American Journal of Research in Business and Social Sciences
Vol. 2(4), pp. 1-13, September, 2022
AJRBSS-21-007

ISSN: 2768-5462
https://www.mprijournals.com/

Full Length Research

Optimisation of Queueing Efficiency and Performance of Nigeria Commercial Banks

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Accepted 7th September, 2022

Abstract: The objective of this research is to carry out an optimisation of the comparative analysis of the queuing efficiency of commercial banks using the TORA Optimisation Approach. Based on a sample size of four commercial banks of the top two performing banks and least two performing banks in Lagos State Nigeria, the research adopted the output from the Tora Optimisation Software to show the performance of each of the banks based on queuing efficiency. The variables measured include arrival rate (λ) and service rate (μ). They were analysed for synchronised efficiency in customer satisfaction as relating to the queuing efficiency of each of the banks which were compared among commercial banks using number of queuing efficiency performances such as; the average number of customers on queue and in the system, average time each customer spends on queue and in the system and the probability of the system being idle. The results showed that Bank A had the highest traffic intensity with its customer arrival rate not being matched with faster service delivery rate by bank officials. Banks peak period with high influx of customers was 10:30 to 11:30am and between 12:30pm to 1:30pm daily is off peak period. The research made recommendation on how the queuing efficiency of each banks, can be improved upon due to its concern to most customers.
Keywords: Queuing Efficiency, Peak period, Traffic Intensity, Queuing system, Arrival Rate, Service Rate

Cite This Article As: Amaihian, A. B., Ogunnaike, O. O., Omankhanlen, E. A. & Peter, F. O. (2022). Optimisation of Queueing Efficiency and Performance of Nigeria Commercial Banks. American Journal of Research in Business and Social Sciences, 2(4): 1-13.

1.0 Introduction of the Study

Queues appear to be a general occurrence in our day to day life. For instance, taking a cue from the several scenarios, where customers would have to queue for several hours before being attended to. Queues are evident at banks, grocery store checkout, barbershops, traffic stoplight, hospitals and also the pharmacy. Waiting to be served has become part of our everyday life (Sathiyabalan & Vidhya, 2015). Regardless of the fact that the concept of waiting particularly for services seems to come in different forms most customers' perceive waiting as a negative construct. The waiting on queues to be served could have a negative effect and also creates a negative opinion about the organization (Toshiba et al., 2014). The management of commercial banks in Nigeria have used a considerable number of strategies to counter the undesirable effects of queues. These include but not limited to entertaining programmes showing in television during waiting period (Odior, 2013). Another strategy that can be used to counter undesirable effects of delay on customer behaviour in queuing system is queue efficiency. Queuing efficiency is often used to describe the adoption of appropriate queuing structure and queuing discipline that are relevant to the arrival rate of the customers thereby facilitating customers' satisfaction through improved service rate (Kimura & Onkabetse, 2014). The ability of the banks to manage its queue system by reducing the waiting time will possibly have effects on customers' satisfaction and loyalty. In other words, queuing efficiency is one of the strategies that can be used to mitigate the undesirable effects of delay in queuing system. Consequent upon this premise, this research work focused on examining the optimisation of the queuing efficiency among commercial banks in Nigeria.

2.0 Statement of problem

Nigeria as a country operates an essentially cash-based economy in its financial transactions. This leaves Nigerian banks with the problem of having to contend with huge volume of operations and activities daily, and this translates to long queues of customers in the banking hall (Onakpa & Alfred, 2022; Shu'ara, 2021). Managing long queues has become a major challenge for banks in Nigeria. However, a cursory look into most of the banking halls in Nigeria exposes awful situation in which they operate. In most of them, few cashiers are found sometimes two or three, attending to large number of customers. Circumstances like these often result in fracases between clients and bank staff and long waiting line and that affect how customers perceive the queuing efficiency in the banking hall (Anichebe, 2013). Banks, like other service oriented organizations, operate in a progressively competitive environment. Speed of service has been proven to offer organizations a competitive advantage in the business world today. In addition, studies such as Wallace et al. (2015) and Odunukwe (2015) authenticated that customer's dissatisfaction with long waiting times is a prevalent problem in banking practice in Nigeria and a common source of anxiety and displeasure among customers (Olagunju et al., 2011; Shu'ara, 2021; Jooda et al., 2022; Malik & Malik, 2022).

3.0 Objectives

The primary objective of this study in line with the identified problems is as follows:

1. Is to carry out an optimisation of the queuing efficiency of the Nigeria commercial banks and to compare their performance.
2. To ascertain the queuing model used in each of the bank queuing system.

4.0 Conceptual framework

4.1 Waiting Line System / Queue System

A queuing system comprises of one or more servers that offer services to arriving customers in a waiting line environment of an organization. Danilo et al. (2012) opined that queuing system also refers to a birth and death system. Birth happens when a customer arrives in the waiting line to be served while death happens when customer leaves the waiting line environment. A queuing system has the following characteristics (Odunukwe, 2013)

a. The set of customers/the source population.

b. The service system/ the server.

c. The order of service.

4.2 Notation for Waiting Line/Queuing System

Queuing models used in a queue system may be completely specified in the following symbolic form using Kendal & Lee notations Since all queues systems have the followings as its characteristics: arrival, service and queue and its discipline, the queue system is usually labelled in a shorten form by using these characteristics (Sree & Palaniammal, 2014).

The general notation is: [A/B/s] :{ d/e/f}

Where, A = Probability distribution of the arrivals

B = Probability distribution of the departures

S = Sum of servers (channels)

d = the capability of the queue(s)

e = the size of the calling population

N (t) = number of customers in queuing system at time t.

