Analysis of the quality of services for the collection process using queuing theory: the case of SONELGAZ of Tamanrasset

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Abstract :
This study aims to analyse the quality of services provided by the Sonelgaz Corporation (Tamanrasset Branch), by applying one of the quantitative methods, which is the waiting queue models. Considering that the quality in providing services is important to achieve excellence, so we chose the collection service that suffers from the problem of waiting at the level of the institution, and determine the distribution that It is followed by the arrival rate and service rate. Applying the appropriate queuing model (M/M/S) to the service system and proposing appropriate solutions for it.
Among the results obtained is that the arrival time in the organization follows the poisson distribution and the service time follows the exponential distribution, and the service rate is greater than the arrival time and this is a prerequisite for achieving the efficiency of the service provided.
Therefore, we suggested improvements using the appropriate queuing model for this system, which would reduce waiting time and thus raise the level of quality of services provided in order to gain more customer satisfaction.
Key Words: Queuing theory, Customers, Arrival time, Service rate, Quality of services.

JEL Classification: L15, C69

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Introduction

The decision maker in service institutions seeks to make the waiting line to receive the service as short as possible to the extent that it guarantees the customer's satisfaction with this service, and not to leave without receiving the service, as well as his conviction to receive this service in the coming times. However, the characteristics that distinguish services from physical goods raises the problem for their producers to meet the demand for them, as he is not able to store them in times of lack of demand due to times of intensity, and the availability of them in abundance always inflates the cost of providing them.

Undoubtedly, customers can face problems before receiving the service, perhaps the most prominent of which is the waiting that wastes their time, and this waiting phenomenon may lead to the institution losing its customers. To confront this problem, it has become necessary for decision makers to carry out quantitative studies that help solve this problem and bring the services provided to the level of quality. Its customers of the services provided in order to arrange their business plan and strategies as much as possible.

In this context, our study comes to discuss how to measure the quality of services using a quantitative method, which is queuing models, with the aim of improving the quality of services provided and developing them according to the desires and needs of customers.

The research problem is to answer the following question: How and to what extent can queuing theory help in making the best decisions to improve the level of services in institutions?

In this paper we have analyzed the quality of services, using queuing models. The past of Queuing Theory was nearly 100 years. A Danish Telephonic Engineer A. K. Erlang developed queuing theory, in early 1920's. During studying applications of automatic telephone switching, Erlang was concerned with the capacities and utilization of the equipment and lines. Queuing theory was unmitigated in applications to furnish for a large number of situations, at the end of World War II. Queuing theory is actually, a study of waiting lines. The theory allows the calculation and derivation of a number of representative measures which includes the estimated number of receiving service, the probability of encounters the system in certain cases, e.g. having to wait for certain time to be served or an vailable server, empty or full, and average waiting time in the queue (Mustafa,2015, p: 2)

Quality of Service is defined as the perception of the customers about the service they avail. The customer's perception of the quality of the service being delivered will determine whether or not they are satisfied with that service and whether or not they shall want to continue to work with that service provider. There may be the temptation to consider the adoption of a customer's perspective to be biased and possibly even one-sided. The most important point is that the customer is concerned with the business functionality, that is, customers need to be able to use the checking out service to perform as a business function (Nafees, A., & Liang, L., 2006, p:3)

Performance can hold various meanings for different people. The main factor of performance is time, the service should be provided sufficiently in acceptable time . Affordable, the cost of the service cannot be ignored from the list of the components of the quality of services. There is always an exchange between cost of the service and the quality of the service

However, some authors confirm that waiting time is not usually seen as part of product quality in manufacturing as opposed to service industries. Deacon and Sonstelie (1985) and Pngand Reitman (1994) report empirical evidence on the importance of service time in a petrol station retailing. Literature on Just-in-Time and Total Quality Management also highlights the importance of delivery time in global market competition (see Stalk and Hout, 1990).

Waiting time therefore can increasingly be perceived as an inseparable part of a good or service and, hence, has a cost for the consumer over and above the immediate money price. Whereas the latter cost is explicit the former is essentially implicit. Rational consumers will bear in mind the full price when they place an order with a firm. That is, consumers will take into account the monetary price plus the waiting cost when deciding whether or not to join a queue for the good or service (Parra Frutos I. &Aanda Gallego J. 1999, pp: 565-566).

In service industries waiting time can also be viewed as quality measure, where long waiting times are associated with low quality and vice versa. Service quality can also be measured by a number of quite different attributes including facility location, guarantees offered by the firm, accuracy of the service, speed and courteousness of the servers (see, Parasuraman *et al*., 1994). Nevertheless, it is waiting time that has attracted special attention in recent times, as evidenced by the latest advertising campaigns of a number of service firms. The fact that consumers, on many occasions, have to wait in order to obtain the product or service often results in frustration and ultimately balking behaviour.

