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**QUEUING MODEL AS A TECHNIQUE OF QUEUE SOLUTION IN FEDERAL  
POLYTECHNIC NASARAWA, NASARAWA STATE – NIGERIA.**

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**ABSTRACT**

Waiting for service in a tertiary institution is a common occurrence in everyday life. The proportion of students who requests for service on a daily basis in Federal Polytechnic Nasarawa (FPN) continues to increase and the available capacity to meet the request is grossly inadequate. The main objective of this study is to measure the effectiveness of the queue system and offer satisfactorily service to waiting students in FPN. The methods employed during data collection were stop-watch, personal interview and direct observation which was analyzed using queuing equations. The study revealed that service delay which leads to long queue occur mostly at the registration point in the bank followed by exams and records unit followed by clinic unit while no delay at all in hostel accommodation unit. The study concluded that queuing model as a technique for queues solution has significantly impacted on the service delivery of the major units of FPN. The study recommends that the registration exercise should be decentralized, employ more servers in the exams and records unit with different specialization to enhance labour productivity and electronic time register (thumb printer) needs to be put in place to check late coming.

**KEYWORDS:** balking, jockeying, queue discipline, renegeing and server.

**1. INTRODUCTION**

Tertiary institutions in Nigeria make use of queues to offer numerous services to their students even though, the service varies from one unit to the other units. Queue existed in every facet of life even among animals that are sometimes seen to drink water, pass some narrow channel one after the other. Service facilities are often designed to handle delivery in such a way that students do not have to queue for too long, not that they may not have to queue at all. If the waiting time and service time is extremely high students may renege prematurely and this in turn results in students' dissatisfaction. Ahmed, Gambo, Jibrin and Kufre (2019) asserted that waiting is painful and stressful for everyone and services can be effectively and efficiently rendered if and only if there is orderliness among the principal actors in a queuing situation such as customers and the server.

Queue occurs in conditions when objects towards an area to be served but suffered a delay caused by having to experience the bustle service mechanisms (Dehantoro, Sumiardi & Hijuzaman, 2016). Queues are characterized structures formed to maintain order and create a hold on time, money and human contribution towards development and efficient performance of any system (Ndukwe, Omale & Opanuga, 2011). Adedayo, Ojo and Obamiro (2006) stressed that many situations in life requires one to line up or queue before being attended to. According to them queue occurs when the capacity of service provided fall short of the demand for the service. Queues form when the demand for a service exceeds its supply (Kandemir-Cavas & Cavas, 2007). The organizations that provide service keeps a watchful eye on the length of their queue and takes immediate action to provide more counters to serve the people so that their waiting time is reduced (Nair, 2002). Ozigbo (2000) asserted that queue can be regarded as one of the most common occurrence of everyday life. According to David (1985), queue is frustrating, demoralizing, agonizing, aggravating, annoying, time consuming and incredibly expensive.

Students are less willing to wait for service in an environment where a standard of living is ideal because time is a precious resources and technology have provided service organisations with the ability to provide faster services. The significance of this study in today's competitive environment cannot be overemphasized especially on the realization that most tertiary institutions in Nigeria still have problem towards managing queues. It is useful to the management of FPN, as it provides them with the causes of their inefficiencies, the type of facilities to provide, avoiding complications due to service delays, ensuring prompt attention to students and finding improvement opportunity for various units in terms of making policy and budgeting decisions. Also, it allows the FPN to notice what factors can be improved to bring new ideas and concept to be implemented in the reducing student waiting time and the system performance.

The study covered registration process, clinic, hostel accommodation, exam and records unit. The choice of these units was as a result of student's patronage. Students of FPN required different services which create a mixed arrival stream and the service time makes the system more complex. This study covered a period of two (2) weeks only this may limit the generalization of the findings. As a result, a further study is recommended to cover other tertiary institution for a longer period of time.

