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USING WAITING LINES THEORY TO SOLVE THE PROBLEM OF WAITING A CASE STUDY IN THE NATIONAL BANK OF IRAQ

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Abstract:
The research aims to determine the advantages of queuing theory, and to describe how customers' waiting time can be counteracted and reduced. Queue models are used to resolve bottlenecks and queues in manufacturing and service delivery processes. The importance of the research came from the importance of the issue of these waiting lines and their connection to the nature of services provided to customers and the intensity of competition between those in charge of providing services. A set of queuing theory computational methods were used to find appropriate solutions to the waiting problem and improve the quality of the time spent by the customer receiving service at the National Bank of Iraq for the first time. The data used to solve the queuing models were collected through interviews and field visits. The research concluded that the use of queue models in the study sample bank leads to reducing the waiting time of customers in the queue to receive the service and strengthening the bank's position in providing the service as quickly as possible, as well as reducing costs through the optimal use of the capabilities of the employees who provide the service.

Keywords: Waiting Line, Arrival Rate, Capacity Uutilization

INTRODUCTION:

Nowadays, the time factor has become very important, and most organizations are working on it. This focus on speed of delivery can be attributed to the increasingly intense competition associated with the emergence of a single global economy and the increasing importance of time for consumers, especially in developed countries with high standards of living. The higher the standard of living, the greater the value of the customer's time, and thus the customer is looking for goods and services that reduce spending their time (Davis & Janelle, 1994). Thus, time can be considered as a resource, like money and the human element, and time can be gained and can be wasted, in other words, it can be saved and can be wasted (Desta, & Tewedros 2019). Organizations of all kinds strive to actively strive to possess the forefront of organizations that win the largest number of customers, and it is necessary to review in our research this the most basic elements of waiting line problems and to provide solutions through mathematical equations for standard case studies, trying to solve these problems. (Dumitru, 2017) These mathematical equations have been developed from the theory of queues in order to enable and assist facilities designers and managers to analyse the requirements and needs of service centres, as well as establish appropriate service facilities to address bottlenecks and provide the best services with appropriate quality, competitive prices and at the right time. The queue theory is broad enough to apply and is able to cover the various delay problems that customers face, whether in commercial centres or in landing aircraft in narrow places, as it is widely used in both industrial and service environments. Queue theory is considered a standard tool in operations management as it contributes to designing the system of service provision, scheduling and machine loading (Damodhar, 2018). Queue theory is considered by scientists as one of the branches of operations research because the results of solutions to its problems are used most often when making business

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decisions about the resources that are required to provide a particular service (www.en.wikipedia.org). In light of the foregoing, this research came with four sections, the first topic was devoted to research methodology, while the second topic dealt with the theoretical aspect, while the fourth research devoted to the applied aspect of the adopted mathematical model and measurement of relationships, while the fourth topic concluded with the most important conclusions and recommendations.

RESEARCH METHODOLOGY

Research problem

The reasons that prompted the researchers to choose the subject of the study is the lack of studies on queue models in Iraqi banks, the position occupied by banks in global economies in general and the national one in particular, and personal preferences that are commensurate with the subject of the study.

The problem must be mentioned, if the customer's waiting time is long to receive the service, this will lead to a long waiting period for the customer and the formation of a long queue, and this may lead to boredom, and the customer will not think about Going back to a business with bad, unmanaged queues, because the customer has a long waiting period and may increase the cost of the customer's waiting time. In light of the above, the following questions can be asked:

1. What is the utilization rate of the employee's energy in the national bank?
2. What is the rate number of arrivals in the waiting lines?
3. What is the rate waiting time in the queue?
4. What is the rate wait time in the system?

Research objectives

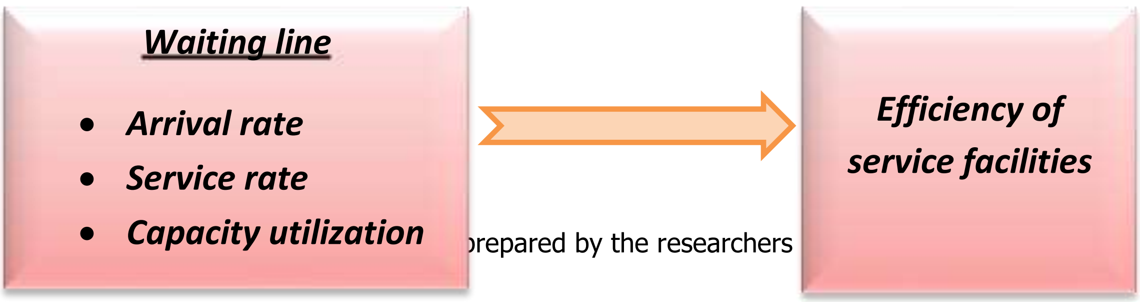
The research seeks to present a set of objectives related to the service provided by the bank to customers:

1. Identify the advantages in queuing theory, and describe how customers' waiting time can be faced and reduced.
2. Empowering and assisting facility designers, managers and planners by analysing service requirements and needs and establishing appropriate service facilities.
3. Knowing the current level of service provided by the employee and what is the level of service that the service employee should realize within a high degree of confidence level.
4. Presenting the theory of queues in the form of mathematical equations that show many types of shapes that can meet all situations.
5. Explore the different ways that those lines affect customers?

Research hypothesis diagram

The dimensions of the independent variable, the Waiting line, represented by (Arrival rate, Service rate Capacity utilization) and its impact on the efficiency of service facilities:

Figure (1) The hypothetical diagram of the research



Research hypothesis

The research can be based on the hypothesis that:

'' There is a positive relationship between energy utilization and waiting time for service facilities ''

Research methods

The practical side relied on using a set of mathematical equations based on the exponential distribution and Poisson's distribution of the queuing theory to find appropriate solutions to the waiting problem. The data used in the waiting form were collected through interviews and field visits.

Research limitations

1. Location limits: Research has concentrated on the National Bank of Iraq.
2. Time limits: On May 2022.
3. Objectivity limits: Operation Research.

The theoretical side

The history of a Waiting-Line Theory

The historical origins of the theory of waiting lines are due to what was done by the Danish engineer named Erlang. In 1909 when Erlang noticed the problem

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facing the female workers in the telephone traffic equipment resulting from the increase in the demand for calls in light of the limited ability of the equipment of these traffics to meet this demand. Eight years later, Erlang produced a study processing delays in automated dialling devices (Mehri, et al., 2006:1). After the end of World War II, Erlang's interest shifted to solving waiting problems at the level of business organizations (Ahmed & Ahmed, 2021:49).

The concept of a Waiting-Line System

Sometimes people get bored waiting in line by going shopping, watching a movie, or seeing a doctor. Not only do people spend time queuing, but machines and equipment queue to be serviced or repaired, trucks queue to be stacked or unloaded at the cargo terminal, and planes stop for take-off and landing.

Waiting occurs in almost every production or service process. Since the time people and things spend waiting in line is a valuable resource, decrease waiting time is significant part of operations management (Russell & Taylor, 2011: 200). Long queues are caused by inadequate service system and low quality of service, which increases waiting time (Zaki, et al., 2019:17).

Waiting line, also known as queuing system, is exactly the same as its name. (Donald A. Norman, 2008) pointed out that queuing means waiting for a person, substance or component to take place an activity. For example, a person may be waiting in line at the reservation desk of any airline, sitting in a restaurant, or obtaining a deposit service in the bank.

Waiting lines are formed when a large number of people requesting a service and a good arrive at the same time. The long waiting time of the customer to get the service and the goods negatively affects his opinion, and may reduce the demand for the offered services and goods. The behaviour of a customer in line could be: (a) waiting in line for their turn, (b) getting impatient and leaving the queue if he feels it is a long queue, and (c) wearing a jockey, asking a queuing friend to see if it's his turn. General behaviour may affect the effectiveness of the Service (Mangkona, & Imaduddin, 2018).

Queues are formed when a service provider has a higher demand which is offset by a lower service capacity. Thus the waiting lines system consists of three processes: the arrival process, the waiting lines, and the process of serving these customers. Most queuing problems focus on determining the level of service a company must provide (Kharela, et al., 2020:22).

Features of Waiting Lines System

There are a number of features that distinguish the queuing system are: (Shastrakar, et al., 2016:13)

a. **Customer Arrival:** The process of customers reaching the queuing system.
b. **Service Punctuality:** It operates on the rule under which customers are selected from a queue for service.
c- **The nature of the customer:** It depends on the nature of the customers' arrival, whether waiting in line is willingly accepted or refused.

