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CONTENT

CAPACITY PLANNING AND SYSTEM UTILIZATION IN THE MANAGEMENT OF QUEUES IN SELECTED BANKING HALL IN ILORIN METROPOLIS

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Abstract
Capacity planning and system utilization have become critical issues because most banks operate their facilities at a rate less than installed capacity. Experts have traced this development to deficiency in capacity planning and system utilization in the management of queues in the banking halls. The main objective of this study is to determine the relative adequacy of capacity planning and system utilization in the management of queues in the banking hall. The study utilized arrival and departure data of customers into the bank through direct observation. Inter-arrival period of 15 minutes was used. The cost function of the bank was also used to determine whether the present system can be improved upon or not. Findings revealed that there were more inflow of customers than expected at a given time interval resulting in pressure on the existing capacity. The paper recommends that management should make a contingency plan to respond to any unusual crowd that may arise during those periods when queues are noticed to be more.

Keywords: - Capacity Planning, System Utilization, Queuing Management.

Introduction

The recapitalization and consolidation that took place in the banking industry between 2001 and 2006 appeared to have led to an upsurge in the number of customers patronizing those banks that scaled through the Central Bank of Nigeria, (CBN) requirement. Long waiting period arising from this policy is fast becoming a permanent feature of most service delivery institutions in Nigeria. This is particularly noticeable in banks. Speaking in the same vein, Olaniyi (2004) posits that the endless customers waiting for service delivery in Nigerian banking halls is a phenomenon that bothered both the managements of banking institutions and customers.

Good and efficient services demand a lot of quality planning and effective decision making. Effective decision making according to Koontz et al (1983), requires a rational selection of a course of action; of central importance to this is capacity planning, which is of relevance to service organization such as banks because the condition of physical facilities in most of the banks is far from being ideal, and has made things difficult for the customers.

In Banks therefore, we talk of capacity in terms of space, the service facilities such as the number of cashiers engaged, and the equipment installed to serve the customers. It has been observed that most organizations operate their facilities at a rate less than the installed capacity, and for some, at a rate more than the installed capacity. Scheduling gives a competitive advantage through dependable delivery. The correct scheduling technique depends on the volume of customers coming into the banks, the nature of operation and the overall complexity of the job as well as the importance placed on each of the four criteria; minimize completion time, maximize utilization, minimize the waiting line, and minimize customers waiting time.

The significance of capacity planning and system utilization has not been appreciated; hence, less attention has been paid to it. This study on capacity planning and system utilization as focused in this work was to assess the flow of customers, the staff scheduling, assessing the working environment and the waiting environment.

The general objective of the study which is in line with the identified problems is to determine the relative adequacy of capacity planning and system utilization in the management of queues in banking hall.

The study specifically aims to determine;

(i) the effects of capacity planning on waiting line
(ii) the effects of system utilization on reduction of waiting period by the customers
(iii) which of the adopted approaches minimizes the cost of service delivery?.

The intermediation role of financial institutions is such that performance in this sector critically impacts on other sectors of the economy. When performance in this sector is good, there is a positive effect on the economy; but when the financial sector is distressed, there is a band-wagon (negative) effect on other sectors of the economy. Undertaking empirical study of capacity planning and system utilization in the financial service organization therefore is very critical for the efficiency of the banks.

Literature Review

The Concept of Capacity and Capacity Planning

According to Aquilanol and Chase (1991), the capacity of the production system defines the firm's competitive boundaries. It sets the firm's response rate to the market. Its cost requirements and its general inventory strategy. They observed further that if capacity is inadequate, a company may lose customers through slow services thus paving ways for new entry into the market. To business, such a company has to reduce prices to stimulate demand. Buffa (1994) defined capacity as the limiting capability of a stated time period, normally expressed in terms of output unit per unit of time. He opined that the concept (capacity) must be related to the intensity with which a facility is used. The definitions above expressed capacity as a rate, as the number of output that can be produced per month, or per year. For many companies, measuring capacity can be straight forward. It is the maximum number of unit that can be produced in a specific time. For some others, determining capacity can be more difficult. Capacity can be measured in terms of beer (cases) in a beer plant, in terms of beds in a hospital. In banks, capacity can be measured in terms of the service facilities such as the space, the number of cashiers engaged, how customers are to be served, when they are to be served and the equipment installed to serve them.

