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DEVELOPING A NEW APPROACH FOR EVALUATION OF BUSINESS PROCESSES IN A FUZZY ENVIRONMENT

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Abstract. Evaluation of business processes plays a significant role in business development and improvement. Therefore, organizations need a systematic approach to evaluate all the changes through robust and powerful techniques that can formulate the relationship between the available information and the degree of the inherent uncertainty. In this paper, a set of operational variables are defined. Then, the SPSS software package is utilized to validate the gathered data. After that, the variables are categorized by the use of a clustering technique. Finally, five major factors are determined as the most effective components. According to the inherent uncertainty involved in the process of modelling, fuzzy set theory, a powerful mathematical tool is applied to handle the vagueness. In order to construct a knowledge base based on the fuzzy set theory, the linguistic concepts for each variable are defined. Lastly, membership functions are described and a set of fuzzy rules based on input-output parameters are written in MATLAB software environment. To demonstrate the potential application of the proposed approach, a real case study is illustrated. The results reflect the capability and effectiveness of the approach proposed in this paper.

Keywords: fuzzy inference system, assessment of BPM and BPR, bank payment systems, exploratory factor analysis, process improvement.

JEL Classification: D81, E42, M21, C02.

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Introduction

Many productions were made by the skilled craftsmen until the mid-seventeenth century, and all phases of design, manufacture, marketing, sales and service in various industries such as textile, metals, jewellery, etc., was implemented in craftsmen's small workshop. After the invention of the steam engine by James Watt (1775), Adam Smith in his book – An Inquiry into the Nature and Causes of the Wealth of Nations – announced the appearance of industrial revolution (Smith 1776).

In the late of twentieth century, revolution and transformation appeared in organizations and companies. This era was famous for a sudden appearance and a sudden disappearance of wealth because of the continuous revolution. Gary Hamel encouraged managers to destroy – smash – the old models and business strategies and to create new ones (Binesh 2005; Hamel 2009). He believed that for doing so we should not regard a thing which is transforming as a stable thing. He mentioned that we should give up using the old patterns and change our perception. In order to do that, we should quit using current business models which stick to imagination and loyalty and create totally different models to compete with our traditional rivals. In order to reach the highest level of ability and be successful in competitions, organizations need to accept changes and use the cutting-edge technology. They should also reach the stable and continuous level in the business. One of the well-known ways to bring these ideas into practice is process reengineering.

One of the main differences of organization reengineering in comparison to other managerial approaches is the deep transformation that it brings in the way of doing activities in organizations. The implementation and deployment of the approach is more complex than other management approaches. Because of the complexity, approximately 70% of reengineering projects are failed in practice (Champy 1995). Due to this fact, reengineering can considered to be a high risk activity for organizations.

Successful organizations are inevitably forced to change their structure from function-oriented to process-oriented (Obolensky 1997). However, due to the uncertainty in creating additional value in future changes, implementation of temporary or permanent changes is always offending. For this reason, a systematic mechanism is needed to evaluate the designed business process (Podviezko, Podvezko 2014; Susniene, Purvinis 2015; Treki, Urban 2015; Morselli 2015; Meyer, Zimmermann 2011). It is obvious that every qualified person has his/her own design, but in the process restructuring, all the effects and consequences should be considered and experts should comment on it. In fact, these effects and consequences are the influential factors, including all the related aspects, in the success of business processes. Moreover, expert opinions and quantitative data play a key role in formulating a problem. The merit of using the fuzzy logic is to handle the uncertainty arisen from less/lack of information in the process of modelling (Efendigil 2009; Baležentis *et al.* 2012; Nouri *et al.* 2015; Stanujkic *et al.* 2015; Yazdani-Chamzini *et al.* 2014; Rikhtegar *et al.* 2014; Khandekar *et al.* 2015). This tool helps decision makers to express the input-output relationships in the form of a linguistic value instead of a crisp one.

In the beginning of the study, process-related indicators were identified by literature review process (Bausys *et al.* 2015; Bausys, Zavadskas 2015; Akhavan *et al.* 2015; Kaya, Kahraman 2014; Ferreira *et al.* 2014; Binesh 2005) and interview with the academic and professional experts with a high background in the field of banking payment system. As well as, other indicators and process-related parameters by the use of questionnaires and experts' information were identified. Then, the indicators by the use of statistical analysis were validated and the related weights were calculated. Next, a set of fuzzy input-output rules were established in MATLAB software environment. Lastly, in the final phase of the process, the priority of the suggested processes of banking payment system was determined by decision maker team. For better understanding, the process is shown in Figure 1. It should be noted that the process is modifiable and reviewable.

In this study, the Cronbach's alpha in SPSS software was applied to measure the stability of the questionnaires. As well as, factor analysis was used to identify the evaluation indicators in order to find the main and influential factors of the final process.

Likewise, the fuzzy inference system, the heart of the system, is employed for scoring the processes by the use of MATLAB software. In this system, the values and their corresponding weights of each indicator are considered as input parameters for scoring the process.

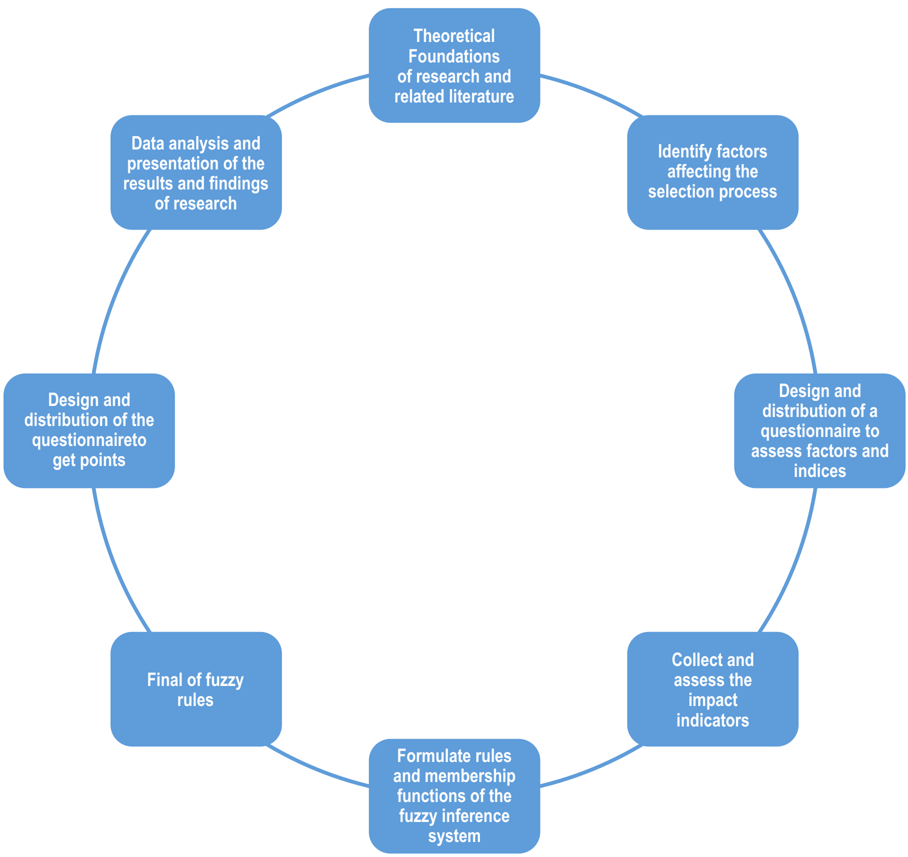

Fig. 1. The proposed methodology

1. Examining the classified indicators to measure systems

Nowadays, performance measurement has caught the eyes of managers. As Neely mentions, the number of conferences held for measuring business performance by organizations such as the Institute for International Research (IIS) and Business Intelligence are increasing (Neely 1999). Also the Britain's Royal Society of Arts, Manufacturers and Commerce (RSA) announced in its 1994 agreement that companies should measure their processes performance to achieve business success in the global marketplace.

