Increasing Citizens' Satisfaction from Bank Shahr ATMs and Reducing Bank's Economic Costs by Applying Simulation Model of Inventory Control

Mohammad Taghi Taghavifard

Associate Professor, Department of Industrial Management, Faculty of Management and Accounting, Allameh Tabataba'i University, Tehran, Iran

Seyyed Mohammad Ali Khatami Firoozabadi*

Associate Professor, Department of Industrial Management, Faculty of Management and Accounting, Allameh Tabataba'i University, Tehran, Iran

Seyyed Khalilollah Sajjadi

Ph.D. Student, Department of Industrial Management-Operational Research, Faculty of Management and Accounting, Allameh Tabataba'i University, Tehran, Iran

Abstract: One of the most important indicators of citizens' satisfaction in metropolises is to provide efficiently banking tools in city. Keeping cash in ATMs is very important for banks. In this paper, increasing citizens' satisfaction from Bank Shahr ATMs has been investigated by using questionnaire among 200 citizens who used them before and after implementing inventory control policy of ATMs' cash. This paper investigates the relationship between citizens' satisfaction evaluation and active ATMs by presenting a model of minimizing total costs of missed opportunity for ATMs. In order to simulate consumer behavior of ATMs, Arena software was used. The results indicated that this model can present reorder point, money order, and combination of notes for each ATM. One of the most important findings is identification of effective factors on citizens' satisfaction from ATMs and a model to optimize missed client's costs and surplus money in them. By the help of this model, satisfaction has been increased. The results represented that citizens' satisfaction from services has been reached to 80 percent from 25 percent. Finally, daily total cost of each ATM has been reduced from 1859000 Rials for each ATM to 1147000 Rials.

Keywords: citizens' satisfaction, ATM, simulation, inventory control, Bank Shahr
JEL Classification: E51, C32, G21, D40

* Corresponding author: smakhf@hotmail.com

1- Introduction

Attracting citizens' satisfaction in each system requires planning. One of the most important areas of attracting clients' satisfaction in banks is update banking devices and equipment in the city (Jafarzadeh et al., 2013). When there is uncertainty, planning will be costly and difficult with high error, and decision-maker takes action after a phenomenon. Thus, one of these areas is planning for the process of cash money in ATM[1]s that needs an estimation of consumption amount and type. Predicting cash money for these machines may affect the results reducing banks' costs (Garcia Herreros et al., 2016). Most citizens and clients' dissatisfaction of these machines are due to faults and errors based on inappropriate combination of notes or inactive errors (Bamdad & Rafiei, 2008). In case of failure or lack of cash money, this results in clients' dissatisfaction. An operator refers to each ATM and after fixing defects of all machines, he fills the machine with notes leading to inactive capital for the bank. Thus, managing ATMs can help to increase number of transactions and clients' satisfaction of machine performance and reduce maintenance cost and inactive capital. Designing a proper model for predicting ATMs' consumption, prepares the ground for banks to achieve their goals by providing required money in ATMs. Therefore, optimization strategies not only estimate proper time for puting money in ATMs through simulation about forecasting ATMs' consumption, they determine bansk' required time and cash enabling the organization to plan daily, weekly, or monthly to provide required money volume based on obtained estimations of

software results. Regarding amount and bills, the use of cash in ATMs can be predicted with acceptable accuracy by modeling the behavior of historical data based on effective parameters. Some of the effective parameters include number of daily clients' referral, withdrawals, type of consumed notes, frequency and type of failures during different days in the year appropriate with financially influential events such as depositing subsidies, salaries and pensions, geographically certain parameters of each ATM including closeness to shopping centers, offices, particular places and other parameters extracted with quantitative studies. Classical and conventional methods of forecasting time series including moving average, auto regression, and obtained combination of these models such as Sarima is not efficient in modeling non-linear behaviors and caused by many parameters. Conversely, artificial intelligence based methods including types of neural or Neuro-fuzzy networks, and support vector regression indicate acceptable performance in finding non-linear and chaotic patterns. The combination of predictors increases forecast accuracy and reduces standard deviation of forecast error, and consequently it improves forecasting (Altunoğlu, 2010). Generally, to forecast accurately, not only effective parameters should be identified and extracted, appropriate forecasting models and finally, combination of predictors should be used properly. In addition to proposed issues, an optimal model should be formulated to predict types of banknotes consumption in ATMs. This study tries to formulate a possible, dynamic, and proper model that will be enable to present order point, reordering of money, and combination of required banknotes in ATMs. By using

---

1- Automated Teller Machine

Arena software, this model can show the times of money putting in Bank Shahr ATMs daily, weekly, or monthly. The hypothesis of this study is independent behavior of each ATM compared to others.

2- Literature Review

The literature can be divided into two general areas i.e. qualitative part related to client's satisfaction measurement of ATMs, and quantitative part about maintenance models and inventory control of cash in ATMs. Studies have indicated that these two parts have significant relationship with each other (Nasrollahi, et al., 2014).

Gümüş et al., (2015) studied clients' satisfaction of ATMs in five Turkish banks in which they measured clients' satisfaction in age groups by applying a 550 people sample from statistical population of 6000 people by using five indicators and statistical tests.

Akhtar et al., (2016) measured clients' satisfaction in one of the largest Pakistan banks from ATMs. They used five indicators including low handling fee, high reliability, appropriate accountability, convenience of operating with ATM, and high security to measure clients' satisfaction.

Nasrollahi et al., (2014) investigated clients' satisfaction of ATMs' quality of services of Tejarat Banks in Mazandaran Province by using questionnaire and random sampling method. They concluded that the clients are satisfied with quality of services, technical quality of staff behavior, cost of satisfaction services, and clients' mental image of ATMs' quality of services.

