International Journal of Advances in Engineering and Management (IJAEM)
Volume 6, Issue 03 Mar. 2024, pp: 649-659 www.ijaem.net ISSN: 2395-5252

Application of Queuing Theory in Enhancing Performance of Petrol Dispensing Stations in Ado-Ekiti

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Date of Submission: 15-03-2024 Date of Acceptance: 30-03-2024

ABSTRACT: This paper examined the application of queuing theory in enhancing the performance of petrol dispensing stations in Ado-Ekiti, Ekiti State, Nigeria. The specific objectives of this research are to examine whether the application of queuing theory increases the performance of petrol dispensing stations, to determine how the use of queuing theory influences customers' waiting time and satisfaction, and to assess how the practice of queuing theory helps in enhancing customers' service time. The study adopts a descriptive research design using a questionnaire for data collection. Primary data are used for the research. The target population comprises 109 petrol dispensing stations, and a simple random sampling method is used to select a sample size of 11 stations. Primary data are collected using a questionnaire. Descriptive statistics such as mean, standard deviation (SD), and coefficient of variation (CV) are used to describe the collected data, and Two-Stage Least Square is used to test the hypothesis of the study. Findings reveal a significant relationship between queuing theory and the performance of petrol dispensing stations. It is found that the usage of queuing principles reduces customers' waiting time and that proper queuing management enhances customers' service time. It can be concluded that queuing theory helps in improving the performance of petrol dispensing stations. It is recommended that both simple and multiple queuing systems should be adopted depending on queue density, though a single queuing system saves customers' time and increases satisfaction.

KEYWORDS: Queuing theory,queue,customers' waiting time, customers' service time and performance.

I. INTRODUCTION

A queue, defined as a line of people or vehicles awaiting service, often arises due to congestion caused by insufficient servers and inadequate management of customer arrivals (13). These queues are prevalent in service-oriented establishments, and prolonged waiting times can indicate poor service quality and inefficiency, underscoring the need for improvement efforts by organizational management.

Queuing theory, a mathematical study of waiting lines, provides valuable insights into predicting queue lengths and waiting times (Wikipedia). Increasingly, managers are adopting queuing theory to enhance the return on investment in their operations, recognizing that extended queuing times can result in customer dissatisfaction and reduced patronage (6). The theory finds broad application across various societal activities, particularly in service provision, where it influences customer satisfaction and service trade-offs, with a significant emphasis on commercial activities.

The theory, including random service theory, plays a crucial role in solving mathematical problems and analyzing diverse systems (12). Literature indicates its application in various fields, including staff scheduling, productivity assessment, hospital services, and analysis of customer waiting times (1; 11). In petrol filling stations, queuing theory can effectively address challenges related to dispensing time, customer waiting time, payment processing, and customer direction.

Utilizing mathematical models and performance measures, queuing theory evaluates and enhances customer flow through queuing systems (14). Successful implementation can positively impact economic and management problems, necessitating assessments of operational efficiency, response time, and utilization rate (12). This study aims to harness queuing theory to regulate queuing performance metrics, including waiting and service times, arrival and service rates, system utilization, service costs, and customer probabilities, with the ultimate goal of improving service delivery standards in petrol filling stations in Ado-Ekiti, Ekiti State.

1.2 **Statement of Research Problem**

Nigerians are facing a pressing issue with prolonged delays at petrol dispensing stations nationwide, hindering their ability to refuel their vehicles efficiently. The fuel dispensing processes in Nigeria are notably behind international standards observed in more developed countries, where customers enjoy seamless service by simply driving into filling stations and using credit cards at strategically positioned dispensing machines.

