Providing a New Strategy for Reducing the Queue Congestion in the Refah Chain Store of Zahedan, Analyzing and Simulating of the Queuing System by Using Minitab and Arena Software

Ali Sadatmandzadeh*, Sepideh HosseiniDoostb

aFaculty of Industrial Engineering, Islamic Azad University, Arak, Iran
bFaculty of Industrial Engineering, Islamic Azad University, Arak, Iran

Abstract

Queuing theory is important as a statistical technique for solving problems, analyzing systems, and reducing the adverse effects of waiting. The present research has been done to solve the problem of overcrowding congestion during the distribution of subsidy goods in the Refah chain stores. The purpose of the research is to analyze the queuing system and provide a solution to overcome the crowds in the Refah stores. In this research, a way of providing customer service was reviewed, then customer arrival times, waiting times in queues and customer service were measured. The type of time distribution was followed by Minitab software. Then, the Arena software and the obtained distributions used to simulate the queue system of the store. And the simulation results were used to analyze the queuing system. The results showed that during the distribution of subsidy goods, to fix the queue congestion, 40% of customers should beat the 2nd fund and the rest should equally be divided between the 5th and 6th funds. The implementation of the run-queue system, before the customer enters the funds, is the innovation of this research.

Keyword:
Simulation
queue system
Analysis
Refah store

1. Introduction

The queuing systems have always been one of the topics that have been considered. In systems where queue and expectation are one of the elements and realities of the system, the purpose of the system analysis is to understand the behavior of the system's, to identify and determine distributions, variables, and parameters. In the end, provides a suitable strategy to determine its optimized capacity in such a way as to meet the determined and considered goals that will be discussed below [1].

Large stores are examples of queuing systems and networks that booths, money boxes and outbound control sections are considered as stations of this type of network.

Research on these networks, given the two objectives of the target (capacity, prediction, testing of various policies, etc.), and the structure of their queuing model, may lead to the use of the analytical method, or it may be possible that simulation seen to be a more appropriate solution and, consequently, this tool will be used [2].

The main task of the Zahedan Refah Chain Store is to provide services to the households of Zahedan by providing them with the necessary goods. In order to do this, the goods are divided into two categories:

1. Subsidy goods (Goods Basket)
2. Other commodities, such as foodstuffs, home appliances, clothes, and others.

One of the problems that chain stores are facing is the distribution of subsidized goods, especially goods basket. At the time of the announcement and in the first days of distribution of the respective goods, a significant crowd of people visits the store. This will cause confusion and disturbance in the regular order of the store. Because, in the discussion of the duties of Refah stores, maintaining the dignities of staff and households were considered and emphasized. Therefore, in order to meet this demand and to solve these problems, it is essential for their queue system to be thoroughly studied and its components are properly recognized.

This article is the result of a research aimed at analyzing the queue system of Refah store and organizing the way of serving customers. In this regard, after understanding the problem and the exact definition of the problem, one of the crowded stores was chosen as a case study to study the queuing of the stores. Then, during the process of analyzing the system and recognizing it, in order to analyze the queue created in the funds, the customer login times to queues, the customer waiting time in the queue, the service, and the log out of the customer from the queuing system are measured by referring to the desired store. After collecting data, using the mini-tab software, the distribution type and the distribution parameters of each time are obtained. Then, by using the Arena simulation software, the queue system was simulated using the obtained distributions and the simulation results were used to analyze the system queue system. Finally, in order to provide a solution to reduce the congestion of the queue, it is suggested that a run-queue system is used before customers entering the funds, and then depending on the efficiency of the different funds, customers split between available funds.

One of the researchers that have been done with similarity to this research is the work of Mortazavi Dorche [3], which was carried out in the Etka store in the field of shopping queues and modeling and simulating a queuing system with the policy of providing multiple services and being dynamics. This article focuses on the queues that are created in the funds of the store. In the end, based on the results of the statistics, which have been made according to the queues the simulation system of funds has been evaluated. Abedi et al. [4] have tried to cover the two goals of increasing the capacity of using the fuel station and satisfying customers by presenting an optimal layout plan for fuel stations. The tools used are queuing theory techniques and simulation tools.

Mohammadlou et al. [5] in an article to measure the role of e-banking in reducing the queues of bank counters, collected the information within six business days in two traditional banking and electronic banking systems at Zanjan Branch of National Bank of Iran, and after analyzing the data in the form of system models a queue of Results Were obtained based on the role of e-banking in reducing the density of the National Bank counters.

