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AN ANALYSIS OF M/M/1: ∞/FCFS QUEUING MODEL BASED ON SUPER MARKETS

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Abstract
Igwe et al. (2014) remarked that queues are common in such places as fuel stations, departmental stores, clinics, hospitals, motor parks, and manufacturing firms, to mention a but a few. An interesting aspect of queuing process resides in the measures of its system's performance, in terms of average service rate, utilization ratio and the costs implied for a given capacity level. Yuejian (2010) suggested that under the condition of market economy, enterprises pursue for the maximum profits with fixed costs. Facing today's serious market competition, supermarket should not only satisfy customers' needs but also make best use of service sources. He further remarked that chain supermarket, as a new business mode, brings about the second revolution of retail commerce due to its special sale mode high sales, low profits, competitive price and quality, self- service, and one- for-all purchase. This business mode at some extent drives the circulation of commodities. There is a require to improve on the service facilities in these supermarkets. The present paper discussed about the queuing models and average utilization factor ratio in different supermarkets. The "M/M/I" model is applied to its relative simplicity as well as its relevance to the firms under-studied: particularly the service unit of each of the supermarket. Comparative study with respect to queuing model among supermarkets in a city, India as a sample has been observed. The present paper shows that service rate is high .The present development would be valuable addition to the human resources development managers and entrepreneurs.
Keywords: queuing models, average utilization ratio, supermarket

1. Introduction:

Queuing theory is the mathematical study of waiting lines, or queues Sundarapandian, (2009). Luca et al. (2015) remarked that queuing theory became a field of applied probability and many of its results have been used in operations research, computer science, telecommunication, traffic engineering, and reliability theory. Green and Kolesar (1989) explained that queuing theory provides good approximations of the system behavior. In a blog.lavi.com (2012) motioned that every business or venue has their own unique challenges when it comes to customer flow and queue strategy, but there are three culprits that show up time and time again as the most challenging queuing problems. Here is how to manage the issues that are plaguing the efficiency of your line

and the moods of the people waiting within it. Challenge are make the line move faster, Keep people happy, and Making a clear clue to queue. The process of queue formation and propagation is defined as queuing theory. As per the concepts of investopedia, queuing theory is a mathematical method of analyzing the congestions and delays of waiting in line. Queuing theory examines every component of waiting in line to be served, including the arrival process, service process, number of servers, number of system places and the number of customers. Real-life applications of queuing theory include providing faster customer service, improving traffic flow, shipping orders efficiently from a warehouse and designing telecommunications systems such as call centers.

Now, Igwe et. al. (2014) suggested that delays and queuing problems are the most common features not only in our daily-life situations such as at a bank or postal office, at a ticketing office, in public transportation or in a traffic jam but also in more technical environments, such as in manufacturing, computer networking and telecommunications. They play an essential role for business process re-engineering purposes in administrative tasks. Queuing models provide the analyst with a powerful tool for designing and evaluating the performance of queuing systems (Bank 2005). Whenever customers arrive at a service facility, some of them have to wait before they receive the desired service. It means that the customer has to wait for his/her turn, may be in a line. Customers arrive at a service facility with several queues, each with one server.

The customers choose a queue of a server according to some mechanism (Adan et al. 2000). Igwe et al. (2014) further suggested that sometimes, insufficiencies in services also occur due to an undue wait in service may be because of new employees. Delays in service jobs beyond their due time may result in losing future business opportunities. Queuing theory is the study of waiting in all these various situations. It uses queuing models to represent the various types of queuing systems that arise in practice. The models enable us into finding an appropriate balance between the cost of service and the amount of waiting. Some references are Schwarz et al. (2006), Simaiakis and Balakrishan (2009), and Medhi (2002). While analyzing the data contribution of following authors were considered, Priyangika & Cooray (2016) , Prasad et al. (2015) , Gupta & Hira (2008), Bakari et al. (2014) ,Vasumathi & Dhanavanthan (2010), Sharma and Barua (2015), Priyangika & Cooray (2015).
Yuejian (2010) explained that the supermarket service model is in accordance with facts in general. However, there are still some defects and problems hard to be solved. Firstly, supermarket service is a flowing service system. In this data are merely records during certain time period in one area. Supermarket service system has a strong liquidity. Customers may face kinds of choices. Secondly, customers' choice for supermarkets is affected by personal income, geological location, and consumption preference. This model does not take these factors into consideration. It is not in accordance with facts and will affect the preciseness of the model. The present paper discussed about the queuing models and average utilization factor ratio in different supermarkets. The "M/M/I" model is applied to its relative simplicity as well as its relevance to the firms under-

studied: particularly the service unit of each of the supermarket. Comparative study with respect to queuing model among supermarkets in Chhattisgarh, India as a sample has been observed. The analysis shows that utilization is rather too high on the average. The present development would be valuable addition to the human resources development managers and entrepreneurs.

