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Application of Queuing Theory in Service Improvement and Time Management in Banking Sector

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Abstract

Queues are commonly sighted in almost every organization where services rendered, especially banks. Therefore, queuing theory which is the mathematical study of waiting lines is suitable to be applied in the banking sector since it is associated with queue and waiting line where customers who cannot be served immediately have to wait (queue) for service. The aim of this research project is to determine the average time customers spend on queue and actual time of service delivery in a certain Bank. The primary data were collected from the bank based on the arrival and service patterns of customers. The methodology employed followed the birth and death Markovian process. The result obtained showed that service rate is nine (9) persons per hour, the arrival rate is twelve (12) persons per hour and the probability that the servers are idle is 0.2471. It is therefore recommended based on the analysis that the bank management should increase the number of servers from three (3) to four (4) in order to help reduce the time customers spend on queue.

Keywords: Arrival rate; Service rate; Waiting line; Queue theory; Poisson and exponential.

Introduction

Queue is a common aspect of modern life encountered at almost at every step of our daily activities. Queue are pervasive almost anywhere. These places includes banks, hospitals, traffic, shopping malls, gas stations, restaurants, airport and many other places. One of the greatest concerns of every business organization is the satisfaction of their customers. In the banking industry, most customers are motivated by the timely service delivery they receive (Amoaka, 2012). Customer waiting in line to receive service is inevitable which is why bank managers face huge challenge on managing of queue (Eze and Odunukwe, 2015). Hence, this makes queuing theory suitable to be applied in banking sector since it is associated with queue or waiting line where customers who cannot be served immediately have to queue (wait) for service (Afrane and Appah, 2014; Spiegel, Schiller and Srinivasan, 2009; Prabhu, 1997). Time is very precious; and is passing very fast. Time management is a set of principles, practices, skills, tools and systems that help us use time to accomplish what we want (Abban, 2011). Especially in banking sector, time improve the quality of the bank services and reduce frustration of a customer on the queue during the services. Effective time management increases the energy level of administrators to a great extent. A service is any act or performance that one party can offer to another that is essentially intangible and does not result in the ownership of anything. The insight of service marketing focuses on selling the services in the best interest of users/customers. It is fretful with a scientific and planned management of services, which makes possible a fair management of the interests of providers as well as the users. Services are vital segment of all economies and they become increasingly more everyday life as economies develop. This means satisfying customer needs is very important for the enterprises to survive. The outcome of using quality practices is:

- Understanding and improving of operational processes.
- Identifying problems quickly and systematically.
- Establishing valid and reliable service performance measures.
- Measuring customer satisfaction and other performance outcomes.

Forming a queue being a social phenomenon, it is beneficial to society if it can be managed so that both the unit that waits and the one that serves get the most benefit. This study objectively analyzed single queue – multiple servers to determine (i) the arrival rate of customers (ii) the service rate to the customers (iii) the probability that the server is idle (iv) the optimal waiting time of customers in the queue.

Methodology

To formulate a model for this system, the following assumptions were taken into consideration:
(i) The arrival of customers into the system is discrete form Poisson distribution with arrival rate.
(ii) The queuing discipline is first come first serve.
(iii) There is only a Three -service channel i.e. $(M|M|3)$.
(iv) The service channel can only render service of finite rate exponentially distribution with service rate.
(v) The number of customers seeking for service is finite.
(vi) The number of customer in the system at the time of initiating the observation is assumed to have arrived in the first unit time.
(vii) The waiting area for the customers in the system is $M,$ which either limited or unlimited. Hence, the model can be formulated appropriately by using a system for the investigation system. Kendall's notation is introduced; $(V|W|X|Y|Z),$ where V is the arrival distribution or pattern is Poisson as indicated earlier, W is the service time distribution and the distribution is exponential as indicated earlier, X is the number of available server in the system as in the assumption above, Y is representing the system capacity. Z is representing the queue discipline which is first come first served (FIFO). Hence, with the above assumptions and approach the formulated model is $(M \mid M \mid 3 \mid N \mid FCFS)$ by Kendall's notation.

M│M│S Model

In a single-line, multi-server, single-face model, customers form a single line and are served by the first server available. The model assumes that there are s identical servers, the service time distribution for each server is exponential, and the mean service time is $\frac{1}{\mu}$.

Using these assumptions, the operating characteristics is described with the following formulas.
$C =$The number of servers in the system.

