

APPLICATION OF QUEUING THEORY: A TOOL FOR MINIMIZING CUSTOMER WAITING TIME WITH ATM SERVICES

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ABSTRACT

This study examined the effect of queuing theory in minimizing customer waiting time with ATM services in selected deposit money banks in Gusau metropolis. A multi-stage sampling techniques was used which includes of stratified simple and purposive sampling techniques. Both single and multiple servers queuing theory were employed to analyse data. According to the study's findings, with exception of polaris bank, ATM machines were under utilized, implying that application of queuing theory has significantly reduce customer waiting time with ATM services of first bank and eco bank in Gusau metropolis. The results also revealed that that mean waiting time of ATM users on queue is approximetly zero. Implying that no queue were observed during data collection with exception of polaris bank, implying that the ATMs of polaris bank are not sufficient for users. The study suggested that the bank management should increase the number of ATMs at Polaris Bank because there aren't enough for the customers to use. This will surely reduce waiting time and improve customer satisfaction. Moreover, when it comes to ATM transactions, bank management should enforce order among ATM users by using a first-come, first-served policy as this will minimize waiting time.

Keywords: ATM services, Queuing theory, Customer waiting time, Deposit money banks

INTRODUCTION

In most cases, the period of time customer spends waiting in a queue for a service delivery is the very first direct contact between them and service delivery process. Ahmed, Burodo and Suleiman (2022) define waiting time as the typically length of time customers have to wait for service provider to complete the services they have requested over a period of time. Waiting times may be subjective or objective. Actual or objective waiting time is the term used to describe how long a customer actually waited to be served. By checking the clock to find out how long a customer actually waited to be served, this could be determined deliberately and impartially. The amount of time a customer believes they have been waiting for a service is known as subjective waiting, or perceived waiting time (Kang and Moon, 2020).

Queue management is actually essential in certain service systems because it is inevitable for customers to wait in line to receive services (Burodo, Suleiman, & Yusuf, 2021). This is because customers who are unable to receive prompt service must wait in line, and they may be required to wait for a few minutes or for several hours. Time is a resource that requires effective and efficient management, the ineffective time management practices could lead to unhappy customers (Kang & Moon, 2020). Customers are usually dissatisfied when they have to wait for a service.

Many business organizations occasionally use queues in an attempt to offer particular services to their clients. These institutions include supermarkets, banks, hospitals, petrol stations, schools, and any other place where customers must wait in line to receive service (Burodo, Mikailu & Yusuf, 2021). An engineer from Denmark by the name of A. K. Erlang

developed queuing theory. Erlang experimented with various demands for telephone traffic in 1909. Eight years later, Erlang A. K. published a report on the delays in automatic dialing equipment. Erlang's initial research was expanded to address broader issues and business waiting line applications at the end of World War II (Adeniran, Burodo & Suleiman, 2022). Burodo, Suleiman, and Shaba (2019) assert that lines form when the demand for a service outpaces the supply. Many customers find standing in line or queuing to be inconvenient because it interferes with their daily lives and irritates them (Koko, Burodo & Suleiman, 2019). Customers are frequently discouraged from seeking out helpful services due to the length of the waiting line. In other situations, waiting may even cause the client to forget or postpone significant occasions (Bonga, 2014).

A significant number of studies on customer satisfaction and waiting times have been carried out. For example, Lahap et al. (2018) study restaurants. However, despite the limited study on the banking industry (Odewole, 2016; Ahmed, Rahman, and Mizanur, 2017), the Gusau metropolis was not a case study in any of the few studies that have been done on the banking industry.

Therefore, the current study empirically evaluated the effect of applying a queuing theory to reduce customer waiting times for ATM services in selected deposit money banks in The Gusau metropolis. In order to accomplish this, the following research objective is formulated: To determine whether application of queuing theory has significantly reduce customer waiting time with ATM services in Gusau metropolis.

LITERATURE REVIEW

The main sections of this literature review are the concept of waiting customer time, a review of empirical studies and theoretical framework.

The Concept of Customer Waiting Time

Customer waiting time is a major concern in banking management. In the banking industry, lengthy waiting time may have detrimental socioeconomic effects. Shorter wait times are directly associated with customer satisfaction, which is considered one of the quality

assessment indicators of ATM services (Joseph & Simon 2018). Once the number of customers arriving exceeds the number of customers receiving services, lines form. The main purpose of ATMs is to cut down on lengthy lines in banking halls. This is because lengthy waiting time reduce the effectiveness of the Automated Teller Machine and could result in dissatisfaction of customers (Lahap et al. (2018).

