Algerian Business Performance Review (ABPR)
Volume : 10 – Numéro : 02 / (2021)
ISSN: 2170- 1938
EISSN: 2602-7313
Université Kasdi Merbah Ouargla –Algérie

The Contribution of (ATM) system to improve the banking services
Case study: Algerian National Bank(B.N.A) Ouargla agency

مساهمة أجهزة الصراف الآلي في تحسين الخدمات البنكية
دراسة حالة: البنك الوطني الجزائري, وكالة ورقلة

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Submitted on:15/05/2021 Revised on: 17/06/2021 Published on: 22/01/2022

Abstract:

This paper investigates how optimization methods improve banks service delivery through reduces customers' average waiting time in obtaining services at Algerian National Bank (B.N.A), Ouargla Agency.

The time measurements were based on customers' arrival times to the banking hall and the service times of the customers who arrived at the bank between the hour of 9.15am and 12.30 which have been previously observed to be the bank's peak period.

The conclusion was reached that provision for one additional ATM will enable to minimize customer waiting time and improve service rate.

The analysis of the queuing system shows that the number of ATMs was not adequate for the customer's service. It observed that they need 2 ATMs instead one at present.

Keywords: quantitative methods, Automatic Teller Machines, Queuing theory, Poisson distribution.

ملخص:

تهدف هذه الورقة إلى البحث في كيفية مساهمة أجهزة الصراف الآلي من أجل تحسين الخدمات المصرفية للبنك الوطني الجزائري (B.N.A) وكالة ورقلة.

استخدمت الدراسة الأساليب الكمية لقياس أزمنة كل من وصول الزبائن إلى القاعة المصرفية وأثناء تقديم أوقات الخدمة. تم تسجيل وصول الزبائن إلى البنك بين الساعة 9.15 صباحًا والساعة 12.30 والتي لوحظت على أنها فترة الذروة للبنك. أظهر تحليل أنظمة صفوف الانتظار أن عدد أجهزة الصراف الآلي لم يكن مناسبًا لخدمة العملاء. وخلصت النتيجة إلى أن البنك في حاجة إلى جهازي صراف آلي ثان بدلاً من جهاز واحد.

الكلمات المفتاحية: أساليب كمية, آلات الصراف الآلي ، نظرية صفوف الانتظار , توزيع بواسون

JEL codes : Z1, F23, M14.

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1. Introduction:

Queuing and waiting for services is a reality of daily life in every situation where demand exceeds the supply of services, we are waiting to eat at restaurants, we “queue up” at the check-out counters in grocery stores, and we “line up” for service in post offices, banks and petrol filling stations.

The waiting phenomenon is not an experience limited to human beings only; jobs wait to be processed on a machine, and cars stop at traffic lights. Unfortunately, we cannot eliminate waiting without incurring inordinate expenses. In fact, all we can hope to achieve is to reduce the adverse impact of waiting to acceptable levels. (H. Taha, 2003,)[1]

Service is part of the operating system Input of service may consist of buildings, spaces, equipment, decorations, and Consumers are becoming more demanding, and their quality expectations have increased; as a result, organizations try to customer-centered, deliver superior value to customers, build relationships, and work on market engineering.

Wherefore, organizations try to satisfy customers by improving their services.

The main purpose of companies is to "sell" products or services, respectively to produce and deliver those products or services that meet in a very high degree requirements and needs of consumers or users.

Thus, the importance of customer satisfaction, in general, consists in recognizing the mode and the way in which organizations generate and create "pleasure" so in the consumers of products or services and among suppliers of such services or products.

So, Businesses especially banks are striving very hard to provide the best level of service possible, minimizing the service time, giving the customer a much better experience.

However, in situations where queue arises in a system, it is appropriate to attempt to minimize the length of the queue rather than to eliminate it completely; complete elimination may be infeasible.

For this reason, banks have adopted automated teller machines (ATM) as an assistant to reduce waiting time, offers considerable ease to both the bank and their customers; as it enables customers to make financial transactions at more convenient times and locations, during and after banking hours. Most importantly, (ATMs) are designed to provide efficient and improved services to customers at the shortest possible time. Yet customers of Algerian National Bank (B.N.A) spend a considerable time before they are finally served.

Research Questions

This research paper is addressing the problematic of the contribution of (ATM) in improving banking service quality.

So, we will try to answer the following question:

What is the contribution of Algerian National Bank's ATM to improve banking service quality?

The study will therefore provide answer to the following research questions in an attempt to provide solution to the above problem.

a. What are the factors responsible for long queues in a BNA bank's ATM?
b. What quantitative methods can we adopt to solve the problem of queues in a BNA bank's ATM?