Pn (t) = probability of exactly n customers in queuing system at time t.

s = number of servers (parallel service channels) in queuing system.

λ= mean arrival rate (expected number of arrival per unit time) of new customers when n customers are in system.

When λ n is a constant for all n, this constant is denoted by λ. O

1/ λ are the expected inter arrival time.

μ= mean service rate for overall system (expected number of customers completing service per unit time) when n customers are in system.

ρ = utilization factor for the system= λ /μ

Ls = average number of units (customers) in the system (waiting and being served)

Ws = average time a unit spends in the system (waiting time plus service time) =

Lq = average number of units waiting in the queue

Wq = average time a unit spends waiting

f = Queue ranking rule (Ordering of the queue).

4.3 Examples of Queuing Systems

One significant type of queuing systems that we all encounter in our day to day activities is **commercial service systems**, where external customers are offered services by commercial establishments. Several of these types of commercial service systems commonly involve person-to-person service at a stationary location, such as a men's hair stylist shop (the men hair stylists are the servers), bank teller service, checkout stands at a grocery store, and a cafeteria line (service channels in series). Conversely, others are not home appliance repairs established (the server travels to the customers), a vending machine (the server is a machine), and a gas station (the cars are the customers).

Another important type is the **transportation service systems.** In transportation service system the automobiles used are the customers, such as cars waiting at a tollbooth or traffic light(the server), a truck or ship waiting to land or take off from where it is packed(the server). (An uncommon example of this type is a parking lot, where the automobiles are the customers and the parking spaces are the servers, but there is no queue since arriving customers go to park in another car-park if the lot is full).In other case, the vehicles, such as cabs, trucks, and elevators that moves human beings within a building, are the servers.

In contemporary times, queuing theory has been used by mostly **internal service systems**, where the customers receiving service are insiders to the organization. Examples include materials-handling systems, where materials-handling units (the servers) transport loads (the customers); maintenance systems. The next section gives a brief description on the components of a basic system

4.4 Components of Queuing System.

In queuing systems the major components of queuing systems will be discussed in the sections. Customers' needs for service are bred overtime by an input source. These customers arrive in a queuing system and join a queue. Mostly a member of the queue is selected using some guiding rules called queuing discipline. The service is being offered to customer by the server or service mechanism, after which the customer departs from the queuing system. The components of the queuing system are discussed below.

1. **Input source (calling population)**

Calling population is called the population from which customers' arrival into the service environment is seen as the calling population. One of the major attributes of the input source is its size. The size is the total number of customers that likely need the service of an organisation at any point in time. The size of the population can be assumed to be either infinite or finite which implies that the input source is either restricted or unrestricted. This makes the calculations to be extremely easier for the infinite case; these assumptions are frequently made even when the actual size is comparatively big finite number and must be seen to be an assumption for any queuing model that does not state the opposite.

The statistical configuration through which customers are spawned overtime must also be indicated. The popular assumption is that customers are entering into a system according to Poisson process. A corresponding assumption is that the probability distribution of the period between sequential arrivals is an exponential distribution. The calling population is further discussed into two classes as follows.

a. Finite population.

A finite population is described as the restricted source of the customer pool which is the source that will possibly use the service and often times they form a queue. The main importance of finite population class arises when a customer leaves his/her place as a member of a population, the size of the population user group is less by one which hereby decrease the probability of the amount of customers that need service. On the contrary when a customer is serviced and returns to the user group, the population increases and the probability of a user demanding more services will also rises. This finite set of populations requires a dissimilar formula for computations.

b. Infinite population

An infinite population is another type of population source that is sufficiently outsized in congruence to the service system that any change in population size caused by withdrawals or adding to the population (e.g. a customer needing service or a serviced customer returning to the population) does not meaningfully affect the system probabilities. For example, there were 200 machines that were maintained by one repair person, and one or two machines stops breakdown and requires service, the probabilities for the next breakdowns would not be different and the assumptions could be made without a great deal of error in the population, for all practical purposes, was infinite.

2. Arrival Pattern

Arrival pattern describes the way in which a customer arrives into a waiting line system. Customers may arrive from a finite population (limited population) or an infinite population (unlimited population). Mohammad, Mohammad and Mohammad (2013) stated that Waiting line occur as a result of the difference in arrival and service of customers. Arrivals in a waiting line are known to be random in nature. It is termed random when each customer's arrival into the queuing system is independent of one another and when the customer arrival time cannot be predicted. This independence among the arrival rate of customer is modelled by the use of Poisson probability distribution while the inter-arrival rate or interval between arrivals is negative exponential distribution. Arrival rate may be regular and irregular or random. Arrival rate is denoted by e.

e **= total number of arrivals / total number of unit time.**

3. Queuing Discipline

A queue discipline is a significant rule or set of rules used in ascertaining the trend of offering service to customers in a queue in an organisation. The queuing discipline type selected can have an influence on the organization whole performance. The number of customers in the queue, the average waiting time, the array of variability in waiting time, and the efficiency of the service facility are just a few of the factors influenced by the decision of priority rules.

