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IMPLEMENTATION OF SINGLE CHANNEL QUEUING MODELTO ENHANCE BANKING SERVICES

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ABSTRACT

Lines of waiting customers are always very long in most of the banks. Queuing is the common activity of customers or people to avail the desired service, which could be processed or distributed one at a time. Bank would avoid losing their customers due to a long wait on the line. Some of bank initially provides one service counter in every branch. But, one counter would not serve a purpose when customers arrive to use banking service and try to use other banking service. Thus the service time needs to be improved to maintain the customers.

This paper focuses on the bank lines system. To implement queuing management system in a bank single channel queuing system [M/M/1 : FCFS/∞/∞] is proposed. The model illustrated in this Bank for customers on a level with service is the single-channel queuing model with Poisson Arrival and Exponential Service Times (M/M/1). For this the data was obtained from a bank in the city. Then arrival rate, service rate, utilization rate, waiting time in the queue and the average number of customers in the queue based on the data using Little's theorem and M/M/I queuing model was derived. To implement single server queuing model and analyses the result for optimum queuing management system in a single window bank. Four week average customer arrival is taken as the input data for both the queuing model and the service rate is obtained by the average service rate per customer they have given

KEYWORDS: Queuing System, Single Server Queuing Model, Service Efficiency, First Come First Serve

1. INTRODUCTION

Queuing Theory: Is the mathematical study of waiting lines (or queues). The theory enables mathematical analysis of several related processes, including arriving at the queue, waiting in the queue (essentially a storage process), and being served by the server(s) at the front of the queue.

Characteristics of a Queuing Process

- **Arrival Pattern of Customers:** In queuing the arrival process is usually stochastic. As a result it is necessary to determine the probability distribution of the inter arrival times.
- **Service Pattern of Customers:** As in arrivals, a probability distribution is needed for describing the sequence of customer service time. Service may also be single or batch. The service process may depend on the number of customers waiting in queue for service.
- **Queue Discipline:** Queue discipline refers to the manner in which customers are selected for service when a queue has formed. The default is FCFS i.e. is first come first served. Some others are LCFS (last come first

served), RSS (random service selection)

- **System Capacity:** A queuing system can be finite or infinite. In certain queuing process there is a limitation on the length of the queue i.e. customers are not allowed to enter if the queue has reached a certain length. These are called finite queuing systems.
- **Number of Service Channels:** A queuing system can be single or a multi server system. In a multi server queuing system there are several parallel servers running to serve a single line.

2. QUEUING SYSTEM OR PROCESS

Entire queuing system can be completely described by:

- The input (Arrival pattern)
- The service mechanism or service pattern
- The queue discipline
- Customer behavior.

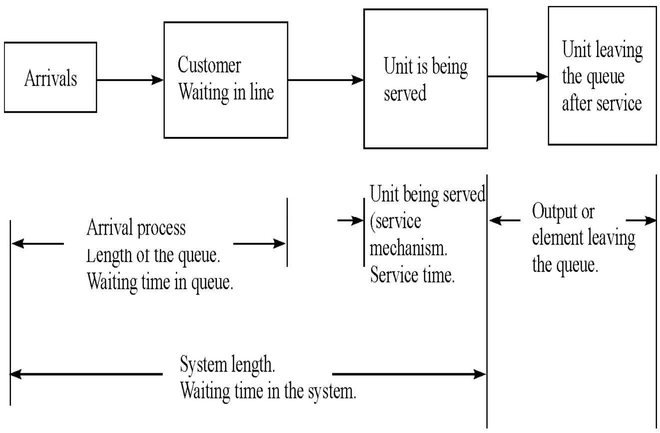

Figure 1: Queuing System or Process

2.1 Service Mechanism or Service Facility

Service facilities are arranged to serve the arriving customer or a customer in the waiting line is known as service mechanism. The time required to serve the customer cannot be estimated until we know the need of the customer. Many a time it is statistical variable and cannot be determined by any means such as number of customers served in a given time or time required to serve the customer, until a customer is served completely.