This study is designed to demonstrate how Quantitative Methods can be used to provide solution to the problems of overcrowding and waiting lines in a BNA bank's ATM and how customer satisfaction can be enhanced through efficient service delivery.

The study seeks to achieve the following objectives:

a. To determine the factors responsible for long queues in a BNA bank's ATM;
b. To find out what measures can be adopted to minimize or remove long queues in a BNA bank's ATM

2. Automated Teller Machine (ATM)

The rise of electronic transaction channels has transformed the banking industry, making smaller, less expensive branches a reality and sparking new opportunity for the ATM.

Today's advanced technology provides new ways for ATMs to deliver a secure, enhanced consumer experience, lower costs and increased revenues. Harnessing this opportunity to maintain a competitive edge, however, requires that your financial institution maximize the potential of their ATM channel.

An automated teller machine (ATM) is an electronic banking outlet that allows customers to complete basic transactions without the aid of a branch representative or teller. Anyone with a credit card or debit card can access cash at most ATMs.

ATMs are convenient, allowing consumers to perform quick self-service transactions such as deposits, cash withdrawals, bill payments, and transfers between accounts. Fees are commonly charged for cash withdrawals by the bank where the account is located, by the operator of the ATM, or by both. Some or all of these fees can be avoided by using an ATM operated directly by the bank that holds the account.

ATMs are known in different parts of the world as automated bank machines (ABM) or cash machines.[2]

The first ATM appeared at a branch of Barclay's Bank in London in 1967, although there are reports of a cash dispenser in use in Japan in the mid-1960s. The interbank communications networks that allowed a consumer to use one bank's card at another bank's ATM came later, in the 1970s.

Within a few years, ATMs had spread around the globe, securing a presence in every major country.[3]

At some large bank, branch employees spend an average of 60% of their time on low-value transactions, administration and idle time. Removing many tellers from the branches and replacing them with full-function ATMs would allow this bank to eliminate 15% of branch staff and redeploy them on high-value advisory-type activities.[4]

3. Queuing theory

Queuing Theory is a collection of mathematical models of various queuing systems. It is used extensively to analyze production and service processes exhibiting random variability in market demand (arrival times) and service times.

It also provides the technique for maximizing capacity to meet the demand so that waiting time is reduced drastically.

Queuing theory was developed to provide mathematical models to predict behavior of systems that attempt to provide service for randomly arising demands can trace its origin back to a pioneer investigator, Danish mathematician named A.K. Erlang, who, in 1909, published *"**The***

***Theory of Probabilities and Telephone Conversations*"** based on the work he did for the Danish Telephone Company in Copenhagen, Denmark.[1]

Although the early work in queuing theory picked up momentum rather slowly, the trend began to change in the 1950s when the pace quickened and the application areas broadened well beyond telephone systems.

There are many valuable applications of the theory, including traffic flow (vehicles, aircraft, communication), scheduling (patients in hospitals, jobs on machines, programs on computer), facility design (banks, post offices, fast-food restaurants).[2]

3.1 Queuing Discipline

It is obvious to notice or reason that ticket at service station or store such as grocery checkout in supermarket, gasoline, manufacturing plants, and banks … line as a typical example of queuing system. Meaning when any arrival occurs, it is added to the end of the queue and service is not rendered on it until all the arrivals that are there before it are attended to in that order. This is in fact a common way by which queue is being handled.[2]

The process whereby arrivals in the queue are being processed is termed queuing discipline.

The example highlighted above is a typical example of first-come-first served discipline or FCFS discipline; other possible discipline include last-come-first- served or LCFS and service in random order SIRO.

It is worth noticing that the particular discipline chosen will greatly affect the waiting time for particular customers; as no one would want to arrive early in an LCFS discipline; the discipline doesn't generally affect the important outcome of the queue itself, as arrivals are constantly receiving service respectively.[3]

Kendall in 1953 and lee in 1966 came-up with a much simpler notation that describes the characteristics of a queue termed Kendall-Lee notation.

The notation gives six abbreviations for characteristics listed in order separated by slash as: M/M/A/B/C/D.

The first and second characteristics describes in the arrival and service time based on their respective probability distribution, where **M** represents exponential distribution, **E** stands for Erlang and **G** stands for a general distribution: uniform, normal est…

The third character gives the number of servers working together at the same time, known as parallel servers;

The fourth describes the queue discipline,

The fifth gives the maximum number of customers the system can accommodate,

While the sixth gives the population size of the customers from which the system can draw from for example: M/M/4/FCFS/50/∞.