Oveysi (2011) investigated clients' satisfaction of Bank Shahr from quality of services of electronic banking in the city of Tehran. In this research, five aspects were determined to investigate quality of services of electronic banking, six aspects for investigating ATMs' quality of services, and four aspects to investigate quality services of point of sale (POS). The results indicated that the clients are satisfied from all aspects of quality services of electronic banking, ATMs, and POSes except reliability. Reliability has average satisfaction.

Sadeqi (2008) measured clients' satisfaction from presented services in Iran's electronic banking system. It was concluded that the clients are satisfied with ease of using ATM and security by using a sample of 35 ATM users.

Simutis (2015) presented an approach to manage cash for ATM system. This approach was formed based on an artificial neural network in order to forecast daily cash demand for each ATM and optimization to estimate optimal cash for each ATM. In optimal time, cash cost, cost of putting cash, and cost of daily services were considered as the most important factors for maintenance of ATMs.

Wagner (2007) developed a conceptual framework to access to the strategy of expanding optimal cash inventory for a network of ATMs and designed an optimal model to provide cash in ATMs by using simulation.

Salimifard and Farajzadeh (2012) investigated money maintenance in ten Bank Saderat ATMs in the city of Shiraz by using an inventory control model and used Monte Carlo simulation, determined point of order based on a certain amount of money insertion, and they did not regard cost of inactive money and missed opportunity. In this research, to determine inventory, five scenarios and four sub-scenarios were used based on maximum and minimum inventory. These scenarios were compared to each other based on money shortage and surplus in turn, and finally, the best one was selected. One of

the weaknesses of this research is applying pre-determined solutions for the problem, yet there may be scenarios that are more appropriate.

In this regard, and given previous studies, in this research, scenarios that are more proper with different limitations can be used by using inventory control (maximum and minimum inventory) after simulation process. Thus, one of the obvious features of this research is the combination of qualitative and quantitative models that by applying qualitative method increased clients' satisfaction that is counted as qualitative index.

3- Theoretical Principles

Clients' satisfaction measurement is one of the most important indicators in the survival of an organization, company, or financial firm. In order to measure this qualitative index, different methods are used. Major researches have been focused on clarifying variables related to client's satisfaction process (Heyrati, 2009).

ServQual scale of quality of services has five aspects including tangible issues, credit, accountability, reliability, and sympathy. ServQual Parasuraman questionnaire is the best-known instrument to measure quality of services. However, there have been criticisms of this questionnaire that ambiguity in determining expectations is the most important of them. In other words, in ServQual model, expectations should be assumed constant in order to have efficient model. The role of staff is of great importance in ServQual scale and most questions are related to how to present services by staff while ATM services downgrade staff role as much as possible. ServQual scale is more proper for organization level whereas analysis

level of this research is only based on ATM that is counted as banking service. Hence, ServQual measurement tool is different from quality aspects of ATMs. Cui et al., (2013) could not obtain validity validity of ServQual measurement scale in an experimental research in South Korean banking industry, by applying confirmatory factor analysis method. According to a research in England, it was indicated that ServQual has limitation and a model that considers outcome process aspects, objectivity-mentality, and hard soft, is more capable. The investigation of ServQual tool indicates that it emphasize extremely on human interaction in presenting services. This is less applicable in ATMs. Regarding these points, it has been decided to explore aspects of ATM services in a field survey (Blanchard, 1994). Moreover, inventory control in ATMs is a method to ensure that inventory level of a certain banknote is maintained. The main purpose of inventory control in all systems is to investigate and maintain a level of inventory that minimize system costs. The main purpose of using inventory control model and formulas is to determine optimal time and amount of order by using mathematical models. The policy of controlling maximum and minimum inventory is applied in a way that the level of system inventory to be checked all the time. If it is less than confidence inventory level, the order would be in a way that system inventory is maximized (Haji & Haji, 2012).

According to the theoretical principles and literature review, inventory control system in ATMs is in this type (Ekinci et al., 2015). Regarding inventory control, it can be stated that previous studies in the field of putting money in ATMs and

money-carrier cars were done by using the policy of maximum and minimum inventory. In order to form the objective function that includes minimizing sum of two costs of inactive money and cost of missed client's loss, we assume that each value is defined as follows:

Cost of total order or total money insertion is equal with sum of inactive money with cost of each money shortage and missed client lost for each ATM.

Cost of inactive money is equal with cost of money maintenance that is equal with 18 percent in 2016 based on maximum annual interest rate of bank deposits. It is calculated about 5000 Rials daily for 10 million Rials.

Cost of each money shortage unit and missed client's loss includes total costs of fines by Central Bank of Iran for system failure, failed transactions, lack of inventory in ATM, missed client, missed fees for each ATM and cost of negative advertisement for Bank Shahr that is estimated as 300 thousand Rials (Haji & Haji, 2012).

Cost of each money insertion operation includes total costs of money-carrier cars, automobile insurance, automobile insurance, and keeping ATM equal 1 million Rials.

