INTERNATIONAL JOURNAL OF RESEARCH AND INNOVATION IN APPLIED SCIENCE (IJRIAS)
ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume X Issue VIII August 2025

Optimal Queuing Model to Optimize Banking Service Performances a Study of Zenith Bank Plc, Bwari Branch Fct Abuja, Nigeria

[1*]Paveun, P. F. and [2] Danyaro, M. L

[1]Department of Statistics, Federal University of Technology Minna, Niger State

[2]Department of General Studies, Yobe State College of Agriculture Science and Technology, Gujba

***Correspondence Author**

DOI: https://doi.org/10.51584/IJRIAS.2025.100800052

Received: 03 August 2025; Accepted: 10 August 2025; Published: 06 September 2025

ABSTRACT

This study is aimed to explore the application of queuing theory for efficient banking operations of Zenith bank Plc Bwari, Abuja. The structural system and the mathematical concept of multiple channel queuing system; a special type of queuing theory meant to evaluate the performance of system is presented. Real-world data was source through direct observation method from Zenith Bank Plc Bwari on arrival time and service time spend by customers to received service for a period of five working days. Multi-channel queuing system **(M/M/C: FCFS/∞)** was used to analyze the data to test the performance of the system with help of 'R' statistical software package using three servers. From the results of our findings, the utilization factor indicate the system is efficient and the servers are optimally working for 43% per hour (26 minutes) and free for 57% per hour (34 minutes), which is considerably okay compared to two servers service operation of the bank. The average waiting time of customers in the queue and in the system stood at 0.005hours (18seconds) and 0.056hours (3 minutes) respectively. This implies that a customer wait in queue for 18seconds before proceeding to any available server and spend a total of 3minutes entirely in the system to perform any transaction at counter teller. The queue length stood at 1.428 customers in system, which indicate that queue will not grow to an extent as a person who comes will join the queue as first person or proceed to any available server to receive service. We therefore concluded and recommended to the management of the bank to increase the number of tellers (servers) from the current operation of two to three tellers.

Keywords: Queue, Queuing theory, queuing system, utilization factor, Bank

INTRODUCTION

One of the major occurring factors business activities encountered everyday life is the problem of queues (waiting lines). Queues are seen and experienced everywhere every day: for example, queues are seen in hospitals, schools, offices, traffic roads, petrol stations, banks, Automated Teller Machine (ATM) galleries, etc. Queues are called waiting lines and they are lines of entities (customers) waiting for their turn to proceed or to receive service from the service attendants.

Adamu (2015) define queues as an act of forming or joining a waiting line for services and they are formed when arriving customers (entities) demanding for service have to wait because the (servers) delay when the service mechanism is busy or their number exceeds the number of servers available to serve them. According to Okafor *et al.*, (2018), queues are formed as a result of insufficient or unqualified service attendants, low service facilities so queues are formed to ease overcrowding for effective service delivery. Long queues (queue length) and delays to receive service is frustrating, provoking, dissatisfaction, etc. This can lead to customers reneging, jockeying and sometimes lead to customer to collapsing in the process of acquiring service. We cannot totally eliminate Waiting lines (queues), but queues be managed through application of a suitable technique called queuing theory to help reduce queue length and predict waiting time of customers for efficient business transaction in any banking activities and other organizations

We can define queueing theory According to Asogwal *et al.*, (2018), explained queueing theory is the mathematical techniques applied to the study and statistical analysis of waiting lines. Queuing theory is also called congestion theory and is the best fair technique to solve overcrowding problem. It is a branch of optimization in the field of operation research and mathematical science which used quantitative analysis approach called queuing models to represent the system which help to reduce delays and predict the queue length of customers requiring service.

Statement of Problem

It has become a worrisome problem to the management of Zenith Bank Plc, Bwari branch, because of the growing annoyance, frustration, dissatisfaction, reneging, etc., exhibited by the customers of this bank due to the growing problem of long queues and delays experienced by its customers to either deposit or withdraw money or perform other transactions with the bank. This delays the experience of these customers in the bank cause because of the long queues and time spent to receive service or due to unqualified service attendants or an inadequate number of servers or a low network communication system. Despite the effort made by the management of Zenith Bank Plc to improve customer satisfaction through the adequate provision of well-equipped network gadgets for banking transactions. This problem of delays keeps occurring, and the bank may be on the verge of losing some of her customers if these problems persist. This research paper focuses basically on examining the causes of growing queues (queue length) and waiting time in rendering service to customers of Zenith Bank Bwari Branch FCT Abuja with a view to reviewing the applicability of the Multiple-channel queuing system to address the queue length and waiting time of customers in the banking hall.

Aim And Objectives of The Study

The main aim of this study is to design a queuing system to minimize waiting time and queue length for efficient banking operations. The objectives are

i. to construct a queuing model to minimize waiting time and predict queue length.

ii. to examine the mathematical characteristics of the parameters of the model.

iii. to apply a multiple-channel queuing model using three servers.

iv. to solve the model using real-world data from Zenith Bank Plc Bwari, Abuja.

LITERATURE REVIEW

Empirical Review of Some Related Studies

Chuka, *et al.*, (2014), in their Analysis of a queuing system, in an organization with evidence from First Bank Plc Nigeria, examined the queuing system of First Bank Plc Enugu Branch, they revealed in the study that the number of service attendants was not optimal enough for customers' service. For improving customers service satisfaction for effective banking operation, they concluded suggested increased the number of service attendants from the present three to five service attendants in order to serve customer better and improved the overall service efficiency of the Banking operations.