2. Research Methodology and Data Collection:

In this research, descriptive and quantitative research design is being used and applying queuing simulation on the collected data. For this research both primary as well as secondary data is collected. The primary data is collected on the basis of observations of customer arrival and service in supermarkets. Total population is infinite and Sample size is 130 customers and Sample units are 3 supermarkets.

3. Proposed M/M/1: ∞/FCFS model:

Here, the arrival rates on based on FCFS (first come first serve basis) model. The methodological frameworks used for this study were the M/M/1. It means a memory less queuing system. It is the most basic queuing system. The first M means that the Markovian arrival is in consonant with the Poisson process i.e. units acting independently coverage at a point or spot. The second M implies memory less (exponential) Markovian service times. The "1" means only "one serve". The model is depicted below in five equations:

$Lq= \lambda^2/\mu(\mu-\lambda)$; $L= \lambda^2/(\mu-\lambda)$; $Wq= \lambda/\mu(\mu-\lambda)$; $W= 1/(\mu-\lambda)$; , $P= \lambda/\mu$

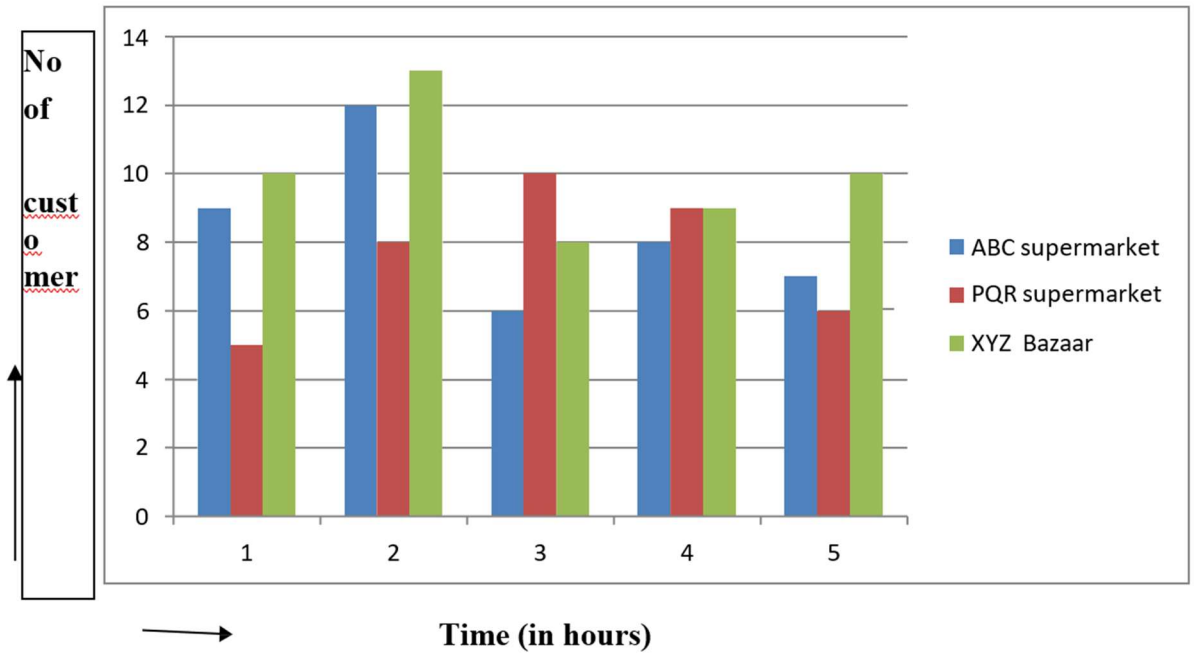
Where, λ = arrival rate and μ= service rate, Lq = average number of customers in the queue, L = average number of customers in the system. Wq = average time spent waiting for service, W = average time spent in the system. P = utilization i.e. the proportion or percentage time each server is busy.

