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Using The Queueing Model To Reduce The Waiting Time Of The Customer At The Bank's Loan Payment Counter

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Abstract:

A queue is a line of people or items waiting for the service to be handled in a specific order. Queuing theory is the mathematical study of how people, things, or information wait in lines**.** It's used to improve efficiency and reduce costs in systems like transportation, computer networks, and healthcare. The goal of this study is to show how the queueing theory can be used to minimize the customer waiting time at the bank's loan payment counter. We propose a new model to reduce client waiting times. After analysis, the new model gives better results than the current model.

Keywords: Average arrival rate λ Average service rate μ, utilization factor ρ , idle time

Introduction

A queue simply put is a place where customers wait being served Frederic.S.H. and Gerald. J.C and they formed when the current demand for a service exceeds the current capacity to provide the service. The idea of queuing theory can be traced back to the classical work of A.K. Erlang is 1900s, however the work in D.K. Kendal in 1951 formed the basis for analytical calculations and the naming convention in queues being used.

A queuing system which consists of the customers and the servers. Waiting line or queues are in the schools, hospitals, bookstores, libraries, banks, post office, petrol pumps, theatres etc., all have Queuing problems. Queues are very familiar in our daily life. Queuing theory is a branch of operations research because the results are used for making decisions about the resources needed to provide service . Many valuable applications of the queuing theory are traffic flow (vehicles, aircraft, people, communications). For instant,Cars along a highway having bottlenecks such as traffic intersections and there is an inconvenience connected with waiting, one may be able to minimize the delays by suitable adjustment of the signal timing. scheduling patients in hospitals, Patients want to enter your hospital, which can only manage a finite number of patients at once, yet delays might have catastrophic consequences, more so for some patients than others.jobs on machines, programs on computer), and facility design (banks, post offices, supermarkets).A queuing theory is the Mathematics of waiting lines. A queuing system can be described by the flow of units for service, forming or joining the queue, if service is not available soon, and leaving the system after being served. McClain (1976) reviews research on models for evaluating the impact of bed assignment policies on utilization, waiting times and the probability of turning away patients.

The queuing theory is an operational research technique that models systems allowing queue, calculates its performances and determines its properties in order to help managers in decision making. The real value of a model would become apparent as to evaluate the effect of proposed changes in the system. It is generally more efficient to use a mathematical model. Usually the arrival process is considered to be a renewable process, which means that the times between arrivals are independent random variables. The easiest inter – arrival time distribution to work with is the negative exponential distribution, which fully characterized by a single parameter, the mean service rate.

If the number of customers arrived in the waiting area is greater than the number of customers the existing waiting capacities can serve in a unit of time. For the selected system of incoming terminals in to the waiting area the arrival intensity flow represent the average number of customers arriving in to the waiting area in a unit of time. The intensity of servicing μ represents also the average number of customers which can be served in a unit of time. Service time is expressed in the number of units of time necessary for the servicing of one customer that is the entry of customers into the waiting area. Dr. Muruganantha Prasad and Jemima Christabel(2016) given the suggestions to the hospital to construct the appointment system take attention of patient flow and set scheduling of the capacity to increase the effective and efficiently outpatient department performance. The most suitable appointment system for outpatient is using no-show. The condition that affect patient waiting times are the physician come on call, go show patient, no proper calculation of the room capacity the number of physicians and the number of sub-specialists.

Queueing system can be described as consisting of customers arriving from arriving for service if it is not immediate and leaving the system after being served.

Queue

Queues are formed if the demand for service is more than the capacity to provide the service. A queueing system can be described as customers arriving for service, waiting if service is not available immediately and leaving the system after having been served.

The basic characteristics of a queueing system are

1. Arrival pattern
2. Service pattern
3. Number of servers
4. System capacity
5. Queue discipline

Arrival Pattern

The arrival pattern is measured by the mean arrival rate or inter-arrival time. Usually arrival process is assumed to be a Poisson process. The arrival rate follows a Poisson distribution and hence the inter-arrival time follows an exponential distribution. Arrival rate is denoted by λ.

Service rate

Service time distribution is assumed to be a exponential and mean service rate is usually denoted by μ.

Number of servers

There may be one or more servers to provide a service. In multi-server queues, there are a number of channels, providing identical service facilities. We denote the number of service channels by c.

Capacity of the System

In some queueing processes, there is limited waiting space, so that when the queue reaches a certain length, further customers are not allowed to join the queue, until space becomes available after completion. Thus there is a finite limit to the maximum system size. If any number of customers is allowed to join the queue, we may say that the capacity is infinite.

Queue discipline

It is the rule according to which customers are selected for service when a queue has been formed. The common queue disciplines are

(i) FCFS- First come, first served
(ii) LIFO- Last in first out
(iii) SIRO- Selection in random order.

There are also priority schemes for selection.

Limitation of Queueing Theory

One major limitation of queuing theory is its reliance on specific assumptions. Many queuing models assume that arrivals follow a Poisson process and that service times are exponentially distributed. While this helps simplify the mathematical model, this isn't always how things work in real systems. For example, customer arrivals may occur in bursts rather than at regular intervals, or service times might vary significantly depending on the complexity of each request.

In practice, unpredictable customer behavior can also complicate systems beyond what standard queuing theory can handle. For instance, some customers may abandon the queue after waiting for too long, while others may decide not to join a long queue at all. These two functions may depend on an individual's unique preferences.