By reviewing literatures, we can conclude that during these years numerous authors (e.g. Efendigil 2009, Obolensky 1997), have attempted to introduce various aspects of systems and proposed their indicators in accordance to them. Some authors tried to design a system for a specific goal by specifying some indicators and dimensions.

Imagine that there is lack of resources in a personal life; of course, it is a difficult life which people are encountered with a lot of challenges in it. There is more complexity and difficulty in organizations because of the emergence of more and more indicators and acute problems. Flexibility, time, cost and quality are the examples of the effective indicators in organization (Delgado *et al.* 2014). Also there are more effective indicators such as internal factors (performance) and external factors (effectiveness), lean manufacturing, competition, cost management, jobs creation and added value, growth and raises Viable Corporation.

Various indicators classifications are also done by different researchers (Neely, Gregory 1995; Kaplan, Norton 1992; Brignall *et al.* 1991; Globerson, Ellis 1996; Maskell 1989; Davis, Blenkinsop 1991; Wisner, Fawcett 1991; Fry, Cox 1989; Neely, Adams 2002; Neely 1998).

The specifications, business processes and the results should be monitored and scored in accordance to the demands of the stakeholders. Therefore, due to the given complexity of the process performance, the organization and its interactions with the environment can be understood. From another viewpoint or prospective, the leading indicators will provide a condition for breeding performance, while the lagging indicators just express the historical events. Therefore, it is essential to use an effective performance measurement system in organizations. The effectiveness of the business process in performance management depends on how to use the collected information (Teymori, Aliakbari 2009). Table 1 shows the total of 30 identified indicators and their references.

According to the key importance of the problem, during the late nineteenth century, a number of researches have been conducted to develop new indicators in order to measure the performance of business process, including Financial Ratio (Foster 1986), Triangular system of proportion of DuPont (Karami, Talaeei 2013), Activity-Based Costing (Neely, Gregory 1995), Performance measurement Matrix (Keegan *et al.* 1989), Benchmarking (Wainwright *et al.* 2005), Strategic measurement analysis and reporting technique (Lynch, Cross 1991), Bringnall and Ballantine method (Brignall, Ballantine 1996), Balanced Scorecard (Kaplan, Norton 1992), Integrated Dynamic Performance measurement System (Ghalayini *et al.* 1997), Tableau de bord (Epstein, Manzoni 1997), Performance Prism (Neely *et al.* 2000), absolute and relative evaluation (Podviezko, Podvezko 2014), Analytical Hierarchy Process (Saaty 1980), the analytic network process (Boran *et al.* 2008), Fuzzy Analytic Hierarchy Process (Buckley 1985).

Table 1. The effective indicators of business processes

No	References	Process indicators	Corresponding questions in the questionnaire
1	Delgado *et al.* 2014; Kennerley, Neely 2002; Mansar, Reijers 2007; Trkman 2010; Zarandi 2011	Integration	1–2
2	Kennerley, Neely 2002; Delgado *et al.* 2014; Teymori, Aliakbari 2009; Reijers, Mansar 2005; Trkman 2010, Mansar, Reijers 2007; Reijers, Mansar 2005; Temponi, Harris 1998	Flexibility	3
3	Delgado *et al.* 2014; Motamedifar 2008	Security	4–13
4	Delgado *et al.* 2014; Zarandi 2011; Wu 2009	Agility	14
5	Delgado *et al.* 2014; Trkman 2010	Collectivity	15–16
6	Trkman 2010, Wu 2009, Treki, Urban 2015	Risk management	17–20
7	Delgado *et al.* 2014; Mansar, Reijers 2007	Centralization	21–22
8	Mansar, Reijers 2007; Trkman 2010	Bureaucratic formality	23
9	Delgado *et al.* 2014; Mansar, Reijers 2007; Trkman 2010	Team working	24
10	Neely *et al.* 2000; Teymori, Aliakbari, 2009; Trkman 2010	Innovation	25
11	Neely *et al.* 2000; Delgado *et al.* 2014	Internal customer satisfaction	26–29
12	Delgado *et al.* 2014, Teymori, Aliakbari 2009; Reijers, Mansar 2005; Temponi, Harris 1998; Zarandi 2011	Saving time	30
13	Zarandi 2011; Afrazeh 2011	Capital knowledge	31–33
14	Delgado *et al.* 2014; Zarandi 2011; Teymori, Aliakbari 2009; Bourne 2000; Temponi, Harris 1998; Trkman 2010	Profitability	34–35
15	Delgado *et al.* 2014; Reijers, Mansar 2005; Mansar, Reijers 2007; Trkman 2010; Zarandi 2011; Temponi, Harris 1998	Saving money	36–37
16	Wu 2009	Senior management satisfaction	38–39
17	Zarandi 2011; Mansar, Reijers 2007	Senior management support	40–41
18	Delgado *et al.* 2014	User friendly	42–43
19	Delgado *et al.* 2014; Spremic, Zmirak 2008; Mansar, Reijers 2007; Maull 2003	Maturity	44–45
20	Delgado *et al.* 2014; Mansar, Reijers 2007	Self control	46–47
21	Delgado *et al.* 2014; Mansar, Reijers 2007	Contribution	48–50
22	Delgado *et al.* 2014; Trkman 2010	Competition	51
23	Kennerley, Neely 2002; Delgado *et al.* 2014; Mombeini *et al.* 2014	Software and hardware performance	52–54
24	Delgado *et al.* 2014; Teymori, Aliakbari 2009; Susniene, Purvinis 2015	Reliability	55–56

End of Table 1

No	References	Process indicators	Corresponding questions in the questionnaire
25	Spremic, Zmirak 2008	Transparency	57–58
26	Zarandi 2011; Temponi, Harris 1998	Training courses and continuous	59–60
27	Zarandi 2011; Delgado *et al.* 2014; Teymori, Aliakbari 2009; Reijers, Mansar 2005; Temponi, Harris 1998	Acceleration process	61
28	Delgado *et al.* 2014; Trkman 2010	Adaptation	62
29	Delgado *et al.* 2014, Trkman 2010; Bourne 2000; Reijers, Mansar 2005; Azizi *et al.* 2014	Customer satisfaction	63–65
30	Delgado *et al.* 2014; Trkman 2010	Feedback and monitoring	66–67

2. An approach for evaluating BPM and BPR by fuzzy inference system

2.1. Exploratory factor analysis results

Descriptive and inferential statistics. In the present study, the techniques of descriptive statistics including frequency tables, the analyzed data related to demographics, Cronbach's alpha formula and factor analysis are used to investigate the problem under consideration. Some descriptive statics are presented as follows:

– The most frequent ages are between 36–45 years old.
– Levels of education contain of 37.3% college graduate, 61.4% postgraduate, and 1.2% PhD.
– Statistical society comprises of 69.9% expert, 12% deputy director, 4.8% head of department, 4.8% senior management, and 8.4% other positions.
– The highest frequency is related to working experience between 11 and 20 years.
– The rate of gender of respondents is 79.5% male and 20.5% female.