Lahap et al., 2018) claim that the length of time that customers must wait in line before getting service is known as their waiting time. Lin, Xia, and Bei (2015) define customer waiting time as the amount of time a customer must wait in line before getting services. (Burodo, Suleiman & Yusuf, 2021; Joseph & Simon, 2018). Some customers have to wait before receiving the desired service whenever they arrive at a service facility. Customers are implied to have to wait for their turn. It can be annoying for customers to have to wait a long time in a queue to be served (Joseph and Simon 2018; Burodo, Suleiman & Yusuf, 2021).

Customer waiting time management is essential because how customers feel about how long they must wait for potential service providers can affect their relationships with those providers now and in the future (Desta & Belele, 2019). Consequently, when customers are pleased with the length of time they had to wait for services, it may encourage them to do business with these service providers in the future.

Customer waiting time, as used in this study, refers to the amount of time a client must wait in line before getting service. It is the length of time users must wait for the ATM system to finish serving them.

Review of Empirical Studies

This section reviews relevant or related studies to establish empirical evidence and identify gaps in this study.

Though, the reviewed studies contributed significantly to the body of knowledge and are crucial for understanding the effect of queuing model application in minimizing customer waiting time. However, there is methodological gap as some studies by (Ahmed, Rahman & Mizanur, 2017; Patel, Chaudhary, Patel &

Makwana 2012; Ikotun, Ademuyiwa & Famule, 2016) employed Little's Theorem and M/M/1 queuing model. Whereas study by Bielen & Demoulin (2007) used Regression analysis. Nevertheless, another study by Lahap et al. (2018) employed factor analysis and correlation analysis. The methodology used by previous authors, however, does not account for the single and multiple server models (M/M/1 & M/M/S) that use three distinct banks.

Therefore, this study used both single and multiple servers models as a tool of analysis to fill this gap. Furthermore, all the geographical location in the abovementioned studies considered other regions other than North-West, particularly Gusau metropolis.

Theoretical Framework

This study is based on queuing theory. An engineer from Denmark named A. K. Erlang developed the theory of queuing. Erlang experimented with different telephone traffic demands in 1909. He released a report on the equipment delays in automatic dialing after eight years. By the end of World War II, Erlang's initial research had expanded to include both business applications of waiting lines and more general issues. In this study, queuing theory was thoroughly investigated following a thorough analysis of pertinent theoretical models. Through the establishment of a distinct or categorical connection concerning the assumptions and the research justification, these models facilitate the development of a comprehensive and convincing justification. By calculating the mean waiting time in the queue, mean service time, utilization of service facilities, distribution of the number of customers in the queue, distribution of the customers in the system, probability waiting time in the queue, and other pertinent queuing parameters, the queuing model can be used to reduce client waiting time with ATM services. Queuing theory, which explains the study's underlying assumptions, is a suitable foundation for this study.

METHODOLOGY

In this study, a survey research design was used. The population of the study consists of all

First Bank, Eco Bank, and Polaris Bank customers in Gusau metropolis. Though, the study's population is infinite. This is due to the fact that Nigerian banks permit their customers to use their ATM services regardless of whether or not they have an account with the bank. Additionally, travelers are free to use any bank's ATM while traveling. In this situation, it is not possible to identify the population of ATM users.

The multi-stage sampling techniques used in this study includes purposive and stratified sampling methods. Stratified sampling and purposive sampling are two components of the multi-stage sampling technique used in this study. A stratified sampling technique was employed in the process of selecting study respondents. This is because, there is heterogeneity among the various ATMs operated by different banks. For example, the amount that can be withdrawn from ATM at once varies from bank to bank, and the charges associated with these transactions also vary and the way that banks operate and serve their customers also differ. However, the respondents (ATM users) were chosen using the purposive sampling technique. Because everyone the researchers met on queue instantly became a part of the study during the process of choosing the intended respondents. But, those not on queue are not included in the study. Primary data was collected by means of observation method during working hours from Monday through Friday. Both single and multiple server queuing models were used to analyse data in the study.