Ugwa et al., (2015), postulate in a study of Application of Queuing Theory in the Effective Management of Time in Money Deposit Bank; particularly in Zenith Bank Plc Enugu branch. The objective was to design a system such as the sum of cost of customers waiting and the cost of idle facilities is optimum. He achieves the objective through primary data collected by observation from Zenith Bank Plc Enugu; a suitable queuing model was designed for the analysis. From the result of analysis, it was discovered that the application of queuing model can be used in the contest of optimization model where we seek to the minimization of sum of two costs. The cost of offering the service and the cost of waiting, they recommended queuing theory is worth studying to enable the business executive determine and install optimum service facilities so that overall service cost is minimized.

Asogwa *et al.*, (2018), also conducted a study on Application of Queuing Model in Nigerian Banking Sector, a study case of Zenith Plc, Abakaliki Branch. The study focuses on the queuing system in Nigerian Banking Sector. Source of primary data was collected from Zenith Bank Plc Abakaliki Branch on the withdrawal section of banking hall for four days in one-month interval. The data was collected based on arrival and service pattern of the customers. The methodology employed was by birth and death markovian process. The result revealed that any increase on the number of servers by the bank management will help minimized time spend by customers in queue. The study suggested more capable servers to reduce customers waiting time for service.

Eze, and Odunukwe, (2015), studied Application of Queuing Models to Customers Management in Banking System, First City Monument Bank. In this study, multiple servers' model was employed in order to reduce the traffic congestion. The study adopted primary data using the observation method. The waiting and service costs were determined with a view to determining the optimal service level. The results of the analysis showed that average queue length and waiting time of customers were analyzed for simultaneous efficiency in customer satisfaction and cost minimization through the use of a multi-server queuing model. The study recommended that the multiple servers' model should be maintained in order to reduce the traffic congestion.

Eze *et al.*, (2015), studied the application of queuing models to customer management in banking system. The study aimed to determine the average time customers spends in queue and the actual time of service delivery, thereby examining the impact of time wasting and the cost it associated with. The Markovian birth and death process was used to analyze the model, which is multiple-servers, single-queue (M/M/S) queuing model, to analyze the data collected by observation from a bank, and from the result obtained, it was with three servers, that the average cost from waiting is reduced.

Toshiba *et al.,* (2014), Application of Queuing Theory for the Improvement of Bank Service. Studied the analysis of a queuing system in an organization: a case study of Access Bank Plc, Nigeria. In the study, the analysis of the queuing system revealed the number of servers was inadequate for the customers' service and suggested increase in the number of servers in order to serve the customers better.

Nsude *et al.,* (2017), did a study analysis of a multiple-queue, multiple-server queuing system; a case study of First Bank Nigeria Plc, Afikpo Branch. The study was focused on a multiple-lines, multiple-servers' system of the customers in First Bank Nigeria Plc Afikpo Branch in Ebonyi State to determine the optimum number of servers suitable for the bank. The primary data was collected on arrival time and service time spent by customers to receive service and was analyzed. The result shows a reduction in the number of the servers as to reduce the idle time of the servers and also reduce the operation cost.

Theory of Queuing System

According to Abdulaziz *et al.,* (2022), have it known that the theory of the queuing system has its origin far back in 1909 with the late Agner Krarup Erlang, a Danish statistician, mathematician and engineer who first published a paper on queuing theory. Abdulaziz and others further explained that A.K. Erlang created a model to monitor and to describe the system of incoming calls and also to predict the wait time of calls at the Copenhagen Telephone Exchange Company. These ideals and developments have since seen applications in the academic community trying to solve the congestion of entities requiring service. The application seen is places including in telecommunication, computing, project management, offices, hospitals, transportation, traffic flow problems, engineering and most especially in the banking system. The application of queuing theory in banking system improves the bank service to customers when each customer observes the queues to be rendered service.

Queuing Problems

The queuing problem is also called the waiting line problem, and they are the things that cause individual or entities to wait in line for service. These are summarized as follows:

i. Queue length

ii. Waiting time

iii. Idle time

iv. busy time

Queuing Discipline

Queue discipline is the rule that a server applies to select a next customer for service from the queue when the server completes the service of the current customer.

Types of Queue Discipline

The commonly used queue discipline includes the following:

First in, First Out (FIFO): This rule is referred to as first come, first served (FCFS). The rule maintains that customers are served one after the other at a time, and the customer that has been waiting the longest is selected and served first.

Last in, First Out (LIFO): This rule selects the next customer with the shortest waiting time to serve first after the current customer has been served. The rule also served customers one at a time, and it is refers to as Last Come First Serve (LCFS).

Priority Discipline: This rule states that customers are selected for service with some given priority set by the management of the organization.

Service in Random Order: This queue discipline selects or picks a customer at random from the waiting line for service after the current customer has been served.

METHODOLOGY

The type of research design adopted in this research study is a case study survey design in which we examine Zenith Bank Plc Bwari out of six different banks in Bwari Area Council, FCT, Abuja. The study is limited to only the withdrawal/deposit of two service counter teller operations of the bank. Zenith Bank Plc, Bwari branch, is located in the main town of the Bwari area council, and it opens for normal banking operations from 8:00am to 4:00pm, Monday to Friday every week, and minimal activities every Saturday for staff on the ATM (Automated Teller Machine) gallery.

