Observed and Evaluated Service Quality on Patients Waiting Time of University of UYO Teaching Hospital using Queuing Models

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Abstract:- Healthcare facilities in most part of the world experience high influx of patients needing clinical service; this creates the issue of long waiting queue, long waiting time of patients and overutilization of medical personnel. The study examined the service quality in consonance with the patience waiting time in order to strike an economic balance between the cost of service and the cost associated with the waiting for the services. The study applies the queuing models waiting time to compare the performance of multi-servers to determine the optimal balance between the cost of patients waiting for clinical services and the cost of providing the services in a specialized clinic. On sorting to access the perception of patients on six (6) dimensions of service, the result shows the optimum balance was achieved between the cost of patients waiting for services and the cost of providing the service.The healthcare managers should assess the impact of not serving potential patients appropriately against the capacity cost of the servers so as to balance the cost of keeping patients waiting with the cost of adding more servers.

Keywords:- *Queues, waiting time, service quality, queuing model, cost minimization, etc.*

I. INTRODUCTION

Health care providers, particularly the ones rendering clinical services in public hospitals are increasingly facing administrative challenges in their bid to render professional services to patients (Mahmond, 2006). According to Ogungbe (1991), not only are resources for healthcare inexplicably inadequate, the available hospitals and municipal infrastructures are in a state of decay. In the face of this dwindling fortune, patients have become more discerning by insisting on prompt and quality healthcare services which cause them to flood the different units of university of Uyo Teaching Hospital.

A common situation that occurs in everyday life is that of queuing or waiting in line. Queues (waiting line) are usually seen at bus stops, hospitals, bank counters and so on. In general, a queue is formed when there is more customer demand for a given service that can be provided. A queueing system consist of customers aiming at a service facility to be served or waiting in a line (queue) if all the servers are busy until service is received and finally departing from the service facility.

Queueing theory is therefore, a mathematical approach to the analysis of waiting lines (Nosek & Wilson, (2001). Hospitals in most part of the world experience high influx of patients requiring clinical services. This high influx creates problem of long waiting line, long waiting time and overutilization of medical personnel. Waiting in line or queue causes inconvenience to patients and economic costs to healthcare facilities when considering improvement in services, the healthcare manager weight the cost of providing a given level of service against the potential costs from having patients waiting. To compare service costs and waiting time, it is necessary adopt a common measure of their impact. These natural choices of the common measure is cost, which therefore requires the cost of waiting estimation.

The main aim of this study is to determine the level of service that minimize the total of the expected cost of service and the expected cost of waiting for theservice.The concept is deduced in the model below where W_c denotes waiting cost, S_c denotes service cost, and T_c denotes total cost, thus the mathematical model of the objective as developed by Kustos (1983) is to:

Minimize: E (T_c)=E(S_c) +E(W_c)..(Equ. 1)

II. REVIEW OF RELATEDLITERATURES

Patient's waiting for clinical services are one of the issues in healthcare delivery services across the globe as most patients find waiting lines irritating. Waiting line is idle and non- productive time. From a service system perspective however, a line represents a demand for service. Most students try to strike the balance between cost of waiting and the cost of providing services.However, it should be noted that if the healthcare providers decide to increase the level of service provided, cost of providing services would increase, if it decides to limit the same, cost associated with waiting for the service would increase (Singh, 2006).

ISSN No:-2456-2165

According to Olusoji, (2009), in Nigeria, patients' view about healthcare service is a neglected subject. These patients are regarded as passive beneficiaries of healthcare services without a voice. In the face of these dwindling fortunes, patients have become more discerning by insisting on prompt and quality healthcare services. (Awobem, et.al, 2005). Patients' satisfaction aspect of healthcare has been highlighted in a study undertaken by Olusina, (2002), which established that patients were dissatisfied with the amount of time they spent with their doctors.

Similarly, patients' dissatisfaction has been expressed with regards to infrastructure, electricity, regular water supply and the treatment of patients by unsupervised medical students in public hospitals. (Ovenuga et. al., 2004).

For quite a long time, government owned hospitals has had to contend with the myriad of problems especially in the area of service quality delivery via-a-vis patient's satisfaction. Consequently upon these, concern has been expressed in such critical areas as; waiting time of patients, quality of service rendered, management of visitors to the wards and humane deposition of medical personnel. All these have led to the reduction in hospital internally generated income as a result of patronage of patients to private owned hospitals who deliver faster services.

