

## Evaluation of Corporate Social Responsibility using Fuzzy Expert System

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**Abstract:** This study aims to evaluate the score of corporate social responsibility for the part-making companies of East Azerbaijan in Iran. The number of part-making companies is 170 in this province where 50 companies are chosen randomly. For gathering data, a questionnaire with 24 questions is developed based on the viewpoint of Carroll and colleagues and the validity and reliability of this questionnaire is tested and approved. A model is designed for evaluating the score of social responsibility based on fuzzy logic. This model involves five stages. First, a fuzzy system is designed. In the second stage, inputs and output are converted to fuzzy number. Then, inference rules are explained. In the fourth stage, defuzzification is done and the model is tested in the fifth stage. The results indicate that the score of social responsibility is in average level for companies under study.

**Keywords:** Corporate social responsibility, fuzzy expert system, fuzzy set theory

### INTRODUCTION

In recent years, Corporate Social Responsibility (CSR) is appears to be a subject of increasing interest amongst academics and practitioners. Based on the philosophy and policy of SCR, organizations have wider responsibilities beyond commerce (Henderson, 2007). The social responsibility has become popular concepts (Steurer and Konrad, 2009). Organizations are invented of individuals whose values, goals and principles often clash with the inflexibility set in laws and organizational structures that lead the operation of organizations.

The theory of CSR is broader than simple compliance with law. CSR history is combined with laws which abuse of women, permitted slavery discrimination, children and workers. It has been contested on ethical, moral, human rights and accountability. CSR frequently associated with promises of moral and communally responsibility conducted to businesses. The scope of CSR is increasingly being broadened (Sikka, 2010). CSR include the legal, economic, ethical and philanthropic expectations placed on organizations by society at a given point in time. CSR is corporate missions and its value statements. Recently, organizations realize that their reputation and long-term success rely on their purchasing actions and supply chain management (Cruz and Wakolbinger, 2008).

Porter and Kramer (2006) stated that the existing approaches to CSR are so disconnected from business strategies as to difficult to understand. Organizations analyze their prediction for social responsibility using the same frameworks that guide their core business choices. Organizations find out that CSR can be a

source of competitive advantage. Porter and Kramer (2006) view is not against society so that one cannot put CSR in generic ways instead of in the way most appropriate to each firm's strategy (Tsai *et al.*, 2010). Recent literatures have focused on CSR as an essential mater in attracting the attention of society and customer satisfaction. Therefore, organizations should assess the conformance for performance of their corporate with CSR inspective. The CSR components including "economic, legal, ethical and philanthropic responsibilities" can be viewed as a process which managers identify interests of those affected by their organization's actions (Ibid, 386).

This study seeks to evaluate the score of corporate social responsibility using fuzzy expert system. The next section addresses a review of literature related to corporate social responsibility. In the other Section, research methodology is explained. Finally, the obtained conclusions are discussed in the last section.

**Corporate Social Responsibility (CSR):** The concept of Corporate Social Responsibility (CSR) has been in subsistence since the 1950s, proliferating in the 1970s (Golob and Bartlett, 2007) Definitions of social responsibility typically evolves ethical behavior. For instance, Watts and Holme (1999) argue that:

"Corporate social responsibility is the continuing commitment by business to behave ethically and contribute to economic development while improving the quality of life of the workforce and their families as well as of the local community and society at large" Linthicum *et al.* (2010).

CSR philosophy also discuss on corporate citizenship and sustainable development. "Being good corporate citizens' means corporations need to fulfill

their social roles and deal with social problems that governments have failed to solve. It entails a shift in business organizations' social involvement from a passive response to social pressure to a proactive engagement in social issues and a belief that such engagement is an inherent duty of business organizations as citizens of society" (Tang and Li, 2009).