Capacity planning attempts to satisfy the level of capacity that will meet market demands in a cost–efficient manner (Dervitsiotis 1981). According to him, management treats capacity related problems in three ways. First, is the issue of large increment in capacity needed for changes in the demand over a long time, say 5-10 years ahead. For most technologies, capacity increment of this type can be made through system design capacity. Second, is intermediate range capacity planning business cycles. This can be sought through aggregate planning. Aggregate planning relies on the use of inventories and changes in the size of the work force through hiring and lay offs, use of over time and sub contracting orders to other firms. Thirdly, adjustment in capacity may be needed to cope with short-time fluctuations in demand. This is done weekly and daily through operation scheduling. This shows that the concept of capacity planning is multi-dimensional. It could be viewed from different angles.

A closer look at capacity related problems reveals striking similarities with aggregate planning and scheduling or sequencing. Aggregate planning is a process for specifying how the production resources of the firm are to be employed over some featured time period in a manner that would support either the intermediate or long term sales forecast (Banjoko 1989). The term scheduling, according to Banjoko (1989), refers to the process of determining when certain jobs are to be processed on given facilities or when the facilities are to be allocated to a given set of jobs. He goes further to see job sequencing as the order in which jobs are to be processed through the system or the order of processing the job through the facility or some facilities Dervistiotis (1981), asserts that for the short run, that is for periods ranging from a few days to a month, management has the task of scheduling operations for existing orders and or imminent forecast demand. This type of scheduling involves the fine-tuning of aggregate production plans. Actual orders in this phase are first assigned to specific resources, facilities, employees and equipment. At each processing center, they are sequenced to achieve an optimum utilization of existing resources or order objectives.

Depending on how facilities are used and managed, effective capacity in terms of the capacity of a firm can expect to achieve, given its products mix, method of scheduling, maintenance, standard of quality and efficiency may be difficult to reach. This is to say that it may be difficult to attain 100% deficiency.

Basically, efficiency is expressed as a percentage of the effective capacity. This suggests that efficiency is a measure of actual output over effective capacity, while the rated capacity measures the maximum usable capacity of a particular capacity. Conversely, capacity cushion measure the amount of capacity in excess of expected demand. For example, if the expected monthly demand in a facility is One Million Naira worth (N1.000, 000.00) of a product per month and the designed capacity is N1.2 million per month, it has a 20% capacity cushion. A 20% capacity cushion equals 80% utilization rate (100% - 120%). However, when a firm`s designed capacity is less than the capacity required to meet its demand, it is said to have a negative capacity cushion. If, for example, a firm has a demand for N1.2million of a product per month; it has a negative capacity cushion of 20%.

Capacity planning according to "Microsoft operating framework glossary (2009)" is the process of forecasting system and environment, utilization and workloads and then develop plans to ensure that the system and environment will be able to support anticipated performance demands. It is also said to be the process of planning, analyzing, sizing and optimizing capacity to satisfy the demand in a timely manner and at a reasonable cost. Looking at the second definition, it looks more like defining capacity management. It is difficult to separate capacity planning from capacity management. The former is an integral part of the latter. Besides, in discussing capacity related problems, the cost elements must be taken into consideration.

Skinner (1974) in Aquilano and Chase (1991) stated that the concept of capacity in factory holds that production capacity works best when it focuses on a fairly limited set of production objectives. This means that a firm should not expect to excel in every aspect of manufacturing operations. That is, cost, quality, flexibility, new product development, liability, short lead time and low investment. Rather, it should select a limited set of tasks that contribute the most to its corporate objectives, those in which it has core competence.

Determination of Capacity Requirements

Dervistiotis (1981) identified the following steps as the phases in system design of capacity. The steps are:

Step I: Determine project capacity requirements given a demand forecast and existing process bottleneck

Step II: Formulate an alternative to meet future capacity requirements;

- Types of technology
- Centralized versus decentralized plants
- Opportunity for subcontracting

Step III: Evaluate an alternative based on;

- Economic factors ; cost, revenue, risks
- Strategic impacts, competition, flexibility, quality and organizational and managerial adjustment.