a. Static queue disciplines are based on the individual customer's status in the queue. Few of such disciplines are:

i. First come first serve

Ii. Last-come-first-served (LCFS

b. Dynamic queue disciplines are centred on the specific customer qualities on the queue. Examples of Dynamic queue disciplines are discussed as follows:

i. Service in Random Order (SIRO

Ii Priority Service

iii. Emergency system

5. **Service Facility Configuration**

Another aspect of waiting line management is the service facility configuration.Thenumber of servers varies with respect to demand. It is pertinent to note that the capability of every server as well as the number of server affects the capability of the waiting line system. In queuing theory channels are also used to represent servers and it is an assumption that a server can attend to one customer per time. There could be either a single server or a multiple server. The following are the basic structures of service facilities:

a. Single Queue, Single Server:
b. Single queue multiple server in series
c. Single queue multiple server in parallel:
d. multiple queue multiple server in parallel

4. **Service Pattern: This is** also called service rate. This is best describes as the amount of customers that can be served at the same time per server. Service rate can be derived by using the number of service points and the number of customers that can be served per time must be known. The service pattern could be in the form of a regular pattern or an unstable pattern. Service pattern can be denoted by using a continuous probability distribution which is called the negative exponential distribution. Waiting lines are known to be created overtime when the service rate is very slow and long. Average service rate (U) which is the average number of customers that can be served per time is

(U)= Total number of customers/ total number of unit time.

Service rate varies like arrival rate and can be described using Poisson distribution in different queuing models. The next section gives an overview of the birth and death process in a queue system.

4.5 Queuing Efficiency

Queuing efficiency is often used to describe the adoption of appropriate queuing structure and queuing discipline that are relevant to the arrival rate of the customers thereby facilitating customers' satisfaction through improved service rate. The main aim of queuing efficiency is to increase the number of customers that an organization can serve within the shortest possible. The purpose of queuing efficiency is to achieve to higher level of customer satisfaction with the entire queuing experience(Kimura &Onkabetse, 2014).. The measurement of the waiting line efficiency is achieved by the number of customers that enter the queue system; this begins from the first point of entering a queue. In the case of a single line queue this is quite evident to see but if the queue starts off-line this should be the start point for measurement (Ernest, 2012). The journey is then measured at all points including both abandonment and successful completion of the queue by attending to all customers on queue (El-Naggar, 2010). This is an approach adopted to develop more efficient queuing systems that can help to reduce customer waiting times or customers perceived waiting times to be served. The aim is to increase both the number of customers that can be served and customer satisfaction with the entire queue experience.

1. **Traffic intensity**: Traffic intensity is also known as capacity or service utilization or system load factor. This is the ratio of the average arrival rate to the average service rate and is denoted by ***p.*** this shows the efficiency of the waiting line system the nearer it is to zero the more efficient the waiting line system (Sulaiman & Onkabetse, 2014. If traffic intensity is expressed in percentage it gives the degree of percentage of average time in which the bank staff is busy. For a simple waiting line P is not greater than 1. If P is greater than 1 then the waiting line will develop into a longer queue. If the waiting $_{\text{line}}$ is equal to 1 it shows that Z = Customer behaviour (CS) the bank teller is used continuously with no queue and the utilization factor will be 100%.

Traffic intensity = Arrival / unit time (ƛ)

Service / unit time (μ)

2. **Number consideration:**

   a. Ls denote the average number of units in the system. These consist of average number of customers in the banking hall which comprises of both in the waiting line and those being attended to by the bank officials (Sammy & Thomas, 2015). The formula for in a single queue system is shown as below:

$$\text{Ls} = \frac{ƛ}{\mu - ƛ} \quad \frac{P}{1-P}$$

The formula for Ls in a multi-channel system is as follows:

.

$$L_{s=} Lq + \frac{\lambda}{\mu}$$

Where μ = service rate

P=traffic intensity

   b. Lq signifies average number of customers in the waiting line.

The formula for Lq in a single queue system is as follows:

$$\text{Lq} = L_s - \frac{ƛ}{\mu =} - \frac{ƛ}{\mu - ƛ} - \frac{ƛ}{\mu} = \frac{ƛ^2}{\mu\,(\mu - ƛ)} = \frac{P^2}{1-P}$$

The formula for Lq in a multi-channel system as follows:

$$L_q = \frac{\left(\lambda/\mu\right)^c \frac{\lambda}{c\mu}}{(c-1)!\left(1-\lambda/c\mu\right)}$$

c. Le= average number of customers in waiting line when waiting line exist.

$$L_e = \frac{\mu}{\mu - \lambda} = \frac{1}{1-P}$$

3. Time Consideration

a. W_s is the averagetime customer spends in the waiting line environment. The formula For W_s in a multi-channel queuing system =

$$W_S = \frac{L_S}{\lambda}$$

a. Wq represents the average time customers spend in the waiting line before being served. Adedayo, Olu, Obamiro, (2010) opined the formula for Wq as a single line waiting system $Wq = Ws - \frac{1}{\mu} = \frac{1}{(1-P)} - \frac{1}{\mu} = \frac{\lambda}{\mu\ (\mu - \lambda)} = \frac{P}{1-P}\frac{1}{\mu}$

$Wq = \frac{Lq}{\lambda}$.

The formula for Wq in a multi-channel queuing system = $W_{q=} \frac{Lq}{\lambda} = \frac{(\rho C)^C}{C!(1-\rho)C\mu}$

Where C= P =

3. **Chance or Probability Consideration.**

A. Probability of Queuing on arrival P = λ/μ X 100, but if there are two or more servers. P= λ/mμ X 100 where m is the number of servers this measures gives the probability that the bank is busy (Son, & Kim, 2004).

