9}\right)^3 0.0391}{32}$$

$$L_q = 4.2213 \quad \dots\dots (3)$$
- 4) Average number of customers in the system [E(n)]

$$L_s = L_q + \frac{\lambda}{\mu} = 4.2213 + 2.5555$$

$$L_s = 6.7768$$

- 5) Average waiting time of an arrival [W<sub>q</sub>]  

$$W_q = \frac{1}{\lambda} L_q = \frac{4.2213}{23}$$

$$E(\omega) = 0.1835 \text{ or } 11 \text{ minutes} \quad \dots\dots\dots(4)$$
- 6) Average waiting time an arrival spends in the system [W<sub>s</sub>]

$$W_s = W_q + \frac{1}{\mu}$$

$$= 0.1835 + \frac{1}{9}$$

$$= 0.1835 + 0.1111$$

$$W_s = 0.2946 \text{ or } 18 \text{ minutes} \quad \dots\dots\dots(5)$$

A. Verification of the Little's formulae

The relationships between the characteristics are given by means of the following formulae known as little formulae there are

- 1)  $L_s = \lambda W_s$
- 2)  $L_q = \lambda W_q$
- 3)  $W_s = W_q + \frac{1}{\mu}$

Our findings also satisfy the Little's formulae.

- 1) To verify  $L_s = \lambda W_s$  from equation (5)  
 In this section, we have obtained that  $L_s = 6.7768$  from Equation (5) we have found that  $\lambda W_s = 23 \times 0.2946 = 6.7758 = L_s$  (appr.)
- 2) To prove  $L_q = \lambda W_q$

From the equation (3) we see that  $L_q = 4.2213$   
 Also from equation,  $\lambda W_q = 23 \times 0.1835 = 4.2205 = L_q$  (appr.)

V. OBSERVATIONS, SUMMARY

A. Observations:

In our study we have made the following observations the following results.

- 1) Intensity,  $\rho = 0.8518$
- 2) Probability that there are no customers in the system,  $P_0 = 0.0391$
- 3) Probability that an arrival has to wait,  $p(n \geq c) = 0.337$
- 4) Probability that an arrival enters the service without wait  $1 - p(n \geq c) = 0.6628$
- 5) Average queue length at any time  $L_q = 4.2213$  customers
- 6) Average number of customer in the system at any time  $L_s = 6.7768$  customers
- 7) Average waiting time of an arrival in the queue,  $W_q = 0.1835$  or hour 11 minutes.
- 8) Average waiting time of an arrival spends in the system  $W_s = 0.2946$  or 18 minutes (appr)
- 9) Average time of service = 9 minutes (appr)
- 10) Average number of arriving rate,  $\lambda = 23$  per hour.
- 11) Average number of service rate,  $\mu = 9$  per hour.

B. Summary:

After conducting the survey and the analysis of data obtained from the Kadathur State Bank of India the following predication are made regarding the characteristics of the queueing made 1 (M/M/C: ∞/FIFO):

- 1) An average of 23 customers are arriving to the counters in an hour.
- 2) Averages of 27 customers are being in the counters in an hour.
- 3) The traffic intensity  $\rho = \frac{\lambda}{c\mu} = 0.8518 < 1$  and therefore the queueing system followed in the Kadathur State Bank attains stability.
- 4) The probability that all the servers bring idle is nearly 15 percent.
- 5) The probability that an arrival has to wait before getting served is 85 percent.
- 6) The probability that an arrival enters the service straight away without having to wait is 14 percent.
- 7) At any time an average of 4 customers are found waiting in the queue.
- 8) At any time an average of 6.77 customers are found waiting in the system.
- 9) On arrival, a customer has to wait in the queue for 11 minutes before getting served.
- 10) On arrival, a customer has to wait in the system for 1.8 minutes before getting served.
- 11) A Cashier takes an average of 9 minutes to serve the customer.

VI. CONCLUSION

In our study we have found that it is optional that there are four clerks employed in the Kadathur State Bank of India counter. It means that if we add one more counter to the existing set up, the chance for a clerk to be idle would increase enormously except the holidays and festival days. But we can suggest them to open the non-working counter to work on the holidays and festival days. Also, if one counter is removed from the existing set up, the no of customers waiting in the queue would increase rapidly, thus it would end up in chaos.

Also we have analyzed that the intensity of the queueing system prevailing in Kadathur State Bank always remains less than unity and therefore the system attains marginally stability.

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