

Decision making for Customer's satisfaction with implementing Queue Networks (Case Study in Bank Service Systems)

Sadegh Abedi^{*} ,Reza Radfar^{**}

Banks in economic is one of the most tools in the financing organization that help to the government to run money policy. Theses organizations are service segment in the division economic section and they have a direct communication with workforce and customers. So evaluation servicing system banks could in the competence environment to decrease expenses and increase satisfaction customer that case to create competence advantage for them. One of the most important techniques in this way use probability queue network. We can use "Customers Waiting time for service index", for measuring customer satisfaction in banking system. Service provider institutes usually need queue theory to optimize their decisions about customers' waiting time. This will help them to specify resources that should be investigated and also to provide customers' satisfaction. In this research with used this technique for evaluation on of the service systems in Iranian bank, present conception model that with used in current branch bank, the result can be analyzed.

Key words; satisfaction, Decision Making, queue network, bank services

1. Introduction

Today bank is one of the most important units of the public. And as they exist in the individual daily that is impossible to imagine the life without it. Each changes or unorganized can damage it public. This great and powerful unit in all public can play a role of influence, power or any other potential of power. According to these instances that is clear understandable that to demonstrate the optimum services and suitable patterns in banking in extremity could cause to ease and expedition of services to the people. Because that today it is one of the indexes of improve and glinted of the public according to the international public, to improve the service organizations and to increase the quality level of services. So in bank to analysis the service systems is the target of maximum performance is essential and economics.

Queuing theory is one of the oldest and best-developed analysis techniques that are daily used in waiting line [1]. The main purpose of manufactures and service providers is to gain customer satisfaction [2]. This satisfaction is mirrored as customer-desired characteristics. One of these characteristics for customer is gaining goods or services as soon as possible [3]. To optimize decisions and to reduce waiting time for customers, manufactures and service providers have to use queuing theory. This will help them to specify the essential

* Corresponding Author: Student PHD, Department Management, Islamic Azad University, Qazvin Branch,Iran ,Email: sadegh.abedi@yahoo.com

** Dr. Reza Radfar, Department Management, Islamic Azad University, sciences and research Branch,Iran . Email: radfar@gmail.com

resource level, that should be allocated and to gain customers satisfaction as much as possible [4]. Resource allocation and customer satisfaction are so important for companies especially in a highly competitive environment. Therefore investigating and describing queuing systems' performance in different environments is an essential issue. Networks in the queue are the symbols for facilities in group of node. Queue network divided in to two parts. First system is customer entering and exiting from or to, is impossible, we call it as "Closed Jackson Network". Second system is consisting of real models. In this system contrary the first one, in any time customers entering for receiving services and exiting is possible. It is called "Jackson Network". In the below equation 1 and 2, we can see entering rate to any node and probable selection of each of them.

$$\gamma_i = \begin{cases} \lambda : i = 1 & \text{If} \\ 0 : & \text{No} \end{cases} \quad (1)$$

$$r_{ij} = \begin{cases} 1 : (j = i + 1, 1 \leq i < k - 1) \\ 1 : (i = k, j = 0) \\ 0 : \end{cases} \quad (2)$$

Current research with analysis real queue system as: allocation, layout , location, line balance in special condition present models by apply queue network [4,8,9,10]. These models can bases of evaluation queue system with probability parameters to service providers. We can see Application of queue network in Location–allocation on congested network, Facility Location and optimization availability location problem [5,6,7]. Other applications can will be see dependent preparation and service times [11] server feedback retrial queue with finite buffer [12] Applied Mathematical Modeling [13] decision models for the optimal maintenance of a production [14]. An other research in this field are analysis supply chain management , transportation[16,17] and industrial problem in manufacture by used conceptual queue models[19,20, 21] . In this paper, the substance able model of research indicates, after the studies in the field of line analysis in services systems implemented. After definition of decision variant and banking modeling system, we study the status of branch system and analyze them by randomly select an excellent branch of bank in Tehran city.

