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The best Suppliers of Sistan Cement Factory using FAHP

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Abstract

Nowadays, Factories consider supply chain system as an essential tool for increasing competitive advantages. Under these certain conditions, creating proximity and long-term relationship between customers and suppliers can be taken into account as a vital factor in setting up the supply chain. Toward this regard, selecting the suppliers and logistics outsourcing have turned to the most important issue in creating this system. Human thoughts and judgment play a crucial role in determining the suppliers' performance rate. Therefore, the fuzzy phenomenon will have more dominance on the systems distribution as long as the human force and complex systems are contributed in decision making. However, AHP method (Analytic Hierarchy Process) has more benefits over other approaches to evaluate the suppliers and logistics outsourcing. Using fuzzy AHP approach, we can minimize the deficiencies. This survey is aimed at prioritizing the suppliers and logistics outsourcing of a cement factory. Sistan Cement factory is our case study in this research. After identifying and collecting the indexes' paired comparisons, fuzzy analytical hierarchy process method was used to rank the suppliers and logistics' outsourcing of the cement factory. Due to great volume of the computation of fuzzy analytical hierarchy process MATLAB and Excel were utilized to follow the procedure of the study. Results obtained from MATLAB software and the experts make the suppliers and outsourcing rating feasible. Concerning this survey, the manager will be able to opt the suppliers and logistics outsourcing with lower risk and in a more transparent environment.

Keywords: Analytic Hierarchy Process approach (AHP), Fuzzy Analytic Hierarchy Process (FAHP), selecting the suppliers and logistics outsourcing

Introduction

Nowadays ,in the highly competitive environment identified as low benefit, high expectations of customers for quality products and short expectation time of delivery , companies have to take advantage of all opportunities in order to optimum their work processes . To reach this goal, those involved have reached the following result: For a company to stay competitive, it needs to work with chain-supplier partners (Aissaoui, Haouari, & Hassini, 2007). According to this, nowadays, companies, instead of competing each other, consider themselves as a part of supply chain competing other supply chains (Min & Zhou, 2002). Among this, selecting supplier has gained growing importance according to being supply-chain processes and influencing all departments of an organization (Aissaoui, Haouari, & Hassini, 2007). Weber and his colleagues (1991) indicate that decisions relevant to selecting supplier are highly complicated because of considering various criteria. Furthermore, different approaches can be used for this selection .Analysis of these two subjects (Criteria and selection method of supplier) has attracted attention of researchers and those involved in purchase process from 1960s onward (Zhiming et al, 2004). A considerable number of factors can affect efficiency of suppliers including quality, delivery, goods history, guarantee, price, technical capability, financial condition to name a few. Thus, the issue of selecting suppliers is a multi-criteria one involving sensible and insensible features considering the fact that some are contradictory. Basically, there are two ways of selecting suppliers. In the first way of selecting a

supplier, a supplier can provide all necessary needs in which the management needs to select by a definite decision. In the second way, not each of suppliers have the capability of meeting all needs of management. Management divides orders among suppliers in this type of situation (Ustan & Demirtas, 2006). Powerful analysis models and decision-logistic tools in order to enable creating balance between multi mental and visual criteria are necessary to select an effective supplier (Bhattacharya, Geraghty, & Young, 2010). In a comprehensive review conducted by Weber and his colleagues, it was obvious that almost all organizations face more than a criterion for selecting their suppliers (Weber, Current, & Benton,1991). Therefore, decision making about selecting a supplier is naturally a multi-criteria issue and it is an important strategic one for organizations (Kahraman, Ruan, & Dogan, 2003).

