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Application of simulation of queue network for reengineering of business processes (case study: process of remittance and withdrawal from bank current account (ordinary and golden)

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ABSTRACT

Systems simulation is growth rapidly as one of the most useful management tools today. This article tries to model and finally improve process of remittance and withdrawal from current account (ordinary and golden) of bank with use of discrete simulation methodology. For this purpose, the said process is identified and then a logical model is simulated with use of ED model (Enterprise Dynamic) for identification of the said model process and data relating to each entity is obtained with use of chronometry and then sample volume has been calculated. For validation and confirmation of the model, a comparison between results of simulation and real measurement has been made by statistical tests. In the next stage, two criteria which include output of the customers and average waiting time of the customers are selected and some suggestions were presented for improvement of remittance and withdrawal processes with regard to the obtained results.

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Introduction

Presentation of theory and creation of structure for solving problems of the organizations and companies are of the goals of researchers in management. Scientists have tried to obtain new applied methods for improvement of industries and organizations. Human beings deal with different types of queue which leads to waste of time, power and capital. The times they spend in bust station, dining room, shopping and the like are clear examples of such wasting times in life.

It is not possible to remove undesirable results of waiting in queue without recognizing characteristics of this phenomenon. Theory of queue which studies queue from the mathematical view studies effect of factors constituting queue and logical ways and decrease of waiting time. Although one cannot remove queue completely, one can decrease its wastes if possible (Modarres Yazdi, 1991).

One of the tools which are used for analysis of queue system is simulation. Simulation is imitation of performance of the process with real system over time. As a system comes into existence over time, its behavior is studied by creating simulation model. This model is set of assumptions relating to performance of system. These assumptions are expressed in the framework of mathematical, logical and symbolic relations between institutes or the intended goals of the system (Amiri, 1995). One can apply the model in order to search for different questions ''what if '' for the real system by creating and validating the model (Amiri 1995). Changes in applicability of system can be simulated in the system to predict their effects on performance of the system (Benks, Nelson and Nicole, 2001).

In recent years, combination of simulation and reengineering leads to emergence of new science as business processes simulation (BPS). BPS can be regarded as compiler of methods, techniques and tools which support business process through simulation, analysis and improvement.

Business Process Re-engineering is one of the categories which have been considered in literature of strategic management and organizational changes as well as strategies of information technology. Focus of reengineering is on adoption of multilateral and comprehensive approach according to most of the theorists which includes main components of the organizations such as strategy, structure, process, manpower and technology (Galirz, 1995).

In spite of increasing importance of processes reengineering, rate of failure in engineering operations and projects has been reported to be 70% (Champi, 1995) (Hammer, 1993). As obtained from the studies indicates an incompatibility and inconformity of expectations and goals of reengineering and what occurs in practice. Revolutionary approaches promised in reengineering are not applied by the organizations which are involved in reengineering (Courier, Wilcox, 1996).

Simulation of business processes helps understand, analyze and design processes. With use of simulation, redesign of the processes can be assessed and compared. Simulation allows quantitative assessment of effect of process design on performance of the process and quantitative selection for the best fabricated plan. Business process simulation is able to analyze business processes models by referring to size of efficiency such as time, operational power, cost or profitability of the resources. In order to keep the organization competitive in changing workplaces, organizations should continue to correct and reconstruct business processes and applied systems of the organization which complement them need changes. Business processes which have been regarded as structure are a set of design of the measured activities in order to produce special

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output for the customers or special market which has comprised critical successful factors for competitive point of the organization.

This improvement is realized through Benchmarking, business processes simulation (BPS) and improvement of business process. Changes are risky in terms of the damage on processes and elements of the organization. Therefore, reengineering efforts are not successful due to the degree of change and lack of trust which they introduce. On the basis of Hammer, rate of failure in reengineering projects has been more than 50%. Paolucci warned that one of the most important subjects which causes high rate of failure in business change processes is lack of tools for assessment of effects of design alternatives before executing them. In fact, mistakes can be known when processes reengineering has been executed. With regard to simulation of business processes, some important steps are as follows:

At first, business process is mapped on the process model; probabilities are attached to the process documentations. Then, sub processes and activities are specified. Definition of control trend is created by identifying entities which flow inside the system and describes relations which link different parts of process to each other. At the end, the resources are identified and are allocated to the activities which are required. Process model is revised to ensure that there is no mistake in the model. Before simulation of the business processes, performance specifications such as time of operational power and use of resources should be considered.

