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Persistent Queueing Problems Bedevilling Medical Centers (A Case Study of Giltoe Aris Specialist Hospital Kaduna)

M. C. Aligwo
Lecturer, Department of Mathematics and Statistics, Kaduna Polytechnic, Kaduna State, Nigeria
M. O. Oladejo
Lecturer, Department of Mathematics, Nigerian Defence Academy, Kaduna State, Nigeria

Abstract:
This work examined the queueing situation in Giltooe Aris Specialist Hospital Kaduna with respect to the arrival and service time patterns. Being a queueing network with five service facilities arranged in series, data collected on arrival time at the first facility and service time at all the facilities that formed a chain link were analyzed to obtain system queue parameters needed to evaluate the measures of performance of the specialist Hospital. Results show that the average time spent on queue is 1.86 hours, and an average queue length of 21.95 patients. These results indicate that so much time is usually spent on queue at the medical centre corroborating incessant complaints on delays in accessing medical care service at the medical centre by patients.

Keywords: *Medical Centre, Out Patients' Department, Multi-channel Queueing Facility, Queue length, Queue Time, Patients.*

1. Introduction

Good health is very fundamental in life, it is a basic necessity without which, only little or nothing meaningful can be achieved in life. In an academic institution, maintenance of good health becomes an issue of paramount importance. This is so because proper teaching and learning can only be achieved in a healthy body. In the business sector, good health is very fundamental as the business man must be in good health to be able to co-ordinate his business. The staff (both managerial and technical) in the manufacturing industry require good health to be productive. This fact informs the establishment of staff medical centres in some companies to cater for the health needs of the community. The medical centres are also to ensure that students, staff members and their families are always in good state of health. It is also of utmost necessity to provide adequate health care facilities, in order to avoid delays or queues as this could lead to complications or even fatalities.

The establishment of Federal Medical Centres and other medical institutions and agencies by the federal government and the provision of free medical services and other forms of health care deliveries by the state governments for the people underscore the importance of providing adequate health care services to the people.

1.1. Statement of Problem

In spite of the efforts of both federal, state governments and academic institutions to provide adequate health care services for the people, the health care sector of the nation is still handicapped to providing instant or prompt health care services to patients. This is occasioned by the presence of queues and could lead to disastrous consequences as human lives are involved, hence the need to tackle this menace.

1.2. Literature Review

In a very simple language, a queue can be defined as a place where customers wait before being served, [6]. According to [5] queues are formed when the current demand for a service exceeds the current capacity to provide for the service. Though the issue of eliminating or reducing a queue is usually very expensive in terms of money according to [4], the time spent on queue is rather more expensive [1], and could be disastrous as human life is involved hence the need to solve this queueing problem at all costs. This need therefore leads us to queueing theory.

Queueing theory by [2], is the body of knowledge dealing with waiting lines. The idea of queueing theory emanated from the classical work of a Danish tele-traffic engineer called A.K Erlang, in the 1900s, however the work of D.K Kendal in 1951 formed the basis for the mathematical calculations and the naming conventions being used today [3, 7].

1.3. Objectives of the Study

The objectives of this Study are to:

- Obtain some historical information about the Hospital.
- Investigate the existing structure and its functionality.
- Obtain the following characteristics of the system through physical observations:
  a) Average arrival
  b) Average service rate.
  c) Average waiting time and
  d) Average time spent in the system.

1.4. Significance of the Study

The result of this study will go a long way in helping the hospital management to:

- To identify the problem in the system.
- Reduce waiting time in the hospital.
- Ensure prompt attention to patients.
- Check undue complications or fatality that may occur due to delay.

2. Methodology

Data were collected on arrival time and service time on 350 patients of those that consulted at the hospital during the period of this study from which arrival rate and service rate were computed. Both arrival rate and service rate are exponential and were analysed and used to compute values for the queueing parameters.

2.1. Data Collection

Data were collected at the Out-Patient's Department for a period of ten days between the hours of 8.00am and 10.00am in the morning.

2.2. The Structure (M/M/5/FCFS/∞/∞)

The system consists of a Records Unit, three Consulting Rooms and the Pharmacy Unit, as at the time of this study. Though a multi-channel queueing network consisting of five stations, each facility is treated as an independent unit, [8]. This is sequel to the fact that each service facility within the network behaves probabilistically as an independent service facility. The following formulae were used in our calculations:

1.Service Intensity of the system is given by $\rho = \frac{\lambda}{\mu}$ (1)