This paper is organized as follows. In the following section, basics about queuing theory, the methodology used to carry out the statistical study of the queuing system at the Sonelgaz Corporation was presented in the third section, where the characteristics of the queue are obtained, and the appropriate queuing model is applied, which can improve the quality of the services of the Sonelgaz Corporation - Tamanrasset Branch - some are made Analyzes of the results obtained. The last section presents the summary that includes the results and suggestions.

I- Fundamentals of queuing theory

AgnerKrarup Erlang (1878–1929), The pioneer investigator was the Danish mathematician A. K. Erlang, who, in 1909, published “The Theory of Probabilities and Telephone Conversations.” In later works he observed that a telephone system was generally characterized by either (1) Poisson input, exponential holding (service) times, and multiple channels (servers), or (2) Poisson input, constant holding times, and a single channel. Work on the application of the theory to telephony continued after Erlang. In 1927, E. C.Molina published his paper “Application of the Theory of Probability to Telephone Trunking Problems,” which was followed one year later by Thornton Fry’s book Probability and Its Engineering Uses, which expanded much of Erlang’s earlier work. (J. F. Shortle, J. M. Thompson and authers, 2018, p2).

He also developed the Erlang probability distribution, which plays a significant role in various queuing applications.

Queuing theory is now an important branch of operations research and has many applications. It measures the flow of demands into and out of the queuing system, and thereby is used to make decisions on the minimum number of resources needed. Queuing theory is used in business, engineering, public service, traffic, healthcare, finance and the military. A vast number of applications in all fields have been implemented and published since Erlang. Only a few are named here.

In 1953, David G. Kendall introduced Kendall’s notation to describe the characteristics of a queuing system. This A/B/C notation is standard in queuing theory. The A/B/C code identifies a system where: A is the arrival time distribution, B is the service time distribution, and C is the number of servers.

In 1961, Thomas L. Saaty, authored one of the first comprehensive books on queuing theory. Another early and informative publication was by Phillip M. Morse in 1958.

In the 1960s, Leornard Kleinrock used queuing theory to applications on packed switching networks. His developments have evolved as the foundation in the birth of the Internet. In 1969, his Host computer became the first node of the Internet, and it was from there that he directed the transmission of the first message to pass over the Internet (Nick T. Thomopoulos, 2012, p:2)

1-Queuing model characteristics

Queuing system is characterized by the components namely (G. Vijaya Lakshmi, C. Shoba Bindhu, 2014, p: 2):

- **Arrival rate:** describes the way the population arrives either static or dynamically.
- **Service rate:** describes how many customers can be served when the service is available.
- **Number of service channels:** Service channel contains single or multiple. Customers enter one of the parallel service channels, where they are served by one.
- **Queue discipline:** describes the manner in which customers choose for the service like First in First out (FIFO), Last in First Out (LIFO).
- **The population supply** is often infinite or finite. In an infinite source situation, patient arrivals are unrestricted, and may exceed the system's capability at any time.
- **Number of servers**: the capacity of the queuing systems is decided by the capacity of every server and also the number of servers being used.
- **Service patterns:** because of the varying nature of the sicknesses and the patients' conditions, the time needed for treatment varies from patient to patient.
- **Queue discipline:** refers to the order during which customers are processed. the belief that service is provided on a first-come, first-served basis is that the most ordinarily encountered rule.
- **The queue system** is usually described in shorten form by using some characteristics.

These characteristics can be represented by Kendall's notation which was initially a three-factor notation A/B/C. Later D, E and F were also included in the model to make it A/B/C/D/E/F (Hajnal Vass and Zsuzsanna K. Szabo, 2015, 481), where:

- A is referred to the arrival time distribution;
- B is referred to the service time distribution;
- C is referred to the number of servers (agent available);

- D is referred to the system's capacity, the number of customers in the system;
- E is referred to the calling population;
- F is referred to the queue discipline.

There are some special notations that have been developed for various probability distributions describing the arrivals and departures. Some examples are: M - Arrival or departure distribution that is a Poisson process, E - Erlang distribution, G - General distribution, GI - General independent distribution.

2-The Multi server system (M/M/s) elements

The application of a queuing model is to approximate a real queuing system in a means, that it can be analyzed mathematically. There are different types of queuing models, but single server and multiple server queuing models are widely applicable.