The Federal Polytechnique Nasarawa (FPN) is expected to provide quality services to students on time when the services is seriously needed but this is not achieved in practice because the proportion of students who request service during the period of study continues to increase on a daily basis. The available capacity to meet the request of students on registration and collection of statement of result is grossly inadequate. In spite of the efforts by the institution and the Federal Government of Nigeria (FGN) in provision of quality services, meeting the needs of students is constrained by the issue of

overcrowding as a result of delay in providing the require services. The flow of students at the bank for payments, clinic for medical check – up, hostel accommodation, exam and records unit for collection of their statement of result where the researchers investigated is outrageous. Additionally, servers are overworked and students are not effectively attended to while those providing services are busy with administrative work or have too many students to attend to also, facilities are limited and cannot satisfy the demand of the students then bottleneck occur which manifest as queue and students are attended to by the servers in an illogical manner i.e. the students are not attended to in the order in which they arrive.

The main objective of this study is to measure the effectiveness of the queue system and offer satisfactorily service to waiting students in FPN.

## 2. LITERATURE REVIEW

Nnaemeka, (2013) asserted that queuing or waiting – line problem arises whenever the demand for customer service cannot perfectly be matched by a set of well – defined service facilities that is, there is more demand for service than there is facility available for service. According to Obamiro (2010), if customers are attended to almost as soon as they join the queue, queuing is minimized. If not, then customers could suffer considerable queuing delays. According to Gupta and Hira (2007), queues or waiting lines or queuing theory was first analyzed by a Danish Engineer, A.K Erlang in 1903, in the context of telephone facilities. He started with the problem of the congestion of telephone traffic and later on extended to business applications and waiting lines. Adedayo, Ojo and Obamiro (2006) stressed that Erlang who is referred to as the father of queuing theory between 1909 and 1929 was given credit for introducing the poison process to congestion theory for the method of creating balance state equilibrium. Adedayo et al (2006) stressed that many situations in life requires one to line up or queue before being attended to. According to them queue occurs when the capacity of service provided fall short of the demand for the service. According to Ozigbo (2004), waiting time has become more important because of the increase emphasis on quality, especially in service related operations. The organizations that provide service keeps a watchful eye on the length of their queue and takes immediate action to provide more counters to serve the people so that their waiting time is reduced (Nair, 2002).

Empirical studies carried out over the years in different places, using various methodologies and variables showed mixed or inconclusive results which give room for further research using different variables and methodologies. Certain factors such as the study objectives, the constraints, the era, the location, etc. accounted for the similarities and differences. It is relevant to commence the review of Agner Kraup Erlang as he directed his first effort at finding the delay of one operator and later extended it to find the delay for several operators using the fluctuating demand on telephone facilities. From this study and contributions, it was obvious that there is too much demand on the

facilities which create room for excess of waiting time or inadequate number of service facilities (Gupta & Hira, 2011). Besides, he examined how much the waiting time will be affected if the number of operators is altered.

Gadi, Arin and Ramalan (2015) carried out a study on the application of queuing model in improving service delivery in the Federal Polytechnic Nasarawa, with the objective of improving service delivery in the institution. It was a descriptive study with a randomly selected sample size of 100 respondents that included registration officers and students. The study employed the use of questionnaires and data was analyzed using tables and percentages. It was found out that, the presence of long queues is as a result of non-availability of full online registration platform, shortage of staff, lack of time, impatience and dishonesty on part of attendants (school staff) and attendees (students). Consequently, it recommended among other things that, the institution provide full online registration platforms; increase servers (desk officers) and other facilities that will enhance efficient registration processes. This study by Gadi et al. (2015) did not discuss the proportion of distribution of questionnaires to the different categories of respondents nor was the employed distribution justified. This is necessary because the perception of categories of respondents also affect the overall findings of researches or studies especially if that study employed the use of primary sources of data. Mwangi and Ombuni (2015) carried out a study on an empirical analysis of queuing model and queuing behaviour in relation to customer satisfaction at Jkuat students finance office, with the objective to find out how effective the queuing model used when serving students at the finance office and how it relates to customer satisfaction. The study showed that on average 22 customers arrive every hour and the service rate is 23.7 customers per hour. It was an empirical analysis using questionnaire of three hundredth and eighty-four (384) respondents. The study found out that almost all customers are not satisfied about the nature of waiting lines and some students have turned away at regular occasions due to the long queues. The study compared the single server model against multi-server model and concluded that M/M/1 model was not the best for the finance department. This study by Mwangi and Ombuni (2015) did not discuss how the sample size was arrived, the proportion of distribution of questionnaires to the different categories of respondents nor was the employed distribution justified therefore, the findings cannot be generalized beyond Jkuat.