3.2 Queue Characteristics

Queuing system are characterized by three components namely:

1. The arrivals or inputs to the system;
2. the waiting line;
3. The service facility.

These three components have certain characteristics that must be examined before mathematical queuing models can be developed.[4]

3.2.1 Arrivals Characteristics:

The input source that generates arrivals or customers for the service system has three major characteristics.

It is important to consider the size of the calling population, the pattern of arrivals at the queuing system, and the behavior of the arrivals.

- *Size of the calling population*: Population sizes are considered to be either unlimited (essentially infinite) or limited (finite). When the number of customers or arrivals on hand at any given moment is just a small portion of potential arrivals, the calling population is considered unlimited. For practical purposes, customers arriving at the bank is the example of unlimited population.
- *Behavior of the arrivals*: Most queuing models assume that an arriving customer is a patient customer. Patient customers are people or machines that wait in the queue until they are served and do not switch between lines. Unfortunately, life and quantitative analysis are complicated by the fact that people have been known to balk or renege.

Balking refers to customers who refuse to join the waiting line because it is too long to suit their needs or interests. Reneging customers are those who enter the queue but then become impatient and leave without completing their transaction.[5]

3.2.2 Waiting line Characteristics

The length of a line can be either limited or unlimited. A queue is limited when it cannot, by law of physical restrictions, increase to an infinite length .A queue is unlimited when its size is unrestricted.

A second waiting line characteristic deals with queue discipline.

This refers to the rule by which customers in the line are to receive service.

- Queue Discipline:

This indicates the rule guiding the order in which customers are selected from the queue for service, the most common service discipline is:

- FCFS: *First Come First Served*.
- LCFS*: Last Come First Served*;
- SIRO: *Service in Random Order*;
- SPT*: Shortest-Processing Time.*

Customers may also be selected from the queue based on some order of *priority* or emergency.

The specification and analysis of the queue discipline is important because it affects the operating characteristic of the queuing system.[6]

3.2.3 Service Facility Characteristics

The third part of any queuing system is the service facility. It is important to examine two basic properties:

- The configuration of the service system
- The pattern of service times.

Service systems are usually classified in terms of their number of channels, or number of servers, or number of phases.

A single channel system, with one server, is typified by the drive-in bank that has only one open teller.

On the other hand, if the bank had several tellers on duty and each customer waited in one common line for the first available teller, we would have a multichannel system at work.

Service patterns are like arrival patterns in that they can be either constant or random.

If service time is constant, it takes the same amount of time to take care of each customer .

More often, service times are randomly distributed; In that case it can be assumed that random service times are described by the negative exponential probability distribution .

The exponential distribution is important to the process of building mathematical queuing models because many of the models' theoretical underpinnings are based on the assumption of Poisson arrivals and exponential services.

Queuing models is often used basic three symbols called Kendall notation:

- Arrival distribution;
- Service time distribution:
- Number of service channels open, where specific letters are used to represent probability distribution:

- M : Poisson distribution for number of occurrences;
- D : constant (deterministic) rate;
- G : general distribution with mean and variance known.[8]

4. Methods and material

The purpose of this study is to examine the performance characteristics of the Algerian National Bank's ATM, Ouargla agency.

The system's characteristics of interest that will be examined in this research work include; number of customers arriving to the service point at a given time, the time it takes for one server to complete customer's service, the average number of customers in the system, and the average time a customer spends in the system.

The results of the operating characteristics will be used to evaluate the performance of the service mechanism and to ascertain whether customers are satisfied with the banks' services.

The data for this study was collected from primary source and is limited to the Algerian National Bank's ATM, Ouargla agency.

Data was collected by observation, in which the number of customers arriving at the facility was recorded, as well as each customer's arrival and service time respectively.

The period for the data collection was during morning hours (9:00am to 12:00) and for a period of ten (10) working days.

Based on the system's arrival and service pattern, and the assumptions made during data collection, the M/M/1 queuing system was used to analyze the data collected using (QM for Windows) program.

4.1 Queuing Model

We present an analytical approach to determine important measures of performance in a typical service system.

In order to keep the model as simple as possible however, some assumptions need to be made: [9]

- Single channel queue.
- There is an infinite population from which customers originate.
- Poisson arrival (Random arrivals).
- Exponential distribution of service time.
- The queue discipline is First Come First Served (FCFS).
- The average service rate is greater than the average arrival rate.

When these six conditions are met, we can develop a series of equations that define the queue's operating characteristics.

- λ : mean number of arrivals per time period;
- μ : mean number of people or items served per time period;

When determining the arrival rate (λ) and the service rate (μ), the same time period must be used.