Reliability. The designed questionnaire was distributed among 95 experts in the field of processes reengineering and 83 questionnaires were returned (the return rate is 83%). The reliability of the questionnaire was evaluated and the results are presented in Table 2. The total Cronbach's alpha number for this questionnaire was equal to 0.963, which is a suitable amount for this study.

Validity. Exploratory factor analysis method was employed to ensure the validity of the questionnaires. Generally, it can be said that the exploratory factor analysis pursues three goals (Anderson, Gerbing 1988):

– Data reduction,
– Structure detection,
– Divergent validity.

The results based on the factor analysis show that the Kaiser-Meyer-Olkin (KMO) index is greater than 0.5. This shows that the number of samples is sufficient for factor analysis (Field 2000).

Table 2. Cronbach's alpha indicators

Cronbach's Alpha	Variable	No of items
0.724	Integration	2
0.884	Security	10
0.508	Collectivity	2
0.821	Risk management	4
0.875	Centralization	2
0.851	Internal customer satisfaction	4
0.895	Capital knowledge	3
0.84	Profitability	2
0.504	Saving money	2
0.685	Senior management satisfaction	2
0.794	Senior management support	2
0.834	User friendly	2
0.749	Maturity	2
0.793	Self control	2
0.809	Contribution	2
0.865	Software and hardware performance	2
0.682	Reliability	2
0.827	Transparency	2
0.793	Training courses and continuous	2
0.81	Customer satisfaction	3
0.934	Feedback and monitoring	2
0.963	All	67

The parameters are grouped according to the results of the confirmatory factor analysis. The average indicator for the 67 questions was related to 30 main indicators. The KMO values are calculated for 30 indicators that are shown in Table 3.

Table 3. KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.791
Bartlett's Test of Sphericity	Approx. Chi-Square	1277.329
	df	435
	Sig.	0.000

The value of 0.791 for the KMO indicator is a confirmation for adequacy of accomplishing a factor analysis method. Then, the numbers of factors are determined. As seen in Table 4, only 5 factors have the special values more than one. These 5 factors together explain 70% of variability and show that they are qualified to be selected.

Each parameter is allocated to these 5 factors by the use of the factor matrix or rotated factor matrix in Table 5.

Table 4. 30 indicators of factor analysis

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	12.615	42.051	42.051	12.615	42.051	42.051	5.134	17.114	17.114
2	2.398	7.995	50.046	2.398	7.995	50.046	4.792	15.972	33.086
3	2.161	7.203	57.249	2.161	7.203	57.249	4.411	14.704	47.790
4	1.540	5.132	62.381	1.540	5.132	62.381	4.196	13.987	61.777
5	1.363	4.544	66.924	1.363	4.544	66.924	1.544	5.148	66.924
6	0.998	3.816	70.741						
7	0.980	3.266	74.007						
8	0.896	2.988	76.995						
9	0.791	2.636	79.630						
10	0.708	2.360	81.990						
11	0.653	2.177	84.167						
12	0.633	2.109	86.276						
13	0.495	1.649	87.925						
14	0.469	1.564	89.489						
15	0.408	1.360	90.849						
16	0.394	1.314	92.163						
17	0.365	1.218	93.381						
18	0.284	0.948	94.329						
19	0.269	0.898	95.226						
20	0.255	0.848	96.075						
21	0.225	0.750	96.825						
22	0.186	0.621	97.446						
23	0.175	0.585	98.030						
24	0.135	0.451	98.481						
25	0.126	0.420	98.901						
26	0.105	0.351	99.252						
27	0.079	0.263	99.515						
28	0.059	0.196	99.712						
29	0.047	0.158	99.870						
30	0.039	0.130	100.000						

Table 5. Factor rotation for 30 indicators

	Component				
	1	2	3	4	5
var1	–0.123	0.450	0.550	0.375	–0.064
var2	0.302	0.259	0.658	–0.041	–0.060
var3	–0.016	0.786	0.152	0.090	–0.059
var4	0.100	0.083	0.786	0.323	0.128
var5	0.296	0.281	0.649	0.202	–0.224
var6	0.147	0.606	0.491	0.231	–0.075
var7	0.015	0.215	0.229	0.279	–0.681
var8	0.072	0.174	0.749	0.213	–0.048
var9	–0.006	–0.012	0.066	0.762	–0.313
var10	0.115	0.049	0.451	0.680	0.012
var11	0.335	0.232	0.206	0.625	0.164
var12	0.220	0.689	0.095	0.277	–0.197
var13	0.284	0.223	0.217	0.797	–0.113
var14	0.053	0.509	0.149	0.413	0.604
var15	0.293	0.645	0.226	0.176	0.053
var16	0.413	0.233	0.210	0.580	0.173
var17	0.511	0.249	0.616	0.187	0.044
var18	0.299	0.707	0.186	0.073	0.076
var19	0.424	0.241	0.071	0.568	0.127
var20	0.340	0.482	0.452	–0.033	0.159
var21	0.596	0.161	0.233	0.440	0.017
var22	0.407	–0.063	0.355	0.388	0.404
var23	0.666	0.291	0.336	0.133	0.064
var24	0.458	0.643	0.160	0.016	0.014
var25	0.614	0.467	0.215	0.159	–0.178
var26	0.610	0.116	0.044	0.427	0.045
var27	0.873	0.069	–0.014	0.157	–0.098
var28	0.524	0.345	0.328	0.199	0.200
var29	0.578	0.512	0.135	–0.011	0.339
var30	0.670	0.256	0.470	0.202	0.060

Based on the exploratory factor analysis and the rotation factor loadings, 30 indicators were classified into 5 groups, as described in Table 6.

Finally, after accomplishing the exploratory factor analysis, based on the experts' opinion, the following factors have been selected as the representation of those 30 indicators and the obtained average weights are shown in Table 7:

- Time,
- Reliability,
- Flexibility,
- Human Factor,
- Profitability.

Table 6. The table of the business process with average indicators

Factor 1	2.922	3.075	3.164	2.865	2.623	2.793	3.1	2.951	2.969	2.924
	Accelerate the process	Feedback and monitoring	Software and hardware performance	Transparency	Training courses and continuous	Contribution	Customer satisfaction	Adaptation	Senior management support	Competition
Factor 2	3.243	2.914	3.086	2.774	3.176	3.115	3.085			
	Security	User friendly	Saving time	Saving money	Reliability	Risk reduction	Self-control			
Factor3	2.986	3.182	3.026	3.12	3.222					
	Agility	Bureaucratic formality	Flexibility	Collectivity	Integration					
Factor4	2.877	2.812	2.839	2.739	2.853	2.746	2.762			
	Knowledge capital	Team working	Innovation	Employee satisfaction	Senior management satisfaction	Maturity	Centralization			
Factor5	2.913									
	Profitability									

Table 7. Final average weight

Factor	Time (T)	Reliability (R)	Flexibility (F)	Human (H)	Profitability (P)
Mean Number	2.9381	3.0523	3.1146	2.8063	2.9135

2.2. Fuzzy Inference System is designed for system measurement

Generally, the fuzzification takes place in the first phase of fuzzy systems by membership functions; so that, the input indicators are converted to linguistic variables. Then, using fuzzy rules, the fuzzy input is converted to the fuzzy output, which is done by the inference engine. Then in the final stage, the output of the fuzzy inference engine is defuzzified by using a defuzzification process. These steps are depicted in Figure 2.

