Determining Flow of Arrivals in Decision Making by the Application of Queuing Theory

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Abstract: ***The places where customers are implicated such as cafeterias , post offices ,departmental store, banks , petrol pumps , restaurants ,airlines counters , cinema halls ,patients in clinics etc are expected to have waiting lines. Waiting line or queuing theory helps in sorting out the problems and is useful in a variety of business situations. When the requirement is more than supply and is difficult to make obtainable related to service or when the offered demands exceeds the existing capacity queue generates .waiting lines also results in when the speed of providing service is higher than the arrival rate due to irregular pattern of arrival of customers. Queuing theory improves the business by providing sufficient concept to the managers that facilitates and boosted their knowledge and aids them in taking their decision. An incorrect decision may affect the income of the organization and the organization may experience a great loss. The proposed work stresses on the function and application of queuing theory. The proposed methodology depicts that queuing theory can be effective tool in decision making tool in numerous situations and conditions. The empirical case is exposed to confirm the legitimacy of the proposed methodology.***

Keywords: Arrival Rate, Customer Satisfaction, Efficiency, Queuing Theory, Margin of Safety.

1. Introduction

In today's era everybody is in hurry and demands service at a rapid and fast rate. For quick and rapid service the numerous customers are ready to pay some additional money on behalf of service acquiring. Service is the need of every human being in today's scenario and is demanded by them in fast response way without making them waiting in any queue as it affects their working time. It is a regular experience to see a bulky digit of persons waiting in front of a booking counter in everyday life.

A decision regarding the amount of capacity in terms of service provider (server) must be accountable by the servicing firms to relief the potential customers by providing services as early as possible. The service providing firms should always assumed that the persons standing in the queue can loss their patience and can move to other similar firm providing the same service. So it is a great concern by the service provider to look into such situations with the major objective of customers satisfaction .The valuable time of the potential customers should have to be given due weight age. The paper presented is trying to outline a concept and emphasizing the decision maker for the adoption of the methodology to take decision in respect to formulation of queue [-5].

The formulation of queues or waiting lines is a common practice in our everyday life. Queue generates when the presented demands is more than the existing supply. Queues also formed even when the speed of providing service is superior to the rate of incoming customers due to random pattern of arrival of clients. The paper aims to advance and enlighten the intuitive and physical understanding of the academic concepts of queuing [1-7].

Queuing theory plays a very important role in decision making and helps in modeling the problem of waiting in lines. This paper will assist in determination of queuing theory model along with example of the model. This paper recommended a line of attack which helps the reader in boosting their knowledge to take decision by queuing concepts. Figure.1 illustrates the elements of queuing system.

The decision making in queuing modele always support to have the solution of problem. While the problem is complicate in arrival time estimation is being solve the queuing mathematical models. The diagram has shown below [8-10].

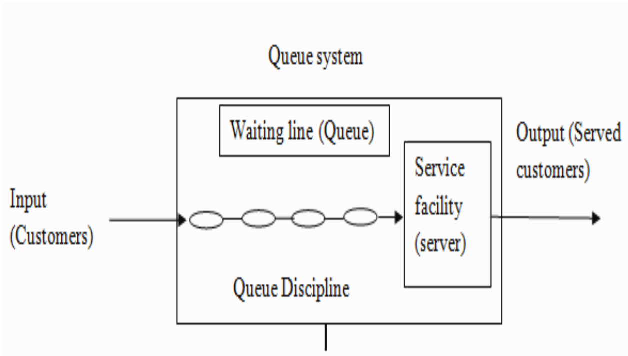

Figure 1: Basic Elements of Queuing Model

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2. Assumptions

There are varieties of queuing models. These queuing models are represented by various notations and parameters like some arrival and service distribution, customer behavior, number of channel facilitating, capacity of the system ,queue discipline, etc. Certain assumptions are set while dealing with the specific queuing model. In this paper we are considering M/M/1: FCFS/∞ model which can be described in the following way [5-9]:

- The arrival rate is approximated by a Poisson distribution and the mean arrival rate is denoted by Ω.
- The service rate is approximated by an exponential distribution and the mean service rate is denoted by ζ.
- The service rate is higher than the arrival rate.
- The queue discipline is FCFS (first come first served).
- The place of offering service is merely single i.e. only one service channel.
- The number of customers being served is infinite.

