OVERVIEW IMPACT OF APPLICATION OF QUEUING THEORY MODEL ON PRODUCTIVITY PERFORMANCE IN A BANKING SECTOR

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Abstract

Banking sectors have perpetual queues owing to the significance of the services they render to humanity and this poses a merging challenge of queue management in the execution their jobs and in the effective delivery of services to their customers. The study focuses on the role of queuing theory in the banking sectors thus far from pedigree of queuing theory till date. This study used the historical approach to juxtapose the likelihood of the impact of queuing in the various activities in the banking as seen in the regular applications to established areas of telecommunications systems and engineering. The outcome of this review espouses that a few approaches have been applied to sort the problems encountered in the banking sectors for needful improvement. Some of these approaches are ANN (Artificial Neural Network), BPR (Business Process Reengineering) M/M/1, M/G/1 and the Erlang B&C formulas for the management of excessive bank reserves and customer queues in terms of waiting times and economic cost. These approaches have been able to improve the performance of the banking sector to an extent, however there is still a couple of limitation regarded as external factors that varies from one banking system to another and lots of works are needed to further combat the problems faced by the banking sectors.

Keywords: Queues, Queuing Theory, Banking Sector, Customers, Erlang

1.0 Queue System Overview

A queue can be referred to as a waiting line and a social phenomenon that is very rampant on our contemporary environmental societies where there are insufficient facilities or unavailability of it to literally meet the needs of the end users of a given good and/or service [1,2]. Customers are referred to as arriving units in a queue, that is, persons who are in demand of a particular service at a service delivery Centre and would have to patiently wait on a queue or in a line if the there is no promptness in the delivery of the services as shown in figure 1[3]. In service system, queues represent the unmet need(s) of the customers that can also invariably give a distraction from the values that an organization provides. A queue is unavoidably found wherever there are pressing demands for certain service deliveries and good acquisition [4]. This conspicuously exposes the inability of the service providers to meet the needs of the end users (customers). Queues at a given service delivery Centre increase as a result of variance in the pattern of arrival of customers, and the times of service alongside unnecessary lines mostly frustrates and discourages the end-users, hence, making them to look for the required service from another Centre.[5,6]
1.1 Queuing Theory
By a way of concise definition, queuing theory is expressed as it relatively pertains to a waiting line as the mathematical analysis. Queuing theory is the numerical investigation of holding up lines or queues [7]. The hypothesis empowers the numerical examination of a few related procedures, for example, touching base at the line, holding up in line and being served by a server [8].

In the early 1900s, there was a researcher by name Erlang who out of passion initiated the studies on a very significant problem as related to the congestions encountered in telephone traffic[9]. This passionately initiated idea further gave birth to queuing theory which is seen to be new in the branch or scope of applied theory of probability [10]. Upon the discovery of the term queuing theory as it gradually became very germane tool to the growth and development of several branches of social life and applied science [11]. The first application of queuing theory was in solving the telephone conversation problems as it was fully categorized in terms of customers and server where the telephone calls was assumed to be the customer and the server to be the telephone line[12]. It was also broken down for the scenario of a computer system, where the job inputted into the computer is the customer and the Central Processing Unit (CPU) is the server. Invariably, queuing theory in our contemporary world has a very wide range of application as it is used in various operations in the computer systems to evaluate the level of performance so as to be able to stay competitive in the business of communication service as it grows at a very fast pace [13]. The impact of queuing theory as applied to solving a traffic junction congestion problem suggested the use of a mathematical models with respect to the queue [14].

2.0 Queuing Theory Models in the Banking Sector
The issue of bank lining has existed for long time wherever our nation or different nations whose populace thickness is high. Be that as it may, this issue can't be understood totally in brief time. It isn't useful for the banks to build the quantity of branch bank and servers in the banks simply. Off-base choice of area choosing and additionally repetitive working of banks will obviously convey colossal misfortune to the bank[15].

In a bid to solve some of the consistent challenges encountered in the banking sector, some researchers have postulated theories formulas and models to aid the resolution of this nagging and perpetual issue affiliated with the banking sector[16]. Some of the banking systems do not really get overwhelmed by the crowding experiences they have during the delivery of services to their customer because of seeming state of complacency [17].
However, some of the impatient and dissatisfied customers gradually begin to withdraw from such banks and look for another with better service delivery modalities, leaving the customer insensitive banks with gradual loss of customer patronage [18]. Bishop et al. [19] analyzed queuing systems obtained from queues from the observed data of some selected banks in Ogun State. The analysis of the data helped to make some suggestions towards the usefulness of queuing theory model in banking.

2.1 BPR Approach
Hao & Yifei [15] proposed a method for the optimization of the queuing system in banks by the use of BPR (Business Process Reengineering). The study investigated the bank business used simulation to appropriately determine the number of available servers in a particular period and eventually improving the queuing systems at the key points. The approach relatively got an optimized outcome from the simulation process.