Another challenge is the static nature of most queuing models. Queuing theory often relies on steady-state conditions. However, in reality, many environments are dynamic. For example, a retail store may experience sudden surges in customer traffic during holiday seasons, though queuing theory may be more useful in steadier, more predictable periods like the non-holiday windows.

Merits of Queuing Theory

The primary merits of queueing theory include:

1. Reducing waiting times,

2. Optimizing resource allocation,

3. Improving service quality,

4. Enhancing customer experience,

5. Cost efficiency,

6. Better employee productivity

7. Providing valuable insights into system performance by analyzing queue characteristics like average wait time,

8. Allowing for informed system design and optimization across various industries.

Examples of Queues

Location	Client	Service facilities
Hospital	Patients	Doctors/ Nurses
Airport	Aircraft	Runways
Post Office	Letters	Sorting Systems
Workshop	Machines/ cars	Mechanics

There are four different types of service facilities: single queue with a single server, single queue with multiple servers, multiple queues with multiple servers, and multiple queues with multiple servers.
Here, we employ the queueing approach with several servers and an infinite population. It outlines ways to improve customer satisfaction rates.

Methodology:

We collect data from a bank in Kanyakumari district between 10 and 12 p.m. We analyzed the system's efficiency by calculating queueing model parameters based on the number of consumers arriving every 15 minutes. We found that many customers were waiting in the queue to pay their bills. There are two counters in the bank. Here, we propose a queueing mechanism for loan payments at counter 1 and other consumers at counter 2.

Different parameter of Queueing Model:

Average arrival rate λ

Average service rate μ,

utilization factor $\rho = \lambda / \mu$

$P_0 = 1 - \lambda / \mu$ is the probability of number of customers in the system

Percentage of idle workstation $=(1-\rho)\times 100\%$

Kendall's Notation for Queuing System.

There is a standard notation for classifying queuing system in to different types. This was proposed by D.G Kendall. System are described by the notation A/B/C/D/ E Where

A - Distribution of inter arrival times of customers.

B - Distribution of service time.

C – Number of server in system.

D – Maximum total number of customers which can be accommodated

E – Calling population size A and B cane take any of following distribution Type.

M – Exponential Distribution Monrovian

D – Degenerate (or Deterministic) Distribution

EK – Erlang Distribution CK=shape parameter

G – General Distribution (arbitrary distribution)

Littles Formula:

Little's theorem describe the relationship between throughput rate (i.e ,arrival and service rate) cycle time and work is process (ie.,number of customers / job in the system) The theorem states that the expected number of customers (N) for a system in steady state can be determined using the following equation $L = \lambda T$

Here λ is the average customers arrival rate and T is the average service time be a customer

Note : Relation between Average Queue Length and Average waiting Time and known as

Little'sformula.

Observation of counter 1:

Time in Minutes	Number of customers in queue	Arrival rate	Average arrival rate
Average arrival rate	20	-	0.325
After 15 min	25	0.3	
After 30 min	30	0.3	
After 45 min	32	0.1	
After 60 min	45	0.9	
After 75 min	53	0.5	
After 90 min	58	0.3	
After 105 min	60	0.1	
After 130 min	62	0.1	

Observation of counter 2

Time in Minutes	Number of customers in queue	Arrival rate	Average arrival rate
Start time 0 min	8	-	0.425
After 15 min	15	0.5	
After 30 min	22	0.5	
After 45 min	35	0.9	
After 60 min	39	0.3	
After 75 min	40	0.1	
After 90 min	0.1	0.1	
After 105 min	48	0.4	
After 130 min	57	0.6	

Calculations:

It is to be noted that on an average each customer spend 7 min to pay.

Average arrival rate of counter 1 and counter 2,

λ=(0.325+0.425)/2 =0.375

L=λT=0.375 x 7= 2.625 customer

$\mu = \lambda(1+L) / L = 0.375(1+2.625) / 2.625 = 0.52$ cpm

ρ=0.7

$P0$ = 1-0.72 =0.3

Percentage of idle workstation =30 %

For the new suggested model:

For counter 1 :

On an average each customer spend 3 min to pay.

L = 0.325 x 3 = 0.625 customer

$\mu = \lambda(1+L) / L = 0.375(1+0.65) / 0.65 = 0.825$ cpm

$\rho = 0.4$

$P0 = 1\text{-}0.4 = 0.6$

For counter 2

: On an average each customer spend 4 min to pay.

L = 0.425 x 4 = 1.7 customers

$\mu = \lambda(1+L) / L = 0.675$ cpm

$\rho = 0.6$

$P0 = 1\text{-}0.6 = 0.4$

Average utilization factor = (0.72+0.6) / 2

Percentage of idle workstation = 66 %

BENEFITS

This can help bank counter to increase its Qos (quantity of service) , byanticipating, if there are many customers in the queue .The result of this paper is helpful to analysis the current system and improve then ext system , Because the bank can now estimate the number of customers going away each day.By estimating the numbers of customers coming and going in a day , the bank can set a target that , how many counters are required to serve people in the main branch or any other branch of the bank .

Conclusion:

In the above discussion we calculate average number of customer waiting in the queue in bank counter . Based to the above results, the percentage of idle workstations rose while the utilization factor decreased. Customers' waiting times will be shortened, and their degree of satisfaction will rise.

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