Holmqvis (2009) argue that they aim to respond to the demands by all the more interest of employees, suppliers, dealers, local communities and even nations the content of CSR has expanded, from relatively narrow concerns of obvious importance to the broad of corporation. Holmqvis also discuss that problems like urban decay, pollution, racial discrimination, poverty and community welfare could be solved by CSR. "CSR is commonly defined as actions that aim to social betterment CSR are today a concept that captures the attention by corporations to a broad range of experienced problems in their environments. The very notion corporate social responsibility implies that the corporation "cares" and wants to do good things" (Holmqvist, 2009). Walker and Parent (2010) view about "CSR implies that businesses are responsible for assessing their wider impact on society and regardless of specific labeling; the concept has been applied to how managers should handle public policy and other social issues" (Walker and Parent, 2010).

Extensive researches have been carried out on CSR; some of them are as follows:

Taghizadeh and Zeinali Kermani (2011) investigated the application of artificial neural networks to recognize the relationship between companies' social responsibility and their financial performance. Goss and Roberts (2011) conducted a survey the impact of corporate social responsibility on the cost of bank loans. The results show Low-quality borrowers that engage in discretionary CSR spending face higher loan spreads and shorter maturities, but lenders are indifferent to CSR investments by high-quality borrowers. Hong and Rim (2010) investigate the influence of customer use of corporate websites: corporate social responsibility, trust and word-of-mouth communication. The research shows that customers' use of corporate websites on their perceptions positively related to company's corporate social responsibility and their trust in the company. Also the results show a close link between perception of corporate social responsibility and trust.

Panwar *et al.* (2010) highlighted a demographic examination of societal views regarding corporate social responsibility in the US forest products industry. The Results indicate that varying degrees of differences exist in different demographic categories (gender, education level, place of residence and age). These results have important implications for the US forest

products sector, especially as companies formulate their socio-environmental strategy and communication. Cruz (2009) studied the impact of corporate social responsibility in supply chain management: multi-criteria decision-making approach. The results show that social responsibility activities can potentially reduce transaction costs, risk and environmental impact. Sadler and Lloyd (2009) underscored Neo-liberalizing corporate social responsibility: A political economy of corporate citizenship. Cramer (2008) studied the Organizing corporate social responsibility in international product chains.

Levis (2006) studied the Adoption of corporate social responsibility codes by Multinational Companies (MNCs). In a competitive environment, MNCs' managers have no incentive to adopt codes that truly limit corporate externalities. Regulation by public authorities or at the industry level Provides better safeguards than regulation by the individual company itself. Werther and Chandler (2005) pointed out Strategic corporate social responsibility as global brand insurance. The results show the premiums for CSR brand insurance are paid by leaders who create an organization-wide commitment to CSR as a means of redefining profit maximization. By integrating a stakeholder perspective, management is best placed to optimize stockholder returns over the longer term.

In order to measure the sustainability of a company, Velde *et al.* (2005) used the Vigeo corporate social responsibility scores. Vigeo is an independent corporate social responsibility agency that screens European quoted companies on CSR. The scores of Vigeo contain information on five dimensions of corporate social responsibility:

- Human resources
- Environment
- Customers and suppliers
- Community and society
- Corporate governance

## MODELING ALGORITHM

Using the concepts of design for fuzzy systems, the modelling algorithm has been formulated in Fig. 1. As it is noticed in this figure, the algorithm consists of five main stages.

As it can be noticed in the algorithm, the process of modelling will end if the model error is in acceptable range after model testing, otherwise the previous stages should be revised and the necessary corrections should be applied. Each of these stages is explained below.

**First stage: system design:** In this stage, inputs and outputs are designed. Aspects of social responsibility are considered as inputs of system and the assigned