A total of 384 sample size was drawn from the infinite population table. The sample size of 384 was determined by applying Kriejcie and Morgan's (1970) sampling technique for calculating sample size for infinite (unknown) populations. The population proportion $P=0.5$ at a 95% confidence level (Z-value of 1.96). Kriejcie and Morgan's (1970) formula for calculating sample size with an infinite population is as follows.

$$SS = \frac{Z^2 P(1-P)}{C^2}$$

Where:

Z = Z value (e.g. 1.96 for 95% confidence level)

P = population proportion (expressed as decimal) assumed to be 0.5 (50%), it is the margin of error

C = confidence level = 0.05

Hence, given P = 0.5, Z = 1.96 and C = 0.05

The above formula returns a sample size of:

$$\begin{aligned} SS &= \frac{1.96^2 \times 0.5(1-0.5)}{0.05^2} \\ &= \frac{3.8416 \times 0.5(0.5)}{0.0025} \\ &= \frac{3.8416 \times 0.25}{0.0025} \\ &= 384. \end{aligned}$$

4. Determination of Average Waiting Time for ATM Users in Gusau Metropolis

Single Server Model (m/m/1)

Mean arrival rate = λ

Mean service rate = μ

$$\text{Utilization factor, } P = \frac{\lambda}{\mu} \quad (1)$$

$$\text{Average number of customers in the system, } L_s = \frac{\lambda}{\mu - \lambda} \quad (2)$$

$$\text{Average number of customers in the queue, } L_q = L_s - \frac{\lambda}{\mu} \quad (3)$$

$$\text{Average time spent in the system, } W_s = \frac{1}{\mu - \lambda} \quad (4)$$

$$\text{Average time spent in the queue, } W_q = \frac{P}{\mu - \lambda} \quad (5)$$

Where, λ and μ represent mean customer arrival and service rates respectively, n signifies number of observations (customers) and S is sample space.

Multi-Server Model (m/m/s)

$$\text{Utilization factor, } P = \frac{\lambda}{s\mu} \quad (6)$$

The purpose of this analysis is to ascertain the average waiting time for ATM users in Gusau metropolis. The queuing system model was used to analyze observational data. Among other relevant queuing parameters, it comprises system utilization, mean waiting time in the queue, throughput, traffic intensity, and average waiting time for ATM users at three selected banks (First Bank, Eco Bank and Polaris Bank) in Gusau metropolis. Due to the large number of ATMs in the banking facility, the study used both single and multiple servers queuing models.

The system model could be represented as either m/m/1 (single server model): FCFS / or m/m/s (multi-server model): FCFS /, in accordance with Kendall's notation (1953). Either of these representations is acceptable. The models are developed with consideration for the following parameters.

Probability of zero customers in the system,

$$P_0 = \frac{1}{\left[\sum_{n=0}^{s-1} \frac{(\lambda/\mu)^n}{n!} + \frac{(\lambda/\mu)^s}{s!} \cdot \frac{1}{1 - \lambda/(s\mu)} \right]} \quad (7)$$

$$\text{Average number of customers in the system, } L_q = L_q + \frac{\lambda}{\mu} \quad (8)$$

$$\text{Average number of customers in the queue, } L_q = \frac{P_0(\lambda/\mu)^s P}{s!(1-P)^2} \quad (9)$$

$$\text{Average time customer spent in the system, } W_s = W_q + \frac{1}{\mu} \quad (10)$$

$$\text{Average time customer spent in the queue, } W_q = \frac{L_q}{\lambda} \quad (11)$$

Where, λ , μ , n and S are as defined earlier and $!$ is factorial.

Table 1: Queue Model Summary of First Bank ATMs Users

Parameters	Description of Parameters	Results
λ	mean rate of arrival	1.03
μ	mean service rate	4.4
c	number of servers in parallel	22
n	Number of clients in the system	79
$\rho = \lambda / (c\mu)$	utilization of the server; also the probability that the server is busy	0.0106405
L	mean number of customers in the system	0.2340909X60=14.046
L_q	mean number of customers in the queue	1.023959e-37
W	mean waiting time in the system	0.2272727X60=13.638
W_q	mean waiting time in the queue	9.941352e-38
X	The throughput	1.03
	The traffic intensity	0.4825
$\lambda + W$	Average Waiting Time	1.03+0.23=1.26
Q_1	First Quartile	12.26310
Q_2	Second Quartile	31.26285
Q_3	Third Quartile	71.41598

Source: Observational data (2024).

