UGC Approved Journal
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ISSN : 2454 – 308X | Volume : 04 , Issue : 05 | May 2018

A Case Study for Improvement in the quality of Service of the Eatery using Queuing Theory

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Abstract- Queuing theory is part of operational research (branch of mathematics) that deals with waiting lines. Queuing theory works with construction of model for the prediction of waiting time. This is a general problem faced at each famous café or restaurant is decrease in the number of clients because of long waiting/holding line. Therefore, we need a model for management of restaurant so that the situation can be understood in a better way. In this paper, we show that the model is satisfied by queuing theory for a real case scenario. We collected data from the "Fauji da Dhaba" eatery, Rohtak, Haryana for deriving different parameters such as holding up time of a queue, service frequency, incoming rate of customers, expected shy away customers. Little's theorem, and M/M/1 queuing model is used for analysis. The customer arrival rate during busy hours of the day is 3.01 clients in a minute and service rate is 3 clients per minute as per our results. The value of average clients calculated is 165 and utility rate is 0.9966.

Keywords:- Queuing Theory, M/M/1 model, Little's theorem.

1 INTRODUCTION

Based on few elements, a café is decided to be decent or amazing. Taste, neatness, the café setup and sitting arrangements are the most influencing elements. These factors, when observed in depth, will result in increase in number of a lot of clients. Nonetheless, there is likewise another factor that should be considered particularly is, the clients queuing time. During the service, the customer's exchange with the staff might be proficient, considerate, and complete. However, unpleasant experience of how much time required to stand out to be noticed contaminates the general decisions that we make about the nature of assistance and facilities. In a waiting line framework, directors should choose the quality of services to be offered. The low degree of assistance might be low price, basically for the short time period, yet may cause significant expenses of client disappointment, such as vanishing of business for future and genuine handling expenses of objections. Queuing theory is the investigation of line or holding up lines. Some analysis used for deriving and utilizing queuing theory are average time in the framework, the probability of customers served at a moment, the probable holding time, the expected number of shying away customers, the expected line length, just as the likelihood of the framework to be in certain states, like vacant or on the other hand full. During lunch and evening meal time, the holding up lines are observed more in eateries. Henceforth, we can apply queuing theory because

it has line same as in an eatery a holding up line of clients can be observed who are waiting (stand by) for service. Analysts have recently utilized queuing theory to demonstrate the eatery activity [2], decrease process duration in a bustling drive-thru eatery [3] to increment throughput, and productivity [5]. This paper utilizes queuing theory to consider the pausing lines in "Fauji da Dhaba", Restaurant at Rohtak, Haryana, India. This café has 4 seats table and 8 seats table, with a total of 35 tables. In this restaurant, 20 servers are working at a time. Consistently it serves more than 750 clients during work days and more than 1450 clients during end of the week. In this paper tries to describe the handiness of application of the queuing theory in a genuine case circumstance.

2. QUEUING THEORY

The invention of queuing theory was run by Agner K. Erlang in 1908. He was an engineer Copenhagen Telephone Company. He desired to find the number of telephone operators required to process given number of calls. He found that the phenomenon fit into exponential distribution and Poisson distribution. In this part, we will talk about two normal ideas in queuing theory.

A. Little's Theorem

Little's theorem [5] discusses about the capacity (for example appearance, and administration rate), arrival rate and time spent (for example number of clients/occupations in the framework) in the system. This theorem holds validity for a lot of queuing models. According to this theorem, the probability of no. of clients in a consistent state system may be resolved utilizing the accompanying condition:

$$L = \lambda t \qquad (1)$$

Where, λ = normal client appearance rate,

t = normal help time for a client,

L = no. of clients in the eatery.

Let us consider the case of a café when the client's appearance rate doubles, however the clients actually invest a similar measure of time in the eatery (t). These realities will dual the no. of clients (L) in the eatery.