Method of Data Collection

We have collected primary data from Zenith Bank Plc, Bwari branch, through a careful direct observation of arriving customers in the banking hall who join the queue at the counter teller to perform any transaction. The data was collected on the variables of arrival time and service time spent by the customer to perform the transaction, the instrument used to collect the data include a recording sheet, pen, and stopwatch. The data was collected for five (5) working days from Monday to Friday for a period of eight (8) hours from 8:00am to 4:00pm on an interval scale of one hour.

Model Specification (M/M/C: FCFS/∞)

The type of queuing model we have used to fit in the data collected to evaluate the performance of the system we are working on is a single-phase, multiple-channel queuing system with three servers available to handle arriving customers and to help predict the queue length and waiting time of the customers. In this queuing system M's representing Markovian Poisson arrival and exponential service time probability distribution, "C" represents the number of three available servers, "$FCFS$" represent the queue discipline "First Come First Serve." We have also assumed in this queuing system that each arriving customer in the banking hall to perform any other transaction on the service teller joins or forms a single queue and proceeds to the next available server to receive service; this represent the infinite (∞) queue length of the system.

INTERNATIONAL JOURNAL OF RESEARCH AND INNOVATION IN APPLIED SCIENCE (IJRIAS)
ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume X Issue VIII August 2025

Design Structural Presentation of M/M/C: FCFS/∞ Queuing System

This is a queuing model that describes a system with more than one service attendant (server) available to serve arriving customers to perform any transaction. In this particular study we have assumed three servers are available to handle arriving customers, and we present the design of the structural system of the model we are working on shown below.

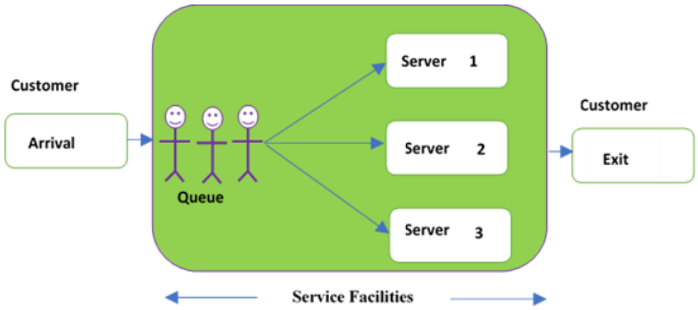


Fig. 5.2.1.1; Design Structural System of Single Phase, Multiple Channel Model (M/M/3: FCFS/∞) we are working on

Mathematical Operating Characteristics of Multiple-Channel Queuing System (M/M/C: FCFS/∞)

We have presented the design structural system of the queuing model **(M/M/C: FCFS/∞)** we are working on as shown in **figure 6.2.1.1** above. In this particular model, we adopt the following mathematical measurement parameters to evaluate the performance of the system to our objective. These operating characteristic parameters are mathematically summarized as we adopt them according to a study in Nsude *et al.*, (2017).

i. The probability that there are no customers in the system (P_o)**:** This parameter evaluates the performance of the system at steady state, possibility of no customers in the system, or the possibility that the system is free or idle at steady state. It is given as

$$P_o = \left[\sum_0^{C-1} \frac{\rho^n}{n!} + \frac{\rho^C}{C!} \frac{1}{\left[1 - \frac{\rho}{C}\right]} \right]^{-1} \qquad \textbf{(5.2.2.1)}$$

ii. The average number of customers in the queue waiting to get service (Lq): This parameter examines the number of customers waiting in the queue to receive service and it excludes the customer(s) being served. It is called the queue length, and it is described as

$$L_q = \frac{\rho^{C+1} P_o}{[C-1]!\ [C-\rho]^2} \qquad \textbf{(5.2.2.2)}$$

iii. The average number of customers in the system (Ls); this parameter examines the total number of customers in the system, this including customers waiting in the queue and those being served. It is called system length and is given as follows.

$$L_s = L_q + \frac{\lambda}{\mu} = \lambda W_s \qquad \textbf{(5.2.2.3)}$$

iv. The average time for which a customer has to wait in the queue to get service $\left(W_q\right)$; This parameter assesses the basic time a customer can wait in the queue before proceeding to any available server to get served. It is called waiting time in the queue, and it is given as

$$W_q = \frac{Lq}{\lambda} \qquad \textbf{(5.2.2.4)}$$

v. Waiting time in the system ($\boldsymbol{W_s}$)**:** this assesses the total time in the system, which defines the average total time spent by a customer in the system from the moment he arrives till he leaves the system. It is taken to be the waiting time plus the service time.