$P = \frac{\lambda}{c\mu}$ = The average utilization of the system.

$$P_0 = \left[\sum_{n=0}^{c=1} \frac{\left(\frac{\lambda}{\mu}\right)^n}{n!} + \frac{\left(\frac{\lambda}{\mu}\right)^s}{s!}\left(\frac{1}{1-p}\right)\right]^{-1} \quad (1)$$

Where P_0 is the probability that no customers are in the system.

$$P_n = \begin{Bmatrix} \frac{\left(\frac{\lambda}{\mu}\right)^n}{n!} P_0 & for\ n \leq c \\ \frac{(\lambda/\mu)^n}{C!C^{n-c}} P_0 & for\ n > c \end{Bmatrix} \quad (2)$$

Where P_n is the probability that n customers are in the system at a given time.

$$LQ = \frac{P_0(\lambda/\mu)^s p}{c!(1-p)^2} \quad (3)$$

Where LQ is the average number of customers waiting in line.

$$WQ = \frac{LQ}{\lambda} \quad (4)$$

Where WQ is the average time spent waiting in line.

$$W = WQ + \frac{1}{\mu} \quad (5)$$

Where W is the average time spent in the system including service.

$$L = LQ + \frac{\lambda}{\mu} \quad (6)$$

Where L is the average number of customers in the service system.

$$T_\iota = \lambda \times 8 \times WQ \quad (7)$$

Where T_ι is the expected total time a customer loses.

Result and Conclusion

From data collected as shown in Appendix I, II, III, a total number of 107 customers arrived at the bank in the period of 3 hours of the 3 working days. From this, we obtained;

$$T_\iota = \lambda \times 8 \times WQ$$
$$= 12 \times 8 \times 0.0117$$
$$T_\iota = 1.1232$$

The number of customers in the system under study is 107, considering the analytical solution; the arrival rate is 12 persons per hour while the service rate is 9 persons per hour. This shows that the arrival rate of the system is greater than the service rate, this shows that customers have to queue up, though the queue will not be long. The average number of customers waiting in line is 0.1405. The average number of customers in the service system is 1.4738. The average time spent waiting in line is 0.0117. The average time spent in the system including service is 0.1228 and the total time lost in waiting by a customer in a day is 1.1232.

Now it is concluded that adding one or more servers will go a long way to reduce the amount of time customers spend on queue. The advantage of using the single queue multiple servers is that; having a slow server among the servers does not affect the movement of the queue i.e. If a server is slow it does not affect the movement of the queue because the next customer can always go to the next available server instead of waiting.

Conflict of Interests

There is no conflict of interest regarding the publication of this paper.

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APPENDIX I

S/N	Arrival time	Service begins	Service ends	Service time
1	10: 5 am	10: 5 am	10: 10	5:00
2	10: 07 am	10:07 am	10: 16	9: 00
3	10:12 am	10: 13 am	10:17	4: 00
4	10: 15 am	10:16 am	10: 21	5:00
5	10: 32 am	10: 32 am	10: 37	5:00
6	10: 40 am	10: 40 am	10:45	5:00
7	10: 41 am	10: 41 am	10:59	18:00
8	10:50 am	10: 50 am	10:55	5:00
9	10: 51 am	10: 55 am	11: 00	5:00
10	11: 00 am	11: 00 am	11: 12	12:00
11	11: 07 am	11:07 am	11:12	5:00
12	11:12 am	11: 12 am	11: 22	10:00
13	11:13 am	11: 13 am	11:25	12:00
14	11:14 am	11: 22 am	11:27	5:00
15	11:30 am	11: 30 am	11:35	5:00
16	11: 38 am	11: 38 am	11:43	5:00
17	11: 42 am	11: 42 am	11:47	5:00
18	11: 43 am	11: 43 am	11:50	7:00
19	11:45 am	11: 48 am	11:53	5:00
20	11:47 am	11:50 am	11:57	7:00
21	11: 50 am	11: 53 am	12:00	7:00
22	11: 52 am	11: 57 am	12:02	5:00
23	11:59 am	12: 00 pm	12:05	4:00
24	12: 04 pm	12:04 pm	12:08	5:00
25	12:05 pm	12: 07 pm	12:10	5:00
26	12:06 pm	12: 08 pm	12:13	8:00
27	12: 07 pm	12: 10 pm	12:18	5:00
28	12: 10 pm	12: 13 pm	12:18	14:00
29	12: 21 pm	12: 21 pm	12:33	5:00
30	12: 27 pm	12: 28 pm	12:35	5:00
31	12:32 pm	12: 35 pm	12:40	5:00
32	12:33 pm	12: 35 pm	12:40	5:00
33	12:40 pm	12:40 pm	12:45	5:00
34	12:45 pm	12:44 pm	12:50	9:00
35	12: 47 pm	12:45 pm	12:54	7:00
36	12:50 pm	12:50 pm	12:57	5:00