For statistical validity of the simulation results, execution of simulation should include multiple executions and each one of such executions should have enough time. During simulation, simulation time has passed. Simulation tools may show animation pictures of the process workflow or real time fluctuations in small sizes. When simulation was finished, results of simulation can be analyzed. In order to receive correct and useful results of such achievements, input and output information analysis has been executed. Although BPS steps are similar to each other far from simulation tools, each one of the simulation tools will have different applications.

Since Petri-nets could model business processes dynamic behavior on the basis of mathematical formulas, it was broadly used for BPA (Business Process Analysis). .(Feng and Jiang,2006; Salimi Fard and Wright,2001; Van der Aalst,1999; Van der Aalst and Ter Hofstede,2000). Among different techniques such as Petri net, analysis tree methods were suggested for analysis of business workflow because they can detect modes of workflow such as Deadlock and Lovelock and can follow changes from a mode to another mode (Choi, Zhao and Han,2006; Van der Aalst and Van Hee,2002). In any way, this research has described qualitative and quantitative analyses for study of process efficiency sensitivity in detail. In BPS (Business Processes Simulation), profitability of simulation for Business Processes reengineering (BPR) was suggested in Apr. 2005 by presenting case study on trend of personal claims in insurance company. Mevius و Oberweis (2005) showed that Petri-net is useful on the basis of simulation for assessment of process efficiency. Greasley proved ability of BPS in 2003 for combination of variety of system and analysis of scenarios and is suitable for representation of process efficiency relation for BPR. Jeng (2005) presented development of system dynamicity business processes model for description of behavior of system and (what-if) analysis. In addition, their model has been focused on details of process behavior which has individual level in process hierarchy. Main goal of this research is to design process of remittance and withdrawal from current account (ordinary and golden) with simulation software through which one can take action regarding study of the process to achieve the following goals in such way and by allocating resources correctly and utilizing capacities:

- comparison of status quo and desirable condition in studied process through simulation
- decrease of average waiting time of the customers for providing services and decrease of length of queue
- provision of a model for desirable prediction in process of provision of services with simulation approach
- Provision of a model for prediction of behavior of the process with process -based behavior with use of process-based approach with use of the available processes improvement simulation methodology.

In this project, chronometry was performed with use of Stop Watch method in order to measure serving times and arrival of chronometric customers and the available documents and view of the bank experts were used for gathering other information. Because we were not sure that distribution of budgets was normal distribution, we regarded sample volume in 30 days on the basis of random times and sample volume was obtained with use of the following formula.

$$n = \left(\frac{z_{\frac{\alpha}{2}} \times \sigma_x}{e}\right)^2$$

In this project, $\alpha = 0.05$ was selected to determine sample volume with high accuracy.

For this purpose, we studied process of study of the remittance slip insertions:

After the first 30 samples were obtained, we calculated standard deviation of the sample with use of SPSS software and obtained value of $Z_{0.025}$ and then calculated value of n.

$$e = Z_{\frac{\alpha}{2}} \frac{\sigma_x}{\sqrt{n}} = 1.96 \times \frac{15}{\sqrt{30}} = 1.72$$

$$n = \left(\frac{Z_{\frac{\alpha}{2}} \times \sigma_x}{e}\right)^2 = \left(\frac{1.96 \times 15.5}{1.72}\right)^2 = 311.9 \cong 312$$

After sample volume was specified, we should specify distribution of the activity cycle. For this purpose, we used Chi-square test. Regarding this process, it seemed that it follows exponential distribution after observation of histogram. We performed the test in significance level of 0.05.

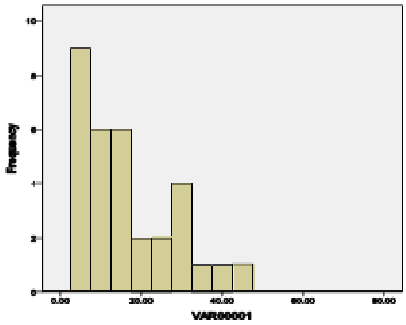

Figure 1: histogram chart

$$\begin{cases} H_0 : \text{Remittance process follows exponential distribustion} \\ H_1 :: \text{Remittance process dosen,t follows exponential distribustion} \end{cases}$$

With use of the software, test statistic was obtained to be 0.538 and because it is larger than 10.05, therefore, H_0 in not rejected.