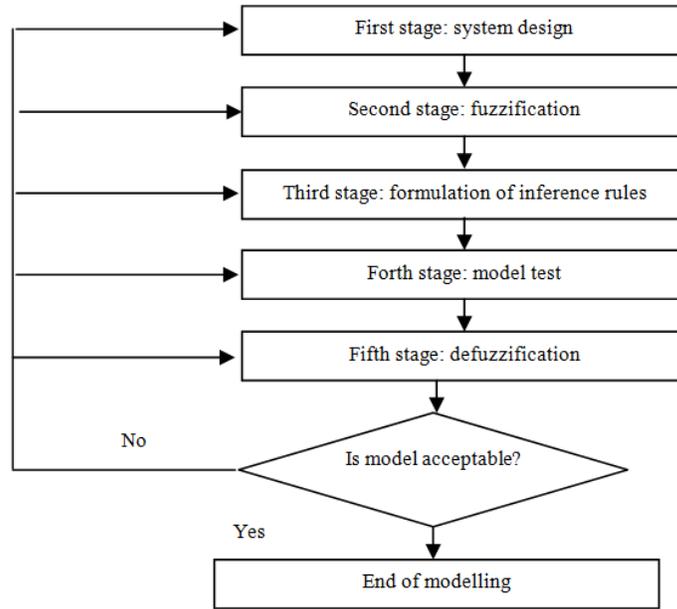


Fig. 1: Modelling algorithm

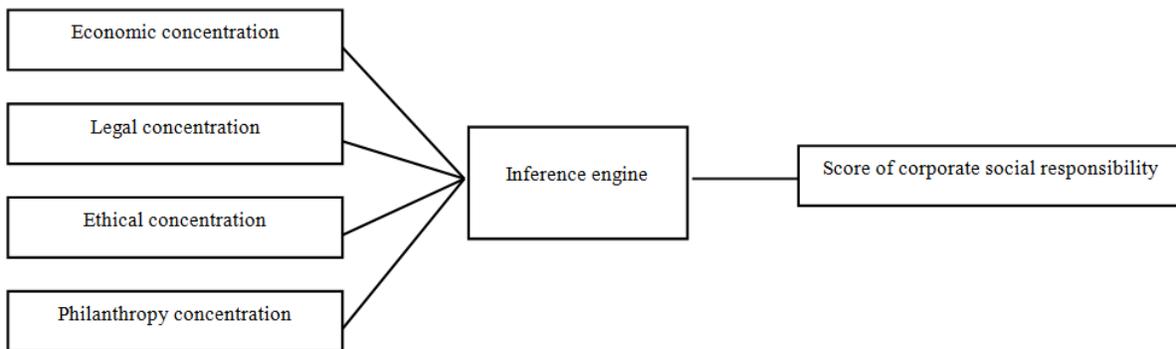


Fig. 2: Proposed system

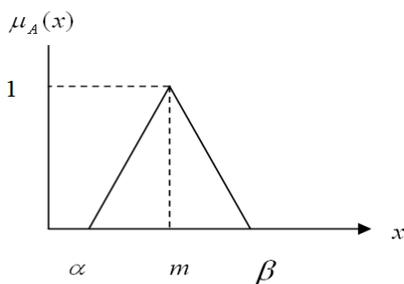


Fig. 3: Fuzzy numbers

score for corporate social responsibility is the only output. With reviewing the literature, the aspects of social responsibility by Carroll's viewpoint are used as the base of this research. Therefore, economic, legal, ethical and philanthropy aspects are the most suitable criteria for measuring the score of corporate social responsibility. Figure 2 indicates this system.

**Second stage: fuzzification:** In this stage, the linguistic terms are converted into fuzzy numbers. Triangular function is used for this purpose Eq. (1). Figure 3 represents the triangular numbers in  $(\alpha, \beta)$ . In this study, the triangular fuzzy numbers relevant to each linguistic term is indicated by  $(\alpha, m, \beta)$ . This stage is formed of two steps which are explained below:

$$\mu_A(x) = \begin{cases} \frac{x - \alpha}{m - \alpha} & \alpha < x < m \\ 1 & x = m \\ \frac{\beta - x}{\beta - m} & m < x < \beta \\ 0 & \text{others} \end{cases} \quad (1)$$