Consider a system with k servers and an infinite queue where the inter-arrival and the service times have exponential probability densities. The average time between arriving customers is 1/k and the average service time is 1/l. This is the (M/M/s) system. The reader should know that the expected wait time values are averages for any service discipline. This part shows how to measure the waiting time distribution when the first-in-first-out (FIFO) service discipline is in use.

We will consider an (M/M/s) queuing model because it will help us to estimate the number of providers needed. Arrivals occur according to a Poisson process and the service duration has an exponential distribution. Poisson distribution is a discrete distribution that shows the probability of arrivals in a given time period, where the mean and the variance of the Poisson distribution are the same. Using this (M/M/s) model, we assume that (Hajnal Vass and Zsuzsanna K. Szabo, 2015, p: 482):

$$\frac{\lambda}{n\mu} < 1,$$

Some of the notation and results for this system are listed below(Nick T. Thomopoulos, 2012, pp:159-160):

- λ: arrival rate;
- μ: service rate;
- s: number of server (provider);
- p: system utilization;
- 1/ μ: service time;
- sa = 1/k: average time between arrivals
- ss = 1/l: average time to service a unit
- k: average number of arrivals per unit of time
- l: average number of units processed in a unit of time for a continuously busy service facility
- q = ss/sa = k/l: utilization ratio
- q\k is needed to assure the system is in equilibrium k\kl
- n: number of units in the system

To optimize the process, we are looking for the probability P_k the probability than an entering patient mustqueue for treatment which means that all physicians are busy. In order to calculate these probabilities,the probability of the time in the queue becomes a mixed discrete and continuous distribution as listed below(Nick T. Thomopoulos, 2012, p:161):

$$P(t = 0) = P_{n<k}\ (t = 0)$$

$$f(t) = P_0 \mu \rho^k e^{(\lambda - k\mu)t}/(k - 1)!\ (t > 0)$$

P_0 - probability of 0 units in system;
P_k =-probability of k units in system.
To find the probability that the time in the queue t is greater than t_0 becomes,

$$P(t > t') = \int_{t>t'}^{\infty} f(t)dt = P_0 \rho^k e^{(\lambda - k\mu)t'}/[(k - 1)!(k - \rho)]$$

II-Methodology

This part shows how to calculate the waiting time probabilities for a multi-server system, with infinite capacity, exponential inter-arrival times and exponential service times, where the customers are serviced in a first-in-first-out discipline. Could be a package delivery service, wants to determine the number of delivery vehicles to have in its fleet so 90 percent of deliveries begin within 20 min of the call. Examples are presented.

1- Statistical study of the waiting system for collection service centers:

In order to improve the quality of the institution's services provided by the Sonalgas Corporation, and in order to project the theoretical aspect onto the practical reality, in order to know the reality of customer waiting in the institution, queuing models were applied.

After the Sonelgaz Corporation, Tamanrasset branch, was chosen as one of the institutions that suffer from crowding, during specific periods of the month, and after being in the institution and observing the various service centers, the collection service center was chosen because it is one of the most crowded service centers, as the waiting queue is long Which may worry customers, so our study will be limited to this service.

2- Modeling the waiting phenomenon:

Before applying the appropriate queuing model, the basic parameters of the appropriate waiting system at the collection service center must be determined.

To receive the collection service, customers go to the payment counter, where they go through one stage:

In which the customer goes to the window accompanied by his ID card and electricity bill, then the window employee routinely monitors the documents and records the process on the system with his own stamp, then the customer pays the amount of the bill and receives a receipt for payment. It should be noted that at this point there are two parallel service centers operating at the same time, meaning that two customers are served simultaneously.

2-1- Determining the components of the waiting structure of the service center: In order to determine the appropriate waiting structure, we present a definition of its various components, as follows:

The source community: in the institution under study, the source society applies to it the advantages of an unlimited society, i.e. infinite, where the institution receives all customers who flock to the service center, regardless of their number, as long as their arrival takes place during official working hours.

- **Arrivals Specifications**: Characteristics of customers arriving at the service center of the institution, as represented in:
- **The degree of control over the number of arrivals**: The organization cannot control the number of customers arriving at the service center or the times of their arrival.
- **Arrivals Authority**: Customers arrive at the service center in the organization individually, which is the predominant situation, but the check-in was done in groups consisting of two or three people at most.
- **Access pattern**: Customers arrive at the service center in the organization in a random manner, and each customer is independent of other customers, and the customer's arrival process is unpredictable.
- **The behavior of the service recipient (customer)**: through the observation, no withdrawal from the class was recorded.
- **Waiting queue specifications**: The waiting queue specifications can be determined in the service center of the organization through:
- **The length of the queue**: The center provides the service through queues of unlimited length, and there is no maximum.
- **Number of queues**: through observation, there is one queue to wait, then customers move to the first or second window employee when either of them finishes the service.