Waiting-Line Models

Waiting line models are often useful in energy planning, waiting lines tend to develop in front of work center, such as the ticket office, waiting for the banking service or waiting for the health service in a hospital. The reason for this waiting in this line is that the time for customers to reach the service or service centers varies, and the processing time may differ from one customer to another. Waiting line models use probability distributions to provide estimates of average customer waiting time, average queue length and utilization of the work center (Krajewski, 2016:166). The primary objective of queuing models is to provide an appropriate level of service that meets the needs of the customer at a reasonable level of costs. The most important benefit of using waiting line models is that it allows estimating the probability of different scenarios for the waiting line system, depending on the organization of the specific waiting line (www.towardsdatascience.com). Queuing theory has proven to be a powerful analytical tool that can be used to solve queuing problems (Salawu, et al., 2020).

Using waiting line models to analyse operations

Operations managers can use waiting line models to weigh the gains that can be made by increasing the efficiency of the service system against the costs of doing so, of particular interest is the use of queue models to improve business efficiency and improve operations. (John Croucher, 2019: 20). Managers must look at the costs of not making the required improvements to the system: And from them, long queues or long waiting periods can lead to customers

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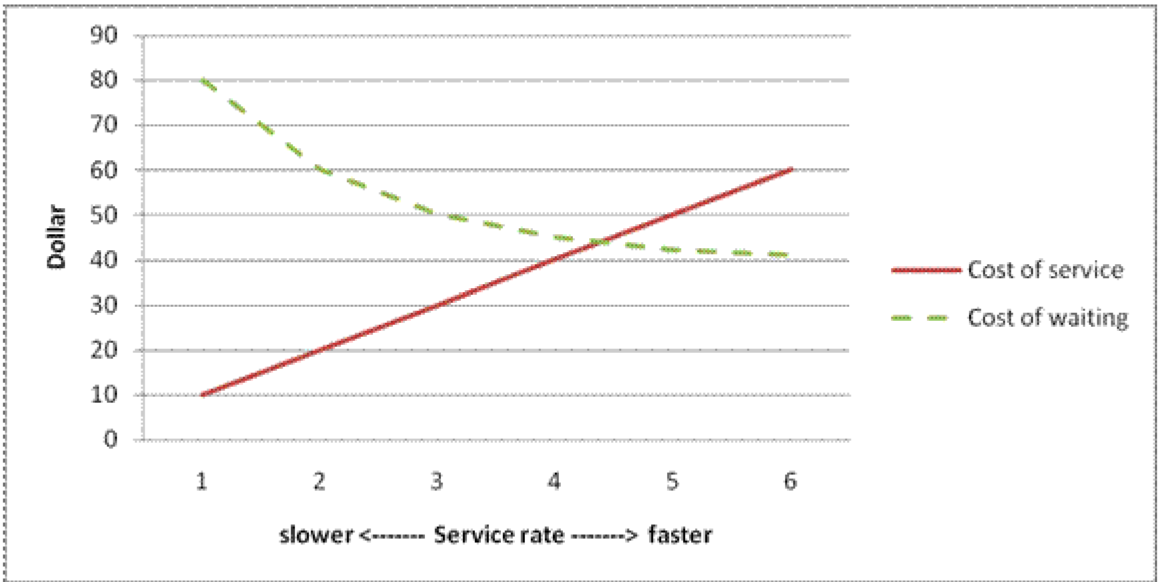
refusing to wait and thus retracting that service, so managers should pay attention to the following operating characteristics (Krajewski, 2016:167):

1. The length of the line: The number of customers in the waiting line reflects one of two conditions, short lines may mean either good customer service or a very large capacity. Likewise, long lines can indicate reduced server efficiency or a need for increased capacity.
2. The number of customers in the system: The number of customers in line that are served is also related to the efficiency and capacity of the service.
3. Waiting Time in Line: Long lines do not always mean long waiting times. If the service rate is fast, a long line can be served efficiently. (Houda Mehri, 2008:2)
4. Total Time in System: The total elapsed time from entry into the system until exit from the system may indicate problems with customers, server efficiency, or capacity.
5. Service Facility Utilization: The collective utilization of service facilities reflects the percentage of time that they are busy. Management's goal is to maintain high utilization and profitability without adversely affecting the other operating characteristics (Krajewski, 2016:183).