Extensive literature indicates that queuing theory offers a promising solution to alleviate the frustrations stemming from queuing problems encountered in various organisations, where customers wait in line alongside others for service (3). However, despite the acknowledged benefits of queuing theory in addressing queue-related challenges, petrol filling stations in Ado Ekiti seems not to have adopted this theory in their operations to enhance customer service. The literature review conducted did not provide longitudinal insights due to the differing nature of the service under study compared to the areas covered by existing studies. Therefore, it would be premature to assume that all organizations where queuing theory is applicable have implemented it without conducting thorough research, such as the one presented here, to determine its effectiveness.

Research Questions

i. Does the application of queuing theory increase performance of petrol dispensing stations in Ado-Ekiti?
ii. To what extent does the use of queuing theory influence customers' waiting time and satisfaction?
iii. How does the practice of queuing theory help in enhancing customers' service time?

Research Objectives

The main objective of this study is to examinehow the application of queuing theory could enhance performance of petrol dispensing stations in Ado-Ekiti.

Specific objectives of the study are to:

i. examine whether the application of queuing theory increases performance of petrol dispensing stations.
ii. Knowhow the use of queuing theory influences customers' waiting time and satisfaction.
iii. Assess how the practice of queuing theory helps in enhancing customers' service time?

II. LITERATURE REVIEW

Concept of Queuing Theory

Queuing theory, as a concept, is a ubiquitous phenomenon encountered by individuals when visiting various waiting environments such as filling stations, eateries, banks, hospitals, and higher education institutions. At petrol dispensing stations, for instance, customers often find themselves in queues awaiting service either from dispensing machines or attendants. Customers are generally averse to long waiting times and are concerned about the duration it takes to complete their service so they can depart promptly. The active involvement of customers in the service production and delivery process is a critical aspect of service management, particularly in high customer-contact systems. Therefore, understanding the theory and psychology of waiting lines is crucial for leveraging customer participation and mitigating the negative impacts of delays and psychological factors on service quality and customer satisfaction (11).

Queuing theory, as described by (1), is not specific to any particular situation but is specifically developed to enhance the performance of queuing systems. According to (14), queuing theory employs mathematical models and performance metrics to assess and potentially improve the flow of customers through a queuing system. Similarly, (8) defines queuing theory as the construction of mathematical models of different queuing systems to enable predictions about their behaviour.

A queuing system, or waiting line, can be defined as a line composed of arriving customers or items that forms in front of servers or service facilities to receive the desired services (4). It serves as a model for evaluating the efficiency of an organization that provides services to multiple customers, whether physical or logical, to achieve intended values for its users. Queuing theory can be applied to assess the effectiveness of processes employing assembly lines, customer service lines fulfilling service requests, or computer systems executing software requests or transactions on behalf of human users (7).

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Basic FundamentalsofQueuing Theory

i. **Service Facility:** This encompasses the available resources for customer service, the structure of the queue to access the service, and the anticipation of service. The underlying assumption is that the service time for customers is independent of their arrival to the queue.
ii. **Server:** Refers to any resource that provides the requested service.
iii. **Single Server:** Customers queue up with only one server available.
iv. **Several Parallel Servers - Single Queue:** Customers queue up, and there are multiple servers.
v. **Several Servers - Several Queues:** There are multiple counters, and customers can choose where to queue.
vi. **System Capacity:** This is the ratio of the average demand over the average service time, which determines the number of servers needed. A larger system capacity leads to shorter wait times, resulting in shorter delays for the same utilization level (12).
vii. **Customer:** Refers to anything that arrives at a facility and requires service, such as people, machines, or trucks. Customers' behaviours while waiting include:

Balking: Customers decide not to join the queue if it is too long.
Jockeying: Customers switch between queues if they believe they will be served faster.
Reneging: Customers leave the queue if they have waited too long for service (3).

viii. **Queue Discipline:** This refers to the logical ordering of customers in a queue, determining which customer is chosen for service when a server becomes available. Queue discipline methods may include:
a. First-in-first-out (FIFO)
b. Last-in-first-out (LIFO)
c. Service in random order (SIRO)
d. Shortest processing time first (SPT)
e. Service according to priority (PR)
ix. **Wait Time:** The period during which a customer waits in line for service.
x. **Service Time:** The duration a customer spends being serviced at a pump.
xi. **Arrival Rate:** The rate at which customers arrive for service.
xii. **Queue Length:** The total number of customers, both waiting and being serviced.
xiii. **Response Time:** The total amount of time it takes to respond to a request for service.
xiv. **Residence Time:** The period of time spent at a station.
xv. **Throughput:** The total number of customers that pass through a queuing system from arrival to exit (Yusuf et al., 2015).