By the same rationale, if the client appearance rate (λ) stays as before yet the client’s administration time duplicates this will likewise dual the all-out number of clients in the eatery. This demonstrates that in request to control the three factors, administrative choices are just needed for any two out of the total three factors. Three central connections can be derived from Little's theorem [6]:

- L increments if λ or t increments.
- λ increments if L increments or t diminishes.
- t increments if L increments or λ diminishes.

According to Rust [8], the Little's theory can be valuable in evaluating the most extreme feasible functional upgrades and furthermore to assess the exhibition change when the framework is altered.

B. Kendall's Notation and Queuing Models

The standard factors in a queue are client and worker. After arriving at an assistance centre, they can begin administration promptly or stand by in a line if the office is occupied. From the angle of dissecting queue, the appearance of clients is addressed by the cover appearance time between progressive clients, and the assistance is presented by the assistance time per client. The queuing conduct of clients assumes a part in holding up line analysis. “Human" clients may jockey starting with one line then onto the next in the desire for slowing holding up time. They may likewise recoil from consolidating a line all due to expected long postponement, or they might renege from a line since they have been standing by excessively long. Much of the time, queuing models can be presented by the sequent components:

Arrival time distribution: Poisson distribution, Deterministic circulation, or a General circulation are most regularly categorized distribution patterns of inter-appearance times. In any case, inter-appearance times are regularly considered autonomous and memoryless, that are traits of a Poisson distribution.

Service time distribution: For determining the service time, first we need to identify the servers in the system. Service time distribution is the measure of how fast or slow a system is. It may be constant, exponential, hypo or hyper exponential. The help time dispersion can be steady, exponential, hyper- exponential, hypo- exponential or general. It does not depend on the inter-appearance time.

Number of workers: The computations of queuing is affected by the number of workers i.e. whether a solitary worker or multiple workers are serving for the line. A line with one worker is called single worker line. This is the situation typically happen at a book store when each cashier has a line of customers waiting for payment. A multiple worker line scenario is same as bank situation wherein a one line hangs tight for first few tellers for turning into accessible.

Lengths of Queue (discretionary): The queue length demonstrates the average no. of the clients waiting for a framework. This incorporates the clients holding up in the line.

Queuing discipline (discretionary): There are a few prospects as far as the grouping of clients to be served like FIFO (First In First Out, for example arranged by appearance), arbitrary request, LIFO (Last In First Out, for example the late comers will be served quickly), SIRO (Service in Random Order).

Queuing Capability (discretionary): The clients of a framework may vary from 1 - limitlessness. Kendall proposed a documentation framework to address the 6 attributes talked about above in 1953. The variable notation of a queue can be written as:

A/S/N/M/P/D

A portrays the circulation sort of the bury appearance times, S portrays the circulation type of the assistance times, N portrays the quantity of workers in the framework, M (discretionary) portrays the most extreme length of the line, P (discretionary) portrays the size of the framework populace and D (discretionary) portrays the queuing discipline.

3. " Fauji da Dhaba" QUEUING MODEL

The data of daily no. of guests was acquired from the café itself. The café recorded the information as a component of its finish of day schedule. We likewise met the café chief to get some answers concerning the limit of the café, the quantity of servers just as the quantity of cooks in the café.

In view of interview with café chief, we found the best suitable model for the presentation of the activity of "Fauji da Dhaba" is M/M/1.

This implies that the appearance and administration time are dramatically dispersed (Poisson measure). The café framework comprises of just a single worker. In this analysis, the eatery has multiple waitress however they have only one cook for serving all the clients. Figure 1 shows the M/M/1 queuing model.