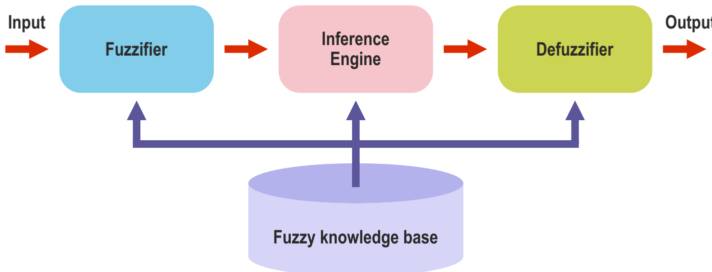

Fig. 2. Overview of the fuzzy systems

Fuzzy sets and membership functions are defined to design a fuzzy inference system. Since the main five factors time, reliability, flexibility, human and profitability, which are the most effective factors on business process, were identified as the five factors of fuzzy set for the implementation of the process of the business evaluation. In order to construct the fuzzy model, the input and output parameters using membership functions are defined and then the fuzzy rules are written. At last, the output values were produced by using centroid defuzzification method.

The overview of the fuzzy inference system is shown in Figure 3. The left side graph shows the membership function of the fuzzy sets that is used as the input of the fuzzy inference system. The middle graph represents the inference rules that derive the system and convert the inputs into outputs. The right side graph represents the evaluation process of the organization. In this paper, MATLAB software package (2011 version) is used to analyze and design the fuzzy inference system.

In the following section, the membership functions of the fuzzy sets are described. There are three ways to select the membership functions (Zarandi 2010):

- Ask an expert about fitting of the sample with membership function.
- Using curve-fitting method for determining the best compliance with the selected sample and selecting the membership functions such as triangular functions, trapezoidal, bell or etc.
- Using techniques of fuzzy and neural-fuzzy network for creating and optimizing the parametric membership functions.

In this paper, the experts' opinion is applied to select the type of membership function. According to the experts' opinion, the triangular membership function is adopted. For achieving the aim, three linguistic terms including low (L), medium (M) and high (H) for each of the membership functions are defined. Table 8 represents how to use these linguistic variables.

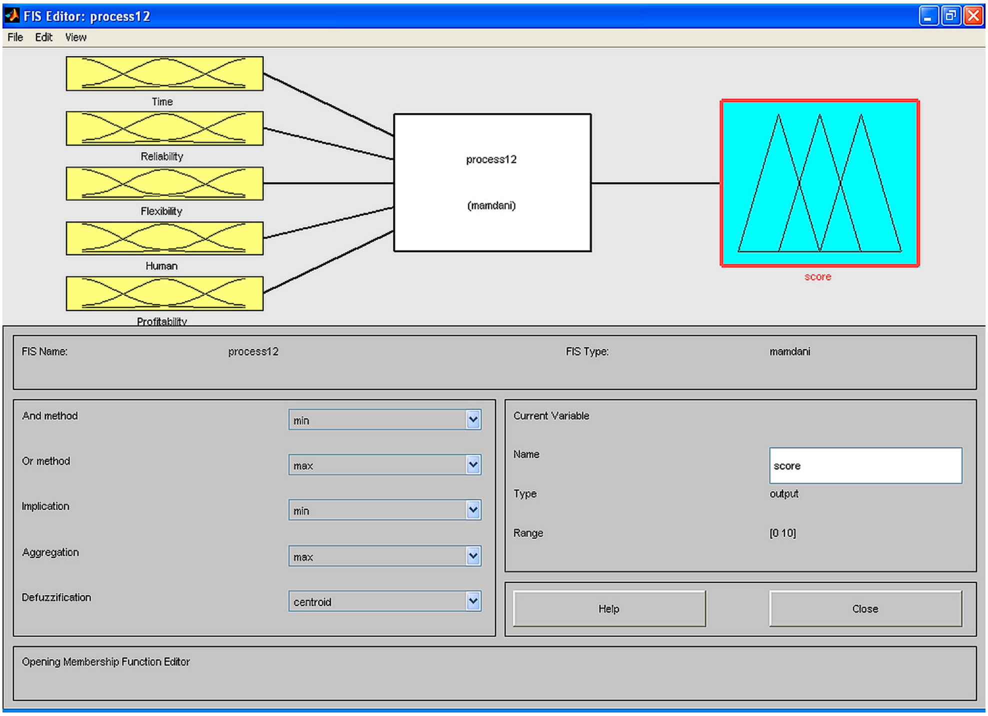

Fig. 3. Input and output of the fuzzy inference system engine

Table 8. Triangular membership function

TFN	Linguistic variable
(0,3,5)	Low
(3,5,7)	Average
(5,7,10)	high

Figure 4 graphically shows the membership functions defined for input and output variables.

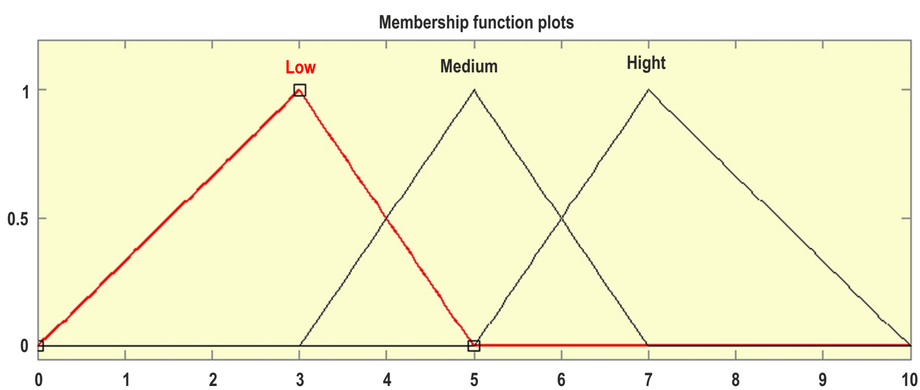

Fig. 4. Membership function of the input and output variables

Each of the variables of the fuzzy set is defined between 1 and 10. Each of the numbers in the range of functions is between zero and one. As above-mentioned, the functions are individually designed and used for each of the input and output parameters.

2.3. Fuzzy inference system rules definition

Then, it is necessary to define fuzzy inference rules to design the fuzzy inference system. Fuzzy inference rules are defined in the form of the IF – THEN rules. These rules show the relation between fuzzy sets and the effectiveness of each of them on the final rating measurement process. In other words, the input data are converted to output data by the use of these rules. To generate the rules, the first questionnaire is designed to define the relationship between input and output components. As well as, the weighting factors for indicators are allocated to obtain the calculated average (final weight of each factor over the total weight of the factors). It should be noted that the upper weight of each variable is applied to calculate the weight of each linguistic variable. In accordance to the adopted factors, each linguistic variable has a different weight as mentioned in Table 9.

Table 9. Final weight and factors normal number

	T	R	F	H	P	Total
Factor	Time	Reliability	Flexibility	Human	Profitability	
Average number	2.9381	3.0523	3.1146	2.8063	2.9135	14.8248
Normal number	0.198189	0.205893	0.210090	0.189296	0.196533	1

The weight of each factor is multiplied with the upper bound of each linguistic variable to obtain the rules. The following example is provided to clarify the matter.

The relative weight of T is considered between zero and one. Regarding to 3 terms of the linguistic variables, the first step should be determining the weight of T in low, medium and high intervals. This process is repeated for the next 4 factors.