Haghighati and Hassan (2013) carried out a study on modelling the flow of crowd during Tawaf at masjid al – Haram using large crowds of pilgrims performing Tawaf during peak seasons. They compared alternative crowd management policies and their performances using three criteria – density, service rate and average time in the system. The simulation results suggest that switching lane during Tawaf is the most significant factor in crowd density development and reduced efficiency of the queuing system. This study by Haghighati and Hassan (2013) did not discuss the proportion of distribution of questionnaires to the different categories of respondents nor was the employed distribution justified. Also, lack of balance in the area they selected given the diverse nature of the

country where the study was conducted. Although reasons were provided for these choices, they seemed not justifiable enough for the imbalance. Consequently, it may be difficult to generalize these findings.

Different practices and experiences have resulted in the evolution of different theories and beliefs in order to achieve effective service delivery. Organizations make use of different queuing methods such as single queue with many servers or multiple parallel queues with a corresponding number of servers and each of these queuing methods have their queuing distributions different from other. Also, the methods of calculating their performance measures is different. For this study, a few related theories underpinnings from which the study is grounded is adopted as theoretical framework and these include David George Kendall's Theory and John Little's Theory.

David George Kendall (1953), was best known for his work in applied probability especially queuing theory, he suggested a notation to classify a wide variety of different waiting line. The Kendall's notation consists of six letters namely: a/b/c/d/e/f where a represents the probability distribution of patient arrivals, b represents the probability distribution of service time c represents the number of servers, d represents the capacity of the queuing system, e represents the size of the source population and f represents additional letter into the Kendall's notation to indicate queuing discipline. Besides, the fourth and fifth letters of Kendall's notation assumed to be infinite also Kendall's notation is use only when either the capacity is finite, or the calling source is finite. In most queuing theory, the common assumption queuing discipline is first in first out (FIFO) likewise in the Kendall's notation the last letter is assumed to be first in first out. Kendall's notation is the standard system used to describe and classify a queueing node.

The Little's law was named after the American professor John Little in 1950s. The law states that the average number of requests in the queue system is equal to the product of average number of requests serviced per unit time and the average time each request stays in the system. This is the foundation of queuing theory and anyone who wants to improve productivity needs to know a Little queueing theory because the law was assumed to be true and used without proof. The form  $L = \lambda W$  where, L is the average number of items,  $\lambda$  is the average arrival rate of the items in the queuing system and W is the average amount of time the items spend in the queuing system. These asserts that the time average number of patients in a queuing system is equal to the rate at which patients arrive and entre the system multiply by the average time of a patient was first published by Philip M. Morse where he challenged readers to find a situation where the relationship did not hold. The Little's law assumed that the system is in a steady state and do not change over time. Besides, the Little's law needs three inputs only which can be applied to many queuing systems regardless of the types of items in the queue. It is useful in analysing how a queue has performed over time or how it is currently performing. Little's theorem described the relationship between arrival and service rate

which has been shown to be valid for many queuing systems. Indeed, the average number of items  $L$  increases if the average arrival rate of the items in the queuing system  $\lambda$  increases or the average amount of time the items spend in the queuing system  $W$  increases also, the average arrival rate of the items in the queuing system  $\lambda$  increases if the average number of items  $L$  increases or the average amount of time the items spend in the queuing system  $W$  decreases likewise the average amount of time the items spend in the queuing system  $W$  increases if the average number of items  $L$  increases or the average arrival rate of the items in the queuing system  $\lambda$  decreases.