2. Research methodology

After plan it the test indicates to analyze the exist system in bank to sampling and recognition of affect elements in create the design of expertness. Thus to the time assay and provide the

samples to calculate the time of waiting in line servicing they are involved elements that should survey their efficiency. Indeed these elements would have direct affects on time of wait in line. According to the recognized elements, calculate the volume of sample and analyze of derivation data, we would calculate the diffusion function inter people to system after indicate the implicit model to transferred banking modeling systems and implement in the random study to estimate the operation. For the beginning of the time measurement action and preparation of some samples for the estimation of waiting time in the queues, there exist some parameters that their effects should be considered in this regard. In fact, the above said factors will influence directly on the formation of waiting queues. First factor is year dividing (include 2 levels is $i=1,2$), Second factor is month dividing(include 2 levels is $j=1,2$), Third factor is week days(include 2 levels is $k=1,2$) and finally Fourth factor is day to night times(include 3 levels is $m=1,2,3$). For the beginning of sampling procedure and with the consideration of external factors, and with refer to three factors which have consisted of two factors with two layers and one factor with three layers, and according to the performed design of experiments we have 24 types for the sampling procedure, in the whole [8]. For the acquisition of each parameter in the statistical analysis and with the consideration of recognized factors in the previous part, we can use the following equation (3) for analysis of queue system in bank system. According to the statistics test in confidence level ($\alpha=5\%$) 95% and power ($\beta=25\%$) 75%, to assay the sample volume we have according equation 3:

$$n = \frac{\left(Z_{\alpha/2} + Z_{\beta} \right)^2 \sigma^2}{(\mu_1 - \mu_0)^2} = \frac{(1.96 + 1.96)^2 * 4}{(4)^2} \approx 4 \quad (3)$$

It means for each implement we should have 4 samples and in total we need minimum 96 samples. Indeed to assay the progression of customers interring to line in real banking system and so the scale of service time to them by real units we need to minimum 96 statistics sample.

3. Queue network in bank servicing algorithm by two services:

The servicing algorithm in studied rank system is that the customers after respect to the bank, they receive their numbers by electronic system, and wait decelerate their shifts. Two kinds of services indicate in banks: first service include general acts and second include especial acts. The customers at the time of inter, select their services and wait in line to take it.