AHP method which is one of MCDM methods was used to select the supplier in this research. This method is for selecting and deciding one choice among frequent choices. This method was invented and presented by Thomas Sati in 1980. AHP is the reflection of natural behavior as well as human thought. This technique investigates complex issues according to their mutual effects, simplify them, and solve them. This method includes four steps for final selection: 1. Modeling 2. Collecting data and forming paired-comparison matrix 3. Calculating relative weight 4. Calculating final weights and selection (Mehregan, 2013). We are facing uncertainty since, in this research, mangers and experts give their verbal opinions .Fuzzy logic is used for accuracy and making results realistic. Theory of fuzzy collections and fuzzy logic are highly useful and they are efficient tools for this purpose. Theory of Fuzzy collections is a mathematical theory which has been designed for mathematical modeling of ambiguity in identifying processes (Lootsma, 1997). Application domain of this theory covers a great deal of areas such as natural and biological sciences, social science ,engineering ,computer science ,systematic and management sciences , planning and decision making (Klir and Folger, 1998).

Research Method

A descriptive survey was administered. Based on data collection method, descriptive research method was applied and then the results were generalized to statistical population. There are different descriptive research. Here, we used survey. Descriptive surveys are used to determine and describe variable features. As many as two questionnaires were designed during the study in order to complete paired tables by experts` opinions.

Elements of Fuzzy Collection

In classic or definite collections, one element of reference collection in a given collection has membership or not. membership in a definite collection, f can be defined with a membership function for each member of x from the reference collection as following:

$$\mu_F(x) = \begin{cases} 1 & x \in F \\ 0 & x \notin F \end{cases}$$

Fuzzy numbers: each fuzzy function is defined by a membership function .The concept of membership function in theory of fuzzy collection has highly got importance. The first point of view is using experts` knowledge because fuzzy collections are being used for formulating human knowledge .In the second point of view, collected data by various sensors are used to determine membership function (Weber, Current, & Benton, 1991).

Triangular fuzzy numbers: the triangular fuzzy number of A or, simply, triangular number with membership function of on r is defined as follows:

$$\mu_A(x)=\begin{cases}\dfrac{x-a}{b-a}, & a \le x \le b;\\ \dfrac{c-x}{c-b}, & b \le x \le c;\\ 0, & x < a \text{ or } x > c.\end{cases}$$

where [a, b] is support span and the point of (b, 1) is the head.

Fuzzy logic has provided a natural –technique tool for investigating this phenomena and affairs due to the fact that it has the capability of competing with artificial intelligence and systematic approach in investigating the conditions and ambiguous situations which are not effective in ordinary mathematics (Andriantiatsaholiniaina, 2004). Fuzzy theory and logic is a scientific tool which has created a possibility and permission for simulation of dynamism of a system without long mathematical description using qualitative and quantity data (Phillis and Andriantiatsaholiniaina, 2001).

In analysis of group and multi-criteria decision making ,fuzzy model has been identified as the most common method for explaining and investigating uncertainties .Fuzzy logic has removed the gap between scientific and organized assessment and measurement considering simultaneous social goals and it has provided a method for converting vast spectrum of information ,visual data ,quantity information ,mental opinions and judgments ,and social needs in to a natural language for explaining effects of environment (Silvert, 2000)

Fuzzy AHP

Assume that x={x1, x2, xn} is a collection of items and g= {g1, g2, gn} is a collection of goals .according to chang method, the maximum is obtained from analysis of each item (serkan ball and serdar korukoglu, 2009) and maximum analysis of each goal has been done respectively, therefore, maximum values of analysis m for each item can be obtained from the following signs:

$m^1_{gi}, m^2_{gi}, ..., m^m_{gi}$ i= 1,2,..., n

steps of maximum for chang analysis is as following:

first step: the maximum value of combined fuzzy is defined as following according to ith item:

$$S_i = \sum_{j=1}^{m} M_{gi}^{j} \otimes \left[\sum_{i=1}^{n}\ \sum_{j=1}^{m} M_{g_i}^{j}\right]^{-1}$$

calculating the fuzzy sum, maximum value of analysis for a particular matrix is obtained where:

$$\sum_{j=1}^{m} M_{gi}^{j} = \left[\sum_{j=1}^{m} L_j, \sum_{j=1}^{m} M_j, \sum_{j=1}^{m} U_j\right]$$

calculating fuzzy sum, the value of mjgi is obtained

$$\sum_{i=1}^{n}\sum_{j=1}^{m} M_{gi}^{j} = \left[\sum_{j=1}^{m} L_j, \sum_{j=1}^{m} M_j, \sum_{j=1}^{m} U_j\right]$$

and then we obtain the inversion of above vector:

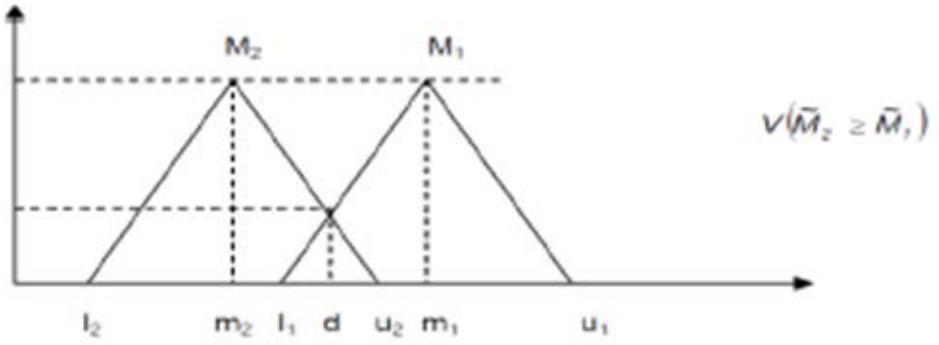
$$\left[\sum_{i=1}^{n}\sum_{j=1}^{m} M_{gi}^{j}\right]^{-1} = \left[\frac{1}{\sum_{j=1}^{m} L_j}, \frac{1}{\sum_{j=1}^{m} M_j}, \frac{1}{\sum_{j=1}^{m} U_j}\right]$$

second step: we define two triangular fuzzy numbers with probability degree:

$$V\left(\tilde{M}_2 \ge \tilde{M}_1\right) = \sup_{y \ge x}\left[\min\left(\mu_{\tilde{M}_1}(x), \mu_{\tilde{M}_2}(x)\right)\right]$$

and we can explain it as follows:

$$V(\tilde{M}_2 \geq \tilde{M}_1) = hgt(\tilde{M}_1, \tilde{M}_2) = \mu\tilde{M}_2 = \begin{cases} 1, & if \quad m_2 \geq m_1 \\ 0, & if \quad I_2 \geq u_2 \\ \dfrac{I_1, U_2}{(m_2 - u_2) - (m_1 - i_2)}, & otherwise \end{cases}$$



third step: if probability degree for a fuzzy curved number is more than k, fuzzy curved numbers of m= (i=1,2,k) can be defined as follows :

$$V(M \geq M_1, M_2, M_3, ...M_K) = V[(M \geq M_1) and\ (M \geq M_2) and ....and\ (M \geq M_k)]$$

fourth step: normal weight vectors are as follows using normalization:

$$W = (d(A_1), d(A_2), ...d(A_n))^T$$

where w is not fuzzy (Ball and Korukoglu,2009).

Using variables with definite values makes it difficult for experts to give their opinions .so, it is clear that qualitative variables gives more freedom to experts .using some qualitative variables such as “low” ,”medium”, and “high” will somewhat solve the problems .peoples` opinions toward qualitative variables such as low or high are not similar. since experts have various characteristics, they will have different opinions as well. if they answer these questions according to different opinions, the analysis will not be valuable .although, they will answer with the same ideas defining domain of qualitative variables, qualitative variables are defined using fuzzy numbers (Chang,1998).