B. probability that there is no customer in the banking hall at a given time or proportion of the time in which the banking hall is idle = Po = 1-λ/μ = 1 - P

C. Pn -= probability of n number of customers in the waiting line environment

$P(x=n) = (1-\lambda/\mu)\ (\lambda/\mu)^n = (1-P)\ P^n$

D. probability of less than n customer in the system = $1-P^n$

E. probability of more than n customer in the system = P^n = $q_i = 1 - \sum_{i=1}^{m} \lambda_i p_{ij}$

5.0 Method and Materials

The population of this study is infinite. The Nigerian banking industry under study is First bank, Zenith bank, Wema bank and Unity bank which was later represented in this study with Bank A, Bank B, Bank C, Bank D respectively. Data for this study was collected with the use of structured observation. The variable measured will be analysed using the TORA optimisation software that accepts hundred observations per one scenario. The variables measured include arrival rate (x,) and service rate (a). Arrival rate was random and exponentially distributed. they were analysed for simultaneous queuing efficiency in customer behaviour through the use of multi-channel queuing models, which were compared among the banks with performance measures including ; the average time each customer spends in the queue and in the system, average number of customers in the queue and in the system and the probability of the system being idle. In the attainment of these objectives, primary data with regards to customer arrival rate and bank tellers' service rate were employed and derived through observation by the researcher with the use of a mechanical stop watch and notes in daily from 10am to 4pm daily during the observation process. The measures of queuing efficiency were analysed using the TORA optimisation software. Note that λ = arrival rate and μ , = service rate.

5.1 Measures of queuing efficiency

The following are measures of queuing efficiency:

Arrival rate = Total number of arrivals/total unit

Service rate= Total number of customers/total number of unit time

Traffic intensity= $\rho = \frac{\lambda}{c\mu}$

Chance probability

1. P_o = the probability that there are no customers in the system(all servers are idle)

$$= \frac{1}{\sum_{N=0}^{C-1} \frac{(\lambda/\mu)^n}{n!} + \left[\frac{(\lambda/\mu}{C!(1-\lambda/C\mu)} \right]}$$

2. P_n (n>c) = $\frac{(\lambda / \mu)^n}{c!c^{n-c}}, n > c =$

Number consideration

1. **$L_{Q =}$ Average number of customers in a queue**

$$L_q = \frac{\left(\lambda/\mu\right)^c \frac{\lambda}{c\mu}}{(c-1)!\left(1-\lambda/c\mu\right)}$$

2. L_s= Average no of units in the system

$$L_{s=} Lq + \frac{\lambda}{\mu}$$

TIME CONSIDERATION

W_S= The Average Time As Unt/Customer Spends In The Waiting Line.

$$W_{S=} \frac{L_S}{\lambda}$$

$W_{q =}$ Average Customer Waiting Time In Queue

$$W_{q=} \frac{Lq}{\lambda} = \frac{(\rho C)^C}{C!(1-\rho)C\mu}$$

L_s = average customer waiting time in the system.

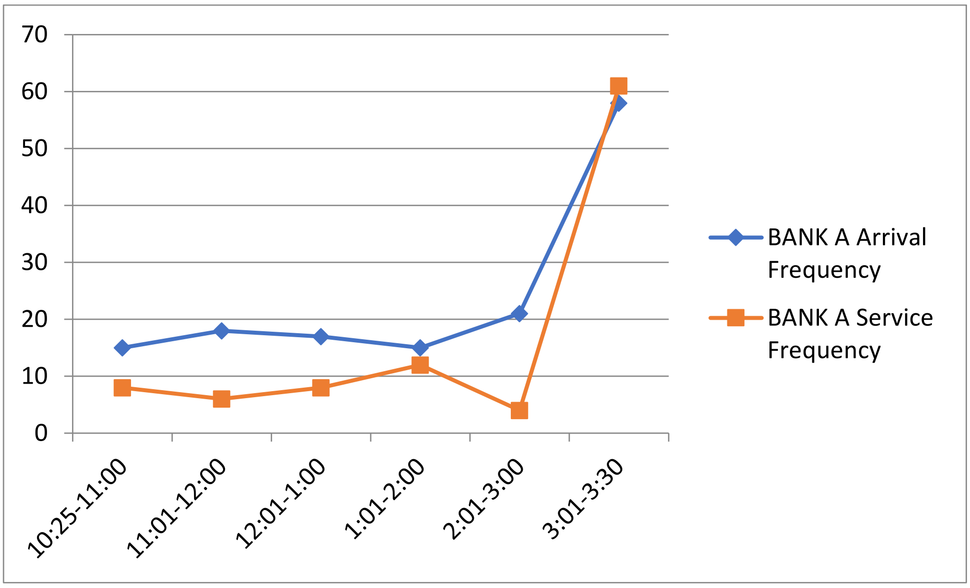
$$L_{S=} \lambda Wq + \frac{\lambda}{\mu}$$

6.0 Data Presentation and Analysis

6.1 Data Presentation

BANK A

The line graph showing customers' arrival, time and service are shown in Figure 1.1



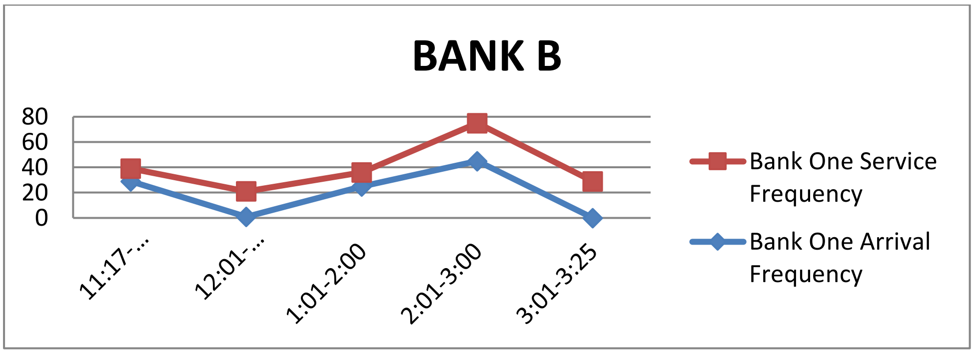
Source: Field Survey Result, (2016)