Significance of Queuing Management and Performance Enhancement

Queuing theory, as an operations management technique, is commonly employed to assess and optimize staffing requirements, scheduling, and inventory management, leading to enhanced customer service. The primary objective of queuing application and management in any organization is to minimise costs, both tangible and intangible, while boosting employee performance in service delivery (14).

Utilising queuing models and performance metrics, organisations can evaluate and improve the flow of customers through their queuing systems. Effective queue management can reduce costs and subsequently improve profitability. (10) argue that there are costs associated with customer queuing, including those related to adding new counters to reduce service time. Queue management strategies aim to strike a balance in this trade-off and offer viable solutions to management.

Petrol dispensing stations, like other service-oriented businesses, operate within competitive environments. Factors such as service time, wait time, fuel accuracy, fuel quality, and the attitudes of service providers have been identified as key elements contributing to a competitive advantage in the marketplace. (1) highlights that lengthy waiting times often lead to patient dissatisfaction and are a prevalent issue in queuing systems, causing anxiety and frustration among patients and sometimes staff.

These fundamental queuing principles have significant implications for queuing management and capacity improvement in service systems. (4) defines average total capacity as the product of the number of servers and the rate at which each server can serve customers, which must exceed the average demand. Essentially, unless the average utilization approaches full capacity, the system will become unstable, resulting in queue build-up. Similarly, smaller systems tend to experience longer delays for a given utilization level, and slower systems lead to extended delays. Queuing systems exhibit economies of scale, enabling larger filling stations to operate at higher utilization levels while maintaining similar levels of congestion and delays. Moreover, effective queuing system management yields benefits for

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Volume 6, Issue 03 Mar. 2024, pp: 649-659 www.ijaem.net ISSN: 2395-5252

both the system and customers. (8) notes that both parties aim to minimize wait time, service time, response time, and residence time, while striving for maximum throughput to remain profitable and ensure customer satisfaction and employee well-being.

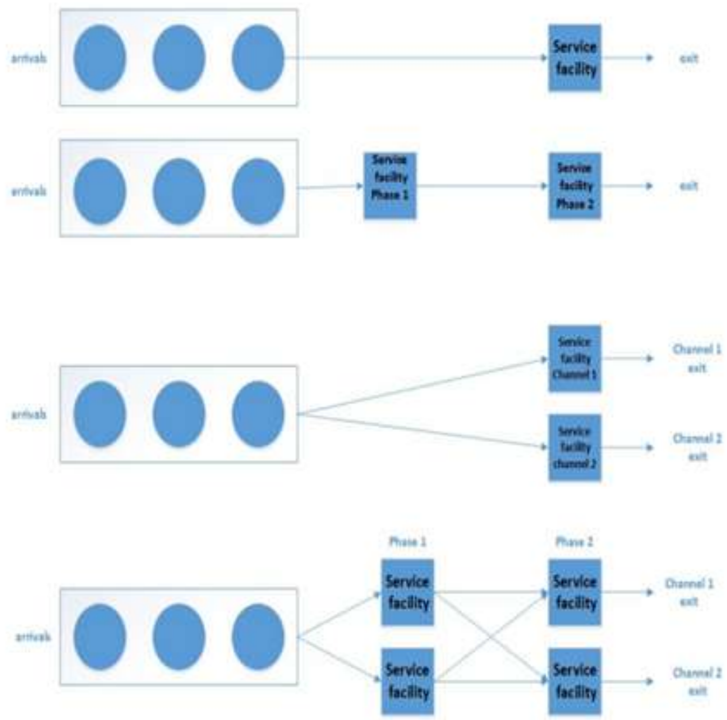

Figure 1. Queuing system design (a) single channel, single phase system (b) single channel, multiphase system, (c) multichannel, single- phase system, (d) multichannel, multiphase system

