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# Queueing Models Using Simulation Method in Busy Mall

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***Abstract-*** This paper contains the analysis of Queuing systems for data of sales check out operation at a busy mall as an example. Queuing theory is a most important area of applied mathematics which pacts with observable fact of waiting and take place from the employ of potent mathematical study to explain busy mall sales and this work provides signifies the data in the form of queueing models to evaluate the performance measures. The paper describes a queuing simulation for a multiple server process as well as for single queue models. This study requires an empirical data which may include the variables like, arrival time in the queue of checkout operating unit , departure time, service time, etc More over study of future behavior of the busy mall, using monte carlo simulation method to reduce minimum waiting time of the customers and length of the queues for M/M/1 and M/M/C so that to provide better service to the customers in the busy mall.

***Keywords-***Queue model, multi channels queuing models (M/M/C), probability distributions, average waiting time, average queue length.

## I. INTRODUCTIONS

One of the most useful areas of application of probability theory is that of queuing theory or the study of waiting line phenomena. Queues are found everywhere in our day – to – day life. For example in industries, schools, colleges, hospitals, libraries, banks, post offices, theaters, ticket booking for trains and buses etc [1].

Queues are also common in computers waiting systems, queues of enquiries waiting to be processed by an interactive computer system. Queues of data base request, queues of input/output requests etc. queuing problem arrases in the following cases. The demand for service is more than the capacity to provide service. For example: Ticket booking counters in the railway stations, queues are always formed. The demand for service is less than the capacity to serve so that there is lot of idle facility time or too many facilities. For example: In a petrol bunk, if there is no vehicle for refilling petrol then the system is idle, both pump and workers are idle.[2] . The path of the network is based on the routing table it is not fixed in Ad-hoc technique network path is also not fixed and create dynamically. It design is practical oriented But it is more cost.[3]

## II. CHARACTRISTICS OF QUEUEING SYSTEM

### a. The input pattern or arrival pattern

The input pattern represents the manner in which customers arrive for service and join the queueing system. The actual time of arrival of a customer can not be predicted or observed. The number of arrivals in a time period or the interval between too successive arrivals can not be a constant, but a random variable. Hence the arrival pattern of the customers is expressed by means of probability distribution of the number of arrivals per unit time or interval time. The number of customers arriving per unit time is called arrival rate, which is a random variable[4]

The arrival pattern usually used in the poisson distribution with parameter $\lambda$ where $\lambda$ is the average arrival rate. Then the time interval between consecutive arrivals follow and exponential distribution with mean $\frac{1}{\lambda}$ [5]

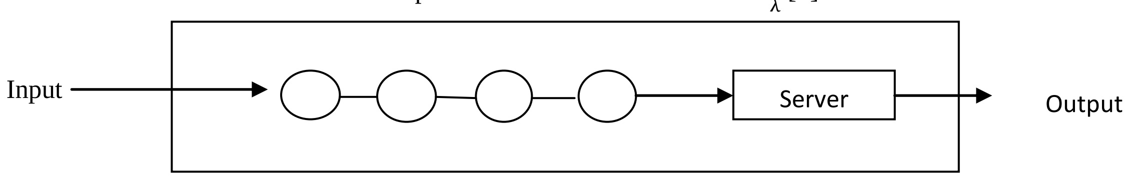


Fig .1.Single server model

 