Table 1: Qualitative variables of the study

Verbal variables	Triangular fuzzy number
Equally Preferred	(1,1,1)
Interstitial	(1,2,3)
Moderateiy Preferred	(2,3,4)
Interstitial	(3,4,5)
Strongly Preferred	(4,5,6)
Interstitial	(5,6,7)
Very Strongly Preferred	(6,7,8)
Interstitial	(7,8,9)
Extremely Preferred	(9,9,9)

Implementation of Research

In this research, FAHP has been used for selecting suppliers .the general issues of research is as follows:

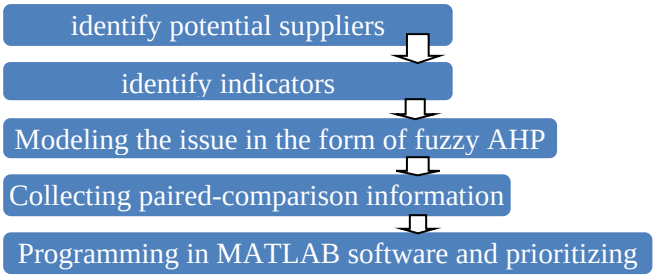


Figure 1: Conceptual model of the study

Identifying Potential Suppliers

According to field collected data, experts` opinions, five companies, were assessed including:

A1: Axon Structure Company
A2: Pars San`at Company
A3: Cement industry activity Company
A4: Hamsou San`at Tannin Company
A5: Sina Joush Gostar Company

Identification of indicators

Based on the collected information in field and library assessments, as many as ten more important indicators were chosen in Sistan cement factory. The rest of indicators were rejected due to minor importance.

These indicators are:

C1: Quality (capability of each supplier for reaching quality features)
C2: Delivery date(Capability of each supplier to reach scheduling delivery)
C3: Performance background
C4: Price
C5: Policies of guarantees and paying for damages
C6: Installations and production capacity
C7: Technical power (including facilities for research and development)
C8: Communication system
C9: Adaptability with buyers ` process (Accepting procedures and guidelines of buyers from supplier side)
C10: Financial situation of the company

Then the weight and importance of each of these indicators were investigated.

Modeling by AHP

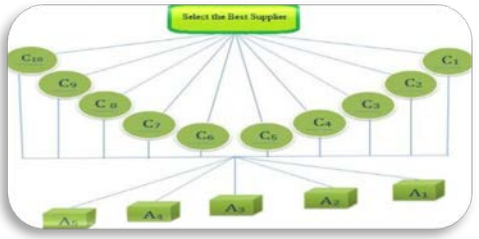


Figure 2: Research AHP model

As it can be seen in Figure 2, the main objective is on top which is select the best of Suppliers. Indicators are in the middle of model, showing each of indicators. As are at the bottom of model, showing Suppliers.

Information collection for fuzzy paired comparison

We took advantage of two questionnaires: first, experts opinions were taken into account toward paired comparison of Suppliers concerning each of indicators. Then paired comparison was sought among eight indicators. The paired comparison tables are as follows:

1. Paired comparison of Suppliers concerning C1: Quality (capability of each supplier for reaching quality features) is listed in table 2

Table 2: Paired comparison of Suppliers concerning C1

	A1			A2			A3			A4			A5		
A1	1.00	1.00	1.00	1.45	2.05	2.65	1.10	1.35	1.60	2.00	2.40	2.40	2.05	3.00	3.95
A2	0.38	0.49	0.69	1.00	1.00	1.00	0.43	0.54	0.71	2.10	2.10	2.90	0.43	0.56	0.80
A3	0.63	0.74	0.91	1.40	1.85	2.30	1.00	1.00	1.00	1.60	1.95	2.30	1.95	2.95	3.95
A4	0.42	0.50	0.63	0.35	0.48	0.77	0.44	0.51	0.63	1.00	1.00	1.00	1.80	2.55	3.30
A5	0.25	0.33	0.48	1.25	1.80	2.35	0.25	0.34	0.51	0.30	0.39	0.56	1.00	1.00	1.00

Source: author

2. Paired comparison of Suppliers concerning C2: Delivery date (Capability of each supplier to reach scheduling delivery) is listed in table 3