Comparatively, John Little’s theory is the foundation of queuing theory which describes the average number of requests in the queue system is equal to the product of average number of requests serviced per unit time and the average time each request stays in the system. Proper application of queuing theory not only helps the institution to solve the problems associated with service delivery or distribution of servers but also gives the various organizations a competitive edge over those that are not applying it. Also, application of queuing theory minimizes cost by reducing inefficiencies and delays in service delivery.

The John Little’s theory was adopted as the theoretical base for this study because it is the foundation of queuing theory and it laid the emphasis on how to improve productivity to solve human problems for effective and efficient performance.

**3. METHODOLOGY**

The data for this study were collected from newly admitted students (2018/2019 session) and graduating students (2018/2019 session) of FPN, Nasarawa state for a period of two weeks. The methods employed during data collection were stop-watch was used, personal interview and direct observation by the researchers to the respondents. The number of arrivals of students and their departures with service times at each service point were recorded. The following assumptions were made in accordance with the queue theory: Arrivals waits to be served regardless of the length of the line; arrivals are independent of the proceeding arrivals; arrivals are served on FIFO basis; service time varies from one student to the next; the average service rate is greater than the average arrival rate and arrivals rates does not change over time. The model is depicted below in six equations:

$$Lq = \frac{\lambda^2}{\mu(\mu - \lambda)} \dots\dots\dots (i)$$

$$L = \frac{\lambda}{\mu - \lambda} \dots\dots\dots (ii)$$

$$Wq = \frac{\lambda}{\mu(\mu - \lambda)} \dots\dots\dots (iii)$$

$$W = \frac{1}{(\mu - \lambda)} \dots\dots\dots (iv)$$

$$P = \frac{\lambda}{\mu} \dots\dots\dots (v)$$



$$P_n = (1 - \mu/\lambda)(\mu / \lambda)^n \dots\dots\dots (vi)$$

Where:

$\lambda$  = arrival rate,  $\mu$  = service rate,  $L_q$  = average number of customers in the queue,  $L$  = average number of customers in the system,  $W_q$  = average time spent waiting for service,  $W$  = average time spent in the system,  $P$  = utilization i.e. percentage time each server is busy and  $P_n$  = the probability that exactly  $n$  customers are in the system.

#### 4. RESULTS AND DISCUSSION

**Table 1: Mean Arrival Rate and Mean Service Rate Per Hour**

<i>UNIT</i>	$\lambda$	$\mu$
Registration (Bank)	23	25
Exams and Records	14	16
Clinic	12	15
Hostel accommodation	8	12

*Source:* Field Survey, 2019

Table 1. Shows that the mean arrival rate per hour for the four major units ranges between 8 and 23 inclusive while the mean service rate per hour ranges between 12 and 25 which is relatively higher. The registration unit had both the highest mean arrival rate and mean service rate of 23 and 25 respectively. The exams and records unit came next in terms of mean arrival rate and mean service rate per hour which ranges between 14 and 16 respectively. In the clinic unit the mean arrival rate and mean service rate ranges between 12 and 15 respectively. The hostel accommodation unit enjoyed the least score in terms of mean arrival rate and mean service rate per hour which ranges between 8 and 12 respectively. The registration unit seemed to accommodate more students with numerous queues waiting to be served in terms of mean service rate per hour.