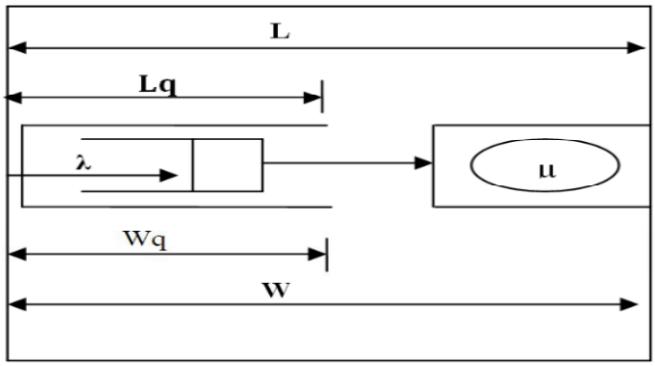

Fig.1: M/M/1 Queuing Model

For this survey of the "Fauji da Dhaba" M/M/1 Queuing Model, the accompanying factors will be researched [6]:

λ: The mean clients appearance rate
μ: The mean help rate
ρ: λ/μ: usage factor

Likelihood of zero clients in the café (Po) is given by

$$P_o = 1 - \rho \qquad (2)$$

P_n: The likelihood of having n clients in the café.

$$P_n = P_0 \rho^n = (1 - \rho)\rho^n \qquad (3)$$

L: normal number of clients eating in the café.

$$L = \frac{\rho}{1 - \rho} = \frac{\lambda}{\mu - \lambda} \qquad (4)$$

L_q: normal number of clients in the line.

$$L_q = \frac{\rho^2}{1-\rho} \qquad (5)$$

W: normal time spent in BKK including the holding up time.

$$W = \frac{1}{\mu-\lambda} \qquad (6)$$

W_q: normal holding up time in the line.

$$W_q = \frac{L_q}{\lambda} \qquad (7)$$

4. RESULTS AND DISCUSSIONS

The examination of one-week is displayed with chart beneath dissected by us at evening meal slot.

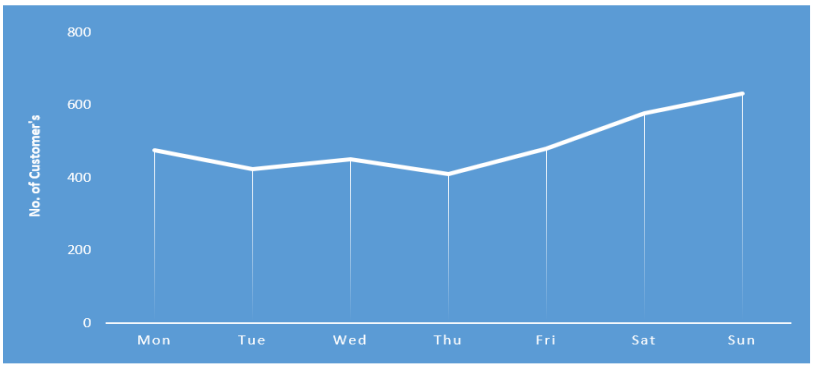

Fig.2: Analysis of No. of Clients showing up in eatery for one week

As can be found in Figure 2, the quantity of clients on Saturdays and Sundays are twofold. The most active period for the eatery is on weekends.

The maximum number of customer's is obtained on weekend during evening meal time. Consequently, centre our examination in this time window. Creators dissected the eatery between 18 to 21 hours.

A. Calculations

Our groups led the exploration at evening meal time. There are normally 450 people that come to the eatery in 2.5 hours' time period of evening meal time. From these observations, appearance rate can be inferred as: $\lambda = 450/150 = 3$ customer each moment (cpm) We additionally discovered

from perception and conversation with supervisor that every client goes through 55 minutes on normal in the eatery (W), the line length is around 25 individuals (Lq) all things considered and the holding up time is around 10 minutes. It very well may be shown utilizing (7) that the noticed genuine holding up time doesn't vary by much when contrasted with the hypothetical pausing time as displayed beneath

$$Wq = Lq/\lambda = 25 \text{ customers } /3cpm = 8.33 \text{ minutes}$$

Then, figure the normal number of individuals in the eatery utilizing the above determined qualities,

$$L = 3 \times 55 \text{ minutes} = 165 \text{ customers}$$

In the wake of figuring the normal number of clients in the eatery "Fauji da Dhaba", infer the assistance rate as: $\mu = \lambda (1 + L)/ L = 3(1 + 165) /165 = 3.01$ cpm (approx)