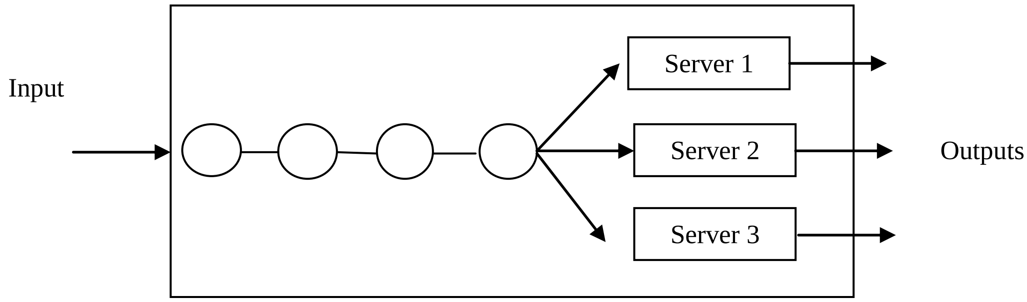


Fig.2 .Multi servers in parallel queueing system

**b. Service pattern (or departure pattern)**

The service pattern is represented by the probability distribution of the number of customers serviced per unit time (i.e. service rate) or the inter service time. This rate assumes that the service channel to be busy always, that is no idle time allowed. [6]

A typical assumption used is that the service time is a random variable following exponential distribution with mean rate of service µ. Some times poisson distribution is also used.[7]

**c. Service channels**

The queueing system may have single service channel. Arriving customers form one queue as in a doctor's clinic. This system may have more than one queue, arranged in parallel as in railway booking counters. That is the system may have server, or more than one server. [8]

**d. Service discipline**

Service discipline or order of service is a rule by which customers or selected for service from the queue. The most common discipline is '**first come, first served' (FCFS)** or **'first in, first out' (FIFO)** according to which the customers are served in the order of their arrival. Example: cinema ticket counters, railway booking counters[9]

**e. Maximum queueing system capacity:**

Maximum number of customers in the system can be either finite or infinite. In some facilities only limited number of customers are allowed in the system, the new arrivals are not allowed to join the queue. In some system the queue capacity is assumed to be infinite, if every arriving customers is allowed to wait until service is provided. The author proposed, the path of the network is based on the routing table it is not fixed in Ad-hoc technique network path is also not fixed and create dynamically. It design is practical oriented But it is more cost[10]

The following are usual notations in the discussions

$n$ = number of customers in the system (i.e. waiting for service in the queue + being served)

$\lambda$ = mean arrival rate (i.e. average number of customers arriving per unit time)

$\mu$ = mean service rate per busy server (i.e. average number of customers served per unit time )

$\rho$ = $\frac{\lambda}{\mu}$ is traffic intensity or utilization factor

$c$ = number of parallel service channels

$L_q$ = mean length of the queue (i.e. average or expected number of customers waiting in the queue)

$L_s$ = mean length of the system (i.e. average or expected number of customers both waiting and in service)

$W_q$ = mean waiting time in the queue (i.e. the expected waiting time before being served)

$W_s$ = mean waiting time in the system (i.e. the expected waiting time in the system)

$P_n$ = steady state probability of n customers in the system [10]

**(f) Multiple queue, multiple server Model Formula (M/M/C)**

The following parameters are calculated, and their formulas have been presented

n – Number of total customers in the system (in queue plus in service)

c – Number of parallel servers (Checkout sales operation units in ICA)

$\lambda$ – Arrival rate

μ– Serving rate

cμ– Serving rate when c > 1 in a system

System intensity is

$$\rho = \frac{\lambda}{c\mu} \qquad \text{--------} \quad [1]$$

P0:Steady-state Probability of all idle servers in the system / Probability that there is no customer in the system

$$p_0 = \left[ \sum_{n=o}^{c=1} \frac{r^n}{n!} + \frac{r^c}{c!(1-\rho)} \right]^{-1} \qquad \text{-------} \quad [2]$$

Lq: Average number of customer in the waiting line(queue)

$$L_q = \frac{r^c \rho}{c!(1-\rho)^2} * P_0 \qquad \text{-----------} \quad [3]$$