Mesgari et al. [6], In his research, have analyzed the queuing criteria in a branch of the bank with the Arena simulation software. Also, they have been made some suggestions to improve the performance of the bank by reducing waiting times in the queue and providing better customer service. In Hashemi et al. [7], basics of the queuing theory have been used in order to optimize the inventory control system in the dual-level supply chain of perishable goods; with Expansive lifespan has been used. The goal is to determine the optimal value of the re-order and the order size is minimized by the total cost of the chain. Kumar [8] in an article studied the impact of improved service processes in a paper. This research examines the competitive impact of improving service processes in retail operations, based on customer expectations, using queuing theories to reduce the waiting time for customers in order to serve. The result of this paper shows that when customers’ expectations about the queues were considered, compared to before it had a significant impact on the decisions, which Has led to a reduction in the waiting time for customers in the queue, as well as customer satisfaction and economic prosperity compared to other competitors. Edis and Ornek [9] have been analyzing and simulating queues created in stores. In this article, queues created in the store have been studied and analyzed and the performance of the funds has been evaluated. Vasumathi et al. [10] by using techniques for simulating ATM devices examined them and provided a technique for reducing the waiting time and of customers’ expectations in queues at ATMs.

Patel et al. [11] have been analyzing the queuing system for solving the long queue problem in ATMs by collecting data from an ATM and using the Little's law and the M/M/1 queue model.

Li et al. [12] examined the bank queuing problem by a proposed model analyzing a state of the distribution function of the input and the lost customer.

Marsudi and Shafeek [13], in their article, have examined the performance of the production line from the perspective of the queue created at the bottleneck stations of the production line, after investigations done, in order to eliminate this queue, a solution to increase the power of the station through technological and through three shifts of the station was presented and implemented. In the research of Arifin et al. [14] Titled the Applications of Queuing Theory in the Tobacco Supply; on the one hand, it is focused on the supply of Final products and, on the other hand, transportation of final products to consumers has been studied. Here, management has raised the supply of products until it reaches to the consumer, considering that these existing demands have made a queue for this system. As a result, transportation costs have declined and the supply of demanded products has been responsive.
Considering the background of the research, there is a Lack of a solution for Reducing Queue Congestion. This article seeks how is it possible to minimize the queues created in Refahstore of Zahedan? What is the solution to the quality of customer services? Therefore, the present study seeks to implement a solution in such a way that before the arrival of customers in the funds, the run-queue system, will be implemented and according to the efficiency of the various funds, customers will be divided among available funds.

2. Research literature

In this section, a preview of the store area is presented and then the queuing system models are described.

2.1. Basic familiarization to store service stations

Figure 1 shows an overview of the location of the parts of the store that is directly related to the customer and the service stations are shown.

![Figure 1. an overview of the store area](image)

2.2. Queuing system models

In this section, two examples of queuing models in which two random variables of time between two consecutive arrivals of customers and the duration of their used customer service are briefly explained. These models are the most important queuing system models used in this research.

A. M/M/1Model [2]

This model is one of the most common examples of queue models that is also known as the classic model. In this model, customers Enter by the $\lambda$ parameter according to the Poisson process. The Arrival rate of customers is independent of the number of people in the system, which is the status of the system. In other words $n=0, 1, 2, \ldots : \lambda n=\lambda$: On the other hand, because there is no more service provider, the departure rate of customers will be equal to the rate of the service. As a result, for $n=0, 1, 2, \ldots : \mu0=\mu$. In this model, $\mu=0$ is assumed, because if the customer is not in the system, there is no service.

B. M/M/$m$ Model [3]

In this model, the queuing system has $m$ service providers, the rate of the service of each of these $C$ Servers is equal to each other and equal to $\mu$, independent of the system status, which is the number of people inside the system. The Arrival rate of customers is the same as before equals to $\lambda$ and is independent of the system status. Here, the withdrawal rate of customers is different from the rate of service. There are two modes. One is $n<m$, in which case $n$ service providers are working and the withdrawal rate of customers is equal to $n\mu$. Second, $n \geq m$, in which case the maximum of $m$ service providers are working and the withdrawal rate of customers is equal to $m\mu$.

2.3. Research method

In this research, after recognizing the problem and the exact definition of the problem, to review the queuing system of the mentioned stores, one of the crowded stores was selected as a case study. Then, after the process of system analysis and its recognition, in order to allow the queue created in the funds to be analyzed, the arrival times of
the customers in the queue, the waiting time of customers in the queue, the service and the withdrawal of the customer from the queuing system were measured by visiting the Refah store. After collecting data, by using the Minitab software, distribution type and distribution parameters were obtained for each time. Then, by using the Arena simulation software and using the obtained distributions the queue of the store was simulated and the simulation results were used to analyze the queue system of the store.