Waiting Line System Costs

Waiting line systems also have costs, operating characteristics, and management response strategies, there are two basic types of costs that need to be balanced in a waiting line system which are service cost and waiting cost (Kembe, et al.. 2012: 20). The most interesting scenario where the access of customer to the system is random- when the customer is unknown before it reaches the system and the access process is random, to avoid waiting lines that are longer than required, the service provider may practice management strategies to increase the rate of service by using faster servers, more servers, automated service, or a combination of strategies. The cost relationship between service and waiting can be depicted in Figure 1



The practical side

Queue theory is a very useful analytical tool in solving queue problems. This theory includes mathematical solutions to problems from which important information required in decision-making is produced with the help of predicting the various characteristics of the waiting line (Siregar, & Aulia, 2020). The National Bank of Iraq is one of the private sector banks and has dealings with a large number of customers. The National Bank of Iraq is one of the private sector banks and has dealings with a large number of customers. The bank's manager and staff have the desire to provide the best services in order to preserve their customers as well as improve the bank's reputation to win more customers, and the bank thus seeks to provide the best services and

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achieve speed in securing that service with less Costs and optimum utilization of the employees 'energies and reducing the waiting time.
The working days of the National Bank of Iraq are five days a week, from Sunday to Thursday, with the exception of official holidays determined by the government. Working hours are 7 hours per day from 08:00 am to 3:00 pm, while the rest period is from 12:00 am to 1:00 pm, so the actual working hours per week are 30 hours (35 hours - 5 hours). The sample of the study consisted of 8 samples that were taken randomly during two days a week for the month of May. The rate of customer arrival during the eight-day sampling period was (10, 11, 12, 15, 16, 17, 18, 19) customers per hour, arranged in ascending order, as shown in Table 1. While the service rate estimated by the service provider (employee capacity) is 20 clients per hour. Therefore, a set of mathematical methods can be used after determining the number of arrivals and the approximate time spent by the employee in providing that service, and this information was provided as follows:

The utilization rate of employee energy.
Service rate μ = 20 customer / hours
Arrival rate λ = 16 customer / hours

- Utilizing the energy of service facilities:

$$P = \frac{\lambda}{\mu} = \frac{16}{20} = 0.80$$

- The average number of customers waiting in line:

$$\dot{n}_l = \frac{\lambda^2}{\mu(\mu - \lambda)} = \frac{(16)^2}{20(20-16)} = 3.2$$

- The average number of customers waiting in the system (including service user):

$$\dot{n}s = \frac{\lambda}{\mu - \lambda} = \frac{16}{20-16} = 4$$

- The average time customers spend waiting in line:

$$\dot{t}l = \frac{\lambda}{\mu(\mu - \lambda)} = \frac{16}{20(20-16)} = 0.2 \text{ hours} = 12 \text{ minutes}$$

- The average time a customer spends in the system:

$$\dot{t}s = \frac{1}{\mu - \lambda} = \frac{1}{20-16} = 0.25 \text{ hours} = 15 \text{ minutes}$$

Table (1) Showing the relationship between capacity utilized and waiting lines

No. sample	Arrival rate	Service rate	Capacity utilization	Waiting time per hour	Waiting time per minute
1	10	20	50	0.05	3.00
2	11	20	55	0.061	4.00
3	12	20	55	0.075	4.50
4	15	20	75	0.150	9.00
5	16	20	80	0.200	12.00
6	17	20	85	0.283	17.00
7	18	20	90	0.450	27.00
8	19	20	95	0.950	57.00

From the above table it becomes clear that there is a relationship between Capacity utilized and waiting lines that is, the more energy is used, the waiting time also increases, so when using energy for service facilities more than 75% to 85%, the waiting lines in the long run become unacceptable, which is widespread, especially by customers.

If there is a desire to have a degree of confidence of 95% and that there are no more than four customers in the system at one time, then we will be able to know the current level of service up to four customers and what is the rate of service that qualifies the employee to be within the level of 95% of service?