Service Mechanism: The service is provided according to the order of arrival of customers, i.e. FIFO, first come first served.

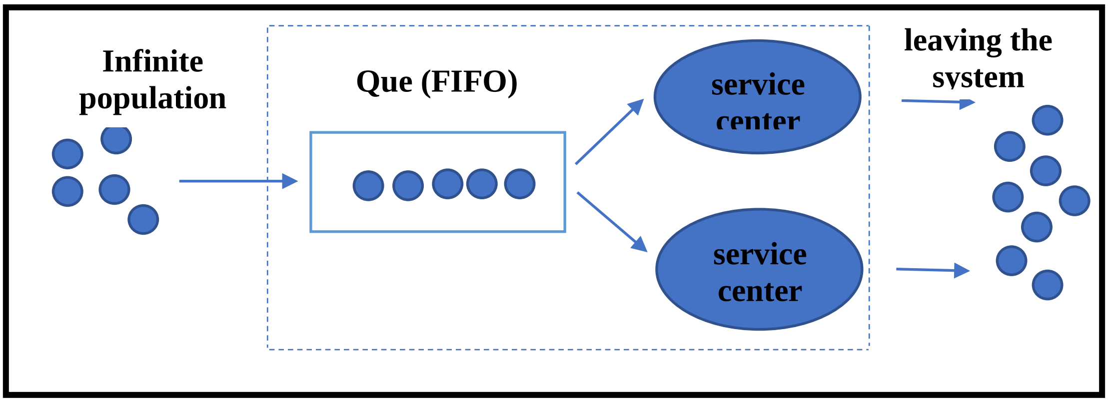
2-2- Characteristics of service delivery centers: The process of providing the collection service, according to one stage, passes through two parallel service centers:

- First, the gate employee routinely monitors the documents and records the process on the system with his own stamp.
- To complete the service, the customer pays the amount of the invoice and receives a receipt for payment.
- Exit: After the customer receives the service permanently, he is exited from the system.

Accordingly, we find that the waiting structure for the collection service in the institution consists of two waiting rows, with two service centers.

Through direct observation of the work of this system, it can be represented as follows:

Fig. 1:« A simplified representation of the waiting structure in the collection service system of Sonelgaz Tamanrasset»



Source: authors

III-Data analysis and Results

1- Statistical study of the pattern of arrival to collection service centers:

Since the mathematical models of waiting queues are different and multiple according to the conditions of these models that are known from the reality and conditions of the waiting phenomenon, and before knowing the appropriate model, the type of theoretical distribution of the rate of customer arrival must be determined, and in order to study the process of customers' arrival at the center Collection service, the following steps have been approved (Thiel. D, 1990, p : 49):

- Determining the total viewing period T, which represent the activity of the studied center.
- Specify the observation period (Δt), and all observation periods should be equal where customers are logged in.

1-1- Determining the total viewing period: In order to determine the average customer arriving at the service center, the total viewing period was determined from 08-05-2022 to 06-02-2022, and the following table shows the method for determining the viewing period:

Table 1: Determining viewing periods

Week days	Hours of official work	Credit hours to watch	Viewing time per hours	Viewing time per minutes	Total number of periods
From Sunday to Tuesday	From 8 :00 to 12 :00 From 14 :00 to 16 :00	From 8h 30 min to 11h 30 min From 14h 30 min to 15h 30 min	4 h	240 min	24 periods per day
Watching hours per week			20h	1200min	20 h
Watching hours per month			480h	4800 min	480 h

Source: authors

Through the data of the table, we found that the total number of viewing periods is 480 per month, and a sample of 144 periods extended over a period of 10 minutes will be selected, taken from the observation that it was found that waiting is very large in the days from 18 to 20 of the month May and 1 to 3 June.

b- Test the probability distribution followed by the rate of customer access to the foreign currency service: we recorded the customer access over the length of the period, and the frequency seen in the following table:

Table 2: Distribution of customer access during the viewing period

Nbr of arrivals during the period (Δt) *X*	0	2	4	6	7	9	11	12	14	16	17	19	21	23	24	26	**Total**
Frequencies f_0	7	18	7	10	6	9	8	12	8	8	17	6	8	5	5	10	**144**
xf_0	0	36	28	60	42	81	88	144	112	128	289	114	168	115	120	260	**1785**

Source: authors

Through the previous table, we calculate the arrival rate λ , which expresses the average number of customers arriving every 10 minutes in the following form:
Arrival rate λ = total customers / number of periods.