Stages of modeling

At first, stages of the current account remittance and withdraw processes were prepared as flowchart and execution of processes in all stages was observed and the required information was gathered through chronometry. We acted as follows for converting the real model to simulation.

We considered bank customers to 9 major groups as bank processes which are our products.

These processes include remittance to current account, withdrawal from current account, payment of slips , payment of installments , payment of pensions , remittance and withdrawal from short-term account , process relating to pos system, repurchase and resale of notes , operations relating to ATM card , then all customers enter a queue and enter seven counters in the branch which are our servers and when each one of the counters is empty , the customer enters that server and because only process of remittance and withdrawal from the current account is considered in this research , the customers who had requests other than remittance and withdrawal were excluded from the process and two processes mentioned above enter the model. In order to obtain time of arrival of the customers to bank and interval between two entries of the customers, we asked authorities of the server for help so that all ATM papers were received from the customers by the authorities and their arrival time to the counter, their exit time meaning time of process completion as well as type of the process requested by the customers were written on such papers and all of the papers were gathered at the last day.

In order to obtain accurate time of remittance and withdrawal processes, table of discrete record of the observed time.

For this purpose, operations cycle was divided into smaller parts and time of performance of each working component was recorded instead of determining total time of the process. In this project, Fly back chronometer was used. This chronometer has two buttons one of which stops the hand with one press and starts moving with the second press. Press of the second button causes Fly back of the chronometer.

This chronometer is suitable for continuous and discrete reading. Discrete method was used in order to record results of chronometer. In this method, time is read from chronometer and the hand flies back to zero at the end of each working component and starts chronometry of the next working component from zero and measures it.

Time of each working element is measured directly. Chronometer never stops and the hand starts to move after flying back to zero in order to show the next element time (Ahmadi, 2001). After recording the required times, one should obtain function of each one of them. For this purpose, Easy fit and SPSS were used. After determination of the required functions, it was time to record them in simulation software.

In the above figure, colored circles of the left side are the products and indicate 9 different processes in bank (with regard to two special processes of remittance and withdrawal from the current account, these two processes have been shown as square. In the next stage, we defined 9 sources and entered time interval between two inter-arrival time for each process. We used set label formula relating to simulation formula for identification of processes and time of performance of each process.

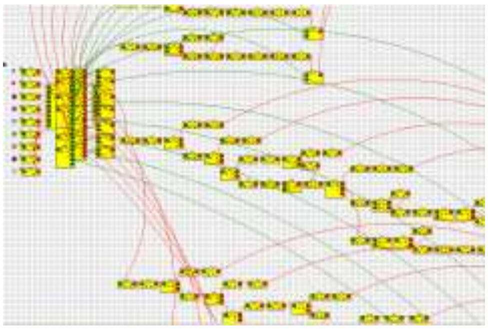

Figure 2: schema of simulated model

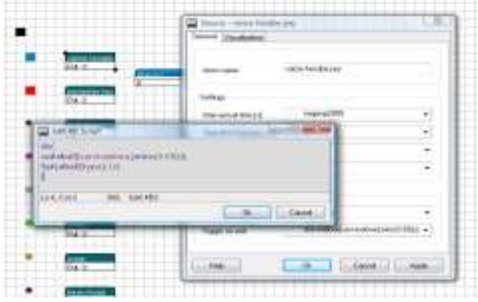

Figure 3: how to enter information in model

When we execute simulation, customers arrive to bank on the basis of input time which we determined and stand in a queue and refer to each one of the empty counters first in first out (FIFO).

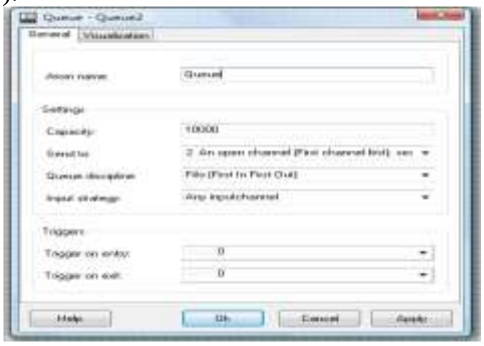

Figure 4: information relating to queue

In this model ,seven counters (server) have been selected for bank and we defined in Send to section on the basis of Set Label formula which played role of identification of type of the process for us that if the customer requests to remit to the current account , he will enter remittance process and if he requests to withdraw from the current account , he will enter withdrawal section otherwise, he will exit from the bank.(it is necessary to note that only remittance and withdrawal process has been focused in this project). Each customer will stay in the related server on the basis of time of performance of each process and exit from the bank.

