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Mathematical analysis of queues in urban area of banks in Thanjavur District

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Abstract

The banking sector the managers are seeking to increase the satisfaction of the customer by providing the best service. Waiting Lines (or) Line of customer is a common phenomenon in day-to-day life. Post offices, bus stations, stores, schools, and banks typically have queues. Any customer waits to be served by the duration of the line. Numerous banks have done awesome exertion to extend the benefit proficiency and customer fulfillment but the foremost of them are confronting a genuine issue of holding up line of clients. Need of palatable benefit office would cause the holding up line of clients to be shaped. The only technique is that service demand can be met with ease is to increase the service capacity to a higher level. In this paper, we used descriptive statistics to estimate the total waiting time and duration of queues and analyzed the results using the ANOVA method. This mathematical analysis are also used to make decisions on how to increase the better service, optimize queue length and waiting time in queues of banking sector.

Keywords

Queues, Banks, Waiting time, Urban areas, Service length, Statistics Tables, Decision Sciences.

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Contents

1. Introduction

A. K. Erlang, a Danish Engineer is appropriately called the father of queuing theory. Inevitably, Queuing hypothesis is considered a branch of operations inquire about since the comes about are frequently utilized when making trade choices around the assets required to provide service. Banks are the places where there is heavy flow of customers every day. An automated model, based on queuing theory, is proposed to develop the bank queuing system. This will maximize server numbers and increase service quality, effectively reducing service costs and the waiting time for customers [5]. Queuing system is a real time queue management process which makes the queuing system work smoothly in Bank. Queues are a part of everyday life. Every human being waits in queues to buy a railway ticket, deposit in the bank counter, supermarket, at a petrol station etc.

2. Empirical Literature

Sheila A. Bishop, Hilary I. Okaybue, Pelumi E. Oguntunde Abiodun A. Opanuga, Oluwole A. Odetunmibi surveyed data set on analysis of queues in banks of Nigeria [5]. A analysis of the banking system queuing model analysed by Toshiba Sheikh Sanjaykumar Singh and Anilkumar Kashya [6]. Eze, Everestus Obinwanne, Odunukwe, Adaora Darlingtina applied a queuing models to customers management in banking system [3]. Queuing theory approach with queuing model studied by Ajaykumar Sharma, Rajivkumar and Girish Kumar Sharma [1]. Throughout the banking sector, waiting lines and service quality are essential aspects [5]. The theory of queuing allows for statistical study of congestion and waiting delays in line [4]. Businesses, in particular banks, work very

Table 1. Waiting Line data for I bank

Weeks	Working Days	A_1	A_2	A_3	Z_1
FIRST	MON	10	25	35	850
	TUE	07	20	27	730
	WED	05	06	11	1009
	THU	16	15	31	780
	FRI	11	20	31	520
SECOND	MON	30	10	40	985
	TUE	33	15	48	680
	WED	14	18	33	544
	THU	20	08	28	1031
	FRI	25	20	45	785
THIRD	MON	06	10	16	1000
	TUE	10	24	34	995
	WED	10	05	15	1010
	THU	11	25	36	970
	FRI	06	15	21	858
FOURTH	MON	06	08	14	960
	TUE	05	08	13	1040
	WED	05	05	10	900
	THU	10	15	25	945
	FRI	20	14	34	250
	TOTAL	260	286	546	16592

hard to have the highest possible quality of service, reducing service time, giving the customers a much better experience.

However in situations where queue arises in a system, It is necessary to seek to reduce the length of the queue rather than completely remove it. Total removal can be unfeasible [2].

A comprehensive analysis of the waiting line environment will also help the bank's management make certain decisions in an attempt to reduce the time a customer spends in a service center.

3. Recitation of the Problem

In this paper, the queuing system is used in the various banks of urban area in Thanjavur district. The data collected for this paper were essentially obtained from primary sources. The method of data collection is through direct observation with the help of a wrist watch, a pen and a note pad for the recording of relevant information. The information collected was used to estimate the length of the queue and the time to wait. The data taken covers only for three months. Four weeks for each bank and time is measured in minutes. Waiting line data for the various banks are the attributes of our problem which are taken as the columns and weeks are considered as the row of the queuing data table.

3.1 Methodology

The following assumptions and the notations used for the representation of data of different banks.