Fig .1 Graphic representation of a queuing system

Source: Maja,et al. (2018)

III. RESEARCH METHOD

A descriptive research design was chosen to provide relevant information for addressing the research questions in this study. This design was deemed suitable given the nature of the data collected through surveys. A survey approach was adopted to gather data pertinent to the study objectives. Additionally, a simple random sampling technique was employed to select 11 filling stations from the population of 109 stations in Ado-Ekiti. Primary data was collected from customers patronizing these stations, with 160 questionnaires distributed to respondents as they arrived, of which 140 completed questionnaires were used for analysis. Data analysis involved descriptive and statistical tools, including the generalized method of moments and Granger causality test, to test the formulated hypotheses.

Validity and reliability tests were conducted on the questionnaire instrument. To assess validity, 30 draft instruments were distributed to attendants and customers at selected filling stations. After respondents completed the draft instruments, they were collected for analysis. The Spearman Brown prophecy formula yielded a correlation coefficient of 0.892, indicating that the instrument used was valid, as it consistently produced high correlation coefficients. Additionally, the instrument was reviewed by a senior lecturer for necessary adjustments. Moreover, the Cronbach's coefficient obtained to assess the reliability of the test instrument was 0.923, indicating high reliability.

IV. PRESENTATION AND INTERPRETATION OF RESULTS

This section of the research focuses on the application of queuing theory to enhance the performance of petrol dispensing stations in Ado-Ekiti. Respondents were asked to rate various aspects on a 5-point Likert scale ranging from 1 to 5. The tables presented in this section display the number (N) of returned questionnaires, scores, mean, standard deviation (SD), and coefficient of variation (CV%). The number represents the quantity of completed questionnaires received. Scores reflect the aggregated ratings from the returned surveys. An average mean score above 3 indicates satisfaction with the test variables. Standard deviation measures the dispersion of data points from the mean. A standard deviation close to 0 suggests that data points are closely clustered around the mean, while a higher standard deviation indicates greater dispersion across a wider range of values. The standard error measures the deviation of the sample mean from the actual population mean. The coefficient of variation (CV) expresses the ratio of the standard deviation to the mean as a percentage. A test item is accepted if the CV% is less than 0.50; otherwise, it is rejected.

Table 4.1 Descriptive Statistics obtained on the measures of queuing theory in filling stations

Tested Variables	N	SCORES	MEAN	SD	CV (%)
Single queue is applied in this station	140	597	4.26	0.69	16.20
Multiple queue system enhances efficient of queue in your filling station	140	573	4.09	0.95	23.23
A combination of single and multiple systems queues sometime used in your station	140	592	4.23	1.24	29.31
The average queue length in your station is reasonable to maintain	140	596	4.26	0.93	21.83
The average time of service on the queue has been reduced effectively	140	540	3.86	1.25	32.38

Source: Researcher's Field work, (2024)

Table 4.1 provides descriptive statistics concerning the implementation of queuing theory in filling stations. The results indicate that filling stations in Ado-Ekiti employ queuing systems for petrol dispensation. This conclusion is supported by the mean values calculated for all the test variables, which exceeded the acceptable mean of 3.00 on a five-point Likert scale. Notably, the single queuing system and the average queuing length both exhibited the highest mean value of 4.26, albeit with different standard deviation (SD) and coefficient of variation (CV) values of 0.69 (16.20) and 0.93 (21.83) respectively. It is noteworthy that the single queuing system, with an SD of 0.69, was the most prominently utilized approach among the surveyed filling stations. This observation is underscored by the significantly lower coefficient of variation (16.20%) compared to that of the multiple queuing system and other methods employed by the selected filling stations.