$$\boldsymbol{W_s = W_q + \frac{1}{\mu} = \frac{L_s}{\lambda}} \qquad \textbf{(5.2.2.5)}$$

vi. Utilization factor($\boldsymbol{R_o}$)**:** this examines how busy the service system is. It is also the proportion of time a server spends with the customers. It is also called busy time or servers' usage or traffic intensity of servers. It is given as

$$R_o = \frac{\lambda}{C\mu} \qquad \textbf{(5.2.2.6)}$$

$$where\ 'c'\ is\ the\ number\ of\ servers$$

vii. Traffic Intensity of the system: this examines the volume measurement of the system and how much the system is busy or congested. It is given as

$$\boldsymbol{p} = \frac{\lambda}{\mu} \qquad \textbf{(5.2.2.7)}$$

viii. Arrival Rate($\boldsymbol{\lambda}$): This parameter evaluates the rate at which customers arrived at the service point per specified time. The arrival is follows a Poison distribution interval per time. It is given as follows:

$$\boldsymbol{\lambda} = \frac{\boldsymbol{TotalNumberofCustomersthatArrived}}{\boldsymbol{TotalTimeobserved\ (Inter-arrivaltime)}} \qquad \textbf{(5.2.2.8)}$$

ix. Service Rate (μ); this evaluates the rate at which customers are served by specified time. The service rate is by exponential service distribution per time. The system is given as

$$\mu = \frac{\boldsymbol{TotalNumberofCustomers\ served}}{\boldsymbol{TotalService\ Time}} \qquad \textbf{(5.2.2.9)}$$

Assumptions of the Model (M/M/C: FCFS/∞)

To achieve our aim of this study, we made some certain assumptions required for this particular queuing model to guide us throughout the study. Some of the assumptions we made in this system include:

i. Arrival rate (λ) of customers and service time (μ) of customers follow a probability distribution of Poisson distribution and exponential service time distribution, respectively.

ii. There is no balking, no reneging, and no jockeying; this implies that arriving customers join the queue and stay in the queue till he/she receives service.

iii. The service discipline we have assumed is a First Come First Serve (FCFS) basis regardless of the rank or status.

iv. Minimal priority is given to some specified categories, such as nursing mothers and senior citizen, but it does not directly affect the service discipline.

v. The queuing system hold a single infinite line so that the queue will hold an unlimited number of customers.

vi. All arriving customers join the line at the bottom to form the queue.

vii. We assumed that the system is stable for $\frac{\lambda}{s\mu} < 1$. This hold for the infinite multiple queuing model.

viii. We assumed the system has a specified number of three servers.

Data Presentation

In this segment, we present the primary data collected for this research study. The data was collected through a careful observation method on arriving customers and service time of customers at interval of one hour, covering a period of 8am to 4pm for five complete working days.

Table 7.0.1 Primary data collected on Monday 16th May, 2025 from Banking Hall of Zenith Bank Plc Bwari, FCT, Abuja Nigeria.

Arriva Time (Hours)	Customer Arrived	Customer served	Service Time (Minutes) Teller I	Service Time (Minutes) Teller II
8:00am-9:00am	37	35	48	54
9:00am-10:00am	35	33	49	52
10:00am-11:00am	29	28	47	35
11:00am-12:00pm	28	26	50	40
12:00noon-1:00pm	25	24	41	37
1:00pm-2:00pm	17	17	34	23
2:00pm-3:00pm	24	23	35	20
3:00pm-4:00pm	15	16	28	32
TOTAL	210	202	332	293

Source; Field Survey Data on Monday 16th May, 2025

Table 7.0.2 Primary data collected on Tuesday 17th May, 2025 from Banking Hall of Zenith Bank Plc Bwari, FCT, Abuja Nigeria.

Arriva Time (Hours)	Customer Arrived	Customer served	Service Time (Minutes) Teller I	Service Time (Minutes) Teller II
8:00am-9:00am	29	29	53	48
9:00am-10:00am	33	30	50	55
10:00am-11:00am	25	23	41	39
11:00am-12:00pm	19	18	33	34
12:00noon-1:00pm	45	39	57	53
1:00pm-2:00pm	15	14	24	20
2:00pm-3:00pm	17	17	30	28
3:00pm-4:00pm	13	11	20	17
TOTAL	196	181	308	294

Source; Field Survey Data on Tuesday 17 17h May, 2025

Table 7.0.3 Primary data collected on Wednesday 18th May, 2025 from Banking Hall of Zenith Bank Plc Bwari, FCT, Abuja Nigeria.

Arriva Time (Hours)	Customer Arrived	Customer served	Service Time (Minutes) Teller I	Service Time (Minutes) Teller II
8:00am-9:00am	45	43	57	51
9:00am-10:00am	35	32	43	45
10:00am-11:00am	33	31	38	42
11:00am-12:00pm	28	25	43	31
12:00noon-1:00pm	10	10	23	13
1:00pm-2:00pm	27	24	35	38
2:00pm-3:00pm	12	12	17	23
3:00pm-4:00pm	15	15	23	25
TOTAL	205	192	279	268

Source; Field Survey Data on Wednesday 18th May, 2025

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume X Issue VIII August 2025

Table 7.0.4 Primary data collected on Thursday 19th May, 2025 from Banking Hall of Zenith Bank Plc Bwari, FCT, Abuja Nigeria.

Arriva Time (Hours)	Customer Arrived	Customer served	Service Time (Minutes) Teller I	Service Time (Minutes) Teller II
8:00am-9:00am	39	39	53	55
9:00am-10:00am	26	24	40	33
10:00am-11:00am	18	18	28	25
11:00am-12:00pm	29	29	35	41
12:00noon-1:00pm	25	23	33	35
1:00pm-2:00pm	43	42	58	67
2:00pm-3:00pm	12	12	20	28
3:00pm-4:00pm	15	14	27	24
TOTAL	207	201	294	308

Source; Field Survey Data on Thursday 19th May, 2025

Table 7.0.4 Primary data collected on Friday 20th May, 2025 from Banking Hall of Zenith Bank Plc Bwari, FCT, Abuja Nigeria.