2. The mean number of patients in each queue (queue length) is given by; $L_q = \frac{\lambda^2}{\mu(\mu-\lambda)}$ (2)

3. The mean number of patients in each facility is $L = \frac{\lambda}{\mu-\lambda}$ (3)

4. The mean time spent in the queue in each facility (queue time) is; $W_q = \frac{\lambda}{\mu(\mu-\lambda)}$ (4)

5. The mean time spent in each facility is given by $W = \frac{1}{\mu-\lambda}$ (5)

6. The probability that the facility is empty is given by: $P_0 = 1-\rho$ (6)

3. Results and Discussion

Data from the tables were analysed to obtain values for the parameters which were used for our calculations to results as shown below:

i. Records Unit
Number of channels = 1
Channel capacity = ∞
Total number of patients = 350patients
Total Arrival Time = 1563minutes
Total Service Time =1478minutes

Mean arrival Rate $\lambda = \frac{\text{total no.of patients}}{\text{total arrival time}} = \frac{350\times60}{1563}$ =13.4357./hr (7)

Mean service rate $\mu = \frac{\text{total no.of patients}}{\text{total service time}} = \frac{350\times60}{1478}$ =14.2084/hr (8)

By (1), ρ = 0.9456; by (3), L = 17.3880; by (2), L_q =16.4424; by (5), W =1.2942; by (4) W_q = 1.2238hr.
by (6), P_0 = 0.0544

ii. Consulting Room 1
Number of channels k = 1
Channel capacity C = ∞

Total number of patients = 135.
Arrival rate, $\lambda_{R1} = \frac{arrivalrateat\ 1stfacility}{totalno.ofpatients}$ x no. of patients in the unit =5.1823/hr. (9)
Total service time = 671minutes
By (8), $\mu = 12.0715/\text{hr}$; by (1), ρ = 0.4293; by (3), L = 0.7522;by (2), L_q = 0.3229; by (5), W = 0.1451hr
by (4), W_q = 0.0623hr; by (6), P_0 = 0.5707

iii. Consulting Room 2
Number of channels k = 1
Channel capacity C = ∞
Total number of patients = 87.
Arrival rate, λ = 3.3397
Total service time = 658 minutes
By (8) $\mu = 7.9331/hr$; by (1), ρ = 0.4210; by (3), L = 0.7271; by (2) , L_q = 0.3061; by (5), W = 0.2177hr; by (4), W_q =0.0916hr; by (6),P_0 =0.579.

Iv. Consulting room 3
Number of channels k = 1
Channel capacity C = ∞
Total number of patients = 128.
Arrival rate, λ = 4.9136
Total service time = 810 minutes
By (8), μ = 9.4815/hr; by (1), ρ = 0.5182; by (3), L = 1.0757; by (2), L_q = 0.5575; by (5), W = 0.2189hr; by (4), W_q=1135hr; by (6), P_0 = 0.4818.

v. Pharmacy unit
Some patients came to the medical centre for consultation and counselling only and had no need to collect drugs, so they left without going through the pharmacy department. The number of patients in this group amounted to 51. Hence only 299 patients, out of the 350 that came to the hospital passed through the pharmacy department.
Total number of patients = 299
Number of channels K = 1
Arrival rate λ = 11.4779/hr.
Total service time = 1309mins.
By (8), μ =13.7051/hr; by (1), ρ = 0.8375; by (3), L = 5.1535; by (2), L_q = 4.3160; by (5), W = 0.4490hr; by (4), W_q = 0.3760; by (6), P_0 = 0.1625
Service intensity $\rho = \frac{\lambda}{\mu} = \frac{11.4779}{13.7051} = 0.83$

4. Summary
After analysis of data and computations of the measures of performance in all the facilities a summary of the results, obtained in each facility is as shown in the table below:

Variable / Facility	ρ	L	L_q	W	W_q	P_0
Records	0.95	17.39	16.44	1.29	1.22	0.05
Room 1	0.52	1.08	0.56	0.22	0.11	0.48
Room 2	0.42	0.73	0 .31	0.22	0.09	0.58
Room 3	0.43	0.75	0.32	0.15	0.06	0.57
Pharmacy	0.84	5.15	4.32	0.45	0.38	0.16

Table 1

4.1. Conclusion
This paper critically analysed the system structure with the application of the system characteristics and computed all the measures of performance for each facility. The total time spent on queue was 1.86hr, while the total time spent in the entire system was found to be 2.33hr. The probability of the system being empty was obtained as 0.0013.
All these results point to the fact that so much time is spent at the medical centre while accessing Medical care and that the centre is indeed a very busy one.

4.2. Recommendations
As a result of observations made in the course of this work in the study area and outcomes from analytical investigations, the followings are hereby recommended. That:

1) More medical doctors be employed at Shehu Mohammed Kangiwa Medical Centre Kaduna Polytechnic in particular and other medical centres in the country at large.
2) The management of Kaduna Polytechnic health centre arrange for a doctor to be deployed to attend to patients as early as from 8.00am in the morning while others are conducting the routine ward round.

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