2.1.1 Single Channel Queues

If the organization has provided single facility to serve the customers, only one unit can be served at a time, hence arriving customers form a queue near the facility. The next element is drawn into service only when the service of the previous customer is over. Here also depending on the type of service the system is divided into Single phase and Multi phase service facility. In Single channel Single Phase queue, the customer enters the service zone and the facility will provide the service needed. Once the service is over the customer leaves the system.

2.2 Queuing Problems

- Queue length
- Waiting time
- Service time
- Average idle time or busy time distribution

2.3 Little's Law

Little's law, Little's result, or Little's theorem is perhaps the most widely used formula in queuing theory. It is simple to state and intuitive, widely applicable, and depends only on weak assumptions about the properties of the queuing system.

It says that the average number of customers in the system is equal to the average arrival rate of customer to the system multiplied by the average system time per customer.

Historically, Little's law has been written as

$L = \lambda W$

W is defined as mean response time, L refers to the average number of customers in the system and λ is the mean arrival rate.

2.4 Assumptions of the Model

- Arrivals are served on a FIFO basis.
- There is no balking or reneging.
- The average number of arrivals (the arrival rate) does not change over time.
- Service times occur according to the negative exponential probability distribution.
- The average service rate is greater than the average arrival rate.
- The waiting space available for customers in the queue is infinite.
- Arrivals are described by a Poisson probability distribution and come from an infinite or very large population.
- Service time also varies from one passenger to the next and is independent of one another, but their average rate is known.
- Both the number of items in queue at anytime and the waiting line experienced by a particular item are random variables.

3. QUEUING METHODS

For the optimization of queue length, waiting time and reducing service time of customer, several methods are used like simulation. But simulation does not produce optimum results. When the model deals with uncertainties the result of simulation are only reliable approximations subject to statistical error. In case of simulation many situation it is not possible to quantify all the variables that affect the behavior of the system. This model is, by no means a cheap method of analysis.

3.1 Queuing Theory

Instead of it, a queuing mathematical model based approach will be very beneficial in finding an approximate optimum range and too with less effort and less time. Time is very important factor in optimization because the banking service organization wants the quick and better solution to serve their customers. A queuing model based approach requires some data base of arrival of their customers and service rate that they given to customers and some analysis based on queuing model. It will not require expensive apparatus and large manpower.

The aim of this paper is to develop an optimization queuing model for the queue management parameters depicting the various assumptions involved in a banking process in terms of arrival of customers, service pattern, service discipline, waiting space and customers behavior. Then the objective function is optimized by applying the waiting line or queuing model with in some assumption. This paper proposes a very simple, effective and efficient way of optimizing queuing process with some assumptions like arrival of customers, service pattern, service discipline, waiting space and customer behavior.

This paper aims to improve the service rate and reduce waiting time of customer. For this data were collected from Chhattisgarh Grameen bank Arjuni, District – Dhamtari. Data includes 4 week customer's arrival in the bank, service rate by which each customer can get service, total no. of counter (service channel), and total working time of employee of bank. With the help of these data arrival rate and customer service time have evaluated.

Formerly Chhattisgarh Grameen Bank, Arjuni, Dhamtari didn't have queue management system. That result's the management was facing some problems regarding population management, analysis of their customers and working efficiency also. In this research paper some efforts are made to improve their working efficiency, analyzing the customer behavior, population in queue, waiting time of customer and reduce waiting time of customer.

3.3 Single Channel Poisson Arrivals with Exponential Service, Infinite Population Model [(M/M/1): (FCFS/∞/∞)]

Let us consider a single – channel system with poisson arrivals and exponential service time distribution. Arrivals are handled on 'First come First served' basis. Also the arrival rate λ is less than the service rate μ.

n = number of customer in the system (waiting line + service facility) at time t

λ = mean arrival rate (number of arrivals per unit of time)

μ = mean service rate per busy server (number of customers served per unit of time)

P_n = steady state probability of exactly n customer in the system

L_q= expected (average) number of customer in the queue

L_s= expected number of customer in the system (waiting + being served)

W_q= expected waiting time per customer in the queue

W_s= expected time a customer spends in the system (in waiting+ being served)

Wn= expected time a customer waits in line if he has to wait at all.