Table 3: Paired comparison of Suppliers concerning C2

	A1			A2			A3			A4			A5		
A1	1.00	1.00	1.00	1.15	1.56	2.15	0.50	0.65	0.91	1.00	1.00	1.00	3.00	3.90	4.80
A2	0.47	0.61	0.87	1.00	1.00	1.00	0.24	0.30	0.40	0.30	0.39	0.57	0.33	0.45	0.71
A3	1.10	1.55	200	2.50	3.35	4.20	1.00	1.00	1.00	1.30	1.90	2.50	2.90	3.85	4.80
A4	1.00	1.00	1.00	1.75	2.55	3.35	0.40	0.53	0.77	1.00	1.00	1.00	2.10	2.90	3.70
A5	0.21	0.26	0.33	1.40	2.20	3.00	0.21	0.26	0.35	0.27	0.35	0.48	1.00	1.00	1.00

Source: author

3. Paired comparison of Suppliers concerning C3: Performance background is listed in table

Table 4: Paired comparison of Suppliers concerning C3

	A1			A2			A3			A4			A5		
A1	1.00	1.00	1.00	0.13	0.14	0.16	1.00	1.00	1.00	0.34	0.44	0.65	0.28	0.36	0.50
A2	6.15	6.95	7.75	1.00	1.00	1.00	7.00	7.65	8.30	6.05	6.80	7.55	7.35	7.90	8.45
A3	1.00	1.00	1.00	0.12	0.13	0.14	1.00	1.00	1.00	1.25	1.65	2.05	1.20	1.75	2.30
A4	1.55	2.25	2.95	0.13	0.14	0.17	0.49	0.61	0.80	1.00	1.00	1.00	2.35	3.15	3.95
A5	2.00	2.80	3.60	0.12	0.13	0.14	0.44	0.57	0.83	0.25	0.32	0.43	1.00	1.00	1.00

Source: author

4. Paired comparison of Suppliers concerning C4: Price is listed in table 5

Table 5: Paired comparison of Suppliers concerning C4

	A1			A2			A3			A4			A5		
A1	1.00	1.00	1.00	0.13	0.14	0.16	1.00	1.00	1.00	0.12	0.13	0.15	0.19	0.23	0.30
A2	6.20	7.05	7.90	1.00	1.00	1.00	7.00	7.65	8.30	1.00	1.00	1.00	5.65	6.45	7.25
A3	1.00	1.00	1.00	0.12	0.13	0.14	1.00	1.00	1.00	0.12	0.14	0.15	0.20	0.25	0.33
A4	6.75	7.55	8.35	1.00	1.00	1.00	6.60	7.40	8.20	1.00	1.00	1.00	4.05	5.05	6.05
A5	3.30	4.30	5.30	0.14	0.16	0.18	3.00	4.00	5.00	0.17	0.20	0.25	1.00	1.00	1.00

Source: author

5. Paired comparison of Suppliers concerning C5: Policies of guarantees and paying for damages is listed in table 6

Table 6: Paired comparison of Suppliers concerning C5

	A1			A2			A3			A4			A5		
A1	1.00	1.00	1.00	0.15	0.17	0.20	0.25	0.31	0.41	0.28	0.36	0.50	0.33	0.43	0.63
A2	4.95	5.85	6.75	1.00	1.00	1.00	2.60	3.35	4.10	4.30	5.30	6.30	5.25	6.15	7.05
A3	2.45	3.20	3.95	0.24	0.30	0.38	1.00	1.00	1.00	1.00	1.00	1.00	1.50	1.90	2.30
A4	2.00	2.80	3.60	0.16	0.19	0.23	1.00	1.00	1.00	1.00	1.00	1.00	1.45	1.85	2.25
A5	1.60	2.30	3.00	0.14	0.16	0.19	0.43	0.53	0.67	0.44	0.54	0.59	1.00	1.00	1.00