Table 4.2 Descriptive Statistics computed on theopinion of respondents on performance of filling stations using queuing theory

TESTED VARIABLES	N	SCORES	MEAN	SD	CV
Effective queue system increases performance of petrol attendants and improves service time of the station	140	579	4.14	0.95	22.95
Queuing system reducescustomers' waiting time thereby improves the effectiveness of petrol attendants and increases sales of the station	140	597	4.26	0.96	22.53
Reduction in traffic intensity could be enhanced through simple queue system	140	606	4.32	0.99	22.92
Effective queuing system helps good service delivery thus encourages customers for more patronage petrol in the station	140	629	4.49	0.99	22.05
The deployment of queuing system helps to maintain queuing discipline amongcustomers in waiting hence manage balking, jockeying and reneging	140	595	4.25	0.96	22.5

Source: Researcher's Field work, (2024)

Based on Table 4.2, descriptive statistics were computed regarding respondents' opinions on the performance of filling stations utilizing queuing theory. The findings suggest a positive perception among respondents towards the effectiveness of queuing systems in enhancing various aspects of service delivery in filling stations. The mean scores for all tested variables were notably above 4.00 on a five-point Likert scale, indicating a high level of agreement with the statements.

For instance, respondents expressed agreement with the effectiveness of queue systems in improving the performance of petrol attendants and reducing service time (Mean = 4.14, SD = 0.95, CV = 22.95). Similarly, they perceived queuing systems as instrumental in reducing customers' waiting time, thereby enhancing petrol attendants' effectiveness and increasing station sales (Mean = 4.26, SD = 0.96, CV = 22.53).

Furthermore, respondents acknowledged the potential of simple queuing systems in reducing traffic intensity (Mean = 4.32, SD = 0.99, CV = 22.92) and facilitating queuing discipline among customers, which helps manage balking, jockeying, and reneging behaviors (Mean = 4.25, SD = 0.96, CV = 22.5).

Overall, the findings suggest a consensus among respondents regarding the positive impact of queuing systems on filling station operations and customer satisfaction.

Table 4.3 Descriptive Statistics obtained on the impact of queue theory on customers' waiting time and satisfaction

TESTED VARIABLES	N	SCORES	MEAN	STD	CV
Customers are satisfied with the service time taken to be served vis-à-vis serviceable pumps, good servers and proper management	140	561	4.01	1.37	34.16
Queue management has helped in reducing customers waiting time	140	591	4.22	0.89	21.09
Effective queuing system has improved service time thereby reduced the waiting in line customers	140	623	4.45	0.91	20.45
Customer are taking turn to be attended to on first come first serve basis thus making them to spend shorter time waiting to be serviced	140	571	4.08	1.17	28.68
There is an equal chance for all customers on queuing based on service in random order and in the shortest servicing time	140	614	4.39	0.89	20.27

Source: Researcher's Field work, (2024)

Based on the data presented in Table 4.3, the mean, standard deviation, and coefficient of variation were computed to assess the impact of queuing theory on customers' waiting time and satisfaction. The variables examined include the effectiveness of queuing systems in improving service time, ensuring fairness in queuing, and overall customer satisfaction.

Among the variables analysed, the most impactful aspect of queuing theory on customers' waiting time was found to be the effective queuing system, which has improved service time and consequently reduced waiting times for customers in line. This variable achieved the highest mean value of 4.45 and the second least coefficient of variation at 20.45%. Following closely behind is the equal chance for all customers on queuing based on service in random order, with a mean value of 4.39 and a coefficient of variation of 20.27%.