Arriva Time (Hours)	Customer Arrived	Customer served	Service Time (Minutes) Teller I	Service Time (Minutes) Teller II
8:00am-9:00am	30	29	43	45
9:00am-10:00am	28	28	36	47
10:00am-11:00am	40	37	50	44
11:00am-12:00pm	16	16	28	32
12:00noon-1:00pm	31	30	42	44
1:00pm-2:00pm	25	24	35	32
2:00pm-3:00pm	13	13	26	30
3:00pm-4:00pm	20	17	25	22
TOTAL	203	194	285	296

Source; Field Survey Data on Friday 20th May, 2025

DATA ANALYSIS AND RESULTS

In this segment we present the results of our discoveries for the whole five (5) complete working days. This result of our findings is based on comprehensive computation of the mathematical operating characteristics parameters of the queuing system we are working on in order to evaluate the performance of the system. The computation of the results of our finding is computed with the help of "*R*" a statistical software package; this result is presented in the table below

Table 7.1; Summary of the Data and the Computed Mean Arrival Rate of Customers and Mean Service Rate of Customers for the Complete five (5) working days.

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume X Issue VIII August 2025

Table 7.1; Present the summary of the Data and the Computed Mean Arrival Rate of Customers and Mean Service Rate of Customers for the Complete five (5) working days.

DAYS	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
Customer Arrived	210	196	205	207	203
Customers Served	202	181	192	201	194
Total Arrval Time (hours)	8	8	8	8	8
Total Service Time (Minutes)	625	602	547	602	581
Mean Arrval rate per hour	26.25	24.50	25.63	25.88	25.38
Mean Arrval rate per hour	19.39	18.04	21.06	20.03	20.03

Source; Computation by the Authors from the data collected

Table 7.2; Present the Result of the Analysis of the Operating Characteristics Parameters of Model for five (5) Working Days.

Parameters	λ	μ	p	C	R_0	P_o	L_q	W_q	L_s	W_s
Monday	26.25	19.39	1.3538	3	0.4513	0.2485	0.1540	0.0059	1.5078	0.0574
Tuesday	24.50	18.04	1.3581	3	0.4527	0.2473	0.1561	0.0064	1.5141	0.0618
Wednesday	25.63	21.06	1.2170	3	0.4057	0.2888	0.0996	0.0039	1.3166	0.0514
Thursday	25.88	20.03	1.2921	3	0.4307	0.2661	0.1271	0.0049	1.4192	0.0548
Friday	25.38	20.03	1.2671	3	0.424	0.2735	0.1174	0.0046	1.3845	0.0545

Source; Computation by the Authors using R software

We have seen the performance of the system from the result of the analysis in **Table 7.2** for the complete separate five working days. To enable us to make a concrete decision on the system we are working on, we will present the results of our findings of **Table 7.2** in a logical way using the cumulative average (mean). This is shown below as presented in **Table 7.3.**

Table 7.3; The Cumulative Average Result of the Operating Characteristics Parameters of the system for five (5) Working Days.

CHARACTERISTICS PARAMETERS		RESULTS
Mean	p	1.2976
Mean	(λ) per Hour	25.526
Mean	(μ) per Hour	19.71
Mean Servers	(C)	3
Mean	R_O	0.433
Mean	P_o	0.265
Mean	L_q	0.131
Mean	W_q	0.005

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume X Issue VIII August 2025

Mean	L_s	1.428
Mean	W_s	0.056

Source; Computation by the Authors Using Cumulative Average

We have used the multiple-channel queuing model to fit in the data collected to evaluate the behavior of the system we are working on, the performance parameters of the system for five (5) working days give us the cumulative average results presented in **Table 7.3** above. This cumulative average result is to enable us to make informed decision on the performance of the system using three servers for banking operations. To help us to make a decision on the system, we will examine and compare the behavior of the system using the current two-servers operations adopted by the bank versus the three-servers system we are working on, this is presented below in **Table 7.4.**

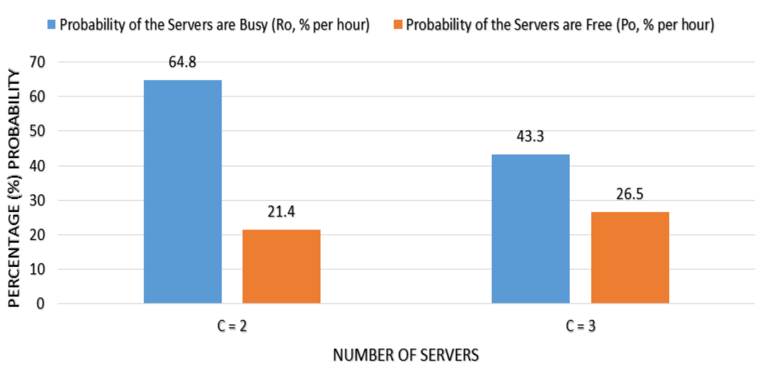
Table 7.4; Differences in behavior of the two servers versus three Servers

Parameters / Servers	λ	μ	R_0	P_0	L_q	W_q	L_s	W_s
C = 2	25.526	19.71	0.648	0.214	0.936	0.037	2.231	0.087
C = 3	25.526	19.71	0.433	0.265	0.131	0.005	1.428	0.056

Source; Computation by the Authors Using R statistical software

Table 7.4 shows the differences in behavior characteristics of the system using two servers versus three servers. These operating characteristic performance of the system indicate a significant decrease in all the parameters using three servers against the two servers. It therefore means that the system is stable using three servers and the servers have been optimally utilized. It shows that customers will not experience delay, and there will be low congestion in the banking hall using three servers against two servers. For more illustration and a clear understanding of **Table 7.4,** we will further visualize the operating characteristics parameter on a graph chart for more understanding of the system.