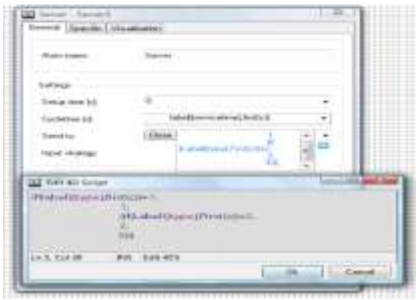

Figure 5: entering information relating to each server

In figure 2, brown circles are observed. These circles indicate Lock and Unlock. Before each Server is a Lock which doesn't allow next customer to enter the bank until process of the previous customer has been completed and there is Unlock at the end of the process and when the process was completed, it unlocks the system and permits the next customer to enter the system. When system is locked, the customers are added to the queue.

Model validation

A model is created only for a special purpose and its efficiency and validity are assessed in terms of that goal. The purpose is to make the model which simulates behavioral issues and characteristics of the studied process or system. In order to achieve such validity, one or more criteria should be defined for comparison of simulation model and real system. The criterion which was considered was waiting time of the customers in queue.

- Average waiting time of the sample obtained from the real model : 16.69 minutes
- Average waiting time of the sample obtained from simulation : 21.88 minutes
- Standard deviation of the sample obtained from real model : 8.98

Before we test equality of the means, we should know if two populations have equal variance or no. at first, we test comparison of variances in two populations. These actions were performed by SPSS.

With regard to the above table and assuming equality of variances

$$H_0 = \sigma_1^2 = \sigma_2^2$$

$$H_1 = \sigma_1^2 \neq \sigma_2^2$$

We conclude that because sig = 0.748 and is more than α= 0.05, then hypothesis of H_0 in not rejected. Now, we study hypothesis of variances equality.

$$H_0 = \mu_1^2 = \mu_2^2$$

$$H_1 = \mu_1^2 \neq \mu_2^2$$

Given equality of variances referred above, we conclude that because value of sig equals to 0.898 in the first line and larger than 0.05, then, there is no reason for rejection of hypothesis H_0.

Study of results of real model and next corrected models

Model 1(real model)

After validity of the model was proved for us, it is implemented for 240 hours. For this purpose, Separate Run was used and the model was implemented for 30 working days and 8 hours every day. As a result, as shown in the following table, total number of the output customers was 342. Total waiting time of the system equals to 1312.8 seconds (21.88 minutes). For calculation of productivity coefficient of the system, we should multiply productivity of all servers and average it.

Model 2(corrected model)

We implement the simulated model with the changes for improvement by studying model 1. In this model, completion time of remittance and withdrawal slips has been excluded. In this case, we compare the presented indices with model 1. After implementation of the model for 240 hours (30 working days), the results are as follows:

With regard to the above tables, we conclude that we can study the number of more customers in remittances and withdrawal processes from the current account and average waiting time is reduced from 21 minutes to 11 minutes which causes satisfaction of the customers. Now, for validation of the model in this case, we implemented the model for 32 working days in the branch and compared its results with simulated model. Before we test equality of the means, we should know if two populations have equal variance or not. At first, we compare variances in two populations and these actions were performed by SPSS.

With regard to the above table and assuming equality of variances:

$$H_0 = \sigma_1^2 = \sigma_2^2$$

$$H_1 = \sigma_1^2 \neq \sigma_2^2$$

We conclude that because sig = 0.358 and is more than α = 0.05, then hypothesis of H_0 is not rejected. Now, we study hypothesis of means equality.

$$H_0 = \mu_1^2 = \mu_2^2$$

$$H_1 = \mu_1^2 \neq \mu_2^2$$

Given equality of variances referred above, we conclude that because value of sig equals to 0.675 in the first line and larger than 0.05, then, there is no reason for rejection of hypothesis H_0.

Conclusion

In this paper, a logical model is simulated with use of ED model (Enterprise Dynamic) for identification of the said model process and data relating to each entity is obtained with use of chronometry and then sample volume has been calculated. For validation and confirmation of the model, a comparison between results of simulation and real measurement has been made by statistical tests. After validity of the model was proved for us, it is implemented for 240 hours. For this purpose, Separate Run was used and the model was implemented for 30 working days and 8 hours every day for real model. We implement the simulated model with the changes for improvement by studying real model. In this model, completion time of remittance and withdrawal slips has been excluded. In this case, we compare the presented criteria with real model. After implementation of the model for 240 hours (30 working days).