4- Research Methodology

After studying and doing researches related with the literature and interview with citizens, it was concluded that ATMs' service satisfaction includes sound ATM, no transaction error message, proper combination of money in ATM, and ease of using ATM menus, a questionnaire with four short questions with yes/no answers was designed to measure ATMs' quality of services and clients and citizens' satisfaction, and necessary data were collected. Although the use of questionnaire with four questions cannot fully measure

client's satisfaction of presented services in ATM, it can be stated that firstly, all presented services are not more than four main types (withdrawal, transfer, buying charge, and bill), yet citizens and clients using ATMs do not have any role in type of ATM, location, and other ATM features. Secondly, given slight variety of clients' need of an ATM (more than 80 percent of clients only ask for withdrawals), applying a questionnaire with four short items can measure client's satisfaction in ATMs. Thirdly, referring to the literature review, questionnaires are very short in these areas because of clients' short time, particularly ATM clients who are in hurry to use ATM. For instance, the questionnaire of Bamdad & Rafiei (2008) can be noted. They designed a questionnaire with five main components of transaction error, bank staff's accountability, service development, sound ATM, enough money in ATMs, and ease of using ATMs. Thus, clients' satisfaction was measured from ATMs with six questions. Typically, in measuring satisfaction of products and services, those questions are proposed that include aspects of satisfaction from service in general, meeting expectations, willingness to reuse, and recommend to others. In this research, two new aspects of accountability to needs and comparison between ATM and bank staff were added. Statistical population of this research includes all Bank Shahr ATMs' clients in Tehran. According to the research environment, distribution of ATM clients in the city of Tehran, lack of access to all ATMs and clients using services, nearly 400 clients use an ATM daily on average; therefore, by using Cochran formula, about 200 clients were calculated as sample size.

$$n= \frac{NZ_{\frac{a}{2}}^{2}p(1-p)}{\varepsilon^{2}(N-1)+Z_{\frac{a}{2}}^{2}p(1-p)} \qquad (1)$$

In Cochran formula, n is sample size, N: statistical population (400 daily clients for an ATM), Z: percent of standard error of acceptable confidence level, P: proportion of the population without certain attribute (male), q: (1-p) proportion of the population without certain attribute (female), d: degree of confidence or potential efficiency. According to formula1, if we want to calculate sample size with demographic gap of 0.5 (i.e. half of population has certain attribute and the other half does not have that attribute), generally, we consider p and q as 0.5. Z is usually 1.96 and d can be 0.01 or 0.05.

In the second part of the research method, consumption behavior of used money in ATMs was identified. For modeling money insertion in Bank Shahr ATMs, bimonthly behavior of money consumption of one ATM in 2016 in crowded branch of Tehran was investigated. Diagram 1 represents a part of this (monthly) behavior.

In this diagram, amount and time of used 5, 10, 50, and 100 thousand Tomans banknotes are represented. It is quite evident times for putting money in ATMs was due to failure and finishing inventory of each ATM leading to missed client. In this regard, the average inventory of cash in ATM in two months was about 410 million Rials; daily average consumption was nearly 190 million Rials. ATM had failure for three non-consecutive days because of inaccurate planning, unfamiliarity with proper behavior of consumption and ATM performance.
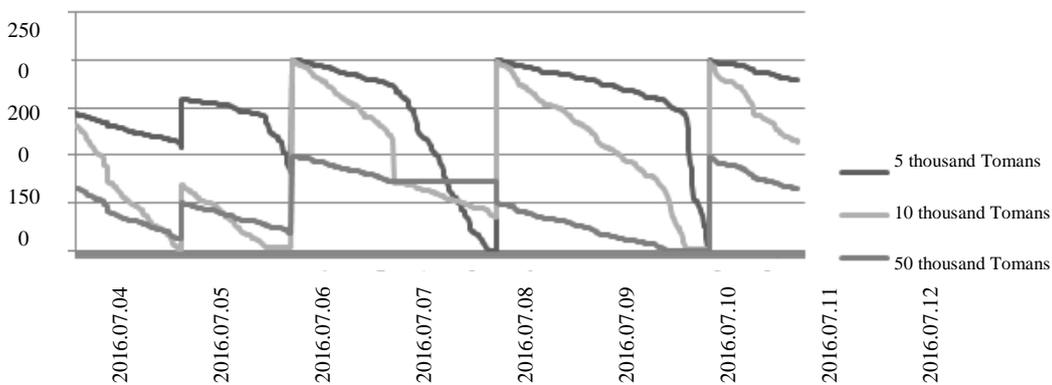

Diagrma1. Amount and time of consuming and charging ATM
Reference: (Excel output)

According to the behaviors and different distributions about number and time of clients' referring and money consumption for each ATM, an inventory control model can be represented for each of them (maximum and minimum inventory). Therefore, given use of model (maximum and minimum inventory) to solve this problem, the daily maximum money insertion in ATMs has been considered as 500 million Rials and the minimum one is 50 million Rials. In other words, firstly, daily maximum charge of Bank Shahr ATMs was 500 million Rials; secondly, when ATM's minimum inventory (confidence inventory) reaches to 50 million Rials or less in a day, money is inserted in ATMs. In this regard, unit of measurement and the basis of the numbers in this issue are million Rials. Money insertion is discrete with 10 million Rials scale. However, ATMs' revenues of received

fees (receptivity) include withdrawals, transfer, paying bills, and buying charge. According to the CBI circulars, the average fee for transfer is 1013 Rials and withdrawal fee is about 1.15 percent. Therefore, ATMs' revenue consists of transfer and withdrawal. On the other hand, each ATM cost is calculated by difference between charge and taken banknotes indicating inventory in ATM. If we consider this as a deposit with annual A investment interest, the cost of extra money ATMs (inactive money) will be imposed B Rials for each ATM to the bank. However, if these ATMs to be inserted money n times monthly, regarding current costs, cost of money-carrying of each ATM will be estimated as C Rials on average, the costs of money insertion and inactive money may be minimized by calculating interest and cost of each ATM, time, and its charge.

5- Research Findings

In this research, we assume that each unit of money or different types of banknotes that we order for each time of money-insertion is free of charge. In other words, whether 10 million Rials or 500 million Rials are inserted, no cost will be paid for each different type of banknotes.