Table 1 shows queuing model summary of ATMs users at First Bank in Gusau metropolis. The information is collected on 79 users ($n = 79$) and 22 ATMs machines ($c = 22$). The result of mean rate of arrival is 1.03 ($\lambda = 1.03$) implying that there is 1.03 minutes interval on average between arrival any two customers (inter-arrival). The result of mean service rate is $\mu = 4.4$ implying that customers spent 4 minutes on the average for their transactions while using ATM Machines at

First Bank. The mean number of customers in the system (users of ATMs machine at First Bank) per hour is 14 users ($L=14$). The result of mean number of customers in the queue per minute is 1.023959e-37 ($L_q=1.023959e-37$) which is approximately zero implying no queue observed at the ATM machines at First Bank. The result of mean waiting time in the system is 14 seconds ($W=14$ sec) means that customers spent only 14 seconds waiting before having access to ATM machines. The result of mean waiting time in the queue is 9.941352e-36

($W_q=9.941352e-36$) implying customers spent approximately zero minute on average in the queue implying adequacy of ATM machines for the users. The traffic intensity of ATM machine at First Banks is 0.4825 (48.25%) implying that ATM machines are only busy for 48.25% of the working hours per day implying that the machines were under-stressed. The throughput of the system reveals that the number of customers served per unit time is

1.03 ($X=1.03$) implying that approximately 1 users on average are usually in the system at a particular time. The result of utilization of the server (the probability that the server is busy) $\rho = 0.0106405 < 1$ implying that the system is stable and no any additional ATM machine is required. Average Waiting Time per ATM machine user at First Bank is 1.26 minutes

Table 2: Queue Model Summary of ECO Bank ATMs Users

Parameters	Description of Parameters	Results
λ	mean rate of arrival	1.45
μ	mean service rate	2.5
c	number of servers in parallel	5
n	Number of clients in the system	18
$\rho = \lambda / (c\mu)$	utilization of the server; also the probability that the server is busy	0.116
L	mean number of customers in the system	$0.5800455 \times 60 = 34.803$
L_q	mean number of customers in the queue	$4.54588e-05$
W	mean waiting time in the system	$0.4000314 \times 60 = 24.0$
W_q	mean waiting time in the queue	$3.135089e-05$
X	The throughput	1.45
	The traffic intensity	0.58
$\lambda + W$	Average Waiting Time	$1.45 + 0.4 = 1.85$ (2.25 mins)
Q_1	First Quartile	13.84363
Q_2	Second Quartile	37.83370
Q_3	Third Quartile	49.76370

Source: Observational data (2024).

Table 2 shows queuing model summary of ATMs users at Eco Bank in Gusau metropolis. The information is collected on 18 users ($n=18$) and 5 ATMs machines ($c=5$). The result of mean rate of arrival is 1.45 ($\lambda=1.45$) implying that there is 1.45 minutes interval on average between arrival any two customers (inter-arrival). The result of mean service rate is $\mu = 2.5$ implying that customers spent 5 minutes on average for their transactions while using ATM Machines at Eco Bank. The mean number of customers in the system (users of ATMs machine at Eco Bank) per hour is 35 users ($L=35$). The result of mean number of customers in the queue per minute is $4.54588e-05$ ($L_q=4.54588e-18$) which is approximately zero implying no queue observed at the ATM machines at Eco Bank. The result of mean waiting time in the system is 24 seconds ($W=24$ sec) means that customers spent only 24

seconds waiting before having access to ATM machines. The result of mean waiting time in the queue is $3.135089e-05$ ($W_q=3.135089e-18$) implying customers spent approximately zero minute on average in the queue implying adequacy of ATM machines for the users. The traffic intensity of ATM machine at Eco Bank is 0.58 (58%) implying that, ATM machines are only busy for 58% of the working hours per day, it implies that the machines were under-stressed. The throughput of the system revealed that the number of customers served per unit time is 1.45 ($X=1.45$) implying that approximately 1 user on average are usually in the system at a particular time. The result of utilization of the server (the probability that the server is busy) $\rho = 0.116 < 1$ implying that the system is stable and no any additional ATM machine is required. Average Waiting Time per ATM machine user at Eco Bank is 2.25 minutes.