The average arrival in 10 minutes is equal to: $\lambda = \frac{1785}{144} = 12.396$

The rate of arrival per minute equals: $\lambda = \frac{12.396}{10} = 1.2396$

In order to determine the type of theoretical distribution of customer access, we use the chi-square test which tests that a set of observations comes from a random variable that follows a given theoretical distribution.

- H_0: The access distribution follows the Poisson probability distribution.
- H_1: The access distribution follows a distribution other than the Poissonian distribution.

Using Excel Theoretical relative frequencies are calculated by the following relationship: $F\text{x} = e^{-\lambda} \frac{\lambda^{x}}{x!}$

After that, the theoretical absolute frequencies are calculated by multiplying the theoretical relative frequency by the total number of observations (144), then the squared difference between the observed frequencies and the expected frequencies is calculated by the following formula:

$$X^2 = (F_0 - F_e)^2 / F_e$$

The following table shows the chi-squared test:

Table 3: Calculating the sum of the squared differences, chi -squared, for the arrival of customers

Number of customer arriving (x)	Frequencies F_0	xf_0	Theoretical Relativistic Frequencies F_x	Theoretical absolute calculable frequencies F_e	squared differences X^2
0	7	0	0,28950482	45,030746	0,006429048
2	18	36	0,222421753	316,04229	0.000703772
4	7	28	0,028480491	48,602084	0.000585993
6	10	60	0,001458739	.99,970827	1,45916E-05
7	6	42	0.000258318	35,9969	7,17613E-06
9	9	81	5,51283E-06	80,999,901	6,80597E-08
11	8	88	7,70075E-08	63,999999	1,20324E-09
12	12	144	7,95477E-09	144	5,52415E-11
14	8	112	6,71595E-11	64	1,04937E-12
16	8	128	4,2998E-13	64	6,71843E-15
17	17	289	3,13527E-14	289	1,08487E-16
19	6	114	1,40864E-16	36	3,91289E-18
21	8	168	5,1535E-19	64	8,05234E-21
23	5	115	1,56496E-21	25	6,25984E-23
24	5	120	8,08291E-23	25	3,23316E-24
26	10	260	1,91076E-25	100	1,91076E-27
Total	**144**	**1785**	**1**		**0,00774065**

Source: authors using Excel.

To find out the extent to which the study phenomenon matches the Poisson distribution, we compare the tabulated chi-square value and its calculated value, and for that we first calculate the degree of freedom with the following relationship$V = c - m - 1$

Where:

c: the number of variables.

m: the number of parameters of the law.

So, the degree of freedom is:$V = 16 - 1 - 1 = 14$

Referring to the chi-squared table At a degree of freedom of 14 and a level of significance of 5% , we obtained the following results:

Tabulate chi square value:

$$\chi^2_{Tab} = 23{,}6848$$

The calculated value from the above table is:

$$\chi^2_{cal} = 0.00774$$

As long as the calculated chi-square value (0.00774) is less than the tabular value (23.6848), the hypothesis H0 is accepted, which states: The arrival of customers follows the Poisson probability distribution, and therefore the distribution of observations of the arrival of customers can be approximated to the theoretical distribution of Poisson, defined by the parameter (λ) estimated by 1,2396 customers/minute.

2- Statistical study of the service time of the collection service centers:

Before knowing which model is suitable, the type of theoretical distribution of customer service time in the collection service center must be determined, and in order to adopt the following steps (Thiel. D, 1990, p: 49)

a- Service time: Service times are characterized by randomness as they are not fixed anddiffer from one customer to another. has, and the periods are shown in the following table:

Table 4: Sample Service Periods (in minutes)

1,25	1,15	1,52	1,29	1,15	1,29	2,02	1,39	1,21
2,36	2,24	3,03	3,06	3,14	2,57	3,32	1,59	2,25
1,19	1,04	1,18	2,27	1,25	1,11	2,34	1,57	1,02
2,01	2,12	2,04	2,15	1,26	2,02	2,14	2,16	1,2
1,15	1,34	1,29	1,21	1,01	2,04	2,1	1,38	1,37
3,07	1,03	1,39	1,35	2,06	1,4	3,17	1,39	3,06
1,31	1,28	1,13	1,06	1,07	1,29	1,01	1,21	1,31
1,53	1,39	2,35	2,33	1,01	1,23	1,45	1,26	1,45
1,23	2,01	1,14	2,01	1,34	1,3	2,06	2,01	1,29
1,27	3,00	1,35	3,29	2,06	3,06	2,47	2,05	2,21
1,14	1,57	1,25	1,07	1,57	2,3	2,05	1,35	1,57
1,43	1,26	2,35	1,1	1,26	1,15	1,3	1,12	1,47
1,25	2,01	1,55	1,3	1,17	1,43	1,39	1,47	1,15
2,36	2,21	1,57	2,31	1,24	3,08	3,29	1,24	1,59
1,14	2,05	1,06	2,05	1,22	1,16	1,25	1,35	1,54
2,05	2,01	2,26	2,33	2,31	1,26	2,24	2,17	1,55

Source: authors.