Clients' referring time to ATMs to receive cash follows continuous exponential distribution with $\lambda=150$ daily clients. In fact, the average daily clients using ATMs to receive cash equals with 150 clients. On the other hand, given that monthly ATMs' transactions have been calculated for different months, 3500 monthly transactions for each ATM are economical. On the other hand, customers' withdrawal of ATMs follows normal distribution with average of 0.08 and standard deviation of 0.02 i.e. average clients' withdrawal of each ATM is 800 thousand Rials on average with standard deviation of 200 thousand Rials. However, we assume that after observing ATM inventory, if inventory is less than minimum inventory equals with 50 million Rials, money is immediately inserted as the inventory subtraction of ATM in that moment from maximum inventory; therefore, the interval from observation to insert money is assumed zero. The last assumption and intended limitation in the problem is number of days to run a simulation by Arena software considered as 30 days. Table1 represents the summary of limitations and assumptions of money-insertion model of Bank Shahr ATMs.

Table1. The summary of limitations and assumptions of money-insertion model of Bank Shahr ATMs

Row	Name	Symbol	Definition/ concept	Limitation/ amount
1	-	s	Minimum inventory of each ATM in a day (confidence inventory) or minimum inventory situation	50 million Rials
2	-	S	Maximum money-insertion in each ATM	50 million Rials
3	Unit Shortage Cost	USC	Cost of each money shortage unit and missed client's loss	300 thousand Rials
4	Unit holding cost	UHC	Cost of inactive money for each unit of money	5000 Rials
5	Total Ordering Cost	TOC	Total order cost or total money insertion	2006110 Rials
6	Set up Cost	SUC	Cost of each money-insertion operation	1 million Rials
7	Incremental Cost	IC	Cost of each unit of money in each money-insertion time	0
8	Exponential Distribution	Λ	Average clients' referring to each ATM to receive cash in a day	150
9	Normal Average	μ	Average clients' withdrawals from each ATM	800 thousand Rials
10	Normal Variance	δ	Standard deviation of clients' withdrawal from ATMs	200 thousand Rials
11	Delivery Lag	DL	Interval from observation to money-insertion in each ATM	0
12	Days to Run	DtR	Number of days to run simulation	30 days
13	Number	N	Number of examined ATMs	250
14	Time	T	Examined interval of ATMs	6 months= 180 days

Reference: (Required variables and parameters to enter into Arena software)

Regarding clients' satisfaction measurement from ATMs' services, the

results before running the model indicated that clients' satisfaction was 55 percent. One of the most important reasons for low rate was failure due to different reasons. In this case, the clients could not answer three other questions, but it increased to 80 percent after running inventory control model and visiting ATMs in determined intervals by model.

The results of questionnaires before and after running model have been represented in table2.

Table2. Final output of questionnaire to measure clients' satisfaction from ATMs

Questions	Before		After	
	Yes answers	**No answers**	**Yes answers**	**No answers**
Q1. Sound machine (physical failure, no banknotes, out of service)	165	35	179	21
Q2. No display of transaction error message (problems in withdrawal, stick money or card, incorrect report during request, finishing paper etc.)	98	102	161	39
Q3. Displaying appropriate combination of available banknotes (choosing type of banknotes)	112	88	152	48
Q4. Ease of using menus (suitable keyboard and monitor)	63	137	144	56
Total	438	362	636	164
Percentage	55	45	80	21
Total percentage of satisfaction	55		80	

Reference: (Researchers' findings)

Regarding the third question, the option of choosing combination of banknote type for client is active in setting menu that banks can activate it. For ordinary users, selecting favorite banknote is one of the most attractive services that it was added this option to ATM menu by Bank Maskan in Iran for the first time, and some ATMs of Ayandeh Bank and Persian Bank use this menu. After putting problem data to Arena software and regarding limitations and assumptions, the mentioned software was run for 30 days. Diagram2 represents the model of money-insertion in Bank Shahr ATMs in Arena software. In this diagram, the model of money-insertion in ATMs has been drawn as the input of Arena software.
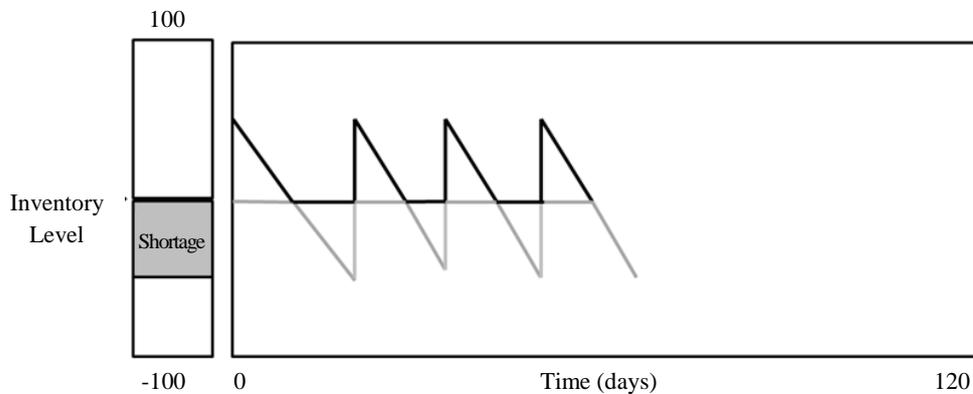

Diagram2. The model of money-insertion (maximum and minimum inventory) in Bank Shahr ATMs

Reference: (Input model to Arena software)