Figure 1.1 Line Graph for BANK A Customer Arrival Time and Service Time Distribution

Figure 4.7.1.1 shows the line graph of bank three with 3.00-3.30 being the time period with the highest arrival frequency 58 and service frequency 61. Between 10:25am to 11:00am 15 customers arrived and 8 customers were served. From 11.01am to 12:00pm about 18 customers arrived and 6 customers were served. From 1; 01pm to 2pm 15 customers arrived the system and 12 customers were attended to. Between 2:00pm to 3:00pm 21 customers arrived the system and 4 customers were served.

BANK B

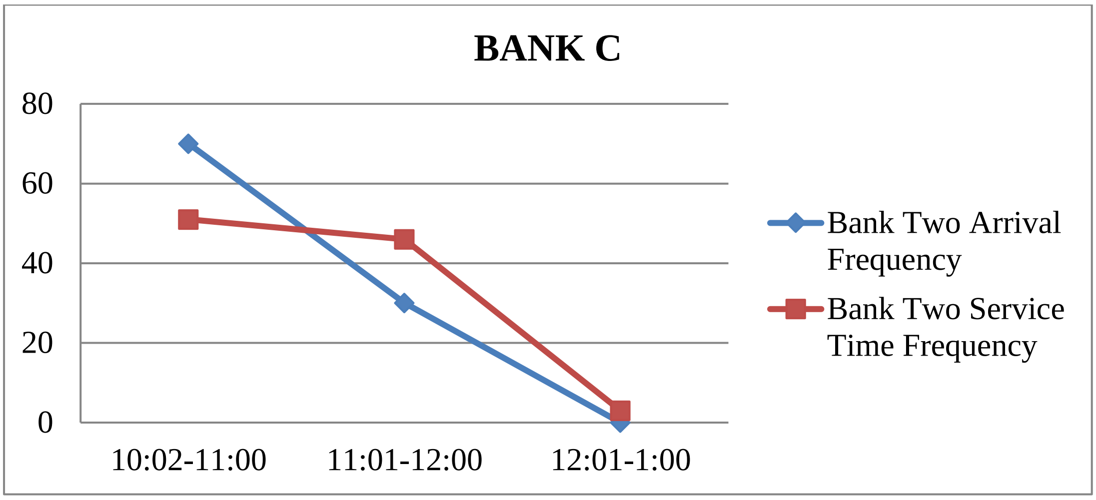
The line graph showing customers' arrival, time and service are shown in Figure 4.7.2.1



Source: Field Survey Result, (2016)

Figure .2.1:+ Line Graph for BANK B Customer Arrival Time and Service Time Distribution

Figure 2.1 above showed the arrival time and service time of customers in BANK B. The arrival time with highest number of customers was between 3:01pm to 3:25 pm, arriving customers were about forty-five in number with the second highest time being between 11:17am to 12:00pm. The red line on the line graph shows the service time notifying that more customers were served by the bank officials between 2:00pm to 3:00pm and 12noon-1:00pm with thirty and twenty customers respectively.



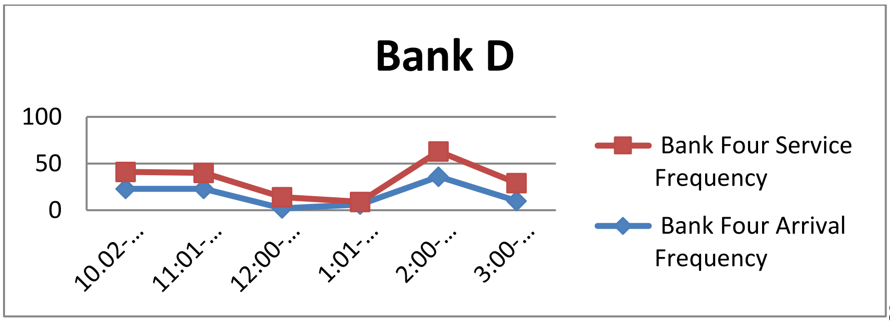
Source: Field Survey Result, (2016)

Figure 4.7.3.1 Line Graph for BANK C Customer Arrival Time and Service Time Distribution

From the line graph above it showed the arrival time and service time of customers in bank two during the observation process. At 10am to 11am 70 customers arrived into the banking hall with 51 out of these customers were served at this time. Between 11:01 am to 12pm 30 customers arrived the banking hall and 46 customers were attended to showing a spill over from the previous time. During the duration of 12:01 to 1:00pm no customer arrived the bank and 3 customers were served.

BANK D

The line graph showing customers' arrival, time and service are shown in Figure 4.7.4.1



Source: Field Survey Result, (2016)

Figure 4.7.4.1 Line graph showing BANK D Customer Arrival Time and Service Time Distribution

From figure 4.7.4.1 shows the customer arrival time and service time distribution.10.02-11:00 twenty customers arrived into the system with about 18customers being served. Between 11:01am-12:00pm 23 customers entered into the banking hall with about 17customers served. Around 12:00pm-1:00pm 2customers entered into the system with about 12 customers served. The time with the highest number of customers' arrival and customers being served is 2:00-3:00 with 36 and 27 customers respectively. From the period of 3:00pm-3:34pm 10 customers arrived into the system and 19 customers were served.