Table 3: Queue Model Summary of Polaris Bank ATMs Users

Parameters	Description of Parameters	Results
λ	mean rate of arrival	2.42
μ	mean service rate	2
c	number of servers in parallel	6
n	Number of clients in the system	22
$\rho = \lambda / (c\mu)$	utilization of the server; also the probability that the server is busy	0.2016667
L	mean number of customers in the system	1.210411X60=72.62
L_q	mean number of customers in the queue	0.0004112643
W	mean waiting time in the system	0.5001699X60=30.01
W_q	mean waiting time in the queue	0.0001699439
X	The throughput	2.42
	The traffic intensity	1.21
$\lambda + W$	Average Waiting Time	2.42+0.5=2.92 (3.32 mins)
Q_1	First Quartile	23.10448
Q_2	Second Quartile	63.14310
Q_3	Third Quartile	83.63972

Source: Observational data (2024)

Table 4.27 shows queuing model summary of ATMs users at POLARIS Banks in Gusau metropolis. The information was collected on 22 users ($n = 22$) and 6 ATMs machines ($c = 6$). The result of mean rate of arrival is 2.42 ($\lambda = 2.42$) implying that there is 2.42 minutes interval on average between arrival any two customers (inter-arrival). The result of mean service rate is $\mu = 2$ implying that customers spent 5 minutes on average for their transactions while using ATM Machines at POLARIS Bank. The mean number of customers in the system (users of ATMs machine at POLARIS Bank) per hour is 73 users ($L=73$). The result of mean number of customers in the queue per minute is 0.00041 ($L_q=0.00041$) which is approximately zero implying no queue observed at the ATM machines at POLARIS Banks. The result of mean waiting time in the system is 30 seconds ($W=30$ sec) means that customers spent only 30 seconds waiting before having access to ATM machines. The result of mean waiting time in the queue is 0.00017 ($W_q=0.00071$) implying customers spent approximately zero minute on average in the queue implying adequacy of ATM machines for the users. The traffic intensity of ATM machine at POLARIS Banks

is 1.21 (121%) implying that ATM machines were only busy for 121% of the working hours per day implying that the machines were over-stressed as a result of usage beyond the working hours period. The throughput of the system revealed that the number of customers served per unit time is 2.42 ($X=2.42$) implying that approximately 2 users on average are usually in the system at a particular time. The result of utilization of the server (the probability that the server is busy) $\rho = 0.03328571 < 1$ implying that the system is stable and no any additional ATM machine is required. Average Waiting Time per ATM machine user at POLARIS Bank is 3.32 minutes.

4.2 Discussion of Results

From the results of the queuing model analysis on observational data, it was obtained that with exception of polaris bank, ATM machines were under utilized, implying that application of queuing theory has significantly reduce customer waiting time with ATM services of first bank and eco bank in Gusau metropolis. This results suggests that the ATM machine at polaris bank are not sufficient. This may be as a result of number of customers or ATM patronage as the traffic intensity of ATM

machine at POLARIS Banks is 1.21 (121%) implying that ATM machines were only busy for 121% of the working hours per day implying that the machines were over-stressed as a result of usage beyond the working hours period. The results also revealed that mean waiting time of ATM users on queue is approximately zero indicating that no queue were observed during data collection. These results does not support the findings of Ahmed, Rahman and Mizanur, (2017) whose results shown that although queuing theory is applicable in finding optimal service levels. But the study discovered a negative relationship between waiting time and cash withdrawals using ATM.

CONCLUSIONS AND RECOMMENDATIONS

The following conclusions are drawn in light of the study's finding:

The study concluded that there are enough ATMs available for users. In other words, the ATM machines for the two banks (first bank and eco bank) were under utilized. Furthermore, Polaris Bank does not have enough to serve ATMs users due their large number. Additionally, the study concluded that the average waiting time for ATM users on queue is approximately zero, implying that there was no queue when the data was being collected. This might be because the queuing model was used to properly reorganize the customers at the ATM terminals.

The study recommended the following based on its findings:

Deposit money banks should use the queuing model to maintain proper customer reorganization at the ATM terminals in order to reduce customer waiting time. Bank management should also implement a first-come, first-served policy for ATM transactions in order to ensure order among users and reduce customer waiting time. In order to maintain the zero queue observed during the study, the bank management should also ensure that the ATMs are operational and loaded with cash. Moreover, the bank management should increase the number of ATM machine at polaris bank as the number are not sufficient for use by the customers. This will surely reduce waiting time and improve customer satisfaction.