Ls : Average number of customers in the system

$$L_s = L_q + \frac{\lambda}{\mu} \qquad \text{-----------} \quad [4]$$

Wq: Average amount of time a customer spends in queue

$$W_q = \frac{L_q}{\lambda} \qquad \text{-----------} \quad [5]$$

Ws Average amount of time a customer spends in the system

$$W_s = W_q + \frac{1}{\mu} \qquad \text{-----------} \quad [6]$$

## III. METHODOLOGY QUEUEING MODEL

Solutions of multi channel queue models are no possible solutions to find out closed form. Solutions of such models can be found out by using Monte Carlo simulation method. A discrete-event simulation simulates only events that change the state of a system. Monte Carlo simulation uses the mathematical models to generate random variables for artificial events and gather observations. Discrete models deal with a device whose behavior changes only at given instants. A standard example happens in waiting lines where we are involved in estimating such measures as the standard waiting time or the measurement of the waiting line. Such actions arise only when the customer enters or leaves the system. The instants at which changes in the system occurs identify the model’s events, e.g., arrival and departure of the customers. The arrival events are separated by using the 'inter-arrival time' the interval between successive arrivals and the departure events are specified by the provider time in the facility. The reality that these events appear at discrete points is known as “discrete event simulation”.

## IV CASE STUDY: OVERVIEW OF THE BUSY MALL

Data analysis is considered to be a significant step in research work. Collection of data is described with the help of relevant tools and techniques, after that analyses and interprets with a view to arrive at a practical solution to the problem. The data analysis for the research study was done quantitatively with the help of inferential statistics. Standard Statistical Package for Social Sciences (SPSS) and the queueing simulation software was used for analyzing the data.

 

TABLE 1: Frequency table for arriving customers

| | | Frequency (Arrival) | | | | Total |
|---|---|---|---|---|---|---|
| | | One queue | Two queues | Three queues | N - queues | |
| First Issue | Yes | 51 | 55 | 42 | 54 | 202 |
| | No | 43 | 44 | 40 | 51 | 178 |
| Total | | 94 | 99 | 82 | 105 | 380 |

TABLE 2: Frequency table for servicing customers

| | | Frequency (Service) | | | | Total |
|---|---|---|---|---|---|---|
| | | One queue | Two queues | Three queues | N - queues | |
| First Issue | Yes | 54 | 49 | 47 | 52 | 202 |
| | No | 47 | 43 | 49 | 39 | 178 |
| Total | | 101 | 92 | 96 | 91 | 380 |

TABLE 3 : M/M/1 MODEL

| | SERVER = 1 |
|---|---|
| Arrival rate | 24.74 |
| Service rate | 26.58 |
| System intensity | 0.93 |
| $W_s$ : average amount of time a customer spends in the system | 0.54 |
| $W_q$ : average amount of time a customer spends in the queue | 0.51 |
| $L_s$ : average number of customers in the system | 13.4 |
| $L_q$ : average number of customers in the queue | 12.51 |
| $P_0$ : | 0.07 |

 

TABLE 4: M/M/2 MODEL

| | SERVER = 2 |
|---|---|
| Arrival rate | 24.74 |
| Service rate | 26.58 |
| System intensity | 0.46 |
| $W_s$ : average amount of time a customer spends in the system | 0.067 |
| $W_q$ : average amount of time a customer spends in the queue | 0.029 |
| $L_s$ : average number of customers in the system | 1.64 |
| $L_q$ : average number of customers in the queue | 0.71 |
| $P_0$ : | 0.36 |

## V. CONCLUSION

This paper presents a queuing model for multiple servers. The average queue length can be estimated simply from raw data from questionnaires by using the collected number of customers waiting in a queue each minute. We can compare this average with that of queuing model. Two different models are used to estimate a queue length: a single-queue multi-server model, single-queue single-server . In case of more than one queue (multiple queue), customers in any queue switch to shorter queue (jockey behavior of queue). Therefore, there are no analytical solutions available for multiple queues and hence queuing simulation is run to find the estimates for queue length and waiting time .Queues are also common in computers waiting systems, queues of enquiries waiting to be processed by an interactive computer system. Queues of data base request, queues of input/output requests. From the table efficiency parameters under two different queueing models by using system utilization parameters, it has changed significantly from 93% to 46% for the models M/M/1 and M/M/2 consecutively. When comparing with single and multi channels, waiting time of the customers are slightly reduced in the multi channels rather than the single channels. So prefer multi channels.

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