**Table 2: Computed Values of Queuing Equations**

<i>UNIT</i>	$L_q$	$L$	$W_q$	$W$	$P$
Registration (Bank)	11	12	0.46	0.50	0.92
Exams and Records	6	7	0.44	0.50	0.88
Clinic	3	4	0.27	0.33	0.80

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Hostel accommodation	1	2	0.17	0.25	0.67
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*Source:* Field Survey, 2019

Table 2. Shows the computed values using queuing equations. The average number of students queuing for registration in the bank is 11, exams and records unit is 6, clinic is 3 and hostel accommodation unit is 1. Queues are common in the bank for registration due to the nature of students coming to FPN with peculiar problems to the only bank in the school serving the new arrival. The average number of students in the system for registration in the bank is 12, exams and records unit is 7, clinic is 4 and hostel accommodation unit is 2. The registration in the bank has numerous students that waits in the system follow by exams and records unit and moderate number of students waiting in the system in clinic for medical check-up while least number of students in hostel accommodation unit that waits in the system.

The average time spent waiting for service in the bank for registration is 0.46 hours (27.6 minutes), exams and records unit is 0.44 hours (26.4 minutes), clinic unit is 0.27 hours (16.2 minutes) while hostel accommodation unit is 0.17 hours (10.2 minutes). Students waits for an average of 27 minutes and 36 seconds to receive the service in the bank and most of these students are expected to complete their registration within two weeks to avoid additional charges for late registration. In the exams and records unit students spent 26 minutes and 24 seconds on average waiting for the server to render the require services, though the students that come to this unit are usually in a hurry to collect their statement of results due the ongoing promotional exercise in their organizations or consideration for new offer therefore, they are expected to be given the desire attention on their arrival immediately but they wait for server and some of the students undergo a lot of stress before given the require service. Students that come to clinic spent 16 minutes and 12 seconds on average before given access to the service, in this unit students that are given admission are expected to go to the clinic for proper check-up. In the hostel accommodation unit, students wait for 10 minutes and 12 seconds to collect their allocation for accommodation. The services rendered in hostel accommodation unit does not require long queue because students do not wait for long time to receive the require services due to the fact that options were available for accommodation and majority of the students prepare to stay off-campus.

The average time spent in the system in the bank for registration is 0.50 hours (30 minutes), exams and records unit is 0.50 hours (30 minutes), clinic unit is 0.33 (19.8 minutes) while hostel accommodation unit is 0.25 hours (15 minutes). Students spent 30 minutes on average in the system to receive services in the bank for registration, in the exams and records unit 30 minutes on average in the system to receive services was spent while in clinic students spent 19 minutes and 48 seconds in the system. The hostel accommodation unit students spent 15 minutes in the system. Besides, the



proportion of time each server is busy was generally very high. The registration in the bank recorded the highest proportion of time each server is busy where it stood at 0.92 (92%) this implies prima facie that servers were being over stressed in this unit. The exams and records unit recorded a high proportion of time each server is busy where it stood at 0.88(88%) this implies that the server in this unit hardly had enough time to rest once students request for their services. The clinic unit also recorded a high proportion of time each server is busy where it stood at 0.80 (80%) this implies that newly admitted students that come to FPN usually go to this unit before preceding to other units. The least proportion of time each server is busy was recorded against the hostel accommodation unit where it stood at 0.67(67%).

## 5. CONCLUSION AND RECOMMENDATIONS

The results from the analysis showed that queuing model as a technique for queues solution has significantly impacted on the service delivery of the major units of FPN. Other related and more specific findings revealed that the service delays which leads students to wait for a long time on a queue is common at the bank for registration followed by exams and records unit while, at the clinic there is a little delay on a queue and at the hostel accommodation unit there is no delay at all due to different options given to the students accommodation.

Based on the findings and conclusion of the study, the following recommendations are made:

- (i) Registration exercise should be decentralized by allowing other banks to per take also employ more servers in the exams and records unit with different specialization to enhance labour productivity.
- (ii) Managing the arrival rate by different appointment methods such as online appointment to drastically reduce the time students spend on the average waiting for services and electronic register (thumb printing) needs to be put in place to check late coming.
- (iii) The entire system needs to be upgraded to meet international standard.

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