4.2 . M/M/1 Systems

An M/M/1:(∞/FCFS) queuing system: here the arrival and service time both has an exponential distribution, with parameters λ and μ respectively, 1 server, FCFS is the queue discipline and infinite population size from which the system can draw from. The expected inter-arrival time and the expected time to serve one customer are ($1/\lambda$) and ($1/\mu$) respectively. An M/M/1 system is a Poisson birth-death process. The probability, Pn(t) i.e. the system has exactly n customers either waiting for service or in service at time t satisfies the KOLMONGOROV equation with λ n= λ and μ n= μ, for all n.

The steady state probabilities for a queuing system are

Pn = Lim Pn(t) as t -->∞ (n= 0, 1, 2, 3,…) If the limit exist.

For an M/M/1 system, we define utilization factor as $\rho = \lambda/\mu$ And steady-state probabilities as: Pn= ρn(1- ρ) If P < 1.

But, If

P > 1, the arrival comes at a faster rate than the server can accommodate.

4.3 Measure of Effectiveness

For an M/M/1 system; the queuing equations follow:[1]

- Ls= the average number of customers in the system: $L_S = \dfrac{\lambda}{\mu - \lambda}$
- Lq= the average length of the queue: $$L_Q = \frac{\left(\lambda/\mu\right)^2}{1 - \left(\lambda/\mu\right)}$$
- Ws= the average time a customer spends in the system: $W_S = \dfrac{1}{\mu - \lambda}$
- W_q = the average time a customer spends in the queue: $W_Q = \dfrac{\lambda}{\mu - (\mu - \lambda)}$

The utilization factor for the system, *P*, that is, the probability that the service facility is being used: $\frac{\lambda}{\mu} = p$

The tables below show a summary of frequencies for the inter arrival time and service time from the data collected:

Table 1. Frequencies for Arrival time and Service Time

Customers arrived	1	2	3	4	5	6	7	8	9	10
Frequencies	47	45	23	16	13	4	6	2	0	3
Service Time	1	2	3	4	5	6	7	8	9	10
Frequencies	33	146	97	21	19	11	6	2	5	3

Source: the researchers.

Result & discussion

Performance measures are calculated using an (QM for windows) software package. The output is given below:

The arrival rate is given by: $\frac{1}{\lambda} = \frac{\sum_{i=1}^{11} F_0 x}{\sum_{i=1}^{11} F_0 x} = \frac{655}{206} = 3.18.$

Thus, the Average arrival rate per hour: $\lambda = 60/3.18 = \mathbf{18.87}$

5.1. Service Rate

The service rate is the number of customers that are served per unit of time.

The service rate (μ) of the customers is given by:

$$\alpha = \sum_{i=1}^{c} \frac{F_0 . t}{F_0} = \frac{1096}{206} = 2.97$$

Therefore; the average hourly rate of service as follows:

$$\mu = \frac{60}{\alpha} = \frac{60}{2.97} = 20.22$$

5.2 Performance measures

Performance measures are calculated using an (QM for windows) software package. The output is given below:

Table 2. results of Performance measures

QM for Windows - [Data] Results

(untitled) Solution

Parameter	Value		Parameter	Value
M/M/s			Average server utilization	.93
Arrival rate(lambda)	18.87		Average number in the queue(Lq)	13.04
Service rate(mu)	20.22		Average number in the system(L)	13.98
Number of servers	1		Average time in the queue(Wq)	.69
			Average time in the system(W)	.74

Source: outputs of (QM Windows**)**

From the results above, the traffic intensity (ρ) = 0.93.
The average number of customers in the system, L =14 the average length of the queue, Lq = 13, the average time a customer spends in the system, W = 0.74,

The average time a customer spends in the queue, Wq = 0.69 The probability that a customer spends more than t units of time in the system, W(t) = 0.74 The probability that a customer spends more than t unit of time in the queue.

Results from the study revealed that the queue is quite long and as such customers that come to the ATM would have to wait too long before they are serviced by the ATM.
Also, the study revealed that the excessively long queue and lengthy service time could be due to the influx of customers and shortage of service mechanism.