Equation 1: Triangular function

Table 1: Separation and equivalent number of each linguist terms

Fuzzy number ( $\alpha$ m $\beta$ )	Philanthropy variable	Ethical variable	Legal variable	Economic variable
(0, 0, 0.5)	Low	Low	Low	Low
(0, 0.5, 1)	Average	Average	Average	Average
(0.5, 1, 1)	High	High	High	High

Table 2: Linguistic terms of corporate social responsibility

Fuzzy number	Score
(0.00, 0.00, 0.25)	Very low
(0.00, 0.25, 0.50)	Low
(0.25, 0.50, 0.75)	Average
(0.50, 0.75, 1.00)	High
(0.75, 1.00, 1.00)	Very high

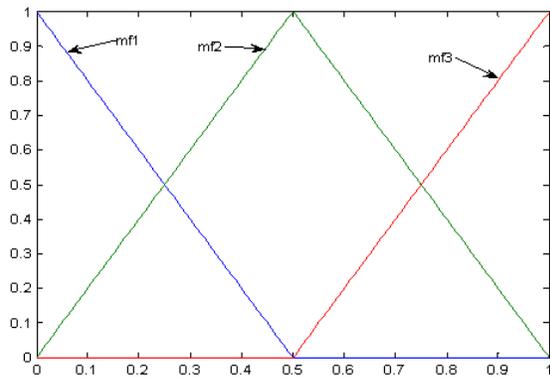


Fig. 4: Equivalent fuzzy numbers of each of input linguistic variables

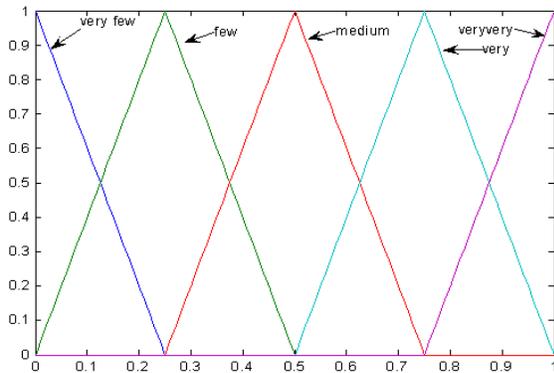


Fig. 5: The equivalent fuzzy number of each output linguistic term

**First step: fuzzification of input variables:** A scale of three choices with equal intervals has been utilized for fuzzification of economic, legal, ethical and philanthropy variables. Table 1 indicates the fuzzy numbers equivalent to the current criteria.

Each of linguistic terms can be shown by a diagram. Each input variable is separated by three linguistic terms and the equivalent fuzzy numbers for each of these terms are shown by Fig. 4.

**Second step: fuzzification of output variables:** The output for expert system is the assigned score for corporate social responsibility as mentioned before. The

equivalent fuzzy numbers for output linguistic terms are exhibited in Table 2 and Fig. 5.

**Third stage: formulation of inference rules:** Since there are four input variables separated with three linguistic terms, there will be 81 cases ( $3 \times 3 \times 3 \times 3$ ) ideally. In this stage, first rules are formulated with regard to literature review. Then, five experts are asked about these rules. These rules are corrected by comments of these experts. One of these rules is as follows:

"If economic aspect is considered highly in a corporate, concentration on legal aspect is low and concentration on ethical and philanthropy is in average, the score of social responsibility for mentioned corporate will be low."

**Forth stage: defuzzification:** Outputs of the previous stage are in the form of fuzzy numbers. It is required to convert fuzzy numbers into crisp numbers for simplifying the analysis. In other words, values for outputs become non-fuzzy. 'Center of Area' is one of the methods for defuzzification.

**Fifth stage: model test:** Error will be unavoidable in converting a conceptual model into application software. If the error is within an acceptable range, the model is also valid; otherwise, the model shall be corrected. For having the necessary assurance that the error is not out of the acceptable range, the model should be tested. Following methods can be used to test the mode:

- Test of the all rules
- Test of the behavior

**Test of the all rules:** Inputs of inference engine are inserted to expert system one by one. The inference engine will produce a related output for each input. The obtained output is compared with the expected output. The expected output is the one assumed to occur based on the rules formulated in the second stage. Errors for the differences of expected outputs and obtained outputs by software, which are considered as errors here. Sum of errors is 0.00296. Considering the experts' views (Expert people are who have scholarly views on inference engine), this error is evitable. Table 3 summarizes the calculations of errors for inference engine using this method.