2.4. Data collection and analysis of the existing system

In order to obtain the distribution function of people entering the Refah chain store, the time interval between the arrivals of people to the store has been calculated. We used Minitab software to estimate the distribution of customers’ arrival to the queue system.

Stat / Quality tools / Individual distribution (identification)

The output of the results indicates that the distribution of the arrival of individuals is a normal distribution. As shown in figure 2, the value of P-value is shown for probability distributions. According to the hypothesis testing, if the value for a distribution is less than 𝛼 (𝛼 = 0.05), then the assumption of 𝐻₀ is omitted, otherwise it is accepted and if more than one distribution is accepted, then a distribution that has the highest value indicator AD must be selected, which can be seen here that the normal distribution is the distribution of the arrival of individuals to the funds.

![Figure 2. Output Identify the type of distribution of the customer arrival to funds according to Minitab software](image)

According to figure 3, Estimation of the service distribution for each fund was shown to us by mini-tab software. As shown in figure 3, the P-value is displayed for probability distributions. According to the hypothesis testing, for a distribution If this value is less than 𝛼 (𝛼 = 0.05), the assumption of 𝐻₀ is rejected otherwise it is accepted, and if more than one distribution is accepted, then a distribution that has the highest value of the AD must be selected. Here it is seen that the normal distribution is the distribution of the arrival of individuals to the funds.

![Figure 3. Output Identify the type of service distribution for the funds according to Minitab software](image)

The service system of the Refah Chain Store of Zahedan, with 8 available funds in the store, only has 3 Funds (Fund 2; Ms. Poodine, Fund 5; Ms. Bandani, Fund 6; Ms. Kuhestani) have responded to customers. Visitors who came to the store after purchasing their own needs went to the service providers and then after finishing their task went out of the store. The working hours of the Refah Store of Zahedan will be from 8:30 am to 10:30 pm during the period from 14:30 to 22:30 pm we saw a queue in the store. In this article, the queue system of the Refah Store of Zahedan has been simulated for this period. In order to provide a solution to reduce customer congestion and customer
satisfaction, so we would not see a queue in the Refah Store of Zahedan during the distribution of the basket of goods or subsidized goods. The simulation results in the Arena software have been extracted as follows.

**Figure 4. Overview of the store system simulation using Arena software**

As shown in figure 4, the simulation of the system is performed with three models of 1M/M. After simulating the system, the output of the software is shown in figures 5 (and 6) and the Information about the average waiting time for customers in the queue, the average, and the maximum queue length are given in table 1.

**Figure 5. Information of Customers’ waiting time in queues in the current system**

**Figure 6. Information on the amount of resource efficiency in the current system**
Table 1. Information about the system with three models of M/M/1 (current system)

| Average of total funds | Fund 6 (Ms. Kuhestani) | Fund 5 (Ms. Bandani) | Fund 2 (Ms. Poodine) | Title |
|------------------------|------------------------|----------------------|----------------------|-------|
| 9.56                   | 21.41                  | 6.43                 | 0.84                 | Average people in the queue (person) |
| 22.33                  | 37                     | 19                   | 11                   | Maximum people in the queue (person) |
| 0.58                   | 1.29                   | 0.42                 | 0.04                 | Average waiting time in the queue (minute) |

2.5. Proposal

After simulating this system and analyzing the results, it is observed that the average waiting time for the customer in fund 2 (Ms. Poodine) is 0.04 minutes (2.4 seconds), fund 5 (Ms. Bandani) is 0.42 minutes (25.2 seconds) and fund 6 (Ms. Kuhestani) is 1.29 minutes (77.4 seconds), which will have dissatisfaction for customers in funds 5 and 6. Therefore, we need to provide a model for improving the queueing situation and reducing the waiting time for the customers. We suggest that instead of the three M/M/1 model use a system with an M/M/3 model. The arrival rate, in this case, is assumed to be equal to the average of the arrival rate of the three previous models. According to figure 6, the table shows the Productivity level of service. It is noted that the service providers of funds 5 and 6 are working in more than 98 percent of the time, while the service provider of the fund 2 is only working in 45 percent of the time, so in the proposed model for balancing, we assign 40 percent of the arrived customers to fund 2 and assign the rest equally to two other funds. The simulation of this model in the Arena software is shown in figure 7. As suggested by the analysis, shown in table 2, by making this offer, the average total waiting time in the queue for all funds is about the average waiting time in the fund 2 queues in accordance with table 1. Therefore, it is possible to reach a consensus on the suggestion that the analysis is presented below.

The results of the simulation of the system are shown in table 2, and the system is considerably improved.

The waiting time for customers in the queue and the length of the queue decreases, which increases customer satisfaction and more profitability of Refah store of Zahedan.