Table 1: Summary of formulas used for Analysis in Single Server Queuing Model

S. No	Summary	Formula
1.	The traffic intensity or system utilization or busy period probability	$\varpi = \frac{\Omega}{\xi}$
2.	The probability that the server remains idle	$P_{idle} = 1 - \varpi = 1 - \frac{\Omega}{\xi}$
3.	The probability that there should be N customers in the system	$P_{customers} = P_{idle} \left(\frac{\Omega}{\xi}\right)^N$
4.	The expected number of customers waiting in the queue	$N_{queue} = \frac{\varpi^2}{1-\varpi}$
5.	The expected number of customers waiting in the system	$N_{system} = \frac{\varpi}{1-\varpi}$
6.	The mean waiting time of a customer in the queue	$W_{queue} = \frac{\varpi}{\xi - \Omega}$
7.	The mean time of a customer waiting in the queue and taking service	$W_{system} = \frac{1}{\xi - \Omega}$

3. Problem Statement: An Empirical Case

In this segment we are accounting the case of Bus Company whose object is to determine the increase in flow of arrival for facilitating their customers during distribution of tickets , but the major question lies in defining the methodology for determining the rise in flow of arrivals so that the company will decide to install an additional window for their customers satisfaction .the company has decided the policy of waiting time for their customers and have decided that if the waiting time of their potential customers in queue remains 10 minutes then the company will install one more counter.

It is found that the arrivals at the window server are reflecting Poisson distribution pattern with an average time of 3 minutes between arrivals and it takes on an average 2 minutes by the window server to print a ticket and is reflecting exponentially distributed pattern. The objective of the decision maker is to select the methodology which will enable their customer to stand in the queue for a certain time period with discipline and satisfaction. Table.2 depicts the data representation of the situation.

Table 2: Data Representation of the proposed Situation

Arrival =		**Service =**	
Time (minutes)	Rate (customers /minute)	Time (minutes)	Rate (customers /minute)
3 minutes	1/3	2 minutes	1/2

The projected case discussed in this paper can facilitate the decision maker in taking their decision. The accomplishment of the projected case deals with arrival rate and service rate as their input .The model incorporates the following steps:

Step: 1 the mean arrival time of the customers during busy hours should be assessed by the decision maker.
Step: 2. Service time of the corresponding server should be calculated on an average.
Step: 3 new arrivals Rate have to be calculated by exploiting the concept of waiting time in queuing theory
Step: 4 the difference in new arrival time and the existing arrival time should be computed
Step: 5 the computed difference should be interrelated in terms of customer's satisfaction parameter to take judgment.

Table 3: Calculations by Queuing Model

Arrival rate = $\Omega = \frac{1}{3}$ Customers /Minute Service rate = $\zeta = \frac{1}{2}$ Customers /Minute
Server utilization= $\varpi = \frac{\Omega}{\xi}$ $= \frac{1/3}{1/2}$ =0.66
Server Busy Period (8 Hours Shift) = 0.66*8 hours =5.28 hours
Server Idle Period (8 hours shift) =(1- ϖ)*8 hours =(1-0.66)*8 hours =0.34*8 hours =2.72 hours
Company policy is to facilitate their customers by making them not waiting in the queue for more than 10 minutes. Waiting time of a customer in the queue as per queue model can be calculated by $\frac{\varpi}{\xi - \Omega}$ Waiting time of a customer in the queue as per company policy=10 minutes Thus $10 = \frac{\varpi}{1/2 - \Omega_{new}}$

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Where Ωnew= New Arrival Rate to determine

$$10 = \frac{\frac{\Omega_{new}}{1/2}}{1/2 - \Omega_{new}}$$

$$\Omega_{new} = \frac{5}{12}$$

Increase in arrival rate

$$\Omega_{increase} = \Omega_{new} - \Omega$$

$$= \left(\frac{5}{12} - \frac{1}{3}\right) customers / minutes$$

$$= \frac{1}{12} customers / minutes$$

$$= \frac{1}{12} * 60 customers / hour$$

$$= 5 customers / hour$$

The calculation shows that if there will be an increment of approximately five customers in one hour the company will install one more additional counter to facilitate their customer by making their waiting time as 10 minutes in the queue. Queuing theory provides huge amount of unconventional mathematical models for unfolding and solving waiting line troubles. The recommended methodology helps in formulating an appropriate balance linking customer relief and the waiting time. The chief matter in waiting line cases is to decide the most excellent level of service that the institute should offer .Delays in service crossing due time may respond in losing future trade opportunities and business practice. Figure 2 & 3 highlights the Existing and required increase in existing arrival rate in customers/hour in terms of histogram and pie chart.