Queuing and Queuing Management

Queuing is a capacity related problem. Some organizations realized that there are queuing–up problems, yet no serious attention has been paid to the problem because of some of these reasons: incompetent personnel, inadequate infrastructure/facilities, faulty design of appointments schedule and resources constraints. Most people queue at least once a day and if we accept the saying that "Time is Money", queuing is an expensive activity. Therefore, it has to be properly managed. In solving a queuing problem, mathematical expression known as the **TRAFFIC INTENSITY** should be used. This is the ratio of the average arrival rate to the average service rate. It is commonly assumed that the traffic intensity of a queue is less than one. Wild (1980) maintained that if the service rate (μ) is less than the arrival rate, the queue elongates, and that if there are λ arrivals per hour, the system will be busy λ/μ proportion of time and $w\mu - \lambda/\mu$ proportion of time.

Dervistiotis (1981) indicated that queuing system is one in which we observe alternating periods of congestion, that is, waiting Lines and Idleness of service facility due to limited capacity and randomness in the arrival of units and time required to serve them. Queuing problems are of considerable interest in this world as a result of its perturbing consistency in both private and public service systems. This implies that waiting Line problem is a common phenomenon.

Queuing theory therefore, is a decision making tool for the manager`s benefit, just as the operations research techniques (Charry 2007). The position expressed above is to view capacity planning, system utilization and queuing management as not only related but falls within the context of operations research.

Methodology

This study utilized arrival and departure data of customers into the banks through direct observation lasting 7 hours every day for two weeks with the help of research assistants. Inter-arrival time of 15 minutes period was used. An open ended, carefully structured questionnaire was prepared and administered to the Branch Manager of the bank. The bank was selected from the list of 25 banks that met the C.B.N condition for consolidation using simple random sampling. The Bank studied was Skye Bank. The total number of customers served during the period of study by the sampled bank numbered 4460. On the basis of first-come-first-served, 112 customers were interviewed per day in the bank studied. The analytical framework utilized was drawn from multiple–server queuing model, specifically M/M/K model. The model provides alternative channels for the customers to approach for service. Descriptive statistics, mainly frequency counts and means were used to determine the average number of customers that arrived and were served. The cost function of the bank was also used to determine whether the present system can be improved upon or not. The model specification for queuing system is shown below.

$$Po = \frac{I}{\left[\sum_{n=0}^{K-1} \frac{}{K!}\left[\frac{}{\mu}\right]^{n} + \frac{1}{K!}\left(\frac{\lambda}{K!}\right)^{K}\left(\frac{K\mu}{K\mu-\lambda}\right)\right]}$$

$$P_n = \frac{(\lambda/\mu)^n}{n!} \; Po \text{ for } n < k$$

$$P_n = \frac{(\lambda/\mu)^n}{K!\,k\,(n-k)} \; Po \text{ for } n > k$$

$$L = \frac{(\lambda/\mu)^k \lambda\mu}{(k-I)!\,(K\mu-\lambda)^2} \; Po + \frac{\lambda}{\mu}$$

$$W = \frac{(\lambda/\mu)^k \mu}{(k-I)!\,(K\mu-\lambda)^2} \; Po + \frac{I}{\mu}$$

$$Lq = \frac{(\lambda/\mu)^k \lambda\mu}{(k-I)!\,(K\mu-\lambda)^2} \; Po$$

$$Wq = \frac{(\lambda/\mu)^k \mu}{(k-I)!\,(K\mu-\lambda)^2} \; Po$$

$$Pw = \frac{I}{K!}\left[\frac{\lambda}{K}\right]^{K}\left[\frac{K\mu}{K\mu-\lambda}\right] Po$$

$$P = \frac{\lambda}{K\mu}$$

Where Po = The probability of having no customer in the system or that the system is idle.

Pn = The probability of having n number of customers in the system

Pw = Probability that all servers are simultaneously busy.

L = Average number of customers in the system

Lq = Average number of customers in the queue

Wq = Average time in the queue.

W = Average time in the system.

Data Presentation, Analysis and Discussion

Table I: Summary of Data collected as arrival and departure of customers for 2 weeks excluding Saturday and Sunday.

Days	Arrival	Departure
1.	828	596
2.	716	530
3.	653	385
4.	830	491
5.	678	432
6.	412	287
7.	685	453
8.	547	396
9.	667	437
10.	693	453
Total	6709	4460

Source: Researcher's Computation (2010).

From table I above, the mean arrival rate (λ) per day = 6709 ÷ 10 days

$\lambda = 670.9 \simeq 671$

The above shows that on the average 671 customers arrived Skye Bank (Plc) per day.