Table 2. Waiting Line data for II Bank

Weeks	Working Days	B_1	B_2	B_3	Z_2
FIRST	MON	15	05	20	795
	TUE	27	18	45	800
	WED	15	10	25	874
	THU	10	12	22	895
	FRI	15	05	20	880
SECOND	MON	15	13	28	847
	TUE	12	08	20	805
	WED	08	15	23	885
	THU	20	10	30	800
	FRI	20	10	30	733
THIRD	MON	15	15	30	861
	TUE	20	14	34	932
	WED	30	10	40	625
	THU	25	08	33	880
	FRI	23	15	38	1009
FOURTH	MON	06	30	36	775
	TUE	07	15	22	790
	WED	10	20	30	750
	THU	08	25	33	687
	FR	15	10	25	710
	TOTAL	316	268	584	16333

Table 3. Waiting Line data for II Bank

Weeks	Working Days	C_1	C_2	C_3	Z_3
FIRST	MON	08	12	20	750
	TUE	10	09	19	902
	WED	05	05	10	811
	THU	18	09	27	868
	FRI	10	11	21	780
SECOND	MON	10	16	26	867
	TUE	14	12	26	930
	WED	12	12	22	840
	THU	16	15	31	900
	FRI	08	08	16	850
THIRD	MON	13	10	23	934
	TUE	07	05	12	810
	WED	11	07	18	849
	THU	06	16	32	780
	FRI	05	05	10	540
FOURTH	MON	10	08	18	883
	TUE	12	04	16	786
	WED	15	19	34	682
	THU	08	05	13	785
	FRI	05	20	25	643
	TOTAL	203	208	411	16190

Table 4. Statistics table for I Bank

	A_1	A_2	A_3	Z_1
MEAN	13	14.85	27.35	842.1
STANDARD ERROR	1.940957	1.63459	2.609672	48.044699
MEDIAN	10	15	29.5	922.5
MODE	10	15	31	# NA
STANDARD DEVIATION	8.460434	7.125012	11.37526	209.421986
STANDARD VARIANCE	71.578947	50.765789	129.397368	43857.568421
KURTOSIS	0.553643	-1.158036	-0.965415	2.056311
SKEWNESS	1.202251	0.17703	-0.010065	-1.1491535
RANGE	03	01	03	09
MINIMUM	30	24	45	1031
MAXIMUM	33	25	48	1040

Table 5. Statistics table for II Bank

	B_1	B_2	B_3	Z_2
MEAN	15.84	13.4	29.2	816.65
STANDARD ERROR	1.576489	1.43637	1.645274	20.739417
MEDIAN	15	12.5	30	802.5
MODE	15	10	30	NA
STANDARD DEVIATION	6.871758	6.26099	7.171581	90.401022
STANDARD VARIANCE	47.221053	39.2	51.431579	8172.3447
KURTOSIS	-0.549743	1.512855	-0.467956	0.232208
SKEWNESS	0.472621	1.152517	0.467956	-0.091909
RANGE	03	05	05	77
MINIMUM	27	25	40	932
MAXIMUM	30	30	45	1009

Table 6. Statistics table for III Bank

	C_1	C_2	C_3	Z_3
MEAN	10.15	10.9	20.95	809.5
STANDARD ERROR	0.865705	1.256341	1.628137	22.702764
MEDIAN	10	9.5	20.5	825.5
MODE	10	10	10	NA
STANDARD DEVIATION	3.773523	5.476265	7.096886	98.959056
STANDARD VARIANCE	14.239474	29.989474	50.365789	9792.894737
KURTOSIS	-0.546158	-0.655064	-0.760558	-0.77147
SKEWNESS	0.380031	0.528807	0.162714	-0.264576
RANGE	02	01	08	02
MINIMUM	16	19	26	932
MAXIMUM	18	20	34	934