The data that was observed was analysed with the use of TORA Optimisation software and its represented below:

6.2 COMPARISON ANALYSIS OF TORA OUTPUT FOR BANK A, BANK B, BANK C, BANK D

Category	**Measure**	**Notations**	**BANK A**	**BANK B**	**BANK C**	**BAN D**
	Arrival rate	Λ	18	25	34	22
	Service rate	M	4	17	24	19
	No of servers	C	5	4	3	3
	Traffic intensity	P	0.9	0.36765	0.472	0.388
Chance consideration	probability that all servers are idle	P0	0.00496	0.22778	0.06611	0.23159
Number consideration	1. Average number of customers in queue	LQ	56	2.50	11.16	1.5
	2. Average number of customers in the system	LS	150	90	96.16	10.60271
Time consideration	1. Average time customer spends waiting in queue(min)	WQ	22.8	9	3.9	4.4
	2. Average time a customer spends waiting in the system(min)	WS	37.8	3.63	2.82	8

In scenario one showing Bank A queue analysis, where the customer arrival per period (lambda effective) = 18.00 customers in an hour with the bank official service rate (Mu) = 4 customers per hour. As affirmed in the model, unlimited number of space on the queue was assumed due to the fact that Nigerian commercial bank will aspire to meet the needs of all arriving customers by satisfying them. The queue system performance of the bank were analysed using parameters are as follows; traffic intensity = 0.900 which implies that the system is receiving customers more than they receive service from the system. Ls= 150 which implies that at least 150 customers visited the banking hall daily. Lq = 56 which implies that there are at least 56 customers on queue waiting in an hour. Ws =37.8 measures the average time delay in the queue system in every one hour. That is, customer spent at least 40mins in the banking hall before receiving service. The time in question covers the time spent before joining the queue and being on the queue, while being served and time spent shortly after being served before departure.

In scenario two showing bank B from the Tora output above queue analysis (table 1), customer arrival per period (lambda effective) = 25.00 customers in an hour with the bank official service rate (Mu) = 4 customers per hour. As affirmed in the model, unlimited number of space on the queue was assumed due to the fact that Nigerian commercial bank will aspire to meet the needs of all arriving customers by satisfying them. The queue system performance of the bank were analysed using parameters are as follows; traffic intensity = 0.367 Ls= 90 which implies that there are at least 90 customers visited the banking hall daily. Lq = 2.50 which implies that there are at least 11 customers on queue waiting in an hour. Ws =3.63 measures the average time delay in the queue system in every one hour. That is, patient spent at least 22mins in the banking hall before receiving service. The time in question covers the time spent before joining the queue and being on the queue, while being served and time spent shortly after being served before departure.

In scenario three showing bank three, where the customer arrival per period (lambda effective) = 34.00 customers in an hour with the bank official service rate (Mu) = 24 customers per hour. As affirmed in the model, unlimited number of space on the queue was assumed due to the fact that Nigerian commercial bank will aspire to meet the needs of all arriving customers by satisfying them. The queue system performance of the banks was analysed using parameters are as follows; traffic intensity = 0.472 which implies that the system is serving customers more than they arrive into the system. Ls= 76.16 which implies that at least 96 customers visited the banking hall daily. Lq = 11.16 which implies that there are at least 11 customers on queue waiting in an hour. Ws =2.82 measures the average time delay in the queue system in every one hour. That is, patient spent at least 3mins in the banking hall before receiving service. The time in question covers the time spent before joining the queue and being on the queue, while being served and time spent shortly after being served before departure.

In scenario four showing bank D from the Tora output above queue analysis (Table 1), customer arrival per period (lambda effective) = 22.00 customers in an hour with the bank official service rate (Mu) = 19 customers per hour. As affirmed in the model, unlimited number of space on the queue was assumed due to the fact that Nigerian commercial bank will aspire to meet the needs of all arriving customers by satisfying them. The queue system performance of the bank were analysed using parameters are as follows; traffic intensity = 0.388 Ls= 10.66 which implies that there are at least 90 customers visited the banking hall daily. Lq = 1.50 which implies that there are at least 11 customers on queue waiting in an hour. Ws =8.00 measures the average time delay in the queue system in every one hour. That is, patient spent at least 22mins in the banking hall before receiving service. The time in question covers the time spent before joining the queue and being on the queue, while being served and time spent shortly after being served before departure.

7.0 DISCUSSION OF FINDINGS

7.1 Findings from observed data

- It was discovered that the arrival rate is at its peak period generally for most of the banks between 10:00am to 11:00am as well as between 2:00pm to 3:30pm daily.

- However it was also observed that the off period of the arrival rate for most of the banks is between the hour of 12:00 noon to 1:30pm daily.
- It is interesting to note that for most of the banks their idle time for the bank officials was between the hours of 12:00noon to 1:30pm.
- Most of the banks under study used the first come first serve and priority forms of queuing discipline.
- It was discovered that most of the bank employ the multichannel queuing system.
- Bank A uses more of the parallel queuing structure while banks B,C,D use the branching form of multichannel queuing system.