From the above table, we calculate the average service time, as it refers to the number of service requesting units that are served during a certain period of time, and we symbolize the average service time with (µ) and it is calculated as follows: We find m the rate of service is equal to:

$$m = \frac{219.1242}{144} = 1.521$$

$$\mu = \frac{1}{m} = \frac{1}{1.521} = 0.6571$$

This is the average service time Equal:

$$\mu = 0.6571 \ service/min$$

In the same way, the chi-squared test was applied in order to determine the theoretical distribution of observations based on the following hypotheses:

H_0: The service times distribution follows an exponential probability distribution.

H_1: traces the distribution of service times in a distribution other than the exponential distribution.

Dividing the sample range into equal time categories: As a first stage, we determine the length of the category according to the following relationship: Using the following method: _

Where: k: the length of the class

$$k = \frac{X_{max} - X_{min}}{1 + 3.32\log(n)} = \frac{3.32 - 1.01}{8.166}$$

k=0.28

b- Finding the number of classes: We denote the number of classes with the symbol α, where:

$$\alpha = 1 + 2.32\log(144) = 8.166 \approx 9\ ranges$$

So we have nine classes of length 0.28

Then we do the following calculations:

- We calculate the center of class x i where it is equal to : (class upper bound - lower bound)/2

Calculate the theoretical relative frequencies according to the following formula:

$$P_n(t) = \mu e^{-\mu t}$$

Absolute relative frequency f e by multiplying the theoretical relative frequency P_n (t) The total number of views 100.

Calculate the squared difference between the observed frequencies and the absolute relative frequencies by the following formula:

$$X^2 = (F_0 - F_e)^2 / F_e$$

These steps are shown in the following table:

Table 5: Calculation of the sum of squared differences, ie squared for service times

Service times (categories)	Frequencies seen F_0	Category Centers x_i	X_i*F_0	Theoretical Relative Frequencies F_x	Absolute Relative Frequencies Fe	squared differences X^2
1,01-1,29	47	1,15	54,05	0,308645724	2180,083	0.000141575
1,29- 1,57	35	1,43	50,05	0,256772085	1207,092	0.00021272
1,57-1,85	7	1,71	11,97	0,213616773	46,055	0,004638297
1,85-2,13	20	1,99	39,8	0,177714511	392,923	0.000452288
2,13-2,41	21	2,27	47,67	0,147846291	434,8123	0.000340023
2,41-2,69	2	2,55	5,1	0,122997979	3,523137	0.034911499
2,69-2.97	0	2,83	0	0,102325887	0,010471	9,772698078
2,97-3,25	9	3,11	27,99	0,085128124	79,47494	0,001071132
3.25-3,53	3	3,39	10,17	0,070820763	8,580091	0,008254081
Total	**144**					**9.822719693**

Source: authors using Excel.

To find out the extent to which the study phenomenon matches the exponential distribution, we compare the tabular value of chi-square and its calculated value, and for that we first calculate the degree of freedom with the following relationship: V=c-m-1

So the degree of freedom is: V=10-1-1=8

Referring to the chi-squared table At a degree of freedom of 8 and a level of significance of 5 % , we obtained the following results:

The tabular value is: $\chi^2{}_{tab} = 15.50731$

The value calculated from the above table is: $\chi^2{}_{cal} = 9.82272$

Long as the computed value of $\chi^2{}_{cal}$ is 9.82272 less than the tabular value 15.50731, then the hypothesis H_0 is accepted which That is : the distribution of service times follows the exponential probability distribution, this means that the distribution of service periods can be approximated to the theoretical exponential distribution defined by the parameter µ Estimated at 0.6571 service/minute.

3- Results of the study of statistical distributions:

Through the study of statistical distributions, the following results were reached:

-The distribution of customer access to the service center of the enterprise follows the poisson distribution.

-The distribution of service times in the first stage of the window employee follows the exponential distribution.

-Applying the appropriate waiting queue model to improve the quality of the services of the Sonelgaz Corporation - Tamanrasset branch-

Based on the results we reached in the previous part, that the arrival rate follows the Poissonian distribution and the service rate in both stations follows the exponential probability distribution. The appropriate model can be determined to study the collection service delivery system. Therefore, the mathematical model that will be applied to measure the quality of service performance is of the type: M/ M/ S

4- Measuring Service Quality Indicators Collection at Sonelgaz Corporation, Tamanrasset Branch:

In order to measure service quality, it requires studying and analysing customers' expectations about the time they can and comparing the obtained results with the final results through the application of queuing models.