The number of clients used ATMs in 30 days of the simulation of Arena software has been represented in diagram3 that is equal 4483 people in a month and nearly 150 people in a day. Arena software package is used for simulation of discrete systems that supports all steps of a simulation study. Simulation in high frequencies in very short time can be done with the exact definition of assumptions and running intended model. In this research, simulation of inventory control model of ATMs' shortages was used.
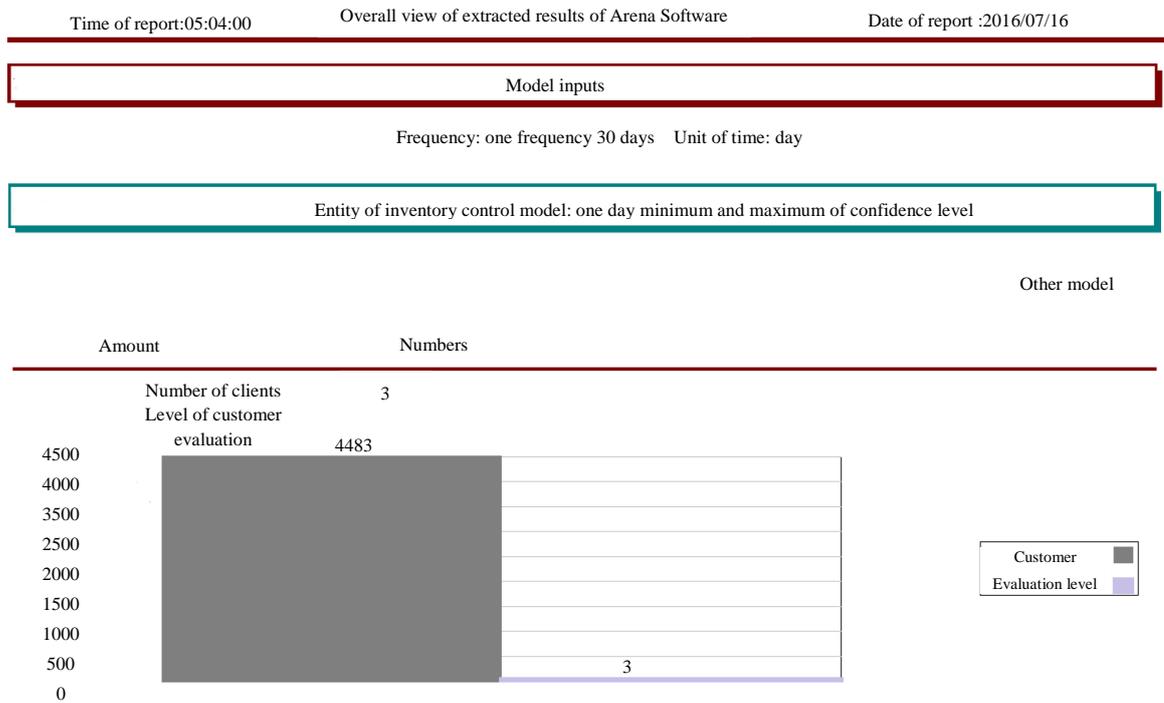

Diagram3. Number of clients used ATMS of Arena software simulation
Reference: (A part of Arena software output)

Diagram3 represents a part of program outputs after running the model. Number of clients used ATM is displayed in black color. Diagram 4 represents a part of program outputs outputs after running the model in which final cost, including average cost of reorder is displayed in light gray and total cost including cost functions of inactive money and cost of missed client are displayed in dark gray.

Time of report: 05:04: 000   Overall view of extracted results of Arena Software   Date of report: 2016/07/16
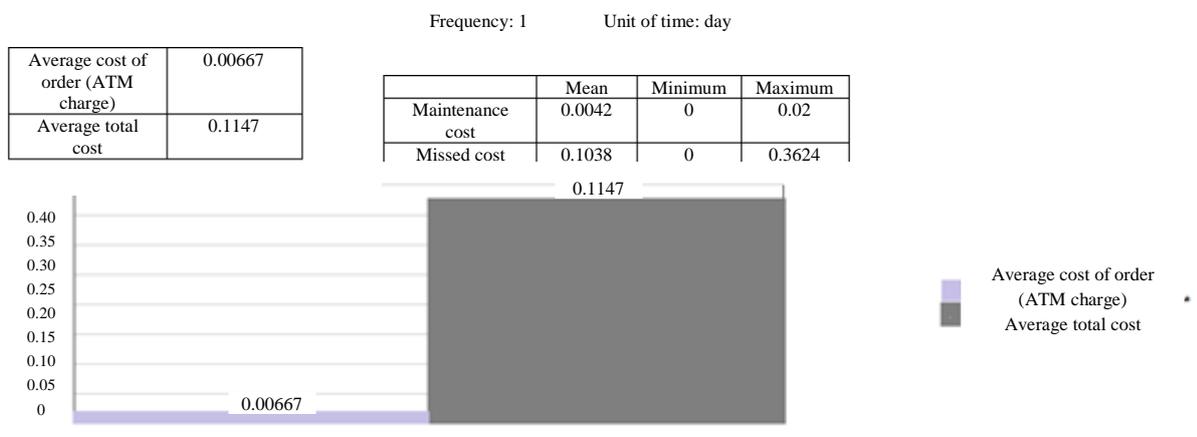
Frequency: 1   Unit of time: day

Average cost of order (ATM charge)	0.00667
Average total cost	0.1147

	Mean	Minimum	Maximum
Maintenance cost	0.0042	0	0.02
Missed cost	0.1038	0	0.3624

Diagram4. Estimating costs related to Bank Shahr ATMs of Arena software simulate
Reference: (A part of final output in Arena software)

Diagram 4 represents the average inactive money, average cost of missed opportunity, and total costs of Arena software simulation. The average cost of inactive money is 0.0042 million Tomans or 42000 Rials. The average cost of missed opportunity is 0.1038 or 1038000 Rials. The average cost of order and money-insertion is 0.0067 million Tomans or 67000 Rials. Finally, total costs were estimated equal 0.1147 million Tomans or 1147000 Rials. Considering presented explanations, table3 presents and compares the obtained value of simulation and actual amounts.