Finally, the results of the different combinations of these 5 factors are concluded. For example, when the T is low, the R is medium, the F is low, the H is medium and the P is high, the output value is M.

A number of the rules were defined according to the determined levels in order to define the fuzzy rules. Then, by using the current data, some rules were set to calculate the output for the determined input. In other words, a matrix for each of the factors is needed that is resulted from multiplying the linguistic values with the weight of each factor in order to create the fuzzy rules. According to the five final inputs and three linguistic variables, the number of all possible rules is (3 *3 * 3 * 3 * 3) = 243. Some fuzzy rules are shown in Table 10.

This table is applied to calculate an output level for each input combination. In this step, fuzzy logic toolbox in MATLAB software is used to define fuzzy inference rules. The AND operator was used to define rules due to the fact that there is reasonable and appropriate level of co-expression at the same time. Figure 5 shows fuzzy logic toolbox rules that the output is based on the input combinations in Table 10.

Table 10. Making rules based on factors

Role	The weight of each factor * Fuzzy number					Time	Reliability	Flexibility	Human	Profitability	Total	Output
1	0.06606	0.06863	0.07003	0.06310	0.06551	Low	Low	Low	Low	Low	0.33333	Low
2	0.06606	0.06863	0.07003	0.06310	0.13102	Low	Low	Low	Low	Medium	0.39884	Medium
3	0.06606	0.06863	0.07003	0.12620	0.06551	Low	Low	Low	Medium	Low	0.39643	Medium
4	0.06606	0.06863	0.07003	0.06310	0.19653	Low	Low	Low	Low	High	0.46436	Medium
5	0.06606	0.06863	0.07003	0.18930	0.06551	Low	Low	Low	High	Low	0.45953	Medium
6	0.06606	0.06863	0.07003	0.12620	0.19653	Low	Low	Low	Medium	High	0.52745	Medium
7	0.06606	0.06863	0.07003	0.18930	0.13102	Low	Low	Low	High	Medium	0.52504	Medium
8	0.06606	0.06863	0.07003	0.12620	0.13102	Low	Low	Low	Medium	Medium	0.46194	Medium
9	0.06606	0.06863	0.07003	0.18930	0.19653	Low	Low	Low	High	High	0.59055	Medium
10	0.06606	0.06863	0.14006	0.06310	0.06551	Low	Low	Medium	Low	Low	0.40336	Medium
11	0.06606	0.06863	0.14006	0.06310	0.13102	Low	Low	Medium	Low	Medium	0.46887	Medium
12	0.06606	0.06863	0.14006	0.12620	0.06551	Low	Low	Medium	Medium	Low	0.46646	Medium
13	0.06606	0.06863	0.14006	0.06310	0.19653	Low	Low	Medium	Low	High	0.53439	Medium
14	0.06606	0.06863	0.14006	0.18930	0.06551	Low	Low	Medium	High	Low	0.52956	Medium
15	0.06606	0.06863	0.14006	0.12620	0.19653	Low	Low	Medium	Medium	High	0.59748	Medium
16	0.06606	0.06863	0.14006	0.18930	0.13102	Low	Low	Medium	High	Medium	0.59507	Medium
17	0.06606	0.06863	0.14006	0.12620	0.13102	Low	Low	Medium	Medium	Medium	0.53197	Medium
18	0.06606	0.06863	0.14006	0.18930	0.19653	Low	Low	Medium	High	High	0.66058	Medium
19	0.06606	0.06863	0.21009	0.06310	0.06551	Low	Low	High	Low	Low	0.47339	Medium
20	0.06606	0.06863	0.21009	0.06310	0.13102	Low	Low	High	Low	Medium	0.53890	Medium
21	0.06606	0.06863	0.21009	0.12620	0.06551	Low	Low	High	Medium	Low	0.53649	Medium
22	0.06606	0.06863	0.21009	0.06310	0.19653	Low	Low	High	Low	High	0.60441	Medium
23	0.06606	0.06863	0.21009	0.18930	0.06551	Low	Low	High	High	Low	0.59959	Medium
24	0.06606	0.06863	0.21009	0.12620	0.19653	Low	Low	High	Medium	High	0.66751	High
25	0.06606	0.06863	0.21009	0.18930	0.13102	Low	Low	High	High	Medium	0.66510	Medium
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
217	0.19819	0.20589	0.07003	0.06310	0.06551	High	High	Low	Low	Low	0.60272	Medium
218	0.19819	0.20589	0.07003	0.06310	0.13102	High	High	Low	Low	Medium	0.66823	High
219	0.19819	0.20589	0.07003	0.12620	0.06551	High	High	Low	Medium	Low	0.66582	Medium
220	0.19819	0.20589	0.07003	0.06310	0.19653	High	High	Low	Low	High	0.73374	High
221	0.19819	0.20589	0.07003	0.18930	0.06551	High	High	Low	High	Low	0.72892	High
222	0.19819	0.20589	0.07003	0.12620	0.19653	High	High	Low	Medium	High	0.79684	High
223	0.19819	0.20589	0.07003	0.18930	0.13102	High	High	Low	High	Medium	0.79443	High
224	0.19819	0.20589	0.07003	0.12620	0.13102	High	High	Low	Medium	Medium	0.73133	High
225	0.19819	0.20589	0.07003	0.18930	0.19653	High	High	Low	High	High	0.85994	High
226	0.19819	0.20589	0.14006	0.06310	0.06551	High	High	Medium	Low	Low	0.67275	High
227	0.19819	0.20589	0.14006	0.06310	0.13102	High	High	Medium	Low	Medium	0.73826	High
228	0.19819	0.20589	0.14006	0.12620	0.06551	High	High	Medium	Medium	Low	0.73585	High
229	0.19819	0.20589	0.14006	0.06310	0.19653	High	High	Medium	Low	High	0.80377	High
230	0.19819	0.20589	0.14006	0.18930	0.06551	High	High	Medium	High	Low	0.79895	High
231	0.19819	0.20589	0.14006	0.12620	0.19653	High	High	Medium	Medium	High	0.86687	High
232	0.19819	0.20589	0.14006	0.18930	0.13102	High	High	Medium	High	Medium	0.86446	High
233	0.19819	0.20589	0.14006	0.12620	0.13102	High	High	Medium	Medium	Medium	0.80136	High
234	0.19819	0.20589	0.14006	0.18930	0.19653	High	High	Medium	High	High	0.92997	High
235	0.19819	0.20589	0.21009	0.06310	0.06551	High	High	High	Low	Low	0.74278	High
236	0.19819	0.20589	0.21009	0.06310	0.13102	High	High	High	Low	Medium	0.80829	High
237	0.19819	0.20589	0.21009	0.12620	0.06551	High	High	High	Medium	Low	0.80588	High
238	0.19819	0.20589	0.21009	0.06310	0.19653	High	High	High	Low	High	0.87380	High
239	0.19819	0.20589	0.21009	0.18930	0.06551	High	High	High	High	Low	0.86898	High
240	0.19819	0.20589	0.21009	0.12620	0.19653	High	High	High	Medium	High	0.93690	High
241	0.19819	0.20589	0.21009	0.18930	0.13102	High	High	High	High	Medium	0.93449	High
242	0.19819	0.20589	0.21009	0.12620	0.13102	High	High	High	Medium	Medium	0.87139	High
243	0.19819	0.20589	0.21009	0.18930	0.19653	High	High	High	High	High	1	High

For example, this condition is assigned to the first fuzzy rule: "IF time factor in the implementation is low, reliability is low, flexibility is low, human factor is low and profitability is low, THEN the success evaluation of the business process is low".