Theoretical framework is based on the assumption that average arrivals and average service follow the Poisson discrete probability distribution. The average inter-arrival time and the average services time follow the exponential distribution. 1. Make the line move faster 2. Keep people happy: and 3. makes a clear clue to queue: The versatility of a belted stanchion will give your line clarity and visibility and guide people along the way once they've reached the correct queue. In fact, a belted stanchion is the single most notable clue to a queue. Add post-top signage and banners to further enhance the visibility and definition of the queue entrance while also telling your customers where they should stop, wait, or conduct any activities that need to happen before they reach an agent. A simple instruction such as 'Line Starts Here' can go a long way toward alleviating tension and helping to relax waiting customers. Comparative study in ABC supermarket, PQR supermarket, and XYZ Bazar, of city.: In this section, three supermarkets of place have been selected as ABC supermarkets, PQR supermarkets and XYZ Bazar. For the comparative study among all these supermarkets the customer arrival rate as well as service rate

would be determined and calculated through simulation. The table 5.1 shows the customer arrival rate/hour in all the three supermarkets and in table 5.2 the service rate/hour of all the three supermarkets would be determined.

S. No.	ABC supermarket	PQR supermarket	XYZ Bazaar
1	9	5	10
2	12	8	13
3	6	10	8
4	8	9	9
5	7	6	10
Total	42	38	50
Mean(λ)	**8.4**	**7.6**	**10**