Source: author

6. Paired comparison of Suppliers concerning C6: Installations and production capacity is listed in table 7

Table 7: Paired comparison of Suppliers concerning C6

	A1			A2			A3			A4			A5		
A1	1.00	1.00	1.00	6.60	7.30	8.00	1.00	1.00	1.00	3.30	4.30	5.30	3.35	4.35	5.35
A2	0.13	0.14	0.15	1.00	1.00	1.00	0.12	0.13	0.14	0.21	0.26	0.34	0.31	0.41	0.59
A3	1.00	1.00	1.00	6.90	7.55	8.20	1.00	1.00	1.00	3.55	4.55	5.55	3.50	4.35	5.50
A4	0.19	0.23	0.30	2.90	3.80	4.70	0.18	0.22	0.28	1.00	1.00	1.00	1.95	2.85	3.75
A5	0.19	0.23	0.30	1.70	2.45	3.20	0.18	0.23	0.29	0.27	0.35	0.51	1.00	1.00	1.00

Source: author

7. Paired comparison of Suppliers concerning C7: Technical power (including facilities for research and development) is listed in table 8

Table 8: Paired comparison of Suppliers concerning C7

	A1			A2			A3			A4			A5		
A1	1.00	1.00	1.00	0.17	0.21	0.26	1.05	1.15	1.25	0.27	0.35	0.48	0.24	0.30	0.42
A2	3.85	4.80	5.75	1.00	1.00	1.00	3.55	4.50	5.45	3.70	4.70	5.70	4.10	5.10	6.10
A3	0.80	0.87	0.95	0.18	0.22	0.28	1.00	1.00	1.00	0.23	0.29	0.41	0.21	0.26	0.36
A4	2.10	2.90	3.70	0.18	0.21	0.27	2.45	3.45	4.45	1.00	1.00	1.00	1.25	1.75	2.25
A5	2.40	3.30	4.20	0.16	0.20	0.24	2.80	3.80	4.80	0.44	0.57	0.80	1.00	1.00	1.00

Source: author

8. Paired comparison of Suppliers concerning C8: Communication system is listed in table 9

Table 9: Paired comparison of Suppliers concerning C8

	A1			A2			A3			A4			A5		
A1	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
A2	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
A3	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
A4	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
A5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Source: author

9. Paired comparison of Suppliers concerning C9: Adaptability with buyers ` process (Accepting procedures and guidelines of buyers from supplier side) is listed in table 10.

Table 10: Paired comparison of Suppliers concerning C9

	A1			A2			A3			A4			A5		
A1	1.00	1.00	1.00	2.85	3.80	4.75	3.40	4.35	5.30	1.90	2.65	3.40	3.85	4.85	5.85
A2	0.21	0.26	0.35	1.00	1.00	1.00	1.35	2.05	2.75	1.30	2.00	2.70	3.55	4.55	5.55
A3	0.19	0.23	0.29	0.36	0.49	0.74	1.00	1.00	1.00	1.00	1.00	1.00	1.30	2.00	2.70
A4	0.29	0.38	0.53	0.37	0.50	0.77	1.00	1.00	1.00	1.00	1.00	1.00	2.75	3.75	4.75
A5	0.17	0.21	0.26	0.18	0.22	0.28	0.37	0.50	0.77	0.21	0.27	0.36	1.00	1.00	1.00

Source: author

10. Paired comparison of Suppliers concerning C10: Financial situation of the company is listed in table 11

Table 11: Paired comparison of Suppliers concerning C10

	A1			A2			A3			A4			A5		
A1	1.00	1.00	1.00	2.45	3.45	4.45	1.65	2.25	2.85	3.25	4.25	5.25	4.60	5.60	6.60
A2	0.22	0.29	0.41	1.00	1.00	1.00	1.00	1.00	1.00	1.45	2.35	3.25	2.70	3.70	4.70
A3	0.35	0.44	0.61	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.20	1.75	2.30
A4	0.19	0.24	0.31	0.31	0.43	0.69	1.00	1.00	1.00	1.00	1.00	1.00	1.15	1.55	1.95
A5	0.15	0.18	0.22	0.21	0.27	0.37	0.44	0.57	0.83	0.51	0.65	0.87	1.00	1.00	1.00