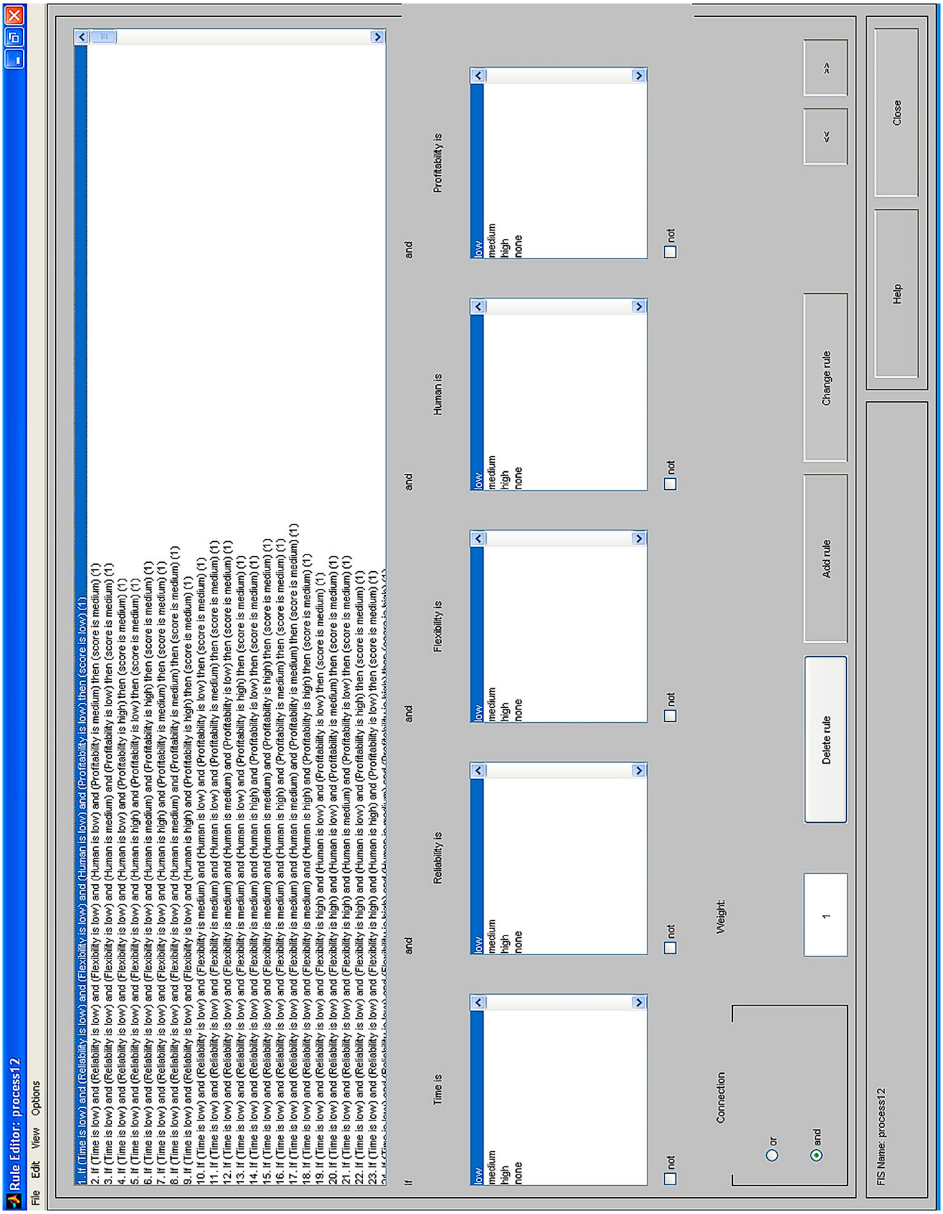

Fig. 5. Part of the fuzzy rules definition of fuzzy inference systems in MATLAB

3. Designing the business process for payment system (Case Study)

The second questionnaire (with the same question from the first questionnaire) which is designed to scoring the business process in the area of payment systems was distributed among experts. We asked the expert team to assign a score between one and ten based on each indicator for each of the business processes. Then, the weight of the five main factors was calculated.

It should be noted that the Interbank Information Transfer Network (IITN) system is an electronic banking clearance and automated payments system used in Iran (Named SHETAB). The SHETAB system was introduced in 2002 with the intention of creating a uniform backbone for the Iranian banking system to handle ATM, POS and other card-based transactions.

The primary business process is shown in Figure 6. It is improved and shown in Figure 7 and the reengineering is shown in Figure 9. Designing the processes is done by the use of Visual Paradigm software that supports Business Process Model and Notation (BPMN). The main goal is to reduce delays and prevent organizations from paying additional costs. Also, the goal is to divide the primary activity into simpler activities to combine the two consecutive operations and to eliminate the couple loops and cycles (Zarandi 2011).

The improved business process, in which the role of information technology and information sending via internet is emphasized, is depicted in Figure 7. The business process reengineering, as shown in Figure 9, illustrates how to eliminate the customers' presence in order to reduce the duration of the business process from 2 days to 3 hours. It should be noted that when there is a discrepancy in IITN, the problem is resolved within 2 working days.

Each of the other indicators is in interaction with business process and experts' opinions are reflected through questionnaires in the fuzzy system.

3.1. Analysis of the first business process

The first business process in Figure 7 is actually the reformed version of the previous business process in Figure 6.

Based on Figure 7, the results of the business process evaluation are shown in Table 11. The input function domain, a number between 0 and 10, is the system input.

Table 11. Weights of the reformed business process factors

Factor	weight
Time	4.56
Reliability	5.15
Flexibility	3.48
Human	5.16
Profitability	6.17

After calculating the factors weight and inserting them in MATLAB software, the score of the reformed business process can be obtained. The weights of the five factors in fuzzy logic toolbox of MATLAB software can be seen in Figure 8. Each of the lines in the figure shows a rule and each column is related to an input variable which is shown on the left side. The value of the output variable is shown on the right side. The red vertical lines can be used to set the input.