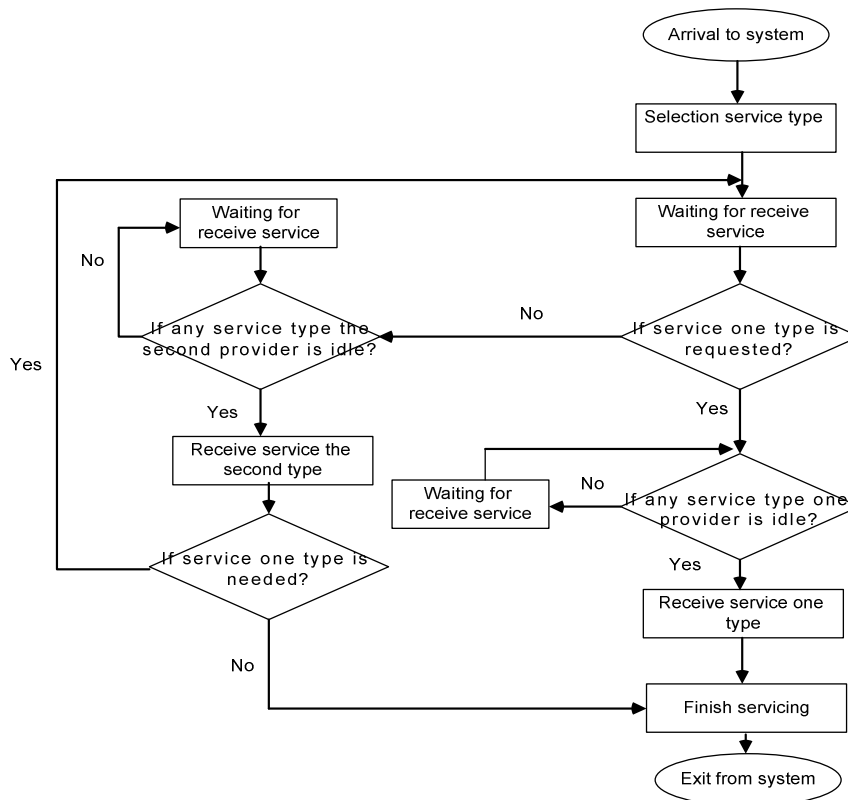


Fig 1. Process of customer's arrival and exit in banking system

In this bank, β_1 is the probability customers of first service demand and β_2 second service. If the one wait for first service and if all server are busy he should wait in line and after void one of them he can respect it, and after all he go away of bank. But the customers of the second service after receive their services it has to states. In first state he go out after finishing his service, but in second state because of the receiver of cash he goes to the first service units, and then after finishing of considerable service he goes out of the bank. Figure 2 shows the entry algorithm to the bank system.

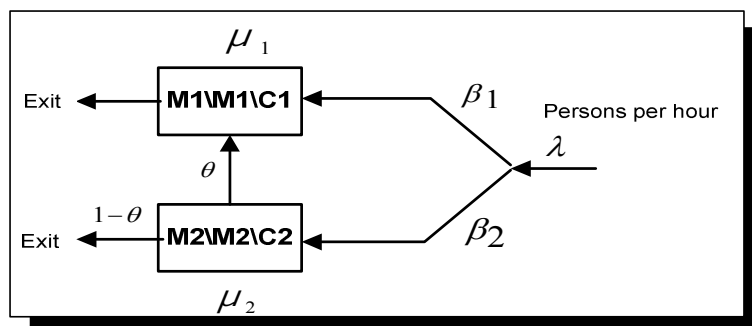


Fig 2. Customer's arrival to banking system with variable parameters

To modify the line system, first we need to the production of line model parameters. This system has the property of open Johnson that has two groups. So by the real laws [18] supposition of model and equilibrium equation, Customer's arrival rate to the one and the second section are similar to the relation equation 4 and 5

$$\lambda_1 = \beta_1 \cdot \lambda + \lambda_2 \cdot \theta \quad (4)$$

$$\lambda_2 = \beta_2 \cdot \lambda \quad (5)$$

According to the queue law, the coefficient of usage is the relation of the entry rate of customers and rate of servicing. Indeed this relation is equal to the entry rate job to the system respect to the maximum capacity, which system can do it, so the usage coefficient in section one is P1 and second section is P2 are below equals .

$$\rho_1 = \frac{\beta_1 \cdot \lambda + \beta_2 \cdot \lambda \cdot \theta}{c_1 \mu_1} \quad (6)$$

$$\rho_2 = \frac{\beta_2 \cdot \lambda}{c_2 \mu_2} \quad (7)$$

To assay the time and linear indexes of line system we need to assay π_0 . So the possibility of that the waiting line of first section in long time would not be any customer in the system is equal 8.

$$\pi_{01} = \left[1 + \sum_{n=1}^{c_1-1} \left(\frac{\beta_1 \cdot \lambda + \beta_2 \cdot \lambda \cdot \theta}{\mu_1} \right)^n \cdot \frac{1}{n!} + \left(\frac{\beta_1 \cdot \lambda + \beta_2 \cdot \lambda \cdot \theta}{\mu_1} \right)^{c_1} \cdot \frac{1}{c_1!} \cdot \frac{1}{1-\rho_1} \right]^{-1} \quad (8)$$

The average customers in line to receive the first service in first section is equal to equation 9:

$$L_{q1} = \frac{\pi_{01}}{c_1!} \cdot \left(\frac{\beta_1 \cdot \lambda + \beta_2 \cdot \lambda \cdot \theta}{\mu_1} \right)^{c_1} \cdot \frac{\rho_1}{(1-\rho_1)^2} \quad (9)$$

And the average waiting time of customers to receive the service in first section is equal:

$$W_{q1} = \frac{L_{q1}}{\beta_1 \cdot \lambda + \beta_2 \cdot \lambda \cdot \theta} \quad (10)$$