Source: author

11. Paired comparison of indicators: Table 12 lists the paired comparison of indicators.

Table 12: paired comparison of indicators

	C1			C2			C3			C4			C5		
C1	1.00	1.00	1.00	1.00	2.00	3.00	1.00	2.00	3.00	1.00	2.00	3.00	2.00	3.00	4.00
C2	0.33	0.50	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	2.00	3.00
C3	0.33	0.50	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	2.00	3.00
C4	0.33	0.50	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	2.00	3.00
C5	0.25	0.33	0.50	0.33	0.50	1.00	0.33	0.50	1.00	0.33	0.50	1.00	1.00	1.00	1.00
C6	0.25	0.33	0.50	0.33	0.50	1.00	0.33	0.50	1.00	0.33	0.50	1.00	1.00	1.00	1.00
C7	0.25	0.33	0.50	0.33	0.50	1.00	0.33	0.50	1.00	0.33	0.50	1.00	1.00	1.00	1.00
C8	0.25	0.33	0.50	0.33	0.50	1.00	0.33	0.50	1.00	0.33	0.50	1.00	1.00	1.00	1.00
C9	0.25	0.33	0.50	0.33	0.50	1.00	0.33	0.50	1.00	0.33	0.50	1.00	1.00	1.00	1.00
C10	0.25	0.33	0.50	0.33	0.50	1.00	0.33	0.50	1.00	0.33	0.50	1.00	1.00	1.00	1.00
	C6			C7			C8			C9			C10		
C1	2.00	3.00	4.00	2.00	3.00	4.00	2.00	3.00	4.00	2.00	3.00	4.00	2.00	3.00	4.00
C2	1.00	2.00	3.00	1.00	2.00	3.00	1.00	2.00	3.00	1.00	2.00	3.00	1.00	2.00	3.00
C3	1.00	2.00	3.00	1.00	2.00	3.00	1.00	2.00	3.00	1.00	2.00	3.00	1.00	2.00	3.00
C4	1.00	2.00	3.00	1.00	2.00	3.00	1.00	2.00	3.00	1.00	2.00	3.00	1.00	2.00	3.00
C5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
C6	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
C7	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
C8	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
C9	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
C10	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Source: author

Data analysis

Table 13 shows decision matrix in this paper. The first row shows the weight of each of indicators and rows 3-7 show the scores of suppliers compared to each indicator.

Table 13: Decision-making matrix with crisp value

W	0.310828	0.20235	0.20235	-0.20235	0.13687	0.13687	0.13687	0.13687	0.13687	0.13687
	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
Alter1	0.376483	0.275457	0	0	0	0.488909	0	0.2	0.70105	0.830088
Alter2	0.117064	0	1	0.529122	1	0	0.88101	0.2	0.29895	0.169912
Alter3	0.336948	0.453994	0	0	0	0.511091	0	0.2	0	0
Alter4	0.133931	0.270549	0	0.470878	0	0	0.087837	0.2	0	0
Alter5	0.05574	0	0	0	0	0	0.31154	0.2	0	0

Source: author

Conclusion

According to the results of Matlab software shown, A2 supplier (Pars San`at Company), A3 (Cement industry activity Company), and A1 (Axon Structure Company) ranked first to third, respectively. A4 supplier (Hamsou San`at Tannin Company) and A5 (Sina Joush Gostar Company) by far ranked fourth and fifth. Table 14 shows suppliers` ranking and scores.

Table 14: Final rank and scores

Rank	Alter	Score
Rank 1	A2	0.27364
Rank 2	A3	0.27139
Rank 3	A1	0.26821
Rank 4	A4	0.10748

Source: Author

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