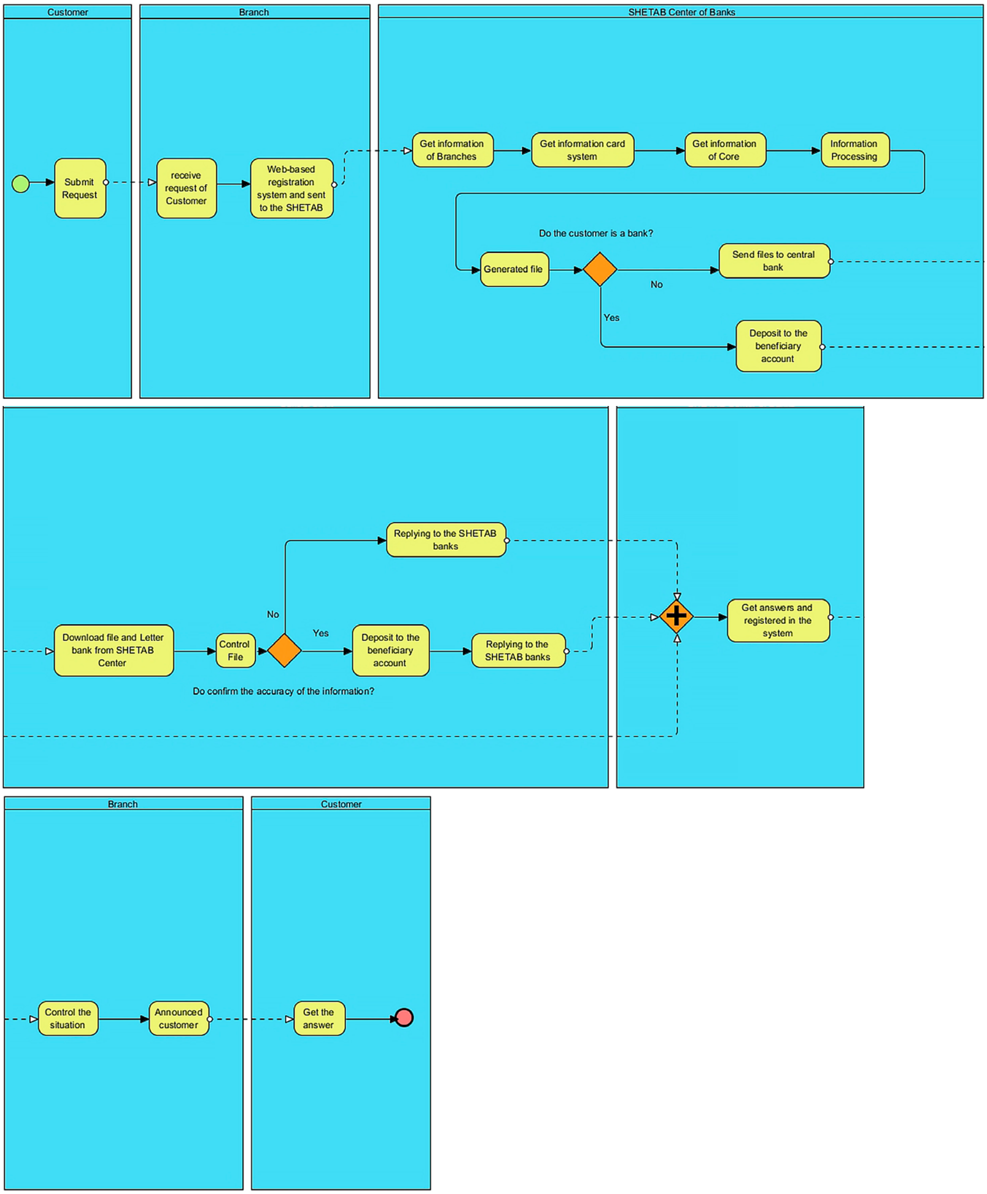

Fig. 6. The primary IITN (SHETAB) business process

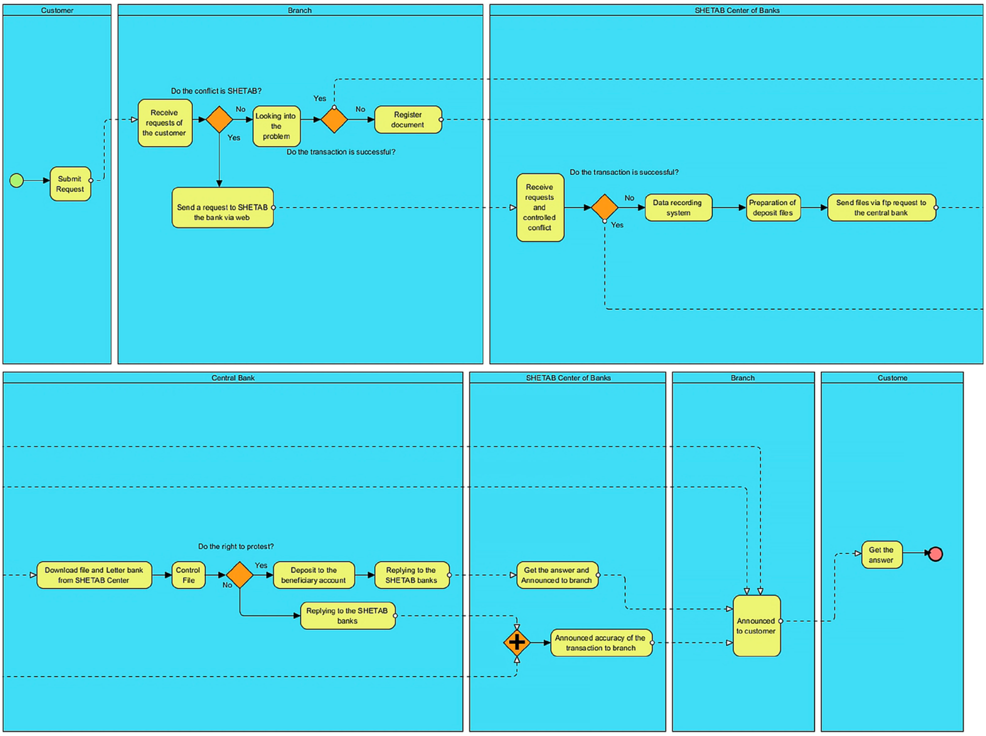

Fig. 7. The improved IITN (SHETAB) business process

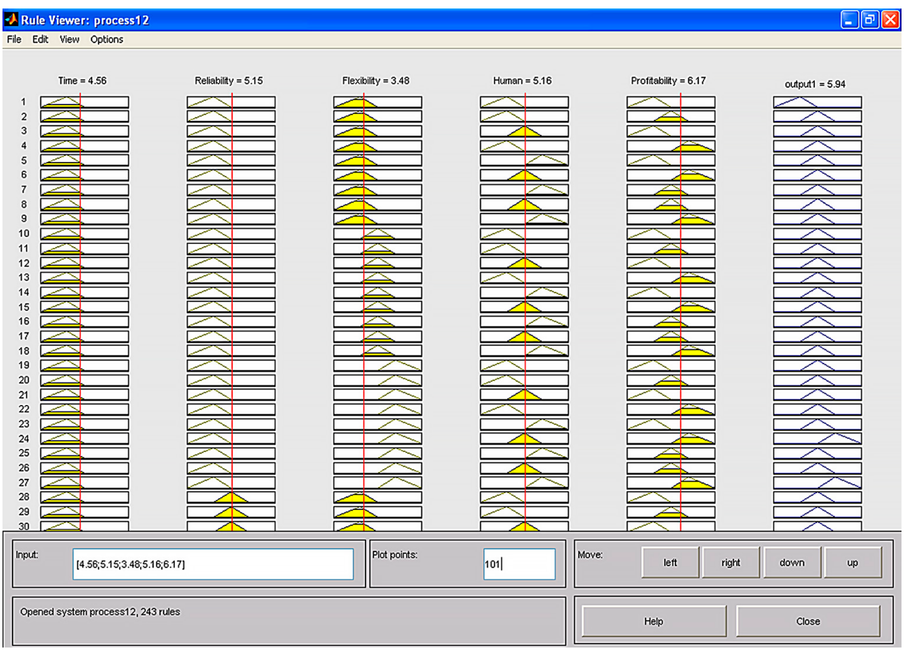

Fig. 8. Final score of IITN in the reformed business process

Finally, the software reflects the final score of the output variable. The software examines the fuzzy inference rules after receiving the input. Then, it determines the output level by finding the related rule. The output should be defuzzified to show the system score in the form of a crisp number. The centroid method is used for the defuzzification process. The centroid point is the area that its right and left surface under the arc are the same. It is automatically determined by the software.