Also to analyze the second section according to assay about the possibility of un presence of second section in line in long time, to the equation of 11, and average number of customers in line to receive second service in second section is equation 12.

$$\pi_{02} = \left[1 + \sum_{n=1}^{c_2-1} \left(\frac{\beta_2 \cdot \lambda}{\mu_2} \right)^n \cdot \frac{1}{n!} + \left(\frac{\beta_2 \cdot \lambda}{\mu_2} \right)^{c_2} \cdot \frac{1}{c_2!} \cdot \frac{1}{1-\rho_2} \right]^{-1} \quad (11)$$

$$L_{q2} = \frac{\pi_{02}}{c_2!} \cdot \left(\frac{\beta_2 \cdot \lambda}{\mu_2}\right)^{c_2} \cdot \frac{\rho_2}{(1-\rho_2)^2} \quad (12)$$

The average waiting time of customers to receive the service in second section and total number of customers in the studied system to receive the service is equal to 13 & 14.

$$W_{q2} = \frac{L_{q2}}{\beta_2 \cdot \lambda} \quad (13)$$

$$L_Q = L_{q1} + L_{q2} \quad (14)$$

4- The random study of existence bank

To survey the analyze of queue system in the studied branch bank in Tehran city, we provide some samples. To start the time assay and provide some samples to assay the time of waiting in queue, according to the above, they're involve elements that have direct affects on create lines, so by recognize them and plan the experimented, we have the scale of sample volume and the number of implementing them. Therefore the consider bank has five server that 3 person do first service and 2 other displays second service.

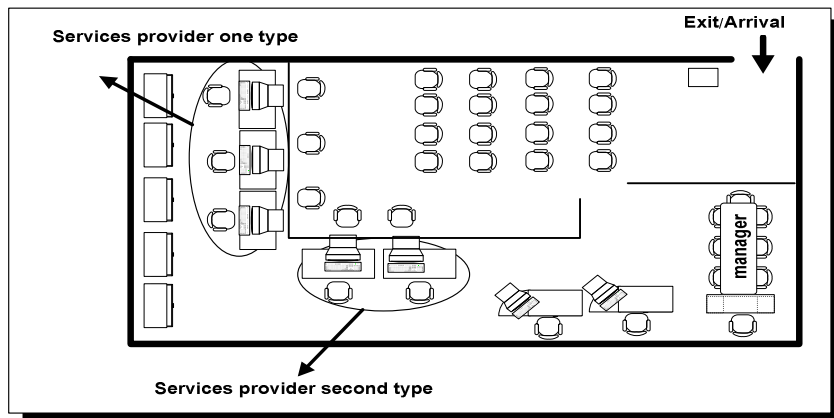


Fig 3. The schematic diagram of the bank existing stats

4-1- Estimate customer's arrival function

To estimate customer's arrival distribution to bank system, according to design of experiences in previous sections, the time between to entry of tow customers in the studied branch is indicates in table(1).

Table 1. Time distance between customers

Run	Year	Month	Week	Day	Samples			
1	A	A	A	A	45	75	42	35
2	A	A	A	B	43	85	45	45
3	A	A	A	C	47	66	45	42
4	A	A	B	A	50	65	45	40
5	A	A	B	B	51	85	42	42
6	A	A	B	C	55	83	70	50
7	A	B	A	A	58	84	75	61
8	A	B	A	B	53	90	78	75
9	A	B	A	C	54	56	54	74
10	A	B	B	A	60	45	56	77
11	A	B	B	B	75	48	45	78
12	A	B	B	C	85	77	48	48
13	B	A	A	A	65	75	77	90
14	B	A	A	B	45	74	75	77
15	B	A	A	C	68	72	74	77
16	B	A	B	A	69	75	72	65
17	B	A	B	B	85	85	75	74
18	B	A	B	C	86	90	87	87
19	B	B	A	A	70	87	87	87
20	B	B	A	B	88	88	90	80
21	B	B	A	C	85	85	92	90
22	B	B	B	A	89	99	98	96
23	B	B	B	B	89	100	112	112
24	B	B	B	C	45	75	42	35