4-1- Determining customers' expectations about the quality of the service provided: In order to analyse customers' expectations, a sample of 100 customers of the institution was interrogated about the waiting period that they considered acceptable. By conducting a personal interview with the study sample in order to obtain data related to the subject of the study. By analysing the answers, the results represented in the following table were reached:

Table 6: Waiting period accepted by the institution's customers customers

Acceptable waiting time	Number	Ratio
Only service time	19	0.19
5 minutes	70	0,70
10 minutes	11	0.11
Total	**100**	**1**

Source: authors based on interviews with customers.

Through the table, we note that there is a difference between the customers in the sample that were questioned about the waiting period that they consider acceptable in order to obtain the service, and it turns out that there is:

- who never wants to wait in line;
- A class that can accept waiting in the system for 5 just minutes;
- Other category accepts to wait in the system for a maximum period 10 minutes.

Based on these results, the actual performance is compared with the results obtained from the interview.

4-2- Determining performance measures for the collection service center: After determining the value of access rate (λ) and service rate (μ), we can calculate other indicators related to queuing models at the Sonelgaz Corporation, Tamanrasset branch, by applying the QM for Windows program as follows:

From the program, we choose a model (M/M/S) for the arrival of a Poasonic distributor and an exponentially distributed service time, which results in a table in which we enter the arrival rate (λ), the service rate (μ) and the number of service centers as follows:

Table 7: Results of performance measures for the stages of providing the collection service

Service stations	Number Service Centers	Λ	μ	P	L S	L q	W s	W q
	02	1.24	0.66	0.94	15.98	14.11	12.89	11.38

Source: authors based on QM for Windows

Based on the results shown in the above table, we note the following:

- Usage factor equals 0.94 This means that the probability that the two service centers are busy is equal to 94 % of the total working time, and this indicates the presence of congestion at the counter.
- The average number of customers in the queue is 14.11 customers, that is, there are about 14 customers in the queue, and we note that this number is large.
- The average number of customers in the system is 15.98 customers, that is, the number of customers in the queue plus the number of customers served is 16 customers.
- The average time a customer takes in a queue is 11.38 minutes, which is a significant amount of time which suggests that there is a significant waiting problem. When comparing this value with the opinions of the interviewed customers, it exceeds the acceptable waiting time for them.
- The average time the customer spends in the system equals 12.89 minutes, and this is an important indicator of the quality of the service provided. The difference between it and the average time the customer takes in the queue gives us an idea of the service time. In this case, it is approximately two minutes.

This period is considered good, as the service delivery time is estimated at approximately two minutes, but when compared to the waiting period, the rate of arrival exceeds the rate of service provision, and this results in the formation of waiting queues.

4-3- Findings: Based on the results, it becomes clear to us that there is a great waiting for the collection staff, and by comparing these results with what was reached through the customer questioning, we find that there are large differences in the average service time taken, and therefore the time spent by the customer for His access to the service in the institution is not desired by the customers, and this negatively affects the quality of services provided by the Sonelgaz Corporation, Tamanrasset branch, in the aspect of collection. In this regard, adding a new service center. Suggesting possible alternatives to solve the problem of waiting for the collection service system at Sonelgaz Corporation - Tamanrasset branch-

In order to provide services that meet the expectations of customers, the institution must modify the structure by adding new service centers in order to provide service to more than one unit at the same time, and we suggest the following alternatives:

a- The first proposal is a waiting structure of several centers and the service in series: a new structure can be proposed, which consists in dividing the service into two stages.

- The first stage: It takes place at the level of a first service center where the window employee routinely monitors the documents and records the process on the system with his own stamp.
- The second stage: It takes place at the level of a second service center, and a receipt for the process is provided to the customer after he has made the payment.

When the institution provides the service in sequence by adding a new service center, the actual performance measures of the service will change , but through the results we note that the problem does not lie in the time of service provision, but rather in wait. Therefore, this alternative is possible, but it prolongs the service time, as it is not good.

b- The second proposal is a waiting structure of several centers and one-stage service

Modeling of a queuing structure of several centers in parallel and one-stage service: in this model The existing waiting structure does not change , but is reinforced by adding a new service center, and new centers are added in the same way until the desired level is reached (within the costs that the organization can bear). Performance measures for the proposed alternative: In this figure, we put the following hypotheses:

- Customer arrival follows a Poissonian probability distribution
- Service times follow an exponential distribution
- Average Service Rate μ It is the same for each center, and by following the same method as before, we get the characteristics of the new system ;
- The access is in one queue and the service provided to customers is in one stage and in several centers, and the queue follows the FIFO system.