- Expected number of units in the system (waiting + being served)

$$L_s = \frac{\lambda}{\mu-\lambda} \tag{1}$$

- Expected no. of units in the queue, L_q

$$L_q = \frac{\lambda}{\mu} \times \frac{\lambda}{\mu-\lambda} \quad (2)$$

- Expected time per unit in the system (expected time a unit spends in the system),

$$Ws = \frac{1}{\mu-\lambda} \quad (3)$$

- Expeted waiting time per unit in the queue, W_q

$$Wq = \frac{\lambda}{\mu} \times \frac{1}{\mu-\lambda} \quad (4)$$

- Average length of non empty queue:

$$Ln = \frac{\mu}{\mu-\lambda} \quad (5)$$

- Average waiting time in non empty queue:

$$W_n = \frac{1}{\mu-\lambda} \quad (6)$$

- Probability that the queue is non empty

$$p(n>1) = \left(\frac{\lambda}{\mu}\right)^2 \quad (7)$$

- Probability that more than 2 customer at the counter

$$= = 1-[p_0+p_1+p_3] \quad (8)$$

- Variance of queue length:

$$\sigma = \frac{\frac{\lambda}{\mu}}{\left[1-\frac{\lambda}{\mu}\right]}2 \quad (9)$$

OBSERVATION AND DISCUSSIONS

Experimental Validation of the Queuing Model

Average number of customer in total 4 weeks	=	59.0416
Average arrival rate of customer a day	=	59.0416
Average working hour of employee in bank	=	5 hours/day
Average arrival rate of customer in a day (λ)	=	11.808 customer/hour
	=	0.19680 customer/min.
Expected service rate to customer in a day (μ)	=	15 customer/hour
	=	0.25customer/min.

Utilization rate (ρ) = $\left[\frac{\lambda}{\mu}\right]$ = 0.78722

Utilization rate (ρ) = 0.78722 < 1

Table 1: Data Taken from Chhattisgarh Grameen Bank, Arjuni, Dhamtari

Week	Monday	Tuesday	Wednasday	Thusday	Friday	Saturday
1	95	80	60	64	57	35
2	75	71	63	45	39	37
3	70	68	55	52	66	49
4	63	61	57	56	50	51
Total	303	280	235	215	212	172
Average 4 Week	75.75	70	58.75	53.75	53	43

Table 2: Results of [M/M/1] Single Server Queuing Model

Serial Number	Notation	Single Channel
1	L_s	3.6996
2	L_q	2.9124
3	W_s	18.798
4	W_q	14.798
5	Ln	4.699
6	W_n	18.798
7	P_{idle}	21.27 %
8	$P_{waiting}$	78.73 %
9	ρ	0.78722
10	σ	17.38
11	$P_{more\ than\ 2\ customer}$	48%

Table 3: Monthly Customer Count Observed Data from Chhattisgarh Grameen Bank

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Week 1	95	80	60	64	57	35
Week 2	75	71	63	45	39	37
Week 3	70	68	55	52	66	49
Week 4	63	61	57	54	50	51