Average time from customer's arrival(second) $\mu = 72$

And effective factors in system analysis

To estimate the expanse function of customer's arrival in system we use data analyzer software. As you see it in figure 4 according to the software exit due to estimate the expanse function of minimum square error we have:

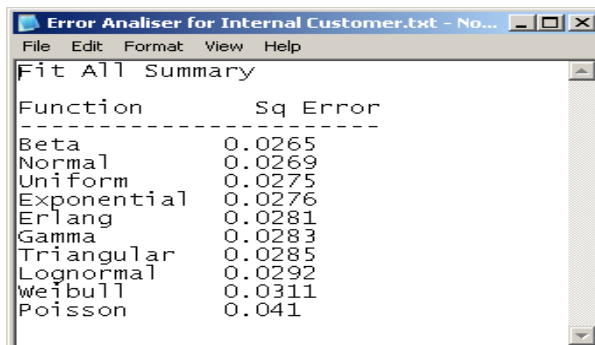


Fig 4. Estimate customer's arrival function to banking system

According to the assay explicitly and the common of the expanse functional to entry to the queue systems, so the expanse train function of enter of people to front system estimates to error square 0.0276.

According to the less square error parameter and because the nature entry of machines to queue system in time unit, is to the concept of queue Povason, so we change it to $\lambda=50$. Namely in each hour 50 person, respect to the bank averagely.

4-2-Estimate of time servicing Function

Also, according to the previous test design, we have the servicing time in table 2, 3. As we said, they are 2 services in the current bank queue system, so to assay the mean of time serving, we need to estimate data in 2 servicing, which indicates in first service by 3 people and in second service by 2 ones. We have to say that the time of receiving service by customers of bank units is independent of outer element of branch and it's relate to the inner element and kinds of customers and their behavior patterns.

Table 2. Average time from service one type

Run	Year	Month	Week	Day	Samples			
1	A	A	A	A	290	22	243	190
2	A	A	A	B	230	300	324	200
3	A	A	A	C	240	270	300	140
4	A	A	B	A	345	130	265	240
5	A	A	B	B	190	240	324	260
6	A	A	B	C	140	300	234	270
7	A	B	A	A	240	230	389	160
8	A	B	A	B	260	290	220	200
9	A	B	A	C	270	260	127	290
10	A	B	B	A	160	310	148	310
11	A	B	B	B	200	175	175	289
12	A	B	B	C	290	150	187	230
13	B	A	A	A	310	202	276	240
14	B	A	A	B	232	230	245	300
15	B	A	A	C	270	158	255	230
16	B	A	B	A	130	310	190	290
17	B	A	B	B	137	320	189	260
18	B	A	B	C	250	320	213	310
19	B	B	A	A	298	290	290	300
20	B	B	A	B	340	298	310	310
21	B	B	A	C	265	240	232	160
22	B	B	B	A	268	150	270	180
23	B	B	B	B	235	178	287	189
24	B	B	B	C	254	230	196	220
Average time (second)					$\mu = 243$			
And effective factors in system analysis								

As you see the software outgoing shows the less square error due to estimate of deal function. According to less square error element and so that we can show the more time servicing in distributing frame, the first function of distributing time service estimates with average of 243 seconds. So the function of individual time server distributes estimates in index system. You can see other derivation parameter of software and related test to the first function of distributing service.

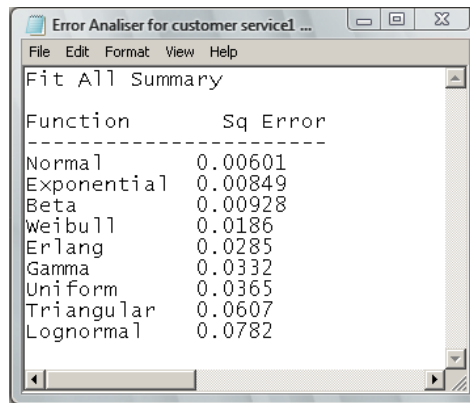


Fig 5. Estimate time service one type function

As you see, to estimate the second server service of distribute and according to the software outgoing due to estimate of distribute functions to the less square error we have some formulas.