Presently, figure Traffic Intensity or use factor $\rho = \lambda /\mu = 3/3.01 = 0.9966$

With the high use pace of 0.9966 during supper time the likelihood of zero clients in the eatery or likelihood that framework is inactive can be determined by (2)

$$P_0 = 1 - \rho = 0.004$$

The conventional formula that can be utilized to ascertain the likelihood of having 'n' client in the eatery is as per the following:

$$P_n = (1 - \rho)*\rho^n = (1 - 0.996)0.996^n = (0.004)(0.996)^n$$

Accept that potential clients will begin to shy away at the point when they see in excess of 27 individuals are in queue for the eatery, and the most extreme line length that a potential client can endure is 35 individuals. As the limit of the café when completely involved is 170 individuals, can ascertain the likelihood of 27 individuals in the line as the likelihood when there are 205 individuals in the framework (for example 178 in the eatery also, at least 27 queuing) as follows

Likelihood of clients disappearing = P (more than 27 individuals in the line) = P (more than 205) individuals in the eatery)

$$P_{165-205} = \sum_{n=165}^{205} Pn = \sum_{n=165}^{205} (.004)(0.996)^n = 7.65\%$$

B. Analysis

The use is straightforwardly relative with the average(mean) number of clients. It implies that the average number of clients increases with the increment in usage. The usage rate at the café is exceptionally high at 0.996. This is the case of usage rate at the time of lunch and supper time on weekend (Saturdays and Sundays). On weekday, the usage rate is practically 40% of it. Reason of this is the quantity of guests coming on week days is just 40% of the quantity of guests on

weekends. Moreover, the quantity of servers or servers stays as before in any case whether it is top hours or off-top hours. In the event that the clients holding up time is lower or at the end of the day we sat tight for under 20 minutes, the quantity of clients that can be served each moment will increment. At the point, the usage will be lower during higher assistance rate, that makes the likelihood of the clients disappearing diminishes.

C. Advantages

This exploration can help "Fauji da Dhaba" to increment the QoS (Quality of Service) of the eatery, by expecting in case when it has numerous clients in line. The administrative work after its effect can become a reference to examine the current structure and work on the following framework. Since the eatery would now be able to gauge of the number of clients will stand by in the line and the number of clients that will disappear every day. By expecting the enormous number of clients going back and forth in a day, the eatery can set an objective benefit that ought to be accomplished day by day and the equations that were utilized during the fruition of the examination is appropriate for future examination and furthermore could be used to foster more intricate hypotheses.

V. CONCLUSION

This investigation has examined the utilization of queuing theory of "Fauji da Dhaba" Restaurant. Here, creators zeroed in on two especially normal choice factors as a vehicle for presenting and representing every one of the ideas. From the outcome creators acquired that the rate at which clients show up in the queuing framework is 3 clients each moment and administration rate is 3.01 (cpm) and usage rate is 0.996. This theory has likewise material for the café in the event that they need to ascertain every one of the information day by day. It very well may be presumed that the appearance rate will be lesser and the help rate will be more noteworthy in case it is on work days since the normal number of clients is less when contrasted with those on ends of the week. The limitations that were looked for the fulfilment of this examination were the error of result since a portion of the information that was simply founded on supposition or estimate. Creators trust that this exploration can add to the advancement of "Fauji da Dhaba" café as far as its way of managing clients.

Future Outcomes

This examination will foster a reproduction model for the café which will actually want to affirm the consequences of the insightful model. Furthermore, a re-enactment model permits adding more intricacy with the goal that the model can reflect the genuine activity of the eatery all the more intently. This investigation gives a summed-up assurance to settle the framework from the issues emerged like clients' shying away, reneging, manoeuvring and intrigue or postponement in administrations by present method of working of café. In this day and age of speeding up headway in PC innovation, it will be productive to café chief to introduce a PC for the legitimate control of

administration offices and to keep the past record in order to make the determining better over great to dominate in the field.

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