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Table 1: Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation	Variance
VAR00001	300	5.00	109.00	20.5700	15.50397	240.373
Valid N (listwise)	300					

Table 2: One-Sample Kolmogorov-Smirnov Test

		VAR00001
N		300
Exponential parameter.[a,b]	Mean	17.7333
Most Extreme Differences	Absolute	.246
	Positive	.129
	Negative	-.246
Kolmogorov-Smirnov Z		1.346
Asymp. Sig. (2-tailed)		.538

a. Test Distribution is Exponential.
b. Calculated from data.

Table3: Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
VAR00001	100	.00	39.00	16.6900	8.98449
Valid N (listwise)	100				

Table 4 : Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
VAR00002	100	16.00	32.00	21.8800	3.85259
Valid N (list wise)	100				

Table 5: Group Statistics

	que2	N	Mean	Std. Deviation	Std. Error Mean
que1	1.00	100	16.6900	8.98449	.89845
	2.00	50	21.8800	3.85259	.54484

Table 6: Independent Samples Test

	Levene's Test for Equality of Variances	t-test for Equality of Means							
								95% Confidence Interval of the Difference	
	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference		Lower	Upper
que1 Equal variances assumed	30.756	.748	-3.904	148	.898	-5.19000	1.32940	-7.81705	2.56295
Equal variances not assumed			-4.939	145.458	.898	-5.19000	1.05074	-7.81705	2.56295

Table 7: the number of output from all processes except for current account remittance and withdrawal process

Observation period:	28800
Warmup period:	0
Number of observations:	30
Simulation method:	Separate runs
Description:	

Sink27

	Average	Standard Deviation	Lower bound (95%)	Upper bound (95%)	Minimum	Maximum
input	175.57	14.62	170.11	181.03	143.00	203.00

Table 8: the number of outputs of the remittance process from the current account

Observation period:	28800
Warmup period:	0
Number of observations:	30
Simulation method:	Separate runs
Description:	

Sink39

	Average	Standard Deviation	Lower bound (95%)	Upper bound (95%)	Minimum	Maximum
input	82.40	8.05	79.39	85.41	60.00	96.00

Table 9: the number of outputs of withdrawal process from the current account

Observation period:	28800
Warmup period:	0
Number of observations:	30
Simulation method:	Separate runs
Description:	

Copy of Sink60

	Average	Standard Deviation	Lower bound (95%)	Upper bound (95%)	Minimum	Maximum
input	85.83	6.89	83.26	88.41	66.00	98.00

Table 10: average waiting time of the customers in queue

Observation period: 28800
Warmup period: 0
Number of observations: 30
Simulation method: Separate runs
Description:

Queue19

average stay					
Average	*S.Dev.*	*L-bound(95%)*	*U-bound(95%)*	*Minimum*	*Maximum*
1312.8	977.59	1423.20	2153.55	208.83	3958.82

Table 11: number of output of the remittance process after improvement

Observation period: 28800
Warmup period: 0
Number of observations: 30
Simulation method: Separate runs
Description:

Sink39

	Average	*Standard Deviation*	*Lower bound (95%)*	*Upper bound (95%)*	*Minimum*	*Maximum*
output	92.33	8.60	89.12	95.55	77.00	115.00

Table 12 : number of output of the withdrawal process after improvement

Observation period: 28800
Warmup period: 0
Number of observations: 30
Simulation method: Separate runs
Description:

Copy of Sink60

	Average	*Standard Deviation*	*Lower bound (95%)*	*Upper bound (95%)*	*Minimum*	*Maximum*
output	93.70	9.15	90.28	97.12	73.00	113.00

Table 13: average waiting time of the customers in queue after improvement

Observation period: 28800
Warmup period: 0
Number of observations: 30
Simulation method: Separate runs
Description:

Queue19

	Average	*Standard Deviation*	*Lower bound (95%)*	*Upper bound (95%)*	*Minimum*	*Maximum*
average stay time	676.54	494.13	491.96	861.12	86.55	1720.19

Table 14: Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
que1	Equal variances assumed	6.009	.358	-3.267	488	.675	1.47000	.45001	-.58228	2.35772
	Equal variances not assumed			-3.310	484.158	.674	1.47000	.44416	-.59371	2.34629