The results of their performance indicators are explained in the following table:

Table 8: Represents the performance indicators in several parallel centers and at one stage

Number ofService Centers	Λ	μ	P	L_S	L_q	W_s	W_q
03	1.24	0.66	0.63	2.53	0.65	2.04	0.53
04	1.24	0.66	0.47	2.01	0.13	1.62	0.1

Source: authors based on QM for Windows

Through the results shown in the table regarding a system with 3 centers or 4 centers and one stage above, we note the following:

The institution's provision of the service in 3 centers or 4 centers and in one phase helps reduce the time it takes to obtain the service. Therefore, if the institution wants to implement this proposal, the actual performance measures of the service will change positively as follows:

- The probability that the system is busy or the utilization factor ρ decreases when adding a third service center from 0.94 to 0.63, meaning that the employee in this center is occupied by 63%, which indicates a decrease in crowding by applying this change. This proposal, in turn, helps to reduce the time spent in the system, as the average number of customers in a queue is 0.65 customers in a queue if the system operates with three centers, and it decreases to 2.53 customers in the system, and this is reflected in the average time spent by a customer in a queue The wait is estimated at 0.53 minutes, or 53 seconds. As for the time spent in the system as a whole, i.e. from the time of its entry until the completion of the service, it is estimated at 2.04 minutes.
- In the case of adding a fourth service center, it decreases to 0.47, meaning that the employee in this center is occupied by 47%, which indicates a decrease in congestion by applying this change. This proposal in turn helps to reduce the time spent in the system, the average number of customers in the queue is 0.13 customers in the queue, and it decreases to 2.01 customers in the system, and the average time spent by the customer in the queue becomes 0.1 minutes, i.e. 10 Seconds. As for the time spent on the system as a whole, i.e. from the time of its entry until the completion of the service, it is estimated at 1.62 minutes.
- Results of the proposal: The results of adding an additional service center in parallel, in line with the customers' desires that appeared in their answers to the interview questions about the acceptable waiting time from the institution's customers, the results of which were that a large group of customers could accept waiting in the system for only 5 minutes, in When the results of this proposal indicated that the time spent in the system as a whole does not exceed 3 minutes in the case of providing the service in three centers, and this proposal is compatible with the institution because its costs are lower compared to the costs of the first proposal.

Conclusion

This study shows us the importance of the statistical study of the phenomenon of waiting experienced by the organization's customers when they receive the service, due to its effectiveness in determining the problem and its size, in addition to the assistance it provides to decision makers in order to take appropriate decisions that would reduce waiting as much as possible in an effort to improve the quality Services provided by the institution.

Through the applied study, we found that the Tamanrasset branch of Sonelgaz suffers from the problem of waiting queues, especially at the cashier level, and this is what led to customer dissatisfaction and dissatisfaction with them. From the rate of service provision at the level of service centers, but the average service time is not large, but waiting in line is a large time. Also, the service center is busy all the time, and this is evidence of the size of the congestion, and the average time taken by the customer in the queue and in the system as a whole is very long, and this leads to a problem that hinders access to the organization's services to the required quality and to customer satisfaction.

Based on these results, it became clear the need to think of solutions to the problem of waiting, and with the help of waiting queue models, we proposed solutions and studied them statistically in order to reach alternatives that would improve the quality of the collection service at the enterprise level, mainly represented in increasing the number of centers, and providing the service in several centers without dividing it into stages. This solution is the best.

Results:

After we conducted the field study, we reached a number of results that can be summarized as follows:

Sonelgaz - Tamanrasset branch - is considered one of the most active institutions in the region, but it suffers from the problem of long waiting queues.

- The main reason for the problem of waiting at the studied service centers is the large number of customers, who accept to purchase the service in one period, and this number exceeds the capacity of the system, and the reason for this problem is due to the habit of individuals to pay bills when the deadline for that is approaching.
- The number of customer access is not specified, and the access is random.
- Through the field study, it was found that queuing models can be applied at a wide level in the institution under study, and there is the possibility of success of this application because they are models that are easy to apply, and do not require great capabilities.
- Through the study, we found that increasing the number of service centers can reduce the severity of queues in the system.

Suggestions:

Based on the results that have been reached, we have decided to put forward the following suggestions:

- Increasing attention to customers and studying their needs.
- Pay more attention to the quality of the services provided.

- Using advanced technology and methods that would organize the service delivery process.
- The necessity of using quantitative methods, especially queuing models, to find solutions to the waiting problem

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