Fig. 7.4.1 Bar chart showing the servers Utilization (Ro) versus probability of no cutomers in system (Po)

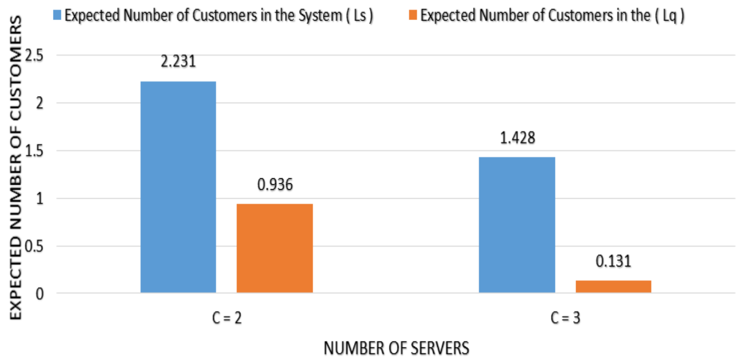


Source; Computation by the Authors using Excel

We notice in **Fig. 7.4.1** that the system is busier for 64.8% using two servers as compared to 43.3% using three. This means the system is busy for every 39 minutes using two servers compared to 26 minutes using three servers. We also observed that the system is freer for 26.5% (16 minutes) using three servers compared to 21.4% (13 minutes) using two servers.

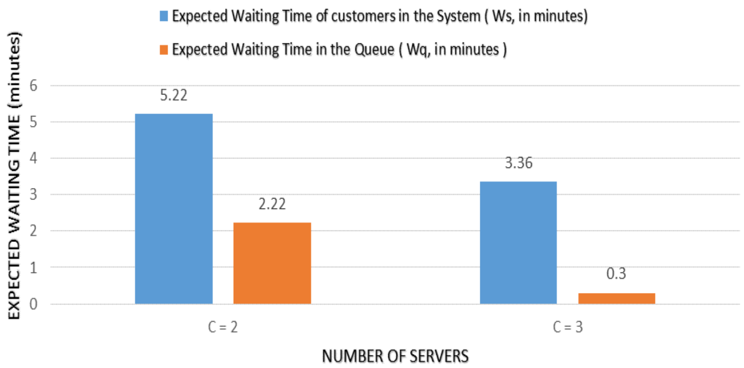
ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume X Issue VIII August 2025

Fig. 7.4.2 Bar Chart showing the Expected Number of Customers in the System (Ls) and in the Queue (Lq)



Source; Computation by the Authors

Fig. 7.4.3 Bar Chart showing the Expected Waiting Time of Customers in the System (Ws) and in the Queue (Wq)



Source; Computation by the Authors using Excel

Another way we are going to check the performance of the system is to examine some certain probability behavior of the system for three (3) servers versus two (2) servers. These are demonstrated below:

The probability of no queue (P [no queue])

The probability of no queue means that there will be no queue if the system is free. This occurs when there is no body in the system or there are fewer customers in the system than all the servers are busy. This probability is shown in **Table 7.5** below.

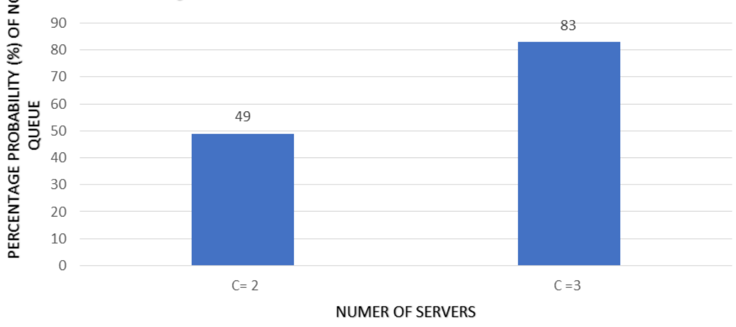
Table 7.5 Probability of no Queue in the System for two Servers and three servers

Parameters / Servers	λ	μ	ρ	P_0	P_1	P_2	Pr. [NO QUEUE]
C = 2	25.526	19.71	1.2976	0.214	0.2777	0.1802	49%
C = 3	25.526	19.71	1.2976	0.265	0.3439	0.2231	83%

Source; Computation by the Authors

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume X Issue VIII August 2025

Fig. 7.5.1 Bar Chart showing the Probability of no Queue in the system for Two Servers versus Three Servers



Source; Computation by the Authors Using Excel

We have observed in this **Fig. 7.5.1** that probability percentage of no queue in the system for two servers is 49%, which means the chance of no queue in the system is moderately low, and customers will experience a wait (delay) in the system. The probability of no queue for three servers indicate 83%. This indicates a very significant high chance of no queue in the system. This means that it is very rare to see a queue in the system using three servers, and customer will not experience a wait (delay) in the system, as the person who comes will join the queue as the first person and proceed to the available server.