Interestingly, customers' satisfaction with the service time taken to be served, vis-à-vis serviceable pumps, good servers, and proper management, which might be intuitively rated highest, achieved the lowest acceptable mean value of 4.01, with the widest deviation and the greatest coefficient of variation at 34.16%.

Based on these results, it can be reasonably concluded that queuing theory has played a significant role in reducing customers' waiting time in most of the filling stations considered for the study. This conclusion is supported by the fact that the coefficient of variation for all test items falls within the acceptable limit, indicating that the application of queuing systems in filling stations could effectively reduce customers' waiting time, especially during periods of fuel scarcity.

Table 4.4 Descriptive Statistics obtained for the influence of queuing theory on customers' service time

Tested variables	N	SCORES	MEAN	STD	CV (%)
There is effectiveness in customers service time due to adoption of queue system in the station	140	577	4.12	1.03	25.00
All customers on queue are sure of being serviced	140	630	4.50	0.91	20.22
The time taken customersto be served at servers and waiting in line has considerably reduced	140	616	4.40	0.98	22.27
The type of queue system uses in this station has no influence on customers service time	140	312	2.23	1.21	54.26
Customers service time and queue system in your station are directly correlated	140	566	4.04	0.92	22.77

SOURCE: Researcher's Field work, (2024)

Table 4.4 provides the mean, standard deviation, and coefficient of variation for the influence of queuing theory on customers' service time. Upon careful examination of the statistical results presented in the table, it is evident that all tested variables exhibit mean values above the acceptable threshold of 3.00, except for the variable "The type of queue system used in this station has no influence on customers' service time," which yielded a mean value of 2.23. This lower mean value suggests that this particular variable does not significantly influence customers' service time.

Further analysis reveals a standard deviation value of 1.21 for this variable, indicating its insignificance, and a coefficient of variation of 54.26%, which exceeds the acceptable limit of < 0.50% for any test item. These findings collectively suggest that the type of queue system used in the station has minimal impact on customers' service time and does not contribute significantly to its improvement.

However, it is important to note that the remaining tested variables demonstrate acceptable mean values, standard deviations, and coefficients of variation, indicating a positive impact of queuing theory on customers' service time. By implementing queuing theory in petrol dispensing stations, it is possible to maximise customers' time effectively, leading to increased turnover and overall performance of filling stations.

In conclusion, while queuing theory proves to be impactful on customers' service time, the influence of the type of queue system used in the station appears to be minimal, as indicated by the statistical results. Nonetheless, the application of queuing theory in filling stations remains beneficial for enhancing customer service and operational efficiency.

Test of hypothesis

H_o: Queuing theory does not significantly enhance performance of petrol dispensing stations in Ado-Ekiti.

Table 4.5 Ordinary Least Square Computed for testing the testing the Significance influence of queue theory on performance of filling stations

Dependent Variable: PERFORMANCE
Method: Generalized Method of Moments
Sample: 140
Included observations: 25
Estimation weighting matrix: Two-Stage Least Squares
Standard errors & covariance computed using estimation weighting matrix
Instrument specification: QUEUETHEORY
Constant added to instrument list

Variable	Coefficient	Std. Error	t-Statistic	Prob.
QUEUETHEORY	0.940008	0.101158	9.292471	0.0000

C	1.679774	4.015146	0.418359	0.6796

R-squared	0.789666	Mean dependent var	28.00000
Adjusted R-squared	0.780521	S.D. dependent var	30.37269
S.E. of regression	14.22916	Sum squared resid	4656.790
Durbin-Watson stat	2.858932	J-statistic	0.000000
Instrument rank	2		

Source: Researcher's computation, (2024)

Table 4.5 displays the results of the regression analysis assessing the impact of queuing theory on the performance of filling stations. The coefficient for the variable "QUEUETHEORY" is 0.940008, indicating a positive relationship between the adoption of queuing theory and filling station performance. This coefficient is statistically significant with a t-statistic of 9.292471 and a p-value of 0.0000, suggesting that the relationship is not due to random chance. The R-squared value of 0.789666 indicates that approximately 78.97% of the variation in filling station performance can be explained by the adoption of queuing theory.