7.2 Discussion of Findings from TORA Optimisation Output Findings.

The queue system in bank one to bank four observed was modelled as a Multi-Server queuing system with this kind of queuing model as follows: ($M / M / S : (FIFO / \infty I \infty)$. This model has multichannel series with Poisson arrivals and exponential service times and data comes from an infinite number of customers with no limit to the length of queue. In theory, it is opined that, arrivals in a queuing system is from infinite population or source and the service pattern was known to usually take the First=Come-First-Server (FCFS), Emergency rules, priority rules and a combination of both. The TORA optimization results of the queue model analysis revealed the following

1) In this section, the study adopts an M/M/∞ in Kendall's notation (Young, 1965) to analyse the impact of fluctuations in arrivals rate of customers on the behaviour of other customers from the observed data. The queuing model adopted assumes Poisson arrivals for the banks daily follow a Poisson distribution (coefficient of variation=1) in consonance with some studies which have asserted that the arrival rate of customers to banking hall reveals a Poisson distribution (McManus et al, 2004). The arrival rate for each of the bank varies and from the data observed customers left without being served as a result of the overcrowding nature of arriving customers in the queue.
2) Findings from the analysis of the observed data revealed that the service rate for Bank A, Bank B, Bank C, Bank D used in this study was as follows: 25,34,18,19 customers were served per hour with system utilization factor of Bank A 0.368 with four servers, Bank B 0.472 with three servers, Bank C 0.900 with five servers and Bank D 0.388 with 3 servers. Bank C has the lowest service rate with the highest system utilization; this shows that the service rate of a queue system affects how customers behave as they approach the queue system. This is supported by the works of Liu & Kulkarni, (2006) the system utilization decreases for increased mean service rate value. Finally, the relationship between waiting time and system utilization for fixed service time shows that if the utilization rate increases, the waiting time increased (almost exponentially). If the utilization rate is about 0.5, the probability of number of delays will increase and a further increase of utilization rates lead to increase in the number of customers served per hour and thus the waiting time per patient starts to decrease. This is also in line with the work of Wideman & Gallet (2006) and Reiner & Siegel (2002) also observed decreased waiting time with increased service rate associated with the adoption of digital system.

3) Adedayo et al. (2008) indicated that the closer the traffic intensity of a queue system is to zero the more effective the operations of the server of the queue system is noted to be and this server would have less queues giving rise to an effective queue structure. From the data collected during the observation process the traffic intensity of each of the banks used was calculated and arrived at the following: Bank A 0.368 with four servers, Bank B 0.472 with three servers, Bank C 0.900

with five servers and Bank D 0.388 with 3 servers. This finding implies that for bank three traffic intensity that is closer to one shows that there is so much queue in that bank queuing system and the server are busy almost throughout the day lead to most customers in this bank queue structure displaying kind of impatient behaviour such as jockeying. For Bank A,Bank B and Bank C whose traffic intensity is closer two zero it showed that no much queue in the bank and their server was effectively utilized with service rate being higher that the rate of arrivals in the queuing system of the Bank A, Bank B and Bank D. From the physical observation in the banking hall of each of the aforementioned banks fewer customers engaged in jockeying behaviour. The findings from the data observed supports findings from hypothesis three and theme three stating that the queue structure supports jockeying of customers in the queue system.

4) From the analysis of the observed data using TORA, the Po column signifies the probability that there are zero queues or ships for each of the banks from Bank one to Bank four. It can be inferred that the probability that there is no queue for Bank a is 0.22778, Bank B 0.23159, Bank C 0.00496 and Bank D is 0.0661 this implies that the probability of the existence of arrivals joining queue in each of these banks is 0.7722, 0.768, 0.995 and 0.934 respectively which if converted to percent Bank C has the tendency to have the highest number of queues and overcrowding present in its queuing system.

5) The Ls column from analysis of observed data using the TORA output shows the average number of customers in the system for each of the banks during the period of observation. This section indicates that an average of at least two, two, eleven and three customers have been in the queue system of Bank A, Bank B, Bank C and Bank D and since the services required by the customers varies significantly from one another and relative to the server attending to each customer. It showed that most especially for bank three will be a delay in attending to customers which may likely be the reason behind the high traffic intensity in the queue system in bank three as compared to bank one, bank two and bank four.

6) And again, from the output of Tora windows version 2.00, the Lq column shows the average queuing length of customers in Bank A, Bank B, bank C and bank D respectively. It was revealed that for bank one at least 2mins will be on queue before being served. For bank B a customer will be on queue, while for BANK C 11customers will be on queue and for BANK D minimum of one customer queue will be on queue. However, the essence of Lq as shown in the analytical queuing solution was to derive the accurate number of customers a new customer will meet on queue in any of the banks used in the study.

7) Ws column from the TORA output reveals the average time a customer is supposed to spend in the system before. This also varies with the arrival rate of customers and the extents to which the banking hall can comfortable accommodate customers into the system. Bank A customers waited about 0.06hours which is about 4 minutes in the system before being served, bank B customers waited for about 0.047hours which is about 3minutes in the banking hall before being served, bank C customers waited for about 0.63hours at least 37minutes in the system before being serve and lastly bank four customers waited for 0.143 at least 8minutes in the queue system before being served. This showed that Bank D servers were unable to accommodate all customers in the banking hall.

8) Tora output shows the average waiting time of each customers present in the banking hall on the queue (Wq).It was equally observed that the waiting time on the queue for bank A, bank B, bank C and D respectively as follows: 0 minutes 9 secs, 3minutes 9 secs, 22minutes 8 secs, 0minutes 4 seconds. This means that Bank C with the highest customers had to queue on arrival for over 22minutes thereby leading to congestion.