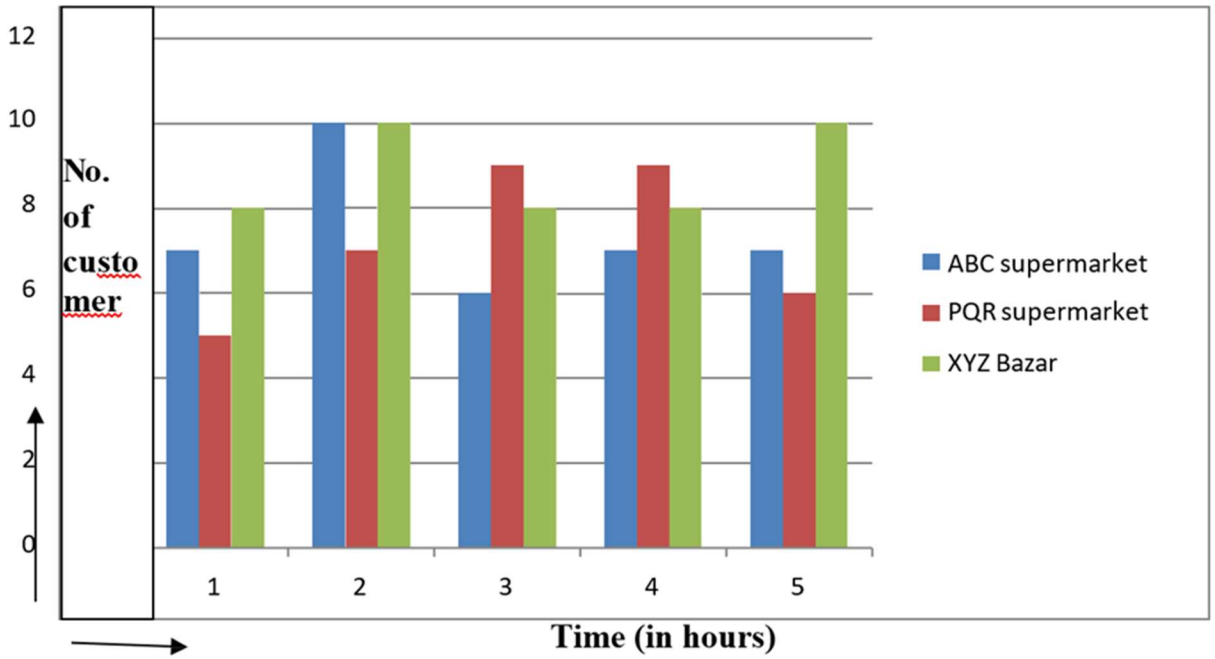
Table 5.1: Customer arrival rate/hour



S.No.	ABC supermarket	PQR supermarket	XYZ Bazar
1	7	5	8
2	10	7	10
3	6	9	8

4	7	9	8
5	7	6	10
Total	37	36	44
Mean(μ)	**7.4**	**7.2**	**8.8**

Fig.5.2 Service rate/hour

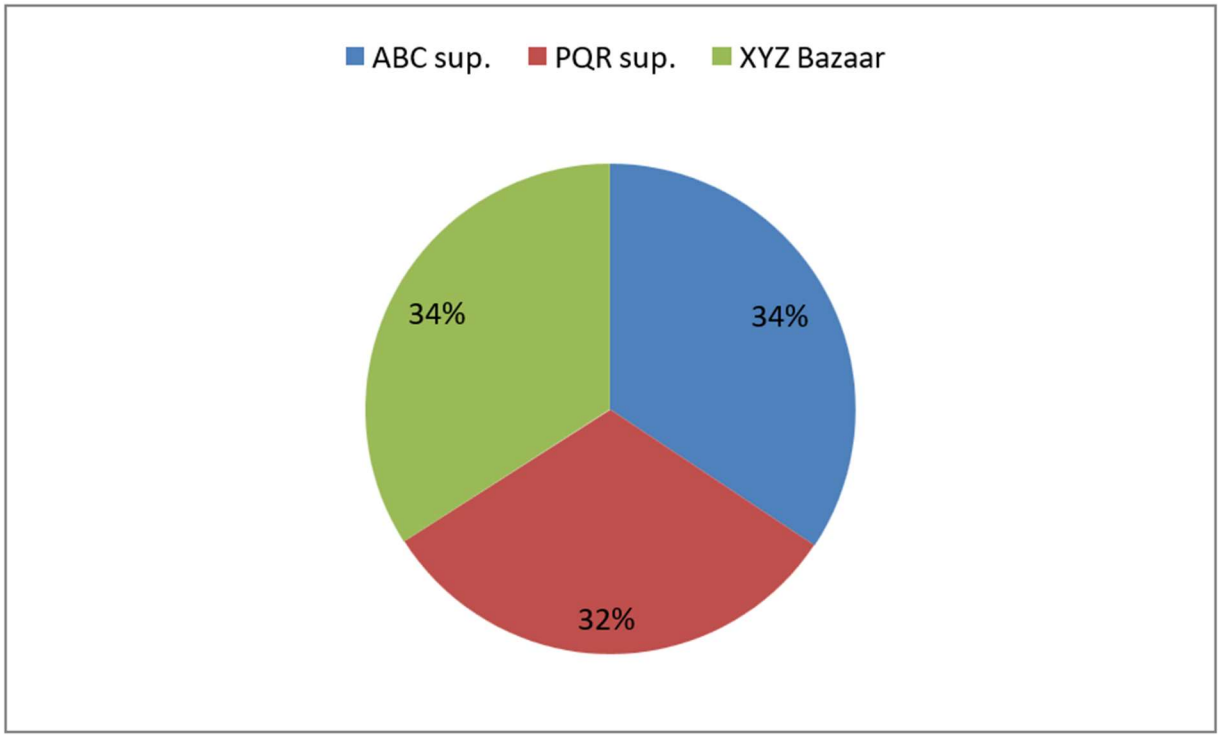


On comparing customer arrival rate/hour among three supermarkets, it has been identified that mean arrival rate of XYZ Bazar is higher as compared to others. While on service rate/hour PQR supermarket has minimum value. By analyzing the whole data, it is to be concluded that average no. of customers in the queue and the system of PQR supermarket is more as compared to ABC and XYZ Bazaar and average time customer spent waiting for service and in the system is more in PQR supermarket. Along with the customer arrival rate and service rate, the utilization factor is also determined as shown in table 5.3.

Table 5.3 Calculation of utilization factor among three supermarkets

Super Market	$Lq= \lambda^2/\mu(\mu-\lambda)$	$L= \lambda^2/(\mu-\lambda)$	$Wq= \lambda/\mu(\mu-\lambda)$	$W= 1/(\mu-\lambda)$	$P= \lambda/\mu$
ABC super.	9.53	70.56	1.14	1	1.14
PQR super.	20.05	144.4	2.63	2.5	1.05
XYZ Bazaar	9.46	83.33	0.95	0.83	1.13

Fig. 5.3 Average utilization in supermarkets



On comparing the average utilization factor among all the three supermarkets it is found that PQR supermarket has less (32%) utilization of customer and service.

4. Conclusion and Discussion of the Result:

The present investigation shows that service rate was not optimal. We have identified that the service was too long. The customers are wailing time is too long as the customer came for their limited time. The supermarket should increase the service rate. The shopkeeper should maintain the queue discipline; there should be clear sign board that from where to start the queue and what are rules should be followed. Yuejian (2010) conclude that chain supermarket, as a new business mode, brings about the second revolution of retail commerce due to its special sale mode 'high turnover, low profits, competitive price and quality, self-service, and one- for-all purchase'.

This business mode greatly drives the circulation of commodities. There is a need to improve on the service facilities in these supermarkets. The maintenance and replacement costs were rapidly skyrocketing. The automation can be applied to enhance labor productivity. The management should consider the optimum level of average utilization so that overall effectiveness of service rate and can improved. The labor can be given some kind of training to maintain their efficiency towards the service. In order to motivate the workers to increase their productivity in the place, overstress an input should be removed.

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