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- Present level of serving four customers or less is 0, 1, 2, 3, or 4 the probability customers in the system.

$$P_n = \left(1 - \frac{\lambda}{\mu}\right)\left(\frac{\lambda}{\mu}\right)^n$$

$$n = 0 \qquad P_0 = \left(1 - \frac{16}{20}\right)\left(\frac{16}{20}\right)^0 = 0.2$$

$$n = 1 \qquad P_1 = \left(1 - \frac{16}{20}\right)\left(\frac{16}{20}\right)^1 = 0.16$$

$$n = 2 \qquad P_2 = \left(1 - \frac{16}{20}\right)\left(\frac{16}{20}\right)^2 = 0.128$$

$$n3 \qquad P_3 = \left(1 - \frac{16}{20}\right)\left(\frac{16}{20}\right)^3 = 0.102$$

$$n4 \qquad P_4 = \left(1 - \frac{16}{20}\right)\left(\frac{16}{20}\right)4 = 0.082$$

Total = 0. 67

The probability that there are more than four customers in the system is 1.0 minus the probability of four customers or less:

(1.0 – 0.67 = 0.33 %)

To achieve a level of service of 95% for four customers or less, it is:

95% = P0 + P1 + P2 + P3 + P4

$$95\% = \left(1 - \frac{\lambda}{\mu}\right)\left(\frac{\lambda}{\mu}\right)^0 + \left(1 - \frac{\lambda}{\mu}\right)\left(\frac{\lambda}{\mu}\right)^1 + \left(1 - \frac{\lambda}{\mu}\right)\left(\frac{\lambda}{\mu}\right)^2 + \left(1 - \frac{\lambda}{\mu}\right)\left(\frac{\lambda}{\mu}\right)^3 + \left(1 - \frac{\lambda}{\mu}\right)\left(\frac{\lambda}{\mu}\right)4$$

$$95\% = \left(1 - \frac{\lambda}{\mu}\right)\left(1 + \frac{\lambda}{\mu} + \left(\frac{\lambda}{\mu}\right)2 + \left(\frac{\lambda}{\mu}\right)3 + \left(\frac{\lambda}{\mu}\right)4\right.$$

We can solve this by using the true-false method for value $\frac{\lambda}{\mu}$

if the value of $\frac{\lambda}{\mu} = 0.50$

- Take advantage of the potential capacity of service facilities: (Jay heizer, 2017: 266)

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$0,95 = 0.50\,(1 + 0.50 + 0.25 + 0.125 + 0.063)$
$0.95 \neq 0.969$

If it is value of $\frac{\lambda}{\mu} = 0.45$

so,
$0.95 = (1 - 0.45)\,(1 + 0.45 + 0.203 + 0.091 + 0.041)$
$0.95 \neq 0.98$

If it is value of $\frac{\lambda}{\mu} = 0.54$

$0.95 = (1 - 0.54)\,(1 + 0.54 + 0.292 + 0.157 + 0.085)$
$0.95 \approx 0.954$

Therefore, benefit from the potential capacity of the facilities is:

$P = \frac{\lambda}{\mu} = 0.54$, the probability that there are four or fewer customers in the system is 0.95

To find the service rate required to reach the 95% level of service, the following equation should be solved:

$$\frac{\lambda}{\mu} = 0.54$$

When, λ = number of arrivals per hour
this means μ = 33 Per hour
This means that the employee will be able to provide almost a service to a customers during one hour, which means an increase of 65% over his original ability to serve 20 customers.

CONCLUSION

This research aims to determine the importance of using the waiting lines method in the National Bank to provide banking services, and the aim is to reduce the waiting time for customers in line to receive the service and to enhance the bank's position in providing the service as quickly as possible. As far as possible, and also reduce costs through optimal use of the capabilities of the staff who provide the service. While Table No. (1) revealed to us that there is a direct relationship between the energy utilization rate and the waiting time, the higher the energy utilization rate, the longer the waiting time.

The results also showed the possibility of an increase in the ability of the service-providing employee by 65 % over his original ability to serve 20 clients, to confidently reach a service level of 95%, which means that there will be no more than four people in the system. In which the employee can complete the customer's transaction within one hour only. Perhaps it is possible to speed up service delivery by modifying the view, for example, adding another employee or defining useful types of actions. Most banks have now set the highest height of actions, which is three actions in order to reduce waiting time and speed up service delivery. Mentioned by having four clients in the system or less, the employee will be idle 46% of his or her time.

The most important results that were reached through the field study is the large number of customer errors, and the reason for this is due to the lack of awareness and knowledge of the procedures of banking operations provided to the customer, especially the elderly customers who do not know how to read, which leads to obstruction of the workflow and an increase in wasted time, which leads to increased costs. Finally, there was a clear difference in the level of total productivity at the current level of the service compared to its index after the implementation of the waiting line methodology.

SUGGESTIONS FOR FUTURE RESEARCH

1. Re-Arrangement plant layout using the queuing theory.
2. The role of using the queuing theory in increasing productivity.

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