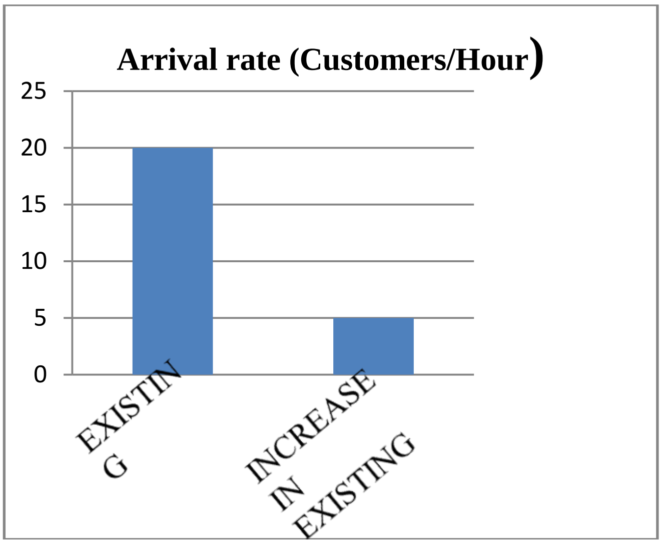

Figure 2: Histogram indicating existing and required increase in existing arrival rate in customers/hour

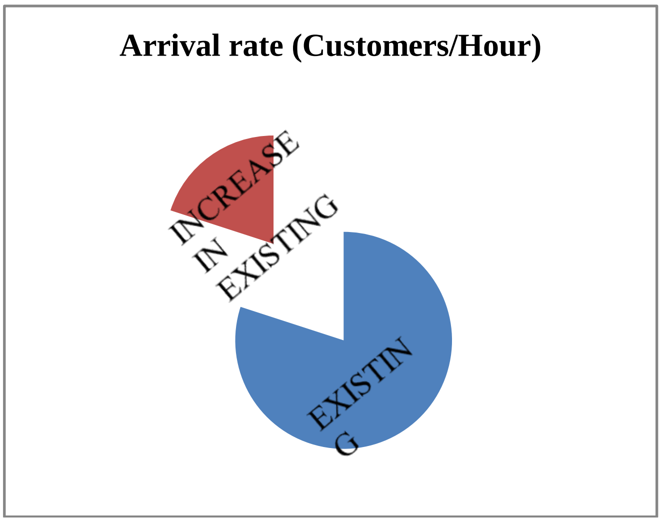

Figure 3: Pie Chart indicating existing and required increase in existing arrival rate in customers/hour

4. Conclusions

Queues or waiting line effects our everyday working life and mostly irritates in case when the customers or employees have to wait more than expected or waiting time in the queue before getting services exceeds our potential energy. Many researchers have stressed and suggested various concepts defining the behavior of the customers while in the queue. This methodology facilitates the decision makers while dealing with certain case of customer's dissatisfaction among the firm or company in context of exceeding waiting time in the queue. The presented case depicts that currently twenty customers are arriving in one hour .The calculation explicates that approx five customers in one hour should be increased to make the waiting time of the existing customers as 10 minutes .The methodology describes that there should be an increment of 25 % in the arrival rate to implement the company policy .The proposed calculation alerts the company that if the customers arriving in their booth increases by approximately five customers in one hour than the company must install second window server to facilitating their customers comfort and satisfaction and this methodology enables the management in deciding the safety margins for their company. Moreover, the work articulates the reader in understanding the basic thoughts and aids them in determining the supportive information such as busy and idle time of the corresponding server from a particular queuing system.

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