Table 2. Information on the M/M/3 model (proposed system)

| Average of total funds | Fund 6 (Ms. Kuhestani) | Fund 5 (Ms. Bandani) | Fund 2 (Ms. Poodine) | Title |
|------------------------|------------------------|----------------------|----------------------|-------|
| 0.13                   | 0.18                   | 0.17                 | 0.04                 | Average people in the queue (person) |
| 2.33                   | 2                      | 2                    | 3                    | Maximum people in the queue (person) |
| 0.06                   | 0.05                   | 0.04                 | 0                    | Average waiting time in the queue (minute) |

The innovation of this research is that, before the arrival of customers in the Funds, a run-queue system is installed, and then by this run-queue system, customers are directed to the funds according to the percentages stated.
3. Conclusion

In this article, the intention was to analyze the queuing system and provide a solution to overcome the crowds in the Refah store of Zahedan. For this purpose, after analyzing the collected data, Arena software was used to develop the simulation model. Regarding the results of simulation of the current system, the waiting time for customers in the queue and the length of the queue of customers was high. To improve the current situation, a system was proposed to reduce the waiting time of customers and the length of the queue, and increase customer satisfaction with the service system and increase the profitability of the store. The run-queue system, like banks, must be run at the time before the arrival of customers to the funds, which, according to the percentages stated, will be divided among customers.

| proposed system | current system | Title |
|-----------------|----------------|-------|
| 0.13            | 9.56           | Average people in the queue (person) |
| 2.33            | 22.33          | Maximum people in the queue (person) |
| 0.06            | 0.58           | Average waiting time in the queue (minute) |

4. Acknowledgement

At the end, we are grateful for the management of Refah store of Zahedan and the sales manager, Mr. Khosravi and other dear people, including Ms. Bandani, Ms. Kuhestani and Ms. Poodineh, who were responsible for the funds. And we are grateful to the security manager, Mr. Sarhadi who has been cooperating with us and providing favorable conditions for us.

References

[1] Gross D, Harris C; Translation: Shahkar GH, “Fundamentals of queueing theory”, University Publication Center, Tehran, 1372.
[2] ModaresYazdi Mohammad; “Queuing Theory”, University Publishing Press, 1370.
[3] MortazaviDorche SM, “Analysis, Modeling and Simulation of a queue System with presentation policy”, Third International Management Conference, (P. 18). Tehran. 1388.
[4] Abedi S, Radfar R. Hamidi N, “layout optimization of deposition of fueling station with the use of simulation tools in queuing theory”, Development management and transformation Journal 4, 1389, 43-52.
[5] Mohammadlou M, Hamidi N, Haj Karimi B, “Electronic banking and queue density of counters of the banks, A Case Study of Queuing Criteria in Traditional and Electronic Banking”, Beyond Management, Summer, 1390.
[6] Mesgari F, BagheriNejad J, “Queuing System of Bank Simulation by Arena Software and Analysis of its Function Criteria”, National Accounting and Management Conference, Shahrvir, 1392.
[7] Hashemi T, Timurid A, July F, “Application of queuing theory to optimize inventory control system in the supply chain of perishable goods”, Tenth International Conference on Industrial Engineering, Tehran, 1392.
[8] Kumar P. “The competitive impact of service process improvement: Examining customers’ waiting experiences in retail markets”. Journal of Retailing. 2005;81(3):171-80. doi:10.1016/j.jretai.2005.07.002.
[9] Edis RS, Ornek A.”Simulation analysis of lot streaming in job shops with transportation queue disciplines”. Simulation Modelling Practice and Theory. 2009;17(2):442-53. doi:10.1016/j.simpat.2008.10.002.
[10] Vasumathi A, Dhanavanthan P. “Application of simulation technique in queuing model for ATM facility”. International Journal of Applied Engineering Research, Dindigul, 2010.
[11] Patel B, Bhathawala P. “Case study for bank ATM queuing model”. International Journal of Engineering Research and Applications (IJERA). 2012;2(5).
[12] Li L, Wu J-L, Ding J-x, “Analysis of Bank Queueing Based on Operations Research”. The 19th International Conference on Industrial Engineering and Engineering Management; 2013. Springer. Doi:10.1007/978-3-642-38391-5_82.
[13] Marsudi M, Shafeek H. “Production Line Performance by Using Queuing Model”. IFAC Proceedings Volumes. 2013;46(9):1152-7. doi:10.3182/20130619-3-RU-3018.00515.
[14] Arifiin MZ, Probawati BD, Hastuti S. “Applications of Queuing Theory in the Tobacco Supply”. Agriculture and Agricultural Science Procedia. 2015;3:255-61. doi:10.1016/j.aaspro.2015.01.049.