Where 'SO' is the output of software and 'SO\*' is the expected score based on each rule.

Table 3: Summary of accuracy for inference engine of corporate social responsibility

Number of rule	SO*	SO	$\sqrt{(SO * - SO)^2}$
1	0	0.08	0.08
2	0	0.08	0.08
3	0.25	0.25	0
.	.	.	.
.	.	.	.
80	0.75	0.75	0
81	1	0.92	0.08
Total			0.0096

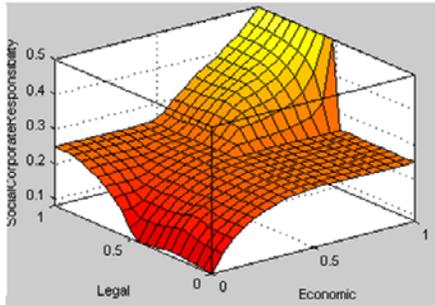


Fig. 6: Behavior of social responsibility in changing of economic and legal variables

**Behavior test:** Based on this method, the value of two input values are kept fixed and two other variables are changed. A score is computed for output variable in each change. The scores obtained for output variable in return for changing of two input variables form behavior. A diagram is drawn for the shape of this behavior; this diagram is approved according to the literature review and points of experts. This act is carried out for each group of inputs. The equivalent outputs are computed for combination by MATLAB Soft-ware. In addition to researchers of this study, the outputs have been analyzed by experts. These analyses confirm the validity of outputs. Figure 6 indicates the behavior of social responsibility in return for changing of economic and ethical variables and Fig. 6 indicates the behavior of social responsibility in return for changing of economic and logic variables.

**CASE STUDY**

In this section, the designed model is utilized for measuring the score of social responsibility for

Table 7: The summarized information for measuring economic aspect

Number of manager	Number of question						Fuzzy average
	1	2	3	4	5	6	
1	(0, 0.5, 1)	(0.5, 1, 1)	(0, 0, 0.5)	(0, 0.5, 1)	(0.5, 1, 1)	(0.5, 1, 1)	(0.25, 0.666, 0.916)
2	(0.5, 1, 1)	(0.5, 1, 1)	(0, 0, 0.5)	(0.5, 1, 1)	(0.5, 1, 1)	(0.5, 1, 1)	(0.5, 1, 1)
3	(0.5, 1, 1)	(0, 0.5, 1)	(0, 0, 0.5)	(0, 0.5, 1)	(0, 0.5, 1)	(0.5, 1, 1)	(0.167, 0.583, 0.916)
.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.
49	(0.5, 1, 1)	(0.5, 1, 1)	(0, 0.5, 1)	(0, 0, 0.5)	(0, 0, 0.5)	(0.5, 1, 1)	(0.25, 0.583, 0.833)
50	(0, 0.5, 1)	(0.5, 1, 1)	(0, 0.5, 1)	(0, 0.5, 1)	(0, 0, 0.5)	(0, 0.5, 1)	(0.803, 0.5, 0.916)
Average of average							(0.22, 0.686, 0.907)
Average of average after defuzzification							0.65

Table 4: The results of reliability for questionnaire

Inputs of the system	Cronbach's alpha coefficient
Economic	0.82
Legal	0.73
Philanthropy	0.89
Ethical	0.84

Table 5: Fuzzy average method

Fuzzy number	Fuzzy average
$(m^1_{\alpha}, m^1_m, m^1_{\beta})$	fuzzy average = $((m^1_{\alpha} + m^2_{\alpha} + \dots + m^n_{\alpha})/n, (m^1_m + m^2_m + \dots + m^n_m)/n, (m^1_{\beta} + m^2_{\beta} + \dots + m^n_{\beta})/n)$
$(m^2_{\alpha}, m^2_m, m^2_{\beta})$	
.	
$(m^n_{\alpha}, m^n_m, m^n_{\beta})$	