The Probability of having at least three or more customers in the system P[n ≥ 3]

The probability of having at least three or more customers in the system using two servers and three servers is given as presented below:

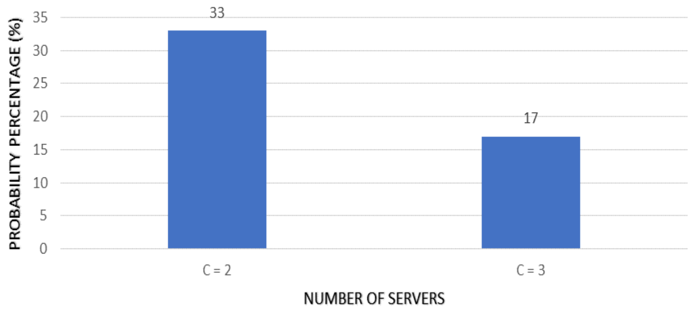
Table 7.6; The Probability of having three or more customers in the system

Parameters Servers	λ	μ	ρ	P_0	P_1	P_2	Pr[n ≥ 3]
C = 2	25.526	19.71	1.2951	0.214	0.2777	0.1802	33%
C = 3	25.526	19.71	1.2951	0.265	0.3439	0.2231	17%

Source; Computation by the Authors

We have seen in **Table 7.6** that the chance of having at least three or more customers in the system using three servers is 17%, which is very low compared to the 33% chance of using two servers. This means that it is very rare to see three or more customers in thw system using three servers, while there is a moderately significant chance to see three or more customers in the system using two servers.

Fig. 7.6.1 Bar Chart showing the Probability of atleast Three or more Customers in the system



Source; Computation by the Authors Using Excel

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume X Issue VIII August 2025

The probability that a customer who arrive can get serve immediately without waiting in the queue (P[[serve immediately])

A customer who arrived can get served immediately without joining the queue if the system is free, there is no queue, or at least one of the available servers is free.

The probability of immediate service on arrival is the same as the probability of no queue in the system. We have presented in **Table 7.5,** which indicates there is a high significant chance of 83% of the time that a customer who arrives can get served immediately without delay (waits) using three servers. 49% of the time using two servers is moderately low and customers may experience delays (waits) on arrival before he or she will be served.

The probability that they will be exactly three persons in the system (P [n = 3])

The probability of having exactly **n** customers in the system for multiple queuing system is given as

$$P[n=3] = \frac{[\lambda/\mu]^n}{C!\ C^{n-c}} \times P_0$$

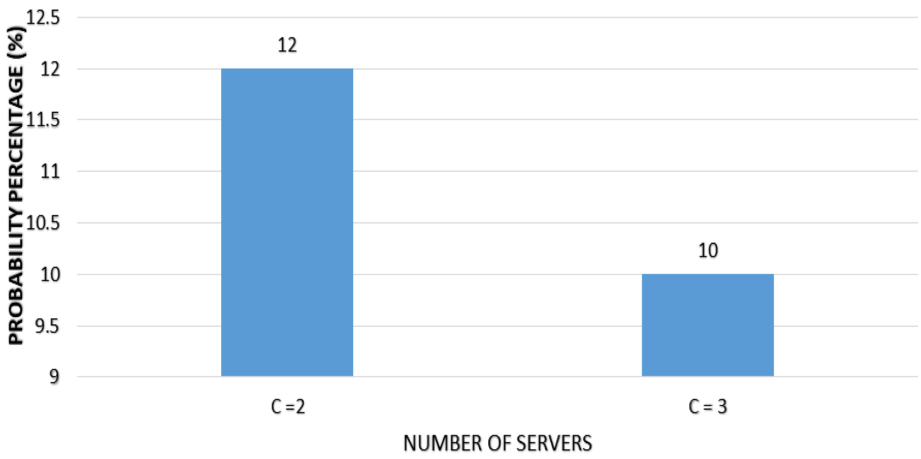
Table 7.7; showing the Probability of exactly three customers in the system

Parameters / Servers	λ	μ	ρ	P_0	Pr. [n = 3]
C = 2	25.526	19.71	1.2976	0.214	12%
C = 3	25.526	19.71	1.2976	0.265	10%

Source; Computation by the Authors

Table 7.7 shows the chance of having exactly three customers in the system for two and three servers in the system; it shows 12% and 10% for two servers, and three servers respectively. This indicates that there is 12% of the time that three customers will be in the system using two servers, of whom two customers are being served and one is waiting in the queue. This is high compared to three servers, which indicates 10% of the time lower than two servers, which implies that seeing three customers in the system is rare compare to two servers.

Fig. 7.7.1 Bar chart showing the Percentage of Exactly Three Customers in the system



Source; Computation by the Authors using Excel

DISCUSSION OF FINDINGS

We have used a single phase, multi-channel queuing system with three (3) servers to fit in the primary data collected from Zenith Bank Plc Bwari Branch Abuja. From the results of our discoveries, **Table 7.1** shows the summary of the data collected for the complete five working days. **Table 7.2** shows the results of our findings for the complete five separate working days from Monday to Friday.