APPENDIX II

S/N	Arrival time	Service begins	Service ends	Service time
1	10: 05 am	10:06 am	10: 14 am	8:00
2	10:24 am	10:24 am	10:28 am	4:00
3	10:26am	10:28 am	10:40 am	12:00
4	10:40am	10:40 am	10:45 am	5:00
5	10:47 am	10:47 am	10:52 am	5:00
6	10:52 am	10:52 am	10: 56 am	4:00
7	11:02 am	11: 02 am	11: 10 am	8:00
8	11:07am	11:07 am	11:12 am	5:00
9	11:08am	11: 10 am	11:15 am	5:00
10	11:08 am	11: 12 am	11:17 am	5:00
11	11:22 am	11: 22 am	11: 27am	5:00
12	11:27am	11: 27 am	11: 33am	6:00
13	11:35 am	11: 35 am	11:40 am	6:00
14	11:43 am	11:43 am	11:47 am	4:00
15	11:50 am	11:50 am	11: 55 am	5:00
16	11: 54 am	11: 54 am	11: 59 am	5:00
17	11: 56 am	11: 56 am	12: 04 pm	9:00
18	11: 59 am	11: 59 am	12: 04pm	5:00
19	12: 02 pm	12: 04 pm	12: 09pm	9:00
20	12:03 pm	12:04 pm	12: 11pm	5:00
21	12:10 pm	12:10 pm	12: 16 pm	5:00
22	12:13 pm	12:13 pm	12:20 pm	9:00
23	12:16pm	12:16 pm	12:23 pm	4:00
24	12:20 pm	12:23 pm	12: 30 pm	7:00
25	12:25 pm	12:25 pm	12: 35 pm	10:00
26	12:27 pm	12:30 pm	12: 43 pm	5:00
27	12: 34 pm	12:40 pm	12:45 pm	5:00
28	12:41 pm	12:41 pm	12:50 pm	9:00
29	12:49 pm	12:49 pm	12:54 pm	5:00
30	12: 54 pm	12:54 pm	12: 59 pm	5:00
31	12:56 pm	12: 56 pm	1:01 pm	5:00
32	1:00 pm	1:00 pm	1:08 pm	8:00

APPENDIX III

S/N	Arrival time	Service begins	Service ends	Service time
1	10: 00 am	10:00 am	10: 07 am	7:00
2	10:00 am	10:02 am	10:07 am	5:00
3	10:04 am	10:07 am	10:12 am	5:00
4	10:10 am	10:10am	10:18 am	8:00
5	10:22 am	10: 22 am	10:28 am	6:00
6	10:25 am	10:25 am	10:30 am	5:00
7	10: 26 am	10:28 am	10:32 am	4:00
8	10:33 am	10:33 am	10:38 am	5:00
9	10:35 am	10:35 am	10:46 am	12:00
10	10:37 am	10: 41am	10: 47 am	5:00
11	10:40 am	10:43 am	10: 50 am	7:00
12	10:44 am	10: 47 am	10: 52 am	5:00
13	10:45 am	10: 50 am	10: 54 am	4:00
14	10:46 am	10: 55 am	11: 00 am	5:00
15	10: 52 am	10: 56 am	11: 01 am	5:00
16	10:56 am	11:00 am	11: 08 am	8:00
17	10: 58am	11: 03 am	11: 09 am	6:00
18	11:01 am	11:08 am	11: 14 am	7:00
19	11:05 am	11: 09 am	11: 15 am	5:00
20	11:10 am	11:15 am	11: 21 am	6:00
21	11:14 am	11: 20 am	11: 25 am	5:00
22	11:16 am	11:21 am	11: 30 am	9:00
23	11:20 am	11:25 am	11: 30 am	5:00
24	11:31 am	11:31 am	11: 45 am	18:00
25	11:36 am	11: 40 am	11: 49 am	5:00
26	11: 40 am	11: 45 am	11: 54 am	10:00
27	11:44 am	11:49 am	11: 55 am	5:00
28	11:49 am	11:54 am	1:04 am	5:00
29	11:54 am	11:55 am	1:12 pm	18:00
30	12:02 pm	12:04 pm	1:12 pm	8:00
31	12:08 pm	12:12 pm	1:17 pm	5:00
32	12:11 pm	12:12 pm	1:30 pm	18:00
33	12:14 pm	12:17 pm	1:22 pm	5:00
34	12:30 pm	12:30 pm	1:35 pm	5:00
35	12:33 pm	12:35 pm	1:44 pm	9:00
36	12:39 pm	12:39 pm	1:44 pm	5:00
37	12:46 pm	12:44 pm	1:49 pm	5:00
38	12:52 pm	12:52 pm	1:01 pm	9:00
39	12:59 pm	12:59 pm	1:10 pm	11:00