Table3. A comparison between actual and simulated amounts of informative items related to Bank Shahr ATMs

Row	Concept/ definition	Actual amount	The value of simulation	Result
1	Number of examined ATMs	50	50	Unchanged
2	Examined interval of ATMs	180 days= 6 months	180 days= 6 months	Unchanged
3	The average clients' withdrawal from each ATM	800 thousand Rials	800 thousand Rials	Unchanged
4	Standard deviation of clients' withdrawal from each ATM	200 thousand Rials	200 thousand Rials	Unchanged
5	The average number of clients' referring to each ATM to receive cash in a day	150 people	Nearly 150 people	Unchanged
6	The interval between observation to money-insertion in each ATM	0	0	Unchanged
7	Number of examined days of ATMs' function	30 days	30 days	Unchanged
8	The cost of each unit of money in each money-insertion time	0	0	Unchanged
9	The cost of each unit of money shortage and loss of missed client	2000000 Rials	1038000 Rials	962000 Rials reduction
10	The cost of each unit of inactive money	6000 Rials	42000 Rials	36000 Rials increase
11	The cost of total order or money-insertion	2006000 Rials	1080000 Rials	926000 Rials increase
12	The cost of each money-insertion operation	1000000 Rials	67000 Rials	933000 Rials increase
13	Total cost	3006000 Rials	1147000 Rials	1859000 Rials increase

Reference: (Results of Arena software outputs)

As it can be seen in table3, the costs of each money shortage unit and loss of missed client, total order or money-insertion, and each money insertion operation in simulation mode were reduced considerably in a way that total cost of reduced 1859000 Rials for each ATM. Regarding cost of each inactive money unit that increased after simulation, it should be mentioned that this difference is natural about cost of inactive money because of using actual information of 50 ATMs for a two-month period and simulation on ATM to run software. If more interval and more detailed information are presented about ATMs' function, software output will be more accurate and closer to actual cost of inactive money. Therefore, this value is completely accurate and logical. In fact, since number of refers to ATM is slight, the amount of money inside ATM is slight in time intervals; therefore, the cost of inactive money is low. But equally, the cost of each unit of shortage (shortage, failure, switch off, client' dissatisfaction etc.) will be increased and this cost reduction rather increase the cost of referral to ATM is more (comparison between 9260000 Rials and 36000 Rials). Due to high expense of each unit of money shortage and loss of missed client rather cost of each inactive money unit, it can be stated that after running this model, we conclude that number of referring to observe ATM inventory and its charge is far better than no referring and inactive money. In this regard, what the heads of bank branches are dissatisfied is not about inactive money or its loss, rather number of failures, dissatisfied clients, switching off, no referring and maintenance. The solution of this problem and observing cost savings were presented after simulation and choosing optimal scenario. After extracting initial answer, in order to optimize and solve this issue, optimal value of minimum inventory (confidence inventory), maximum inventory, and assessment interval should be calculated. It is noteworthy that all mentioned values are discrete. Table4 represents values related to minimum inventory (confidence inventory), maximum inventory, and assessment interval in Arena software. The software is simulated for 100 times and 30 days for each time. 20 possible answers were extracted that optimal answer has been obtained in the output of run 32. Diagram5 represents the output of simulation.

Table4. Assumed values in Arena software for three factors of confidence inventory, maximum inventory, and assessment interval

| Row	Confidence inventory		Maximum inventory		Assessment interval	
1	Low	20 million Rials	Low	30 million Rials	Low	1 day i.e. Daily refer to ATM and insert money if necessary.
2	High	60 million Rials	High	50 million Rials	High	15 days i.e. Refer to ATM once every two weeks and insert money if necessary.
3	Suggested value	40 million Rials	Suggested value	40 million Rials	Suggested value	7 days i.e. Refer to ATM once a week and insert money if necessary.