Arrival rate per hour = 671 ÷ 7 hours

$\therefore \lambda = 96$ customers per hour

It means that within an hour, at least 96 customers arrived the bank for service.

Arrival rate per hour for each channel = 96 ÷ 4

$\therefore \lambda = 24$ customers per channel

It means that within an hour, at least 24 customers arrived and waited in Line before a cashier for service.

From the same Table I above, the mean service rate (μ) per day = 4460 ÷ 10 days

$\therefore \mu = 446$ customers served per day

The above shows that on the average, 446 customers were served per day.

The service rate (μ) per hour = 446 ÷ 7 hours

$\therefore \mu$ 64 customers served per hour

This shows that, on the average, 64 customers were served in an hour. This is very impressive. It further shows that no customers spent up to a minute before they were served.

The service rate (μ) per channel = 64 ÷ 4

$\therefore \mu = 16$ customers

This means that, on the average, 16 customers were served per hour

Table 2: Skye Bank (Plc) Present and Proposed System

Operating Characteristics	Present	Proposed	% change
S	4	5	-
Λ	24	24	-
μ	16	20	25
P	1.5	1.2	(20)
Po	0.22	0.3	36.4
Pu	0.38	0.24	(36.8)
Lq	0.045	0.003	(93.3)
Ls	1.544	1.203	(22.1)
Wq	6.71 seconds	0.39 seconds	(94.2)
Ws	231.71 seconds	180.39 seconds	(22.1)

Source: Researcher's Computation M/M/K Queuing Output (2010).

From Table 2 above, the arrival rate (λ) for Skye Bank (Plc) per hour per channel was 27 customers while the service rate (μ) per channel was 16 customers.

From table 2 above, with 4 cashiers, the traffic intensity (P) was 1.5 representing 15%. This high percentage was an indication of a large inflow of customers to the bank. There were more customers coming into the bank than expected. The effect of this could be congestion and long waiting Line. The average number of customers in the queue (Lq) and in the system (Ls) can be reduced by 93.3% and 22.1% respectively. Since our objective is on the effect of this decision on waiting line, one can comfortably submit that the first objective has been achieved by Skye Bank.

The second objective is to determine the effects of system utilization on reduction of waiting period. To achieve this objective, the operating characteristics derived from M/M/K queuing model were used. The relevant characteristic in this case is the utilization factor (Pu).

Table 2 above shows again that with 4 servers, the utilization factor (Pu) was 0.38. With the present system, customers spent 6.71 seconds in the queue (Wq) and 231.71 seconds in the system (Ws). By engaging 5-servers, the utilization rate (Pu) will be reduced to 0.24. This will in turn reduce the time a customer spends in the queue (Wq) and in the system (Ws) to 0.39 seconds and 180.39 seconds respectively. Table 2 above shows that 5 server systems can be more efficient and saves time more than the present 4-server systems. This is because the rate of utilizing the cashiers can also be reduced by 36.8%. A 5 server systems can be more efficient since it is capable of reducing the waiting period both in the queue (Wq) and in the system (Ws) drastically by 94.2% and 22.1% respectively.

Systems Cost Consideration

The objective of queuing modelling is to minimize the total costs of waiting time and providing services. It is therefore the responsibility of the management to balance these to make any economic queuing system decision.

The objective here therefore is to calculate the costs of the present service system in the bank under consideration and those of possible alternative systems that enable the organization to perform optimally.

To build costs into a queuing model for the purpose stated above, the following denotations are used

Cs = Cost per service per unit of time
Cw = Cost of waiting in the queue per unit of time
Lq = Average number of customers in the queue
Ls = Average number of customers in the system.
S = Number of servers
The applied total cost (TC) equation is given as;
Tc = Cs (S) + Cw (Lq)

The cost of waiting for the bank is obtained from the expression. $\mu = \sqrt{\frac{\lambda + Cw\lambda}{Cs+}}$

which is the minimum service facility that minimizes cost. From the above expression therefore, waiting Cost (Cw) = $\frac{Cs(\mu - \lambda)^2}{\lambda}$

The third objective is to determine which of the adopted approaches minimizes the cost of service delivery. To achieve this objective, the cost function of the bank was incorporated into the operating characteristics. It is considered necessary to compare the present system with the possible alternatives for the bank with a view to determine the alternative that minimizes the cost of service delivery.