Table 3. Average time from service the second type

Run	Year	Month	Week	Day	Samples			
1	A	A	A	A	540	410	430	400
2	A	A	A	B	230	498	420	200
3	A	A	A	C	454	450	450	435
4	A	A	B	A	435	430	410	500
5	A	A	B	B	345	432	498	576
6	A	A	B	C	510	430	420	654
7	A	B	A	A	450	510	490	200
8	A	B	A	B	320	490	510	344
9	A	B	A	C	340	454	127	454
10	A	B	B	A	260	430	470	435
11	A	B	B	B	410	345	460	345
12	A	B	B	C	430	430	509	510
13	B	A	A	A	450	400	540	490
14	B	A	A	B	430	650	436	260
15	B	A	A	C	231	430	430	410
16	B	A	B	A	430	433	510	498
17	B	A	B	B	548	450	430	450
18	B	A	B	C	250	239	546	430
19	B	B	A	A	298	236	430	432
20	B	B	A	B	410	430	310	500
21	B	B	A	C	430	432	690	548
22	B	B	B	A	560	150	430	546
23	B	B	B	B	430	178	549	344
24	B	B	B	C	433	230	540	300
Average time (second)					$\mu = 422$			

And effective factors in system analysis

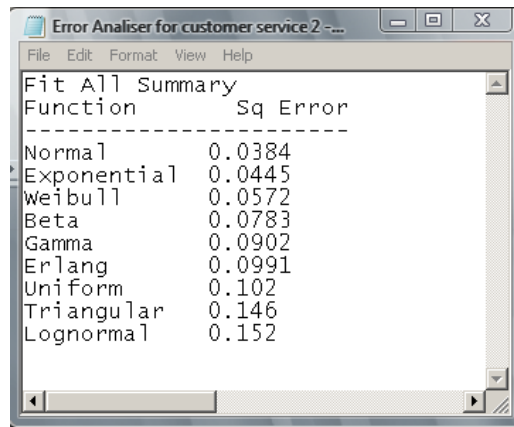


Fig 6. Estimate time service the second type function

According to the less square error parameter and so that we can show the majority of the time servicing distribute in distributing frame, the second service function estimates by average of 422 seconds. You can see other software derivation parameters and tests relate to the second servicing function.

5- Analysis the studied branch bank

In this part according to the get parameters in previous part, we assay the rate of the usage of bank system, waiting time and queue length average of bank. To modeling the queue system it's necessary to identify the decision variant. The queue system algorithm of the studied bank like to list assay is that the customer's arrival of bank with poisson distribution and $\lambda=50$ parameter. Customer respects according to select of the type of need service with possibility β_1 to first service units and possibility β_2 to the second service units. The average of time serving indicates first type would get out of the bank after finishing their services, but those who respect to the second type units, 2 states occurs after finishing the service or with possibility θ they respect to the first type units or with possibility $1-\theta$ get out of the bank. Indeed the system of this bank is an open Johnson system that exists on those 2 sections.

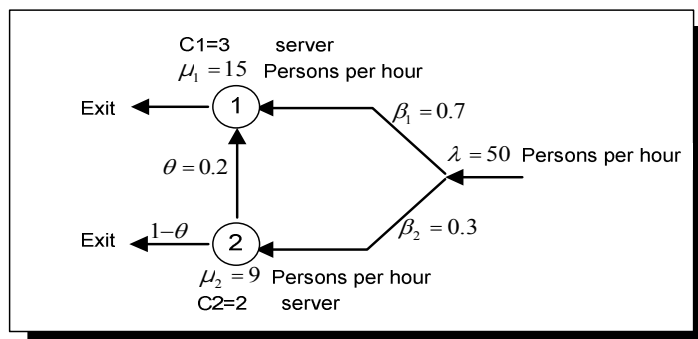


Fig 7. Design queue network case study

Table 4 indicates the base derivation parameter to analyze the network system of study.