Reference: (Researchers' findings)
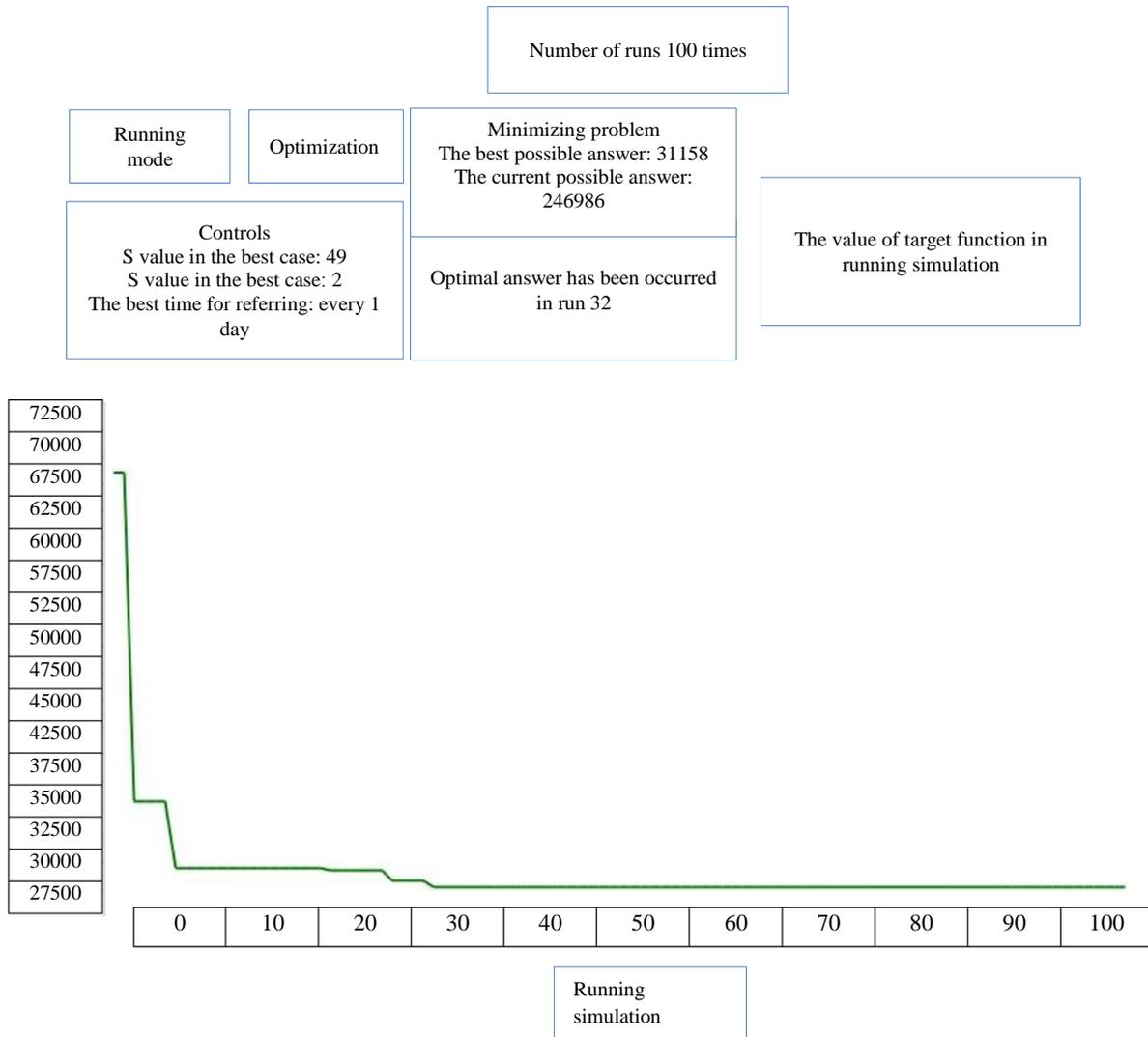
Diagram5. The output of Arena software simulation to calculate the best answer
Reference: (Software output)

As it can be seen in diagram5, among 20 possible answers and the best point of simulation -32, the best answer is to refer to ATMs daily. However, the optimal value of confidence level is equal with 20 million Rials and optimal value of maximum inventory is 490 million Rials. Finally, solving minimum cost of the model is 311850 Rials, but alternative alternative scenarios can be used. For instance, number of refer days can be increased from one day to two days by imposing the cost of 321540 Rials in the fourth scenario. Table 5 represents other scenarios with details. Moreover, table 6 compares actual and optimal simulated values of putting money in Bank Shahr ATM.

Table5. 10 possible scenarios to put money in Bank Shahr ATMs

Row	The amount of small S (million Rials)	Time to visit or evaluation period	The amount of big S (million Rials)	Response status	The value of target function	Simulation number
1	2	1	49	Reasonable	311185	32
2	2	1	50	Reasonable	31748	28
3	2	1	48	Reasonable	32154	30
4	2	2	45	Reasonable	32156	59
5	2	2	44	Reasonable	32244	68
6	2	2	46	Reasonable	32416	50
7	2	2	47	Reasonable	32655	70
8	2	2	48	Reasonable	32669	66
9	4	1	43	Reasonable	32878	22
10	6	2	44	Reasonable	32879	7

Reference: (A part of model output data in Arena software)

Table6. A comparison between actual and optimal simulated values of putting money in Bank Shahr ATMs

Row	Concept/ definition	Actual value	Optimal value of simulation	Result
1	Daily minimum inventory (confidence inventory)	50 million Rials	20 million Rials	30 million Rials reduction
2	Maximum putting money or inventory in ATM	50 million Rials	49 million Rials	10 million Rials reduction
3	Total order cost or total putting money	2006000 Rials	311850 Rials	1694150 Rials reduction

Reference: (Researchers' findings)

According to the data in table7, if minimum confidence inventory of ATMs is 20 million Rials and the maximum is 490 million Rials that is less than current putting money 30 and 10 million Rials respectively, the cost of each inactive money unit will be reduced. However, assuming that refer to ATM to put money is daily, final cost of putting money in Bank Shahr ATMs will be 311850 Rials for each one that is 1694150 Rials less than current cost of putting money in ATMs.

Table7. Optimal combination of banknotes to charge Bank Shahr ATM

Row	Banknote type	Number of banknotes First scenario	Number of banknotes Second scenario
1	50 thousand Rials banknote	700	2000
2	100 thousand Rials banknote	700	2000
3	500 thousand Rials banknote	290	400
4	1000 thousand Rials banknote	250	0
	Total inventory of ATM	500 million Rials	500 million Rials

Reference: (Results of Arena software outputs)