An average cashier in this bank earns a minimum of N50, 000.00 per month which represents the cost of service (Cs). The effective working hour was 7 hours daily. The bank opens to customers 5 days in a week and works for a minimum of 4 weeks in a month. The cost of service (Cs) per hour therefore is given as

Cs = N50, 000 ÷ 7x4 which equals N357.14 per hour.

Waiting Cost (Cw) is N$\frac{357.14\,(16-24)^2}{24}$ which equals N952.37.

The total cost (Tc) for the Skye Bank (Plc) with 4 servers is N357.14 (4) + N752.37 (0.045) equals N1471.41. With 5 servers, the total cost (Tc) is N357.14 (5) + N952.37 (0.003) which equals to N1788.55. With 6 servers, the total cost (Tc) will be N2142.93

Table 3: Comparative Operating Characteristics Skye Bank (Plc)

Operating Characteristics	Present System	Alternative I	Alternative II
S	4	5	6
Λ	24	24	24
μ	16	20	24
P	1.5	1.2	1
Po	0.22	0.3	0.37
Pn	0.38	0.24	0.17
Lq	0.45	0.003	0.00001
Ls	1.544	1.202	1.000
Wq	6.71 seconds	0.39 seconds	
Ws	231.71 seconds	180.39 seconds	150 seconds
Cw	₦833. 33	₦833. 33	₦833. 33
Cs	₦312. 50	₦312. 50	₦312. 50
Tc	₦1471.41	₦1788.55	₦2142.93

Source: Researcher's Computation M/M/K Queuing Output (2010).

Table 3 is the comparative operating characteristics of Skye Bank Plc. From Table 3 above, with the present system of 4 cashiers serving, the total cost was N1471.41. By increasing the number of cashiers from 4 to 5 which is alternative 1, the Total cost (Tc) will increase to N1788.55. A decision to increase the number of servers from 5 to 6 will lead to a corresponding increase in the Total Cost (Tc) to N2142.93. The present system provides the best alternative as it minimizes the cost of service delivery. Any other option will lead to increase in the overall total cost. Since our objective is to determine the alternative that minimizes the cost of service delivery, the present system will satisfy this objective.

Discussion of Findings

The focus of this paper is on capacity planning and system utilization in the management of queues in Skye Bank. This section is based on the deductions and inferences that have been drawn from the analysis of the gamut of data collected.

The result of the finding revealed that there were more inflow of customers than expected at a given time interval resulting in pressure on the existing capacity. The average arrival rate per day was 671 customers. On the average, each cashier attended to 16 customers per day. It took each customer 231.71 seconds to be served. This waiting period is so much that customers could become frustrated and irritated. There is health associated problems arising from keeping customers waiting in line for long. On the average, about 2 customers were waiting in the system. The utilization factor which represents the rate at which the servers were being used was 38%. This shows that this bank operates its facilities at a rate less than installed capacity. The total cost of engaging the servers per hour was N1471.41. This cost is the least cost. Any attempt to increase this may increase overall-total cost.

Conclusion

Banks as service organizations were saddled with the responsibility of providing the most efficient service they can offer, so as to minimize the cost associated with loss of good will and clientele. It is very important that the management of banks must as a matter of deliberate policy carry out thorough capacity planning such as the need to determine the volume of customers they can comfortably serve, how they intend to serve them and where they will be served. Failure to do this may have serious implications such as erosion of customers and profits.

Again, it is important to state here that it will be very expensive for an organization and in particular banks to get rid of queue by increasing the service capacity. The most appropriate thing, however, is to strike a balance between the cost involved in waiting for the desired service capacity and the most economic alternative system, and select the most economic alternative that enables the organization to perform optimally.

Recommendations

In the light of the above findings and conclusions, the following recommendations are made:

(i) Management should make a contingency plan to respond to any unusual crowd that may arise during those periods when queues are noticed to be long.

(ii) The present service rate should be improved upon.

(iii) An alternative mechanism for controlling arrival should be explored.

(iv) More ATM service points should be installed in strategic locations outside the bank premises to decongest the banking hall.

(v) Increase the number of servers by one in the bank. This action would further help in reducing the waiting time in the queue by about 94.2%. However, from the point of cost minimization, the bank may retain the present number of servers as any attempt to increase, may increase overall total cost.

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