A general business process was given by Hao & Yifei [15] as shown in the figure 2 below;

Figure 2; Business Process (Hao & Yifei, 2011)

2.2 Erlang B and C Formulas to Manage Bank Excess Reserves
Taufemback & Da Silva [20] observed that the erlang B and C formulas had always been used for traffic analysis in the traffic systems and telecommunication sector as established areas within the scope of queuing theory and had not been applied in the any financial institutional sector. This led to the application of the formulas to the problems faced by a particular bank for a proper adoption of it. The erlang B and C formulas are stated in equations 1 and 2 below.
2.3 ANN Method

Satya et al., [21] estimated the waiting time of customers in the bank with the use of Artificial Neural Network method. Two approaches namely, structural approach and time series approach was relatively compared. The study showed that waiting time estimation given by the structural approach was better than the time series approach. Pictorial view of the network is presented in the figure 3 below.

![Artificial Neural Network](image)

Source: (Taufemback & Da Silva, 2012)

3.0 Impact of Queuing Theory in Various Sectors of Banking.

The significance of the theory of queuing via the use of several models is a full definition of its relevance in various annexes of the banking sectors. Some of the impact of the applications in some selected banking units is highlighted thus;
3.1 Banking Services.
Numerous queues had been observed to repeatedly occur at most ATM points owing to several reasons which could be as a result of insufficient ATM units or nonfunctional machines at the payment points [23]. Yakubu & Najim [24] carried out a study to optimize the ATM services for a selected terminal as shown in figure 4 below. The M/M/s queuing model gave a robust illustration and analysis of the queuing pattern of the case study. The model was optimally able to find a level of service but there were some external constrains to that. Ahmed et al.[25] also addressed the challenge of waiting time at a selected bank’s ATM point in Bangladesh. M/M/1 queuing model was applied in this scenario which was to significantly minimize the waiting time at the ATM point. However, some limiting factors were observed like poor banking service/network, and some other external factors. Dhar & Rahman [26] also carried out a study on the waiting period of customers for service delivery at a given ATM point of a bank. It was discovered that the arrival rate is one customer per minute and the capacity or the rate of service delivery at the bank is 1.5 per minute [27]. This poses a little challenge as some customers might be impatient and opt for another bank’s service(s) lading to loss of customers. Amos et al.[28] used the M/G/1 model in the modelling of the system of queuing amongst three banks in Nigeria namely, Ecobank, Diamond Bank and Guarantee Trust Bank in Nasarawa State specifically Lafia. Over utilization of the ATM server, long waiting time and long queue length were observed to be problems of the three banks. Sequel to that, the need for the upgrade of the speed of the ATM processor was highly recommended to ensure that one customer spends just one minute for every transaction for an improved service delivery and performance. Agyei et al. [29] modelled and analyzed the queuing theory in commercial bank of Ghana in Kumasi. The data used was obtained from the bank and was analyzed with the use of TORA optimization software. In terms of the waiting time, it was observed that using a 6-teller or 4-teller was not effective, Hence, the use of a five-teller system was recommended in terms of the average economic cost and waiting time to be adopted by the management of the bank for improved efficiency and performance [30].

Figure 4; Queuing pattern at a selected ATM point (Yakubu &Najim, 2014)

3.2 Banking Customer Services
Alvi [31] investigated the effect of queuing in some Nigerian banks. His report shows that the Guarantee Trust Bank of Nigeria had the highest queue status with a traffic intensity of $(p=0.98)$ and Ecobank conversely had $(p=0.78)$. Owing to the poor service delivery at these banks, a 10-server and 13-server model was recommended for adoption by Ecobank and GTBank respectively in a bid to improve their efficiency on service delivery. Odunukwe, (2013) examined the time wasted in service delivery of a banking system alongside the determination of the time customers spend on an average on a queue. The process of markovian birth and death was used from the queue analysis which showed that the server was improved to being busy at 56% output and seemingly idle for 44%. This resulted in a reduction in the waiting cost of the bank [32].

In Ethiopia, Dashen bank and a commercial were taken for a case study in a comparative analysis using a queuing theory model by[33]. In the comparison, there was an average of 6.125 and 7.125 customers arriving and being served per hour. And the queue waiting time for the customers was 0.828 minutes and 0.216 minutes respectively[34]. It was observed that the service waiting probability was highest in Dashen Bank than the commercial bank of Ethiopia. It was recommended for the two banks to increase their number of servers for optimal performance. In Maiduguri, Nigeria, a fidelity bank was examined for service delivery to customers by [35]. Data collection was via observation with a deep emphasis on the use of Poisson distribution. The value of the traffic intensity in the system as $(p = 0.96)$. This implies that the system was actively busy for 96% and for 4% of the time. Hence, the system is highly utilized [36].

### 4.0 Conclusion

Coming from the historical significance of queuing theory, it has been seen to have a very germane role in the queue congestion of several sectors like telecommunications, traffic in transportation systems, computer systems to a very large extent. However, this review shows that a few studies has been carried out with the scope of the banking sector with respect to the application and impact of queuing theory on such systems. Approaches and methods like ANN (Artificial Neural Network), BPR (Business Process Reengineering), Erlang Band C formulas, M/M/1, M/G/1 models have been found very effective with a little shortcoming as it improved the productivity performance of the systems. However, it is recommended that these evaluations been done for most if not all of the banking sectors for operational optimization and effective performance.

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