REFERENCES

- Adeleye, I.O. & Samson, O. F. (2015). An empirical study of automatedteller machine service quality on customer satisfaction. *International journal of scientific research in information systems and engineering (IJSRISE)* Vol. 1, No.1.
- Adeniran, A. M., Burodo, M. S. & Suleiman, S. (2022). Customer Satisfaction with the Point of Sale (POS) System: Moderating Role of Age. *Gusau Journal of Business Administration (Gujoba)* Vol 1. Issue 2.
- Ahmed S, Rahman M. Z and Mizanur M. R, (2017) Minimizing Waiting Time in ATM Services by Applying Queuing Model: Hands on and Hands off Perspectives, *Imperial Journal of Interdisciplinary Research (IJIR)*, Vol-3, Issue-6, 2017.
- Bonga W.G. (2014), An Empirical study of the Queuing Theory and Customer Satisfaction: Application in Small and Medium Enterprises. *PhD Economics Thesis in Atlantic International University based in Zimbabwe*.
- Burodo, M.S, Shehu, S. & Babangida, M.U., (2022). Moderating effect of age on the relationship between electronic banking and customer satisfaction: empirical evidence from selected deposit money banks (DMBs) in Funtua, Katsina State Nigeria. *International Journal of Novel Research in Marketing Management and Economics*, 9(2), 157-166.
- Burodo, M.S., Mikailu, I & Yusuf, G (2021). An Empirical Analysis of the Queuing Theory and its Application to Customer Satisfaction in a Small and Medium Enterprises (SMEs): A Study of Danjalele Enterprise, Funtua, Kastina State, *International Journal of Novel Research in Healthcare and Nursing*, Vol. 8, Issue 3, pp: (89-99).

- Burodo M.S., Suleiman S. & Yusuf G, (2021). An assessment of Queue Management and Patient Satisfaction of Some Selected Hospitals in North-Western Nigeria. *International Journal of Mathematics and Statistics Invention (IJMSI)*, Volume 9 Issue 8, PP 14-24.
- Burodo M.S., Suleiman S. and Shaba Y. (2019), Queuing Theory and ATM Service Optimization: Empirical Evidence from First Bank Plc, Kaura Namoda Branch, Zamfara State American Journal of Operations Management and Information Systems; 4(3): 80-86.
- Ikotun D. O, Ademuyiwa J. A. & Famule F. D, (2016) Comparative Analysis of Customers' Queue Management of First Bank Plc. and Guaranty Trust Bank Plc, Isokun Ilesa, Nigeria, *I.J. Mathematical Sciences and Computing*, 4, 1-11
- Johanna, P.N. & Asa, R.A. (2022). The impact of quality service on customer satisfaction in the banking sector amidst Covid-19 Pandemic: A literature review for the state of current knowledge. *International Journal of Management Science and Business Administration*, 8(3):31-38
- Joseph M. & Simon N. G, (2018) Assessing the effect of Waiting Time Management Strategies on Waiting Time Satisfaction among Bank Customers in Ghana, *Accounting and Finance Research*, Vol. 7, No. 1; 2018
- Kang, B. N., & Moon, S. S. (2020). Research on the Effect of Perceived Waiting Time Coffee Shop on the Evaluation of Negative Emotions and Quality of Service. *Culinary Science & Hospitality Research*, 26(9), 145-152.
- Kotler, P. & Keller, K. (2016). *Marketing Management* (Global Edition, 15/e), Hardcover, Prentice Hall.
- Koko M.A., Burodo M.S. and Suleiman S. (2019). Queuing Theory and Its Application Analysis on Bus Services Using Single Server and Multiple Servers Model. *American Journal of Operations Management and Information Systems*. 3(4), 81-85.
- Krejcie, R. V., & Morgan, D. W. (1970). Determining sample size for research activities. *Educational and psychological measurement*, 30(3), 607-610.
- Lahap J, zlan R. I, Bahri K. A, Said N. M, Abdullah D, Zain R. A (2018) The Effect of Perceived Waiting Time on Customer's Satisfaction: A Focus on Fast Food Restaurant, *Int. J Sup. Chain. Mgt*, Vol. 7, No. 5
- Lahap, J., Ramli, N. S., Radzi, S. M., Said, M. N. & Zain, R. A., (2016) *A Study of Brand Image towards Customer Satisfaction*: Journal of Procedia Social and Behavioral Science, Elsevier. Vol. 224, pp. 149-157.
- Lin, Y. T., Xia, K. N., & Bei, L. T. (2015). Customer's perceived value of waiting time for service events. *Journal of Consumer Behaviour*, 14(1), 28-40. <https://doi.org/10.1002/cb.1498>
- Osoko, O.O. & Habsah, B.M. (2021). Issues and challenges of total quality management practices on customer satisfaction, *The Journal of Management Theory and Practice (JMTP)*, 2:2.
- Patel J.J, Chaudhary R. M, Patel P. A & Makwana P, (2012) Minimize the Waiting Time of Customer and Gain more Profit in Restaurant using Queuing Model, *International Conference on Management, Humanity and Economics (ICMHE'2012)*.