OPTIMIZATION OF LIBRARIES SERVICES

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ABSTRACT:

The Queueing Theory has been playing an important role for problems solving in library services by the presence of a group of customers who arrive randomly to receive some service. The customers, upon arrival may be attended to immediately or may have to wait until the server is free. It is applicable in the field of Industries, Business, Government, Transportation, Restaurants, Theatres, ATM Bank and Libraries etc. Queueing models are basically relevant to service oriented organizations and suggest ways and means to improve the efficiency of the service. In libraries, there are three types of services usually rendered: Circulation of books, Counter service and allied services like reprography etc.

In the present paper, Queueing theory has been applied to optimization of library services (e.g. counter services & circulation of books).

Keywords:- Queueing system, Library, Queueing models.

INTRODUCTION:

Queueing theory has wide applications in day to day life. Some of the services are:-

(i) Commercial service system:- Such services are like Barber's shop, Café Airline, Railway booking counters etc.

(ii) Transportation service system:- These services may be mentioned as Vehicles waiting for traffic signal, Aero planes waiting for landing etc.

(iii) Social service system:- These services are relating to the Telephone booths, Post-offices, Doctor's clinic, Libraries etc.

In this paper Queueing theory has been applied to the services rendered in libraries.

Queueing problems are identified by the presence of group of customers who arrive randomly to receive some services. The customer, upon arrival may be attended to, immediately or may have to wait until the server is free.

Queueing models are basically relevant to service oriented organizations and suggest ways and means to improve the efficiency of the service. In library usually three services are rendered.

(a) Counter service (b) Circulation of books and (c) Allied services like reprography.

In this paper we have considered the first two services.

Let us have a Queueing model as (A/B/C); (D/E.)

Where,

- **A**= Represents the probability law for the arrival (inter- arrival) time.
- **B=** Represents the probability law according to which the customers are being served.
- **C**= Represents the number of channels (or service stations) in the system.
- **D**= Represents the capacity of the system, i.e., the maximum number allowed in the system (in service and waiting).
- **E**= Represents the queue discipline (or service mechanism.)

For example, in the model (M/M/1): (∞/FCFS) queueing system has a Poisson arrival (exponential inter-arrival), Poisson departure (exponential service time), Single server, Infinite capacity and "First come, first served" service discipline.

Some important notations in the queueing system are:

$\lambda =$ Mean arrival time

$\mu =$ Mean service rate

$\rho = \frac{\lambda}{\mu} =$ Average utilization rate/ traffic density

W_q = Average waiting time in the queue

L_q = Average number of the customers in the queue

The time spent by the customer in the queue is of interest to the decision maker. The purpose of this paper is to minimize the waiting cost in the queue and cost of service.

METHODOLOGY:

A suitable statistical distribution is fitted to the data on arrival rate and service time in a particular period and then ρ, W_q and L_q is evaluated. If these indices are not within the range of the specified performance measures, the studies in terms of increasing the number of counters for the economics thereof, is carried out.

Counter Service:

Suppose the service mechanism of the library has one counter for issue/return of books. Let us assume that the service time is exponential distributed with mean **μ =60 customer/hr** . The arrival rate of customers (student as well as faculty members) at the counter be approximated by Poisson distribution which is a satisfactory model in most of the cases with arrival rate of one in 6 minutes. It is required to find the measures of performance.

Let us assume M/M/1 queue in which arrival rate is one customer at every 6 minutes, the arrival time between customers follow a negative exponential distribution with mean.

$$\lambda = \frac{1}{6} \text{ customer / minute} = 10 \text{ customers / hr}$$

Mean service rate is 60 customers per hour (μ)

i.e., μ =60 customer/hr

(i) The average waiting time in the system (w) is

$$w = \frac{1}{\mu - \lambda} = \frac{1}{60 - 10} = \frac{1}{50} = 0.02 \quad hours / customer$$

(ii) The average waiting time per customer in the queue (w_q) is

$$w_q = \frac{\lambda}{\mu(\mu - \lambda)} = \frac{10}{60(60 - 10)} = 0.003 \; hours / customer$$

(iii) The average number of customers in the system is

$$L = \frac{\lambda}{\mu - \lambda} = \frac{10}{60 - 10} = 0.2 \; customers$$

(iv)The average number of customers in the queue

$$L_q = \frac{\lambda^2}{\mu(\mu - \lambda)} = \frac{100}{60(60 - 10)} = 0.033 \; customer$$

(V) The probability of finding the system busy is

$$\rho = \frac{\lambda}{\mu} = \frac{10}{60} = 0.166 < 1$$

(vi) The probability that the counter clerk will be idle is

$$P_0 = 1 - \frac{\lambda}{\mu} = 1 - \frac{10}{60} = \frac{50}{60} = 0.833$$

Now it may be desired to know

(i) Whether the demand for another counter service is justified or not?

(ii)Is it the opportune moment for the management to take initiative in this regard?

(iii) What should be the increase in the arrival of customers warranting such action?

(iv)Whether this type of analysis is possible for an optimum Queueing system or not?