Thus, if the bank agreed to deploy one additional service point and considering a service pattern of single queue, multiple servers in parallel,
The output of the M/M/C :(∞ /FCFS) where C=2 is given as below:

Table 3. Summary of a Two Channel Waiting Line

Perf.measures	*λ*	*μ*	*ρ*	L_Q	L_S	W_Q	W_S
2. mach	23.59	22.26	0.47	.026	1.19	0.01	0.06

Source: outputs of (QM Windows)

The table Results showed that the performance measures for an
M / M / 2: puts the System Utilization
(ρ) at 47%. And Average number of customers in the system at approximately 2.
The average number of customers in the queue is one.
Similarly, a customer spends an average of 0.06 hours in the system while queue waiting time for a customer is 0.011 hours on the average.
From the analysis, it was observed that number of servers necessary to serve the customers in the case study establishment was two servers.

This is the appropriate number of servers that can serve the customers as and at when due without waiting for long before customers are been served at the actual time necessary for the service.

This increase in servers reduces the waiting time, and the probability that an arrival will have to wait for service is 0.06.

Conclusion

This paper investigated how ATMs influences the banks 'effective delivery Systems and reduces waiting line of customers In Algerian national Bank.

Although, automatic teller machines (ATM) have been designed to provide efficient and improve services to customers at the shortest time possible, yet customers wait too long before they are finally serviced by the facility.

The findings of this study have revealed that the system is highly, if not over utilized. This implies that arrival comes at a faster rate than the system can accommodate.

The analysis of their queuing system shows that the case study company needs to increase the number of their servers up to 2 as show in the result analysis. The increase in the number of servers will reduce the time customers have to wait in line before been served.

The conclusion was reached that management should make provision for one additional ATM so as to enable her minimizes customer waiting time and improve service rate.

RECOMMENDATIONS

- Based on the above findings, the following recommendations if accepted and implemented by the bank management may help in tackling these problems:

  - The need for the management of the bank to deploy another ATM within the bank's premises as this will minimize the waiting time of customers and hence reducing the inconveniences and frustrations associated with waiting.
- Therefore; to reduce long waiting lines and improve customer satisfaction in banks, the following measures need to be considered:
  - There should be continuous human power development where staffs will be regularly updated on modern technologies used in efficient service delivery to enhance customers' satisfaction at all time.
  - The present facilities (physical, manpower and technologies) should be increased and improved to accommodate the numerous customers visiting the bank.
  - Bank should re-configure their service delivery channels to multiple-channels system.
  - The technologies and computer networks (internet, ATM) of banks should be greatly overhauled on timely basis so as to reduce incessant breakdown. This will enable customers to transact their business outside the banking halls and will reduce long waiting lines.
  - Weekend banking service should be operational in the bank, as this will to some extent reduces the number of customer struggling to transact banking business on week days, as there is opportunity to visit the bank on weekends.

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Appendices

Table (1): performance measures

QM for Windows - [Data] Results

(untitled) Solution

Parameter	Value		Parameter	Value
M/M/s			Average server utilization	.93
Arrival rate(lambda)	18.87		Average number in the queue(Lq)	13.04
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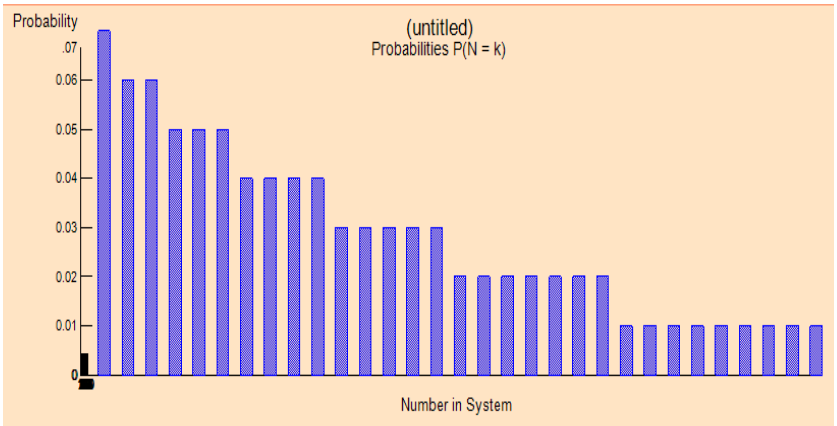
Number of servers	1		Average time in the queue(Wq)	.69
			Average time in the system(W)	.74

Source: QM for windows outputs

Figure (1): probabilities of p(n=k)



Source: QM for windows outputs

Table (2): sensitivity to num servers

Sensitivity to num servers

(untitled) Solution

	1	2	3	4	5
Average server utilization	.93	.47	.31	.23	.19
Average number in the queue(Lq)	13.04	.26	.03	.0	0
Average number in the system(L)	13.98	1.19	.97	.94	.93
Average time in the queue(Wq)	.69	.01	.0	0	0
Average time in the system(W)	.74	.06	.05	.05	.05

Source: QM for windows outputs