Table 6: Defuzzification method

$x^1_{max} = (m_{\alpha} + m_m + m_{\beta})/3$	Crisp number = $Z^* = \max \{x^1_{max}, x^2_{max}, x^3_{max}\}$
$x^2_{max} = (m_{\alpha} + 4m_m + m_{\beta})/6$	
$x^3_{max} = (m_{\alpha} + 2m_m + m_{\beta})/4$	

automotive part making companies in East Azerbaijan. For this purpose, the top managements of 175 companies are chosen as statistical population and the volume of sample is defined 50 individuals using the formula for computing the size of statistical sample. Questionnaire is used for determining the size of system inputs which are economic, legal, ethical and philanthropy aspects. Face validity is employed for defining the validity of the questionnaire and Cronbach's alpha coefficient is used for defining the reliability of the questionnaire. Table 4 represents the value of this coefficient for the questionnaire for the inputs of the system in separation.

The answers of these managers for each question of the questionnaire are changed into fuzzy number using triangular function. Then fuzzy average is computed for each questionnaire. This average indicates the view of each manager to the questionnaire. Finally, the average of 50 managers' views is computed for each criterion. In this manner, a number is obtained for each criterion which shows the views of 50 managers. This average is fuzzy; therefore, defuzzification should be applied. The method of Bujadziev is used for obtaining the fuzzy average and also defuzzification. Table 5 and 6 represent the fuzzy average and defuzzification respectively. Table 7, 8, 9 and 10 indicate the summary of results for this calculation.

Table 8: The summarized information for measuring legal aspect

Number of manager	Number of question						Fuzzy average
	19	20	21	22	23	24	
1	(0.5, 1, 1)	(0, 0.5, 1)	(0.5, 1, 1)	(0.5, 1, 1)	(0.5, 1, 1)	(0.5, 1, 1)	(0.416, 0.916, 1)
2	(0.5, 1, 1)	(0.5, 1, 1)	(0.5, 1, 1)	(0, 0.5, 1)	(0.5, 1, 1)	(0.5, 1, 1)	(0.416, 0.916, 1)
3	(0.5, 1, 1)	(0.5, 1, 1)	(0.5, 1, 1)	(0, 0, 0.5)	(0.5, 1, 1)	(0.5, 1, 1)	(0.416, 0.833, 0.916)
.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.
49	(0, 0.5, 1)	(0.5, 1, 1)	(0.5, 1, 1)	(0.5, 1, 1)	(0.5, 1, 1)	(0.5, 1, 1)	(0.583, 0.916, 1)
50	(0.5, 1, 1)	(0.5, 1, 1)	(0.5, 1, 1)	(0.5, 1, 1)	(0, 0.5, 1)	(0.5, 1, 1)	(0.416, 0.916, 1)
Average of average							(0.5, 0.9, 0.987)
Average of average after defuzzification							0.85

Table 9: The summarized information for measuring ethical aspect

Number of manager	Number of question						Fuzzy average
	13	14	15	16	17	18	
1	(0.5, 1, 1)	(0, 0.5, 1)	(0.5, 1, 1)	(0, 0.5, 1)	(0, 0.5, 1)	(0, 0.5, 1)	(0.167, 0.666, 1)
2	(0.5, 1, 1)	(0, 0.5, 1)	(0.5, 1, 1)	(0, 0, 0.5)	(0.5, 1, 1)	(0.5, 1, 1)	(0.333, 0.75, 0.916)
3	(0.5, 1, 1)	(0.5, 1, 1)	(0, 0.5, 1)	(0, 0.5, 1)	(0, 0.5, 1)	(0.5, 1, 1)	(0.25, 0.75, 1)
.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.
49	(0.5, 1, 1)	(0.5, 1, 1)	(0, 0.5, 1)	(0.5, 1, 1)	(0, 0, 0.5)	(0, 0, 0.5)	(0.25, 0.583, 0.833)
50	(0.5, 1, 1)	(0, 0, 0.5)	(0.5, 1, 1)	(0.5, 1, 1)	(0.5, 1, 1)	(0.5, 1, 1)	(0.333, 0.75, 0.916)
Average of average							(0.2, 0.7, 0.95)
Average of average after defuzzification							0.66