III. METHODOLOGY

The survey research design was adopted to yield data and findings which are empirical and generalizable. A sample of 1500 respondents who visited the University of Uyo Teaching Hospital for medical attention were interviewed after consenting to participate. Systematic sampling technique was employed during recruitment of participants. The questionnaire elicited information on socio-demographic characteristics of respondents such as age, gender, educational status, marital status, occupation, as well as six important dimensions of service namely; clinical service satisfaction, waiting time, physical services and management of visitors to the ward, level of noise and humane disposition of medical personnel. Data was analyzed using statistical package for social sciences (SPSS) version 15.0 for window. Charts and tables were used for result presentations.

A. *Methodology of the Study*

The graph below demonstrate the trade-off considered in this analysis;

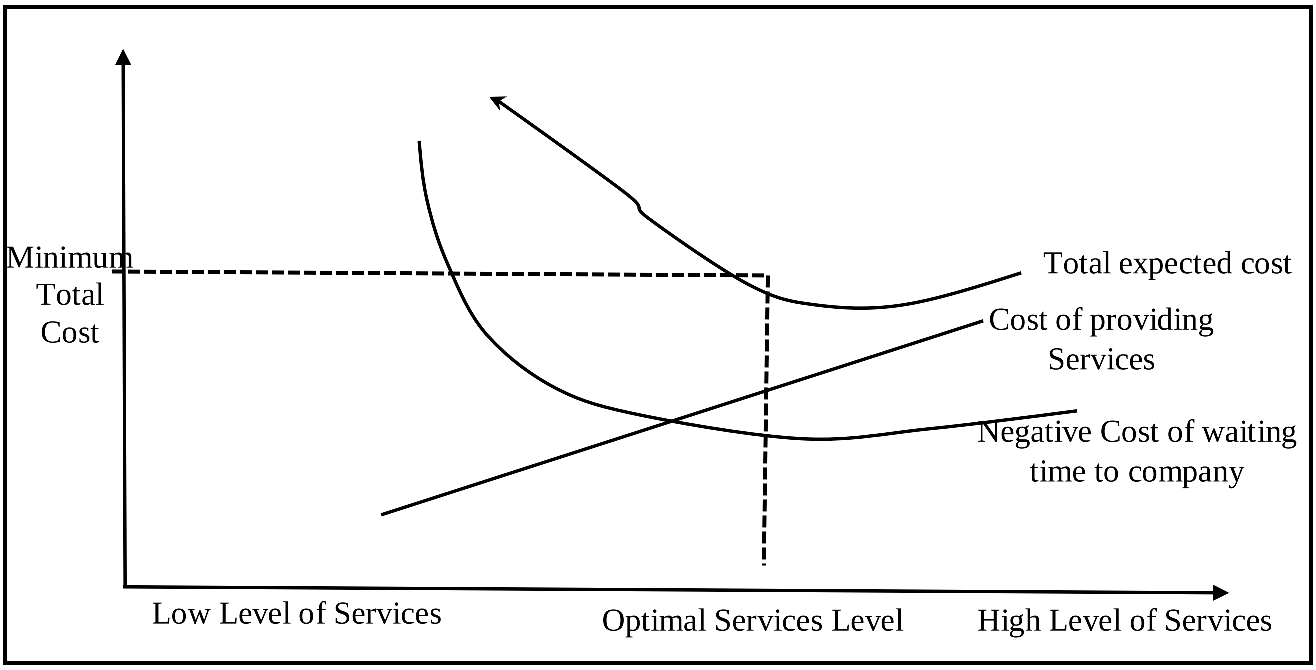

Fig. 1: The graph demonstrate the trade-off considered in this analysis

Source: Yasar, A. Ozean. Quantitative Methods in Health Management

B. *Assumptions*

For queuing system which are in line with queue theory, the below assumptions were reached;

- That the arrivals follow a Poisson distribution at an average rate of customers(patient)per unit of time.
- The queue discipline is first-come, first-served(FCFS). There is no priority classification for any arrival.
- Service times are distributed exponentially, with an average of µ patients per unit of time.
- There is no limit to the number of the queue (infinite).
- The service providers are working at their full capacity.
- The average arrival rate is greater than average service rate.
- Servers here represents only nurses but not other medical personnel.