Table 4.6 Granger Causality Test obtained for testing the direction of causalityrelationship between queuing theory and performance of filling stations

Pairwise Granger Causality Tests
Sample: 140
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
QUEUETHEORY does not Granger Cause PERFORMANCE	140	10.29475	0.0000
PERFORMANCE does not Granger Cause QUEUETHEORY	140	1.40220	0.2717

Source: Researcher's computation, (2024)

Table 4.6 presents the results of the Granger Causality Test conducted to assess the direction of causality relationship between queuing theory and the performance of filling stations. The test evaluates whether one variable "Granger causes" changes in another variable. In this case, the null hypothesis for the first test is that queuing theory does not Granger cause performance, while for the second test, it is that performance does not Granger cause queuing theory. The results indicate that queuing theory significantly Granger causes performance ($p < 0.001$), suggesting that changes in queuing theory have a predictive relationship with changes in performance. Conversely, performance does not significantly Granger cause queuing theory ($p = 0.2717$), implying that changes in performance may not reliably predict changes in queuing theory.

V. DISCUSSION OF FINDINGS

Tables 4.5 and 4.6 present the statistical results obtained from the analysis conducted to assess the relationship between queuing theory and the performance of petrol dispensing stations in Ado-Ekiti. The findings from these tables provide valuable insights into the impact of queuing theory on the efficiency and effectiveness of service delivery in filling stations.

Firstly, from Table 4.5, it is evident that queuing theory significantly influences the performance of petrol stations in Ado-Ekiti, as indicated by the p-value of 0.0000, which is less than the critical value of 5%. This implies that the adoption of queuing theory has a significant positive effect on the overall performance of petrol stations in the region. This finding aligns with previous research by (14), which also highlighted the significance of effective queuing systems in enhancing the performance of service industries.

Furthermore, the regression coefficient obtained for queuing theory (0.94) suggests a positive relationship between queuing theory and the performance of petrol stations. This indicates that improvements in queuing system adoption by filling stations in Ado-Ekiti may lead to corresponding enhancements in performance. For instance, a 1% improvement in queuing system adoption could potentially result in a 0.94%

increase in the performance of petrol stations in the region. Therefore, it can be concluded that queuing theory plays a crucial role in optimising the performance of petrol dispensing stations in Ado-Ekiti.

Similarly, the results of the Granger Causality Test presented in Table 4.6 further support the significance of queuing theory in influencing the performance of filling stations. The rejection of the null hypothesis indicates that queuing theory Granger causes the performance of petrol dispensing stations, underscoring the importance of effective queuing systems in driving performance improvements. Additionally, the finding that performance of filling stations does not Granger cause queuing theory suggests a unidirectional causality relationship, wherein queuing theory influences performance but not vice versa.

Overall, the findings from both the regression analysis and Granger Causality Test provide compelling evidence that queuing theory significantly enhances the performance of petrol dispensing stations in Ado-Ekiti. The high coefficient of determination (R2) of 0.79 further confirms the strong explanatory power of queuing theory in explaining variations in performance. Thus, it can be inferred that the adoption of queuing systems is essential for improving the efficiency, effectiveness, and overall performance of filling stations in the region.

VI. CONCLUSION AND RECOMMENDATION

In conclusion, the findings of this study unequivocally demonstrate that the application of queuing theory significantly enhances the performance of petrol dispensing stations in Ado-Ekiti. The results revealed that an effective queuing system plays a crucial role in increasing the performance of these stations by reducing customers' waiting time and improving overall satisfaction.

By implementing an efficient queuing system, petrol dispensing stations can effectively manage customer queues, thereby reducing service time and enhancing customer satisfaction. This improvement in service efficiency is expected to positively impact the performance of petrol attendants, leading to increased turnover and higher returns for the stations.