Table 10: The summarized information for measuring philanthropy aspect

Number of manager	Number of question						Fuzzy average
	7	8	9	10	11	12	
1	(0.5, 1, 1)	(0, 0.5, 1)	(0, 0.5, 1)	(0, 0, 0.5)	(0, 0.5, 1)	(0.5, 1, 1)	(0.167, 0.583, 0.916)
2	(0.5, 1, 1)	(0, 0.5, 1)	(0.5, 1, 1)	(0, 0.5, 1)	(0.5, 1, 1)	(0.5, 1, 1)	(0.333, 0.833, 1)
3	(0.5, 1, 1)	(0, 0.5, 1)	(0.5, 1, 1)	(0.5, 1, 1)	(0, 0.5, 1)	(0, 0, 0.5)	(0.25, 0.666, 0.916)
.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.
49	(0, 0.5, 1)	(0, 0, 0.5)	(0.5, 1, 1)	(0, 0, 0.5)	(0.5, 1, 1)	(0.5, 1, 1)	(0.25, 0.583, 0.833)
50	(0, 0, 0.5)	(0.5, 1, 1)	(0, 0.5, 1)	(0, 0.5, 1)	(0, 0.5, 1)	(0.5, 1, 1)	(0.167, 0.583, 0.916)
Average of average							(0.243, 0.71, 0.95)
Average of average after defuzzification							0.67

After applying inputs to the expert system, the value for each of the outputs is computed. The score of social responsibility for automotive part making companies is 0.608. This number indicates approximately an average value.

### RESULTS AND DISCUSSION

The viewpoint of Carroll on dimensions of corporate social responsibility has been developed as the theoretical base for the current study; then, a model based on expert systems has been designed using these dimensions and the score of social responsibility for automotive part making companies has been measured by this model. Using Eq. (1), score of social responsibility for the automotive part making companies in East Azerbaijan is a member of medium set with membership degree of 0.568 and is a member of high set with membership of 0.432. Since the selected range is between zero and one, it can be concluded that the score of social responsibility is in average level. Furthermore, test of model confirms that the designed model possesses high reliability.

On the whole, many researchers believe that nowadays governments don't have enough power and resources for solving social and environmental problems due to reasons such as privatization and transfer of economic authority from governments to organizations which results in shrinking the governments and organizations should assist the governments in this field. The concept of corporate social responsibility has a history more than 50 years. As referred in the previous section, this concept was first introduced by Harvard Boven in 1953. But, this concept has gained importance once again because of appearance of many social and environment problems at the present time. Some experts believe that governments should solve the social problems. This group supposes that resources of organizations are not sufficient enough for solving the social problems and they should not be wasted. The other group of experts believes although governments are the main responsible for solving the problems of the society, the participation of organizations is troubleshooting in this field. This group of experts believes that participation of organizations is necessary and crucial for solving the

social problems considering the fact that economic power has transferred from governments to organizations at this time. This study aims at defining suitable ways for evaluating the social responsibility activities related to the organizations. In this research, an expert system was designed by the fuzzy logic which it can be used for measuring the social responsibility activities of organizations. The degree of concentration on social responsibility will be clarified in each organization by this approach. The proposed system is a tool for scoring and it will be used when we are planning to evaluate the attention of different organizations on their social responsibilities. Since the value of input variables for social responsibility is defined by linguistic terms and there is an internal relationship between these variables which different combinations can result in different outputs on social responsibility in some situations, so fuzzy expert system will be a suitable tool for scoring; although, such systems have their own constraints.

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