As shown in Figure 8, the value of 5.94 is obtained as the first business process scoring by entering the weight of the business factors as inputs of fuzzy inference system.

3.2. Analysis of the second business process

The designed business reengineering process can be seen in Figure 9.

The results of the second questionnaire of business reengineering process (Fig. 9) can be seen in Table 12.

It's time to calculate the IITN business reengineering process score by entering the results in MATLAB software. The results can be seen in Figure 10.

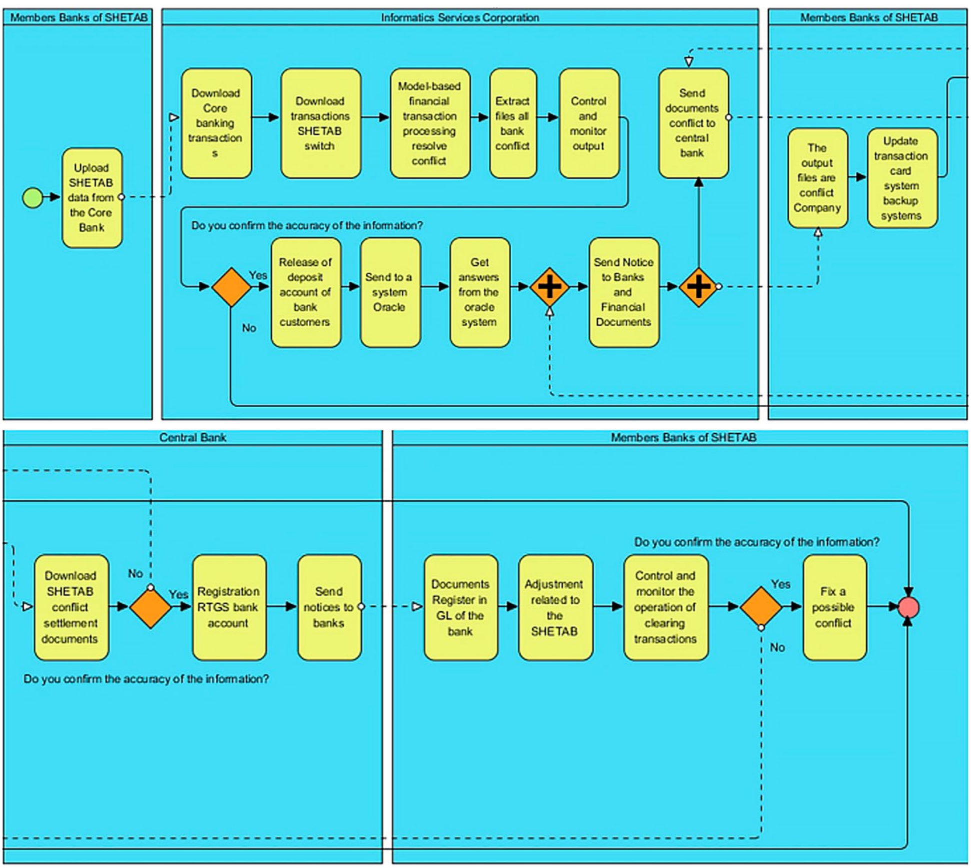

Fig. 9. IITN (SHETAB) Reengineering

Table 12. Weights of the reengineering business process factors

Factor	weight
Time	6.46
Reliability	8.16
Flexibility	7.18
Human	7.29
Profitability	6.68

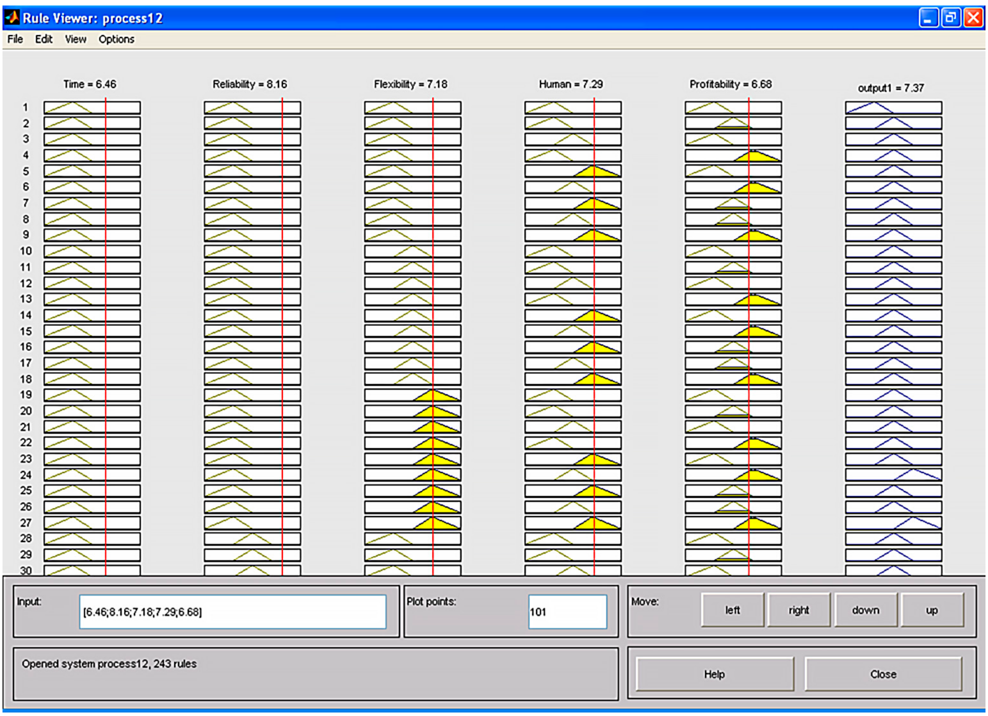

Fig. 10. Final reengineering score

As seen in Figure 10, the value of 7.37 is obtained as the second business process scoring by entering the weight of the IITN business reengineering process factors as the inputs of fuzzy inference system.

Table 13. Final score of business process

Process	Final score
Modified	5.94
Reengineering	7.37

It can be seen in Table 13 that business reengineering process score is higher.

Conclusions

The present study has the following results and advantages in comparison to the previous studies:

- Providing a useful system to enable organizations to reach success by entering their own input indicators.
- The collected indicators that are effective in business process selection are more comprehensive than the indicators in previous studies.
- Previous studies were forced to eliminate some of the indicators, but in this study – because of its approach – there was no need to eliminate any indicator.
- The fuzzy approach and fuzzy inference system that are used to score the business processes are more useful approaches for obtaining the better results.
- Fuzzy logic approach increases the reliability of the business process evaluation and prevents the organizations from paying additional costs.
- Because of using experts' opinion and determined indicators, this approach can be used in all generative and service-provided organizations.

Therefore, organizations should evaluate their own designed processes in banking payment systems by using the five factors in order to be successful.

According to the results of the present study, the following recommendations seem necessary for future research:

- The weight of each indicator in non-linear form in addition to the selected and codified indicators helps to the clarification of the business process score.
- Using a larger Statistical population and examining more banks and organizations helps to the system be comprehensively evaluated.
- The results of the present study should be evaluated by a wider community of experts and, if possible, at the international level.
- We need intelligent systems and a combination of fuzzy logics and neural networks to optimize the system. If it is done, the system will provide us with the best business processes.
- The organizations can localize the main factors in their own business processes by using exploratory factor analysis and fuzzy logic methods.

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