These conclusions are consistent with the findings of previous studies by (1) and (11), which also highlighted the importance of effective queuing management in reducing customers' waiting time and enhancing satisfaction in service-oriented environments.

Overall, the findings underscore the critical role of queuing theory in enhancing the performance of petrol dispensing stations. By adopting and implementing efficient queuing systems, these stations can significantly improve their operational efficiency, customer service quality, and ultimately, their overall performance in the competitive market landscape.

Therefore, based on the findings of the study, the following recommendations are made:

i. Petrol dispensing stations should prioritise the application of queuing theory to effectively manage congestion and minimise unnecessary waiting times for customers. By implementing queuing theory, stations can streamline their operations and improve overall efficiency.
ii. It is advisable for filling stations to adopt the single queuing approach, as it offers simplicity in management and can help reduce complexities in handling customer queues.
iii. In situations of fuel scarcity or high customer demand, stations may consider employing both single and multiple queuing systems. This approach can help alleviate long queues, prevent customer dissatisfaction, and mitigate issues such as balking, jockeying, and reneging.

By implementing these recommendations, petrol dispensing stations in Ado-Ekiti can enhance their operational efficiency, improve customer satisfaction, and ultimately increase their returns on investment.

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International Journal of Advances in Engineering and Management (IJAEM)
Volume 6, Issue 03 Mar. 2024, pp: 649-659 www.ijaem.net ISSN: 2395-5252

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REQUEST FOR COMPLETION OF QUESTIONNAIRE

Dear Respondent,

I am conducting a research study on the topic "Application of queuing theory in enhancing performance of petrol dispensing stations in Ado-Ekiti." Your filling station has been selected as one of the participants for this study. Attached to this letter is a questionnaire designed to gather essential information to aid in the completion of my research.

I assure you that any information provided will be treated with the utmost confidentiality and will be used solely for academic purposes. Your participation is voluntary, and you have the option to skip any questions you do not wish to answer.

Please take a moment to complete the questionnaire by ticking the appropriate box(es) next to each question. The test items are rated on a five-point Likert scale, ranging from Strongly Agree (SA) to Strongly Disagree (SD).

Thank you for your cooperation and valuable contribution to this study.

A	**Measurement of Queuing Theory System**	SA	A	UND	D	SD
	Single queue is applied in this station					
	Multiple queue system enhances efficient of queue in your filling station					
	A combination of single and multiple systems queues sometime used in your station					
	The average queue length in your station is reasonable to maintain					
	The average time of service on the queue has been reduced effectively					
b	**Impact of Queuing Theory on Customers' Waiting Time**					
	Effective queue system increases performance of petrol attendants and improves service time					

	of the station					
	Queuingsystem reduces customers' waiting time thereby improves the effectiveness of petrol attendants and increases sales of the station					
	Reduction in traffic intensity could be enhanced through simple queue system					
	Effective queuing system helps good service delivery thus encourages customers for more patronage petrol in the station					
	The deployment of queuing system helps to maintain queuing discipline among customers in waiting hence manage balking, jockeying and reneging					
C	**Influence of Queuing Theory on Customers' Service Time**					
	Customers are satisfied with the service time taken to be served vis-à-vis serviceable pumps, good servers and proper management					
	Queue management has helped in reducing customers waiting time					
	Effective queuing system has improved service time thereby reduced the waiting in line customers					
	Customer are taking turn to be attended to on first come first serve basis thus making them to spend shorter time waiting to be serviced					
	There is an equal chance for all customers on queuing based onservice in random order and in the shortest servicing time					
D	**Performance Measures**					
	There is effectiveness in customers service time due to adoption of queue system in the station					
	All customers on queue are sure of being serviced					
	The time taken customersto be served at servers and waiting in line has considerably reduced					
	The type of queue system uses in this station has no influence on customers service time					
	Customers service time and queue system in your station are directly correlated					