ISSN No:-2456-2165

C. Model

This study adopted the multi-server queuing models equations as presented by Sharma (2009)

- The probability that there are no customers in the system. That is, the servers are idle (p_o)

$$P_o = \frac{1}{\sum_{n=0}^{S=1} \frac{\frac{1}{S!}\left(\frac{-\lambda}{-\mu}\right)^{-n} + \frac{1}{S!}\left(\frac{-\lambda}{-\mu}\right)^{-s\mu S}}{\mu S - \lambda}} \quad (Equ. 2)$$

- The average number of customers in the system (L_S):

Average number of customers in the queue (L_q)

$$L_q = L_S - \frac{\lambda}{\mu} - - - - - - - - - (Equ. 3)$$

Average time a customer spends in the queue (W_q) :

$$W_q = \frac{L_q}{\lambda} - - - - - - - - - - - (Equ. 4)$$

Where:

⋋ =The carnival rate of patients per unit time

μ=The service rate per unit time

S =The number of servers

P_O=The probability that there are no customers in the system

L_Q=Average number of patients in the queue

L_S=Average number of patients in the systems

W_Q =Average time a patient spends in the queue

W_S=Average time a patient spend in the system

$$L_S = \left[\frac{1}{(S-1)!}\left(\frac{\lambda}{\mu}\right)^S \frac{\lambda_\mu}{(S_\mu - \lambda)^2}\right] P_o + \frac{\lambda}{\mu} - (Equ. 5)$$

Average time a customer spends in the system (W_S):

$$W_S = \frac{L_S}{\lambda} - - - - - - - - - - (Equ. 6)$$

IV. RESULTS

A. Queuing output analysis

Table 1: Comparative Analysis table

Case	S	Lambda	M_u	L'da eff	P_o	L_s	L_q	W_s	W_q
1	2	10.0000	7.0000	11.0000	0.03152	11.3456	9.3111	1.0510	0.7652
2	3	10.0000	7.0000	11.0000	0.2641	5.2215	0.3458	0.3211	0.0421
3	4	10.0000	7.0000	11.0000	0.2812	3.8021	0.1061	0.2682	0.02158

Table 2: Table of Inputs Variable

Inputs:	Value	Value	Value
Parameters M/M/S			
Arrival Rate (lamba)	7	7	7
Service Rate (mu)	4	4	4
Number of Servers	2	3	4
Server Cost (₦/time)	5,000	5,000	5,000
Waiting Cost (₦/time)	8,000	8,000	8,000

From the above inputs, each server cost ₦5, 000 per hour and waiting cost ₦8, 000. If each server costs the same, the service costs is $E(S_C) = C_S S$ where C_S is the marginal cost of a server per unit time. To evaluate $W_C$for any value of S: $E(W_C) = C_W L$; where CW is the waiting cost per unit for each customer.

We want to minimize $E(T_C)$ = ₦5,000 + ₦8,000.

Table 3: Capacity Analysis for a clinical information

S	L	$E(S_C) = C_S S$	$E(W_C) = C_W L$	$E(S_C) = E(S_C) + E(W_C)$
2	10.47	9,000	56,261	₦58,031
3	5.61	11,000	20,385	₦32,382
4	2.89	14,000	16,452	₦26,251

ISSN No:-2456-2165

V. DISCUSSIONS

Performance Measures	2 Clinicians	3 Clinicians	4 Clinicians
Patients' Arrival Rate (λ)	7	7	7
Service Rate (μ)	4	4	4
Overall SystemUtilization	80%	70%	50%
L_S	11.34	5.22	3.80
L_q	9.31	0.34	0.10
W_S – in hours	1.05	0.32	0.26
W_q – in hours	0.70	0.04	0.02
P_o (idle)	3.15%	26.40%	28.10%
Total system cost in ₦ per hour	₦58,031	₦32,382	₦26,251

Table 4 shows that increasing the capacity of the system from two clinicians to three, improves the system performance measures significally. As such, the average waiting time of patients in the queue (Wq) also reduces and the total time spent in the system utilization from 80% to 70%. It should be noted that the use of four servers, although eliminates waiting, but at a higher cost which is not optimal.

VI. CONCLUSION

The queuing model given by Sharma (2009) which is adopted for this study can help clinical service providers and policy makers to make decision that would improve service delivery to customers at a minimal cost. Healthcare providers are marketing tools for healthcare organizations and as such should be assessed for cost effectiveness. The healthcare managers should assess the impact of not serving potential patients appropriately against the capacity cost of the servers so as to balance the cost of keeping patients waiting with the cost of adding more servers.

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ISSN No:-2456-2165

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