- The symbols used for the exhibiting of data are A_1, A_2, A_3 and Z_1 for I bank, B_1, B_2, B_3 and Z_2 for II bank and C_1, C_2, C_3 and Z_3 for III bank respectively.
- A_1, B_1 and C_1 shows the duration, when a customer arrives at the bank and the period his/her opening a bank account, withdrawal booklet and depositing a cheque was grouped for the I , II and III bank respectively.
- A_2, B_2 and C_2 denotes the time used to process the opening a bank account, withdrawal booklet and cheque collection in the I, II and III bank respectively.
- A_3, B_3 and C_3 specifies the total time in the system of all banks respectively.
- Z_1, Z_2 and Z_3 depicts the total number of people who arrived to the I , II and III bank.
- Waiting line is a linear data structure.
- In queues positioning can take place at only one end called rear (or) backup.
- In queues cut out can takes place at the another end called front line.
- Queues are called FCFS: FIRST-COME FIRST-SERVE. The element first into the queue is the element deleted first from the queue.
- Queues are called LCFS: LAST-COME FIRST-SERVE. The element entered last into the queue is the element deleted last from the queue.
- Descriptive statistics are brief descriptive coefficients that summarize a given collection of data that can either represent the entire population or be a subset of the population.
- ANNOVA Table applies the mean difference test to the multiple samples between the two independent samples. This stands for variance analysis.
- The Bank's queuing features were evaluated using decision taking.

The data are represented from the table (1-3) noted that the departure time was not captured because the customer often wait behind to count their non transaction activities such as renewal of ATM cards, registration of bank verification number, applying for net banking, count their money and other complaints.

Graphical representation shows the analysis of variance calculation is done to examine the mean differences among the total time spent by the clients in the banks. There are significant mean differences among the total time spent by the clients in the three banks at 0.05 level of significance

Table 7. Analysis of variance results

Groups	z	Mean	STANDARD DEVIATION	STANDARD ERROR
I Bank	20	13	8.4604	1.8918
II Bank	20	15.8	6.8718	1.5366
III Bank	20	10.15	3.7735	0.8438

F-Statistic value = 3.59931, P-value = 0.03372

Table 8. Anova Summary

Source of Variation	SS	df	MS	**F** statistics value	P
Between group of Bank	319.233	02	159.6167	3.5993	0.0337
Within group of Bank	2527.748	57	44.3464		
Total	2846.9801	59			

4. Conclusion

In this paper the above numerical result has been estimated by descriptive statistics, interpreted by using an ANOVA table and analysis of variance results depicted in the Fig. 1. This numerical results shows that model has practical applicability in several real life situations. Decision making is the process of identifying and choosing alternative based on the values, preferences and beliefs of the decision-maker. Every decision making process produces a final choice may (or) may not prompt action. The utilization factor can be evaluated using the arrival rate and the service time. This can be used to determine average required servers, number of ATMs. Average service rate and arrival rate can be estimated assuming, the service time and the arrival time are independent and identically distributed. The results from each bank can be compared to determine the level of service efficiency.

4.1 Suggestions

Mathematical models are applied to find a solution to operational challenges and to refine economic strategies in order to help decision-makers make optimal decisions. Therefore, the queuing theory is among those mathematical models which analyze and address the organizational difficulties faced by organizations with files to manage and organize. Banks in the city are usually characterized by congestion, which also results in a low level of customer satisfaction and facilitates migration of customers from one bank to another, in search of the services offered without much delay.

Some managerial recommendations for managing queues within the banks.

1. Reduce response times, good communication is vital and customers avoid waiting.
2. A queue management system can integrate with in-branch dash boards that are visible for all customers.
3. Internet banking, mobile banking utilize by customers which may lead to reduce the long waiting time in the

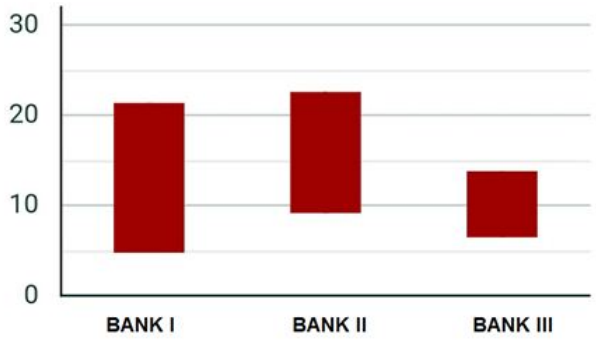

Figure 1. Shows the one-way ANOVA (Average ± S.D.)

bank. Create to make it easier for students to pay the tuition fees.

4. Customers are suggested to avail the privileges of automatic passbook entering, ATM deposit machines, automatic cheque deposit machine etc., which are provided by the banks.

5. If banking becomes fully digitalization which causes the minimizing waiting time, improving the service efficiency and optimization cost of banks.

6. Mobile virtual queuing solutions equip employees to connect with customers wherever they are keeping the customer informed and sustaining a higher level of productivity.

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