Circulation of books:

In this paper we study the book circulation process in library by using Queueing theory. The customer behavior is entirely different from other situations. If on arrival, the customer does not find his desired book on the shelf he may give up totally and may not come again. It can be considered as a Queueing system where there is no waiting room. When the servers are busy, customer may have to leave the system. Let us assume that λ persons in a year wish to lend a particular book and that these λ arrivals are randomly distributed over the year. The number of circulations in a year, if a book is borrowed by someone else immediately after its returns is denoted by μ then $\frac{1}{\mu}$ equals to the average time the book is not on the shelf, so that $\frac{1}{\mu}$ is the mean loan period (circulation time), including handling time.

If the average number of time a book is effectively loaned out during a year (i.e. circulation rate per year) is denoted by **R**. Then $R \le \mu$ options or $R < \mu \Rightarrow \frac{R}{\mu} < 1$. The expected proportion in a year that book may not be on the shelf is given by the expression $\lambda\left(\frac{R}{\mu}\right)$.

As the λ persons in a year want to lend the book and $\lambda\left(\frac{R}{\mu}\right)$ do not find the book on the shelf and hence give up to lend it, then the remaining $\lambda - \lambda\left(\frac{R}{\mu}\right)$ will still like to lend the book.

By definition we know that, $\lambda - \lambda\left(\frac{R}{\mu}\right) = R \Rightarrow R = \lambda\left(1 - \frac{R}{\mu}\right) \Rightarrow R = \frac{\lambda\mu - \lambda R}{\mu}$

$$\Rightarrow R\mu = \lambda\mu - \lambda R$$
$$\Rightarrow R(\lambda + \mu) = \lambda\mu$$
$$\Rightarrow R = \frac{\lambda\mu}{(\lambda+\mu)}\text{.........}(i)$$
$$and \Rightarrow \lambda = \frac{R\mu}{\mu - R}\text{......}(ii)$$

Let us denote by P_0 the probability that the book will not be available and P_1 to denote its availability. Therefore,

$$P_0 = \frac{R}{\mu} = \frac{\lambda}{(\lambda+\mu)} \text{ and}$$
$$P_1 = 1 - P_0 = 1 - \frac{\lambda}{(\lambda+\mu)}$$
$$\Rightarrow P_1 = \frac{\mu}{(\lambda+\mu)}\text{.............}(iii)$$

The average number of persons who do not find the book may be denoted by **U** ,then

$$U = \lambda - R = \frac{\lambda R}{\mu} = \frac{\lambda^2\mu}{\mu(\lambda+\mu)} \Rightarrow U = \frac{\lambda^2}{(\lambda+\mu)}\text{..........}(iv)$$

Here **U** is the degree of dissatisfaction, which is the average non satisfied demand (a function of **μ & R**). **U** is given by

$$U = \frac{R^2}{(\mu - R)}\text{..............................}(v)$$

Table

Distribution of λ, R and **U** under varying levels of μ

(i) When $\mu = 15$ then the average loan period = **365/15=24** days (approx.).

λ	0	1	2	3	5	10	15	20	100
R	0	0.94	1.76	2.5	3.75	6	7.5	8.6	13
U	0	0.06	0.24	0.5	1.25	4	7.5	11.4	87

(ii)) When $\mu = 20$ then the average loan period = **365/20=18** days(approx.).

λ	0	1	2	3	5	10	15	20	100
R	0	0.95	1.82	2.61	4.0	6.67	9.14	10	16.67
U	0	0.05	0.18	0.39	1.0	3.33	6.42	10	83.33

(iii) When $\mu = 24\frac{1}{3}$ then the average loan period = **365/** $24\frac{1}{3}$ =**15** days (approx.).

λ	0	1	2	3	5	10	15	20	100
R	0	0.96	1.85	2.67	4.15	7.09	9.29	10.98	19.57
U	0	0.04	0.15	0.33	0.85	2.81	5.72	9.02	80.43

From table (i), (ii) and (iii) the correlation between the loan period and customers dissatisfaction can be visualized. When $\lambda = \mu$ then R will be equal to U otherwise not.

Conclusion:

When the usual norms of the library is not followed, in terms of lending and return of books then the application of Queueing model becomes complicated. In such situations additional parameters may be required to be included in the model to solve such complications.

References:

1. Applegate (Rachel), "Model of satisfaction". In: Allen Kent, Ed. Encyclopedia of library and information science Vol. 60; p 195-227.
2. Brophy, P. Coulling, H (1997); Quality Management and Library Science for Information and Library Managers, Mubmai: Jaico.
3. Burell, Q. L.& Fenton,M.R.(1994); "Amodel for library book circulations incorporating loan period." Journal of the American Society for Information Science, 45, 101-371.
4. Goehlert, R. (1978); "Book availability and delivery service." The Journal of Academic Library ship, 4, 368-371.
5. Morse, P.M. (1968); "library Effectiveness-A system approach." Cambridge, M.A.: MIT Press.
6. Wagner H.M.: "Principles of Operation Research."
7. Kellaher, L. (2005) Quality measurement: A user approach. Available:
8. Samuel Fomundam, Jeffrey Herrmann (2007) A survey of Queueing theory applications in Healthcare.
9. Kim.B.J.(2011). Conceptualization of traffic flow for designing Toll Plaza configuration: A case study using simulation with estimated traffic volume.18 (1): 51-57.
10. . Ajay Kumar Sharma (2013) Queueing theory approach with queueing model: A study.