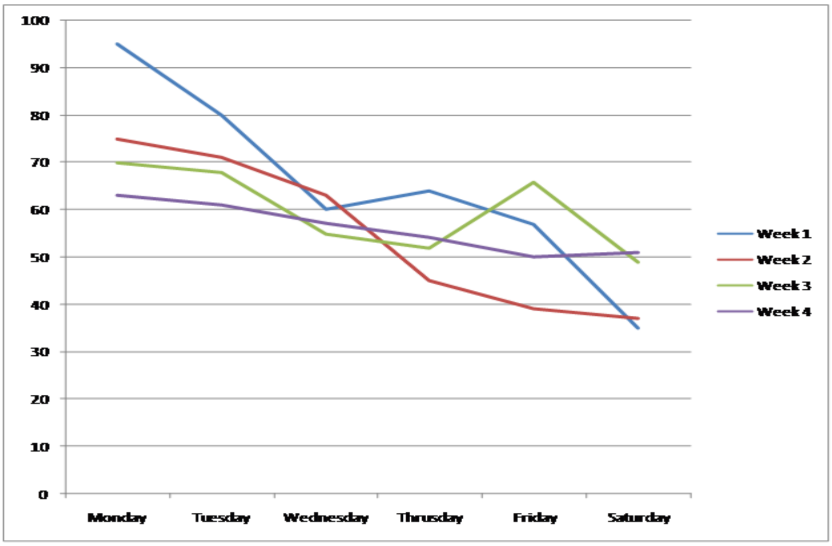

Figure 2: Monthly Customer Count Observed Data from Chhattisgarh Grameen Bank, Dhamtari Customer's Arrival

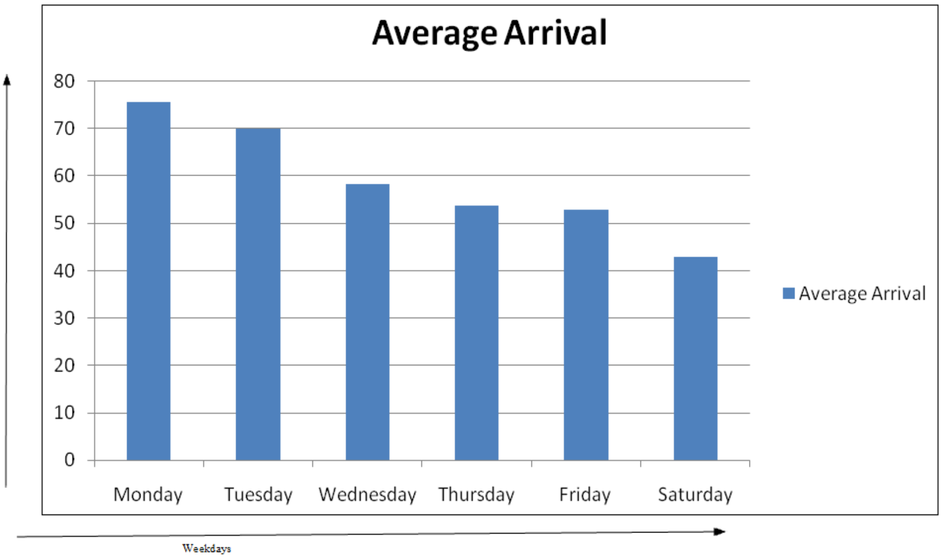

Figure 3: (M/M/1) Expected No. of Customer's Arrival in the System Vs Days

RESULTS

- Expected number of units in system, (L_s) = 3.6996
- Expected no. of units in the queue, (L_q) = 2.91246982
- Expected time per unit in the system, (Ws) = 18.79830 min.
- Expected waiting time per unit in queue, (W_q)= 14.79830 min.
- Average length of non – empty queue, (L_n) = 4.69968
- Variance of queue length, (σ) = 17.3887
- Average waiting time in non empty queue = 18.7987 min.
- Probability that employee will be idle,(p_0) = 21.27%
- Probability that more than 2 customer at = 48%
- Number of hours each day a = ρ×ρ total working hour employee spends doing his job

  = 3.9361 = 4 hour (approximate)

5. CONCLUSIONS

In this paper waiting line theory is optimize for customers arrival rate, service rate, average no. of customers in the system and queue, average time any customer spend in system or queue, utilization rate and the efficiency of the system by applying [M/M/1] queuing model. The overall conclusion can be stated as under:

- For the total average arrival of customers in the bank single server queuing model [M/M/1] gives the optimum result.
- [M/M/1] have high rate of utilization ratio, working efficiency and less percentage of idle employee.
- The average number of customer in the queue and system, average time spent by any customer in system and queue and the traffic intensity of [M/M/1] queuing model is practical and better.

- Queuing theory also provides to the organization a data base of their customer. By adopting or applying queuing theory optimization method the organization have queuing management tool or queue management strategy.

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