6- Conclusion

In this research, optimal solving the problem of putting money in Bank Shahr ATMs has been presented based on minimum value, maximum value, time, and cost of putting money. In this regard, given data related to the function of 50 Bank Shahr ATMs in the two-month

period of 2016 and assuming one-year and long-term deposit interest rate equal with 22 percent, minimum inventory of an ATM is 200 million Rials and maximum maximum is 490 million Rials in a day. The optimal time of visiting ATMs is daily and final cost of putting money in ATMs is about 312000 Rials for each one. Therefore, if the model (maximum and minimum inventory) is achieved for Bank Shahr ATMs, totally, 40 million Rials of putting money will be reduced for each ATM, and money-putting cost will be diminished to one-sixth of the current cost. According to the previous studies and information about ATMs' efficiency increase, generally issues including the status of ATMs' finance, ATMs' maintenance that its related costs in this paper include failure costs and its fines, cost of unsuccessful transactions, cost of no inventory in ATM, cost of missed client, cost of missed fees, and cost of negative advertisement for Bank Shahr to be calculated and optimized in the form of cost of each unit of money and loss of missed client and ATMS installation location should be considered. Therefore, according to the stated materials, and in order to improve the efficiency of Bank Shahr ATMs and solve their problems, following suggestions are recommended:

1. Previous studies indicate that about 20 percent of Bank Shahr ATMs are located in office sites (such as municipalities and affiliated organizations) that their efficiency is low because of presenting service by the end of the working hours of these offices. It is necessary to change the location of these ATMs in mentioned places in order that in addition to access to the organization's staff, other people can use ATMs services out of office works.

2. By running the simulation model, inefficiency of ATMs inside and outside branch in Tehran and ATMs in cities, because of no banknotes or improper maintenance, due to presented model and focused monitoring operation by branch and money carrying by treasury or branch are done. Merely, ATM installation location can be regarded for future studies as inefficiency factor of this group of ATMs. In this regard, in cases that ATMs are not efficient because of no banknotes or technical support and installation location is influential, new places and their transfer should be put on an agenda based on definite timing since proper location increases ATMs' efficiency and share of bank's fee revenues.

This paper includes the model of minimizing the cost of excess money maintenance and missed cost. However, inventory control model (maximum and minimum inventory) was used in the field of services and financial systems and order system for the first time in Iran. Thus, recommendations for future studies include presenting bi-objective mathematical model of minimizing the cost of retention of surplus money and minimizing missed cost, solving the model to achieve the variables of money order point and amount by using optimization through simulating and with the help of metaheuristic algorithms, and calculating optimal combination of notes in ATMs in case of having information about the combination of put money in ATMs.

7- References

Akhtar, N., Reza, A., Seddigi, U.I., Maghsoud, T., & Shoghoua., U. (2016). Impact of A.T.M Service Quality on

Customer Satisfaction: An Empirical Study in Kasur Pakistan Banking Sector, *under incomplete information* (Doctoral dissertation, Bilkent University).

Bamdad, N., Rafie, N. (2008). The study of clients' satisfaction of banks' ATMs services quality, *Journal of humanities and social sciences, 8*(4), 40-58.

Bell, P. C., & Hamidi-Noori, A. (1984). Foreign currency inventory management in a branch bank. *Journal of the Operational Research Society*, *35*(6), 513-525.

Ekinci, Y., Lu, J. C., & Duman, E. (2015). Optimization of ATM cash replenishment with group-demand forecasts. *Expert Systems with Applications*, *42*(7), 3480-3490.

Esiyon, A. (2014). inventory control, translated by Tabibi, H. Tehran: Termeh publication.

Garcia Herreros, P., Agarwal, A., Wassick, J.M.,& Grossmann, I. E. (2016). Inventory policies in process networks under uncertainty, *Computers and Chemical Engineering,* No92, 256-272.

Gümüş, S., Apak, S., Gümüş, T. B., Gümüş, H. G., & Gümüş, S. (2015). Ultimate Point in the Service Provided by the Banks to their Customers: Customer Satisfaction in the Common use of ATMs. *Procedia-Social and Behavioral Sciences*, *207*, 98-110.

Haji. R., & Haji. A. (2012). *Planning and controlling production and inventory,* Tehran: Azarin Mehr.

Heyrati, N. (2007). *Measuring clients' satisfaction by using ACSI model,* national conference on Tehran customer relationship.

Jafarnejad, M.B., Eslami, H., & Alavirad, A. (2013). Measuring Tehran citizens' satisfaction of Tehran municipal services and staff, *Quarterly journal of urban economics and management, 2*(5), 103-117.

Moutinho, L., & Brownlie, D. T. (1989). Customer satisfaction with bank services: a multidimensional space analysis. *International Journal of Bank Marketing*, *7*(5), 23-27.

Nasrollahi, M., Ghoreyshiyan, S.H., & Mola Aghayi, M. (2014). *The study of clients' satisfaction of Tejarat Bank ATMs services quality in Mazandaran Province,* national conference on strategic analysis of Supreme Leader's views in economy and management of economic epic.

Neave, E. H. (1970). The stochastic cash balance problem with fixed costs for increases and decreases. *Management Science*, *16*(7), 472-490.

Oveysi, S. (2011). *The study of Bank Shahr clients' satisfaction of electronic banking services quality in the city of Tehran,* M.Sc. theses, Faculty of social and economic sciences, Payeme Noor University, Alboraz branch.

Sadeqi, T. (2008). Clients familiarity and satisfaction of electronic banking services in Iran, *journal of marketing management, 3*(pre issue 4).

Salimifard, k., & Farajzadeh, S. (2012). *Using Monte Carlo simulation to determine the amount of money in the ATM and the improvement of customer satisfaction.* Proceeding of the 3rd Annual European Decision Science Institute Conference, 24-27 June, Istanbul Turkey.

Simutis, R., Dilijonas, D., Bastina, L., Friman, J., & Drobinov, P. (2015). Optimization of cash management for ATM network. *Information technology and control*, *36*(1).

Wagner, M. (2007). *The optimal cash deployment strategy* (Doctoral dissertation, SWEDISH SCHOOL OF ECONOMICS AND BUSINESS ADMINISTRATION).