Table 4. Definition the first parameters in case study

Explanation	Value	Definition parameters	Index
Number per hour	50	Customer's arrival rate	λ
Number per hour	15	Average service time in one section	μ_1
Number per hour	9	Average service time in the second section	μ_2
Percent	70	Selection Probability one section	β_1
Percent	30	Selection Probability the second section	β_2
Percent	20	Arrival Probability from one section to the second section	θ
Number	3	Number of service provider in one section	c_1
Number	2	Number of service provider in the second section	c_2

After get the primary values to analyze the queue network of study according to the modeling in part 3 of the assay, the results of function evaluation yields according to table 5.

Table 5. Summery result analysis in current state

Explanation	Value	Definition parameters	Index
Numbers	5	Total service provider in the bank	C
Number per hour	38	Customer's arrival rate to the one section	λ_1
Number per hour	15	Customer's arrival rate to the second section	λ_2
Percent	7	Probability of any customers for receive service one type	π_{01}
Percent	36	Probability of any customers for receive service the second type	π_{02}
Number	6	Average of customer's number in waiting line for receive service the one type	L_{q1}
Number	3	Average of customer's number in waiting line for receive service the second type	L_{q2}
Minute	10	Average of time for receive service one type	W_{q1}
Minute	13	Average of time for receive service the second type	W_{q2}
Number	9	Average of customer's number in waiting line	L_Q
Number	14	Average of customer's number in banking system	L

6- Conclusion

All the productive and server institutes need the customer's satisfaction. These consents reflect in the common characteristics. One of these characteristics, access to the goods or services in less time. The queue network is in the issues that now many researchers are occupy to estimate the special events because of its high extensively. To evaluate the bank server servicing can have the challenging profit in today's competition environment to increase the customer's satisfaction and decrease the costs. In this way, one of the important techniques is to gain of evaluate queue network. In this report by this technique implements to analysis of banking server systems to recognize the affective inner elements of the systems of the system with variable server costs, and indicates a conceptual model to sampling and research. After the indicate of conceptual model, it performs according to the arrival rate of customers at the base of 3 parameters of β_1 , β_2 , θ , and the variable rate server μ_1 , μ_2 queue network modeling with server C. Totally after the explanation of the diverse decision and banking system modeling, we study the situation of the branch and evaluate the results by randomly select a good branch of Saderat bank in Tehran city. The results in this bank shows that in total number of 9 customers are in waiting line, the averages of 6 are in line to receive the one service and the average and the average of 3 for second service. That this job has the time average to first and second service 10 and 13 minute respectively. By analyze sensitivity (figure 8) on customer's arrival rate parameter β_1 , β_2 to the bank system by θ fixed assumption, it shows that the queue length analyze indexes have serve trend to the above values.

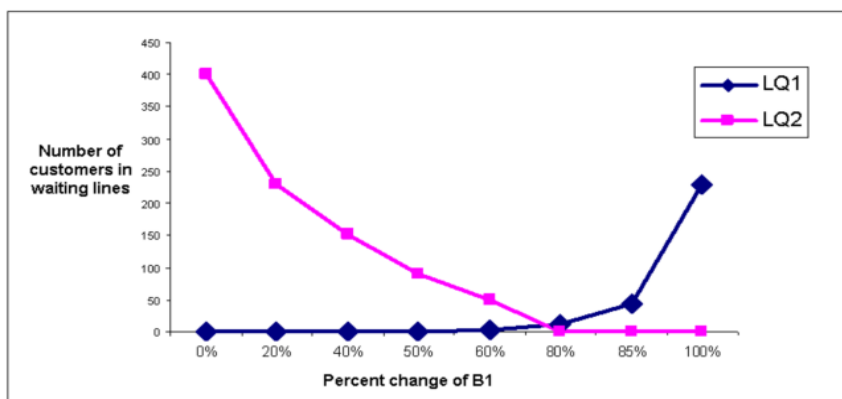


Fig 8. Sensitivity analysis customer's arrival rate to type of system's services

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