Table 7.3 summarized the results of **Table 7.2** in a cumulative average result to make a concrete decision on the performance of the system. From the results of the analysis presented in **Table 7.3**, it was revealed that a customer waits in a queue for an average of 0.005 hour (18 seconds) before being served and spends a total of 0.056 hour (3.36 minutes) in the system to perform any transaction. It therefore means that a customer spends an average total time of 3.36 minutes in the system to receive service, out of which the customer waits in queue for an average time of 18 seconds before proceeding to the next available server to receive service. We have also found out from the result of the analysis in **Table 7.3** that the average total number of customers in the system is 1.4281 customers. This indicates a significant low queue length, and it means that a customer who comes in will join the queue as the first person and wait for 18 seconds before proceeding to the next available server to receive service. **Table 7.3** also shows the busy time of each server stood at 0.433 hours (26 minutes) while each server is free or idle for 0.567 hours (34 minutes), this means that the servers are optimally working for 26 minutes (43%), while the servers are free for 34 minutes (57%), which is considerably okay compared to the two tellers (servers) service operation of the bank.

We also observe the difference in behavior performance of the system using two tellers (servers) versus three servers presented in **Table 7.4.** We observed a significant decrease of all the characteristic parameters of the model using three servers; this implies a significant low congestion if the bank adopts three servers (tellers) for their normal counter teller (servers) transaction. This will reduce the waiting time and queue length of the customers.

CONCLUSION

This study analyzed Multiple-channel queuing model with three (3) service servers to improve the queuing system of customers with a specific focus to minimizing the waiting time of customers at Zenith Bank Plc Bwari Branch Abuja. From the results we have obtained as presented by the Researchers, it shows that an increase in the number of service channels will drastically reduce customers waiting time and queue length and enhance maximum customer satisfaction. We conclude to the management of Zenith Bank Plc Bwari Branch, Abuja that three servers are optimally okay and recommend an increase in the number of servers from the present two tellers (servers) to three tellers (servers) as presented in the research study.

REFERENCES

1. Chuka, E. C., Ezeliora, C. D., Okoye, P. U., & Obiafudo, O. J. (2014). Analysis of Queueing system in an Organization (a case study of first Bank Plc Enugu, Nigeria). American Journal of Engineering Research (AJER) e-ISSN: 2320-0847 p-ISSN: 2320-0936 Volume-03, Issue-02, pp-63-72
2. Okafor, I. B., Njoku, O.D., Eke, E., et al (2018). Application of Multi-Channel, Single Stage Queue Model to Optimize Service Delivery in Banking Industry (A Case Study of Diamond Bank PLC, Eziukwu Branch, Aba). International Journal of Scientific Engineering and Science Volume 2, Issue 2, pp. 36-41, 2018. ISSN (Online): 2456-7361.
3. Nsude, F.I., Elem Uche, O., & Bassey, U. (2017). Analysis of Multiple-queue Multiple-server Queuing System: A Case study of First Bank Nig. plc, Afikpo Branch. International Journal of Scientific & Engineering Research, Volume 8, Issue 1, January-2017 1700 ISSN 2229-5518
4. Adamu, M (2015), Analysis of Single Queue-Single Server and Single Queue-Multiple Servers Systems Using Simulation: Case studies of Eco and First Banks Plc. International Journal of Scientific and Engineering Research. 6(1), 1284-1296.
5. Asogwal, O.C., Eze C.M., & Edeaja, M.T. (2018), On the Application of Queuing Model in Nigeria Banking Sector: A Case Study of Zenith Bank Plc, Abakaliki Branch International Journal of Scientific Research in Multidisciplinary Studies E-ISSN: 2454-9312 Vol.4, Issue.11, pp.01-05, November (2018).

6. Eze, E.O and Odunukwe, A.D (2015), On Application of Queuing Models to Customers Management in Banking System, First City Monument Bank Pls Kubwa Abuja. American Research Journal of Bio Sciences ISSN-2379-7959, Volume 1, Issue 2, June-2015.
7. Toshiba, et al., (2013), Application of Queuing Theory for the Improvement of Bank Service Access Bank keffi. International Journal of Advanced Computational Engineering and Networking, ISSN: 2320-2106, Volume 1, Issue-4, June-2013.
8. Ugwa, et al., (2015), The Application of Queuing Theory in the Effective Management of Time in Money Deposit Banks: A study of Zenith Bank Plc in Engugu Metropolis. The International Journal Research Publication's (TIJRP); ISSN: 2251-1571. Research Journal of Social Sciences and Management (RJSSM); Volume 05, November 2015.
9. Victor, A. O (2015), Application of Queuing Theory: Analysis of Services of Commercial Banks; A case study of some commercial banks in Abuja, Nigeria. The Journal of Science Teachers Association of Nigeria; Volume 48(1) pp 102-120.
10. Abdulaziz Maruf, A., Muhammad, S.B & Shamsuddeen, S (2022), Application of Queuing Theory and Management of Waiting Time Using Multiple Server Model: Empirical Evidence from Ahmadu Bello University Teaching Hospital, Zaria, Kaduna State, Nigeria. International Journal of Scientific and Management Research Volume 5 Issue 4 (April) 2022 ISSN: 2581-6888 Page: 159-174