8.0 Recommendations

Based on the afforementoned objectives and the findngs from the dada analysis the following are the recommendations of the study:

1. **Queuing model:** Based on the findings, the study recommends the finite- queue M/M/c model and the general self-service model M/G/α Model as the appropriate models for banking system**.**
2. **Offering price incentives:** The findings of this study showed that there is a fluctuation in the arrival rate of customers giving rise to a peak period of between from 8am to 11am in the morning and also 2pm to 3:30pm daily. During this peak period the bank management can offer differential pricing by making sure higher charges are billed on customers who use their services during this peak period and charge customers less during off peak period this will help to minimise queues in the banking hall during those peak period.
3. **Promoting off peak period:** Creative use of off peak period capacity arises from seeking different sources of customers demand. Bank management should endeavour to promote their off peak period by encouraging their customers to come for bulk transactions at this period. The strategy of promoting off-peak period can be used to discourage overtaxing the facilities at other times which will help the service rates to be faster with greater service delivery.
4. **Cross training employees:** Cross training of employees to carry out certain tasks in several operations creates flexible capacity to meet localized peaks in demand. During period of queues in the banks if employees are cross trained idle employees can be mobilized to help other busy bank officials in order to enhance greater service delivery during queue periods.
5. **Increasing customer participation:** The use of computerized system should be introduced by the banks where customers can deliver basic services to themselves while in the banking hall. Where as customers arrive a bank they can key in their purpose of visiting the bank and the computer assigns them to numbers to different bank officials that attends to them in relation to their purpose of visiting the banks.

6. **Customers Consideration:** The queue efficiency measures should be observed from the perspective of customers as to whether the waiting time is equitable and satisfactory by making queue discipline fair and increasing or reducing the number of servers based on the daily queuing circumstances.

9.0 Acknowledgments

Authors of this research work express sincere appreciation to the management of Covenant University for giving full sponsorship to this research work and attendance to the conference.

10.0 References of the Study

Anichebe, N. A. (2013). Queuing Model as a Technique of Queue Solution in Nigeria Banking Industry Developing Country Studies, 3(8): 78-83.

Danilo, G., Trevor, A., Saleh, M. & Bibinaz, G. (2012). Waiting in Vain: Managing Time and Customer.

Jooda, D. T., Ladokun, I. O., Ayo-Oyebiyi, G. T. & Ijiwole, A. A. (2022). Mediating Effect of Impulsive Buying on the Relationship between Financial Behavior, Materialism, and Savings Decision of Generation Z. *American Journal of Research in Business and Social Sciences*, 2(1): 1-11.

Kimura, T. (2004) Diffusion Models for Computer/Communication Systems. *Economic Journal of Hokkaido University*, 33: 37-52.

Malik, A. F. & Malik, A. H. (2022). A Study of Financial Performance of Small-Scale Industries in Kashmir. *American Journal of Research in Business and Social Sciences*, 2(1): 1-6

Mohammad, S., Mohammad, T. & Mohammad, R. (2013). "Solving of Waiting Lines Models in the Bank Using Queuing Theory Model the Practice Case: Islamic Bank Bangladesh Limited, *Journal of Business and Management*, 10(1): 22-29.

Odior .O. A. (2013). Application of Queuing Theory to Petrol Stations in Benin-City Area of Edo State, Nigeria. *Nigerian Journal of Technology*, 32(2): 325 - 332.

Odunukwe, A. D. (2013). Application of Queuing Models to Customers Management in the Banking System: A Case Study of United Bank for Africa, Okpara Avenue Branch Enugu), Ms.C Project.

Olagunju, A., Adeyanju, O., David, O. & Oluwayinka, S. (2011). Liquidity Management and Commercial Banks' Profitability in Nigeria: *Research Journal of Finance and Accounting, of Economic Sciences*, 2(7/8): 24-38.

Onakpa, S. M. & Alfred, O. G. (2022). Influence of Social Media Covid-19 Messages on the Lifestyle of Students in Two Nigerian Universities. *American Journal of Research in Business and Social Sciences*, 2(2): 1-9.

Sammy, K. M. & Thomas M. O. (2015). An Empirical Analysis of Queuing Model and Queuing Behaviour in Relation to Customer Satisfaction at Jkuat Students Finance Office American. *Journal of Theoretical and Applied Statistics*, 4(4): 233-246.

Sathiyabalan, P. & Vidhya, V. (2015). Queuing Theory and its Impact on Various Applications - A Review: *Global Journal of Engineering Science and Researches*, 55-66.

Sree, P. & Palaniammal, S. (2014). Application of Queuing Theory in Bank Sectors *International Journal of Development Research*, 4(12): 2783-2789.

Sulaiman, S. & Onkabetse, A. (2014) Mathematical Modeling in Heavy Traffic Queuing Systems. *American Journal of Operations Research*, 4: 340-350.

Shu'ara, J. (2021). Consumer Perception of Food Security during the Period of Covid19 Pandemic. *American Journal of Multidisciplinary Research in Africa*, 1(2): 1-8.

Shu'ara, J. (2021). Consumer Education as a Strategy for Sustaining Human Rights and National Security in Nigeria. *American Journal of Research in Business and Social Sciences*, 1(2): 1-8.

Toshiba, S., Sanjay, K. & Anil, K. U. (2013). Application of Queuing Theory for the Improvement of Bank Service. *International Journal of Advanced Computational Engineering on Networking*, 1(4): 8-18.

Wallace, A., Christian, O. & Frank, O. (2015). Modeling and Analysis of Queuing Systems in Banks: (A Case Study of Ghana Commercial Bank Ltd. Kumasi Main Branch). *International Journal of Scientific & Technology Research*, 4(7): 160-163.