Priority of Technology Transfer Methods in Oil Drilling Industry by using analysis Network Process (ANP)

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Abstract

Now, we live in knowledge era. Technology is a Knowledge which is used to create products and services that improve the use of limited and precious resources. Whatever technology is used, its outcome is the knowledge development. Information era in the late twentieth century has led to the knowledge development and it has had a huge impact on the rate of technology change.

Introduction

The accelerated rate of technological change has a deep effect on society and the living standards. Not only what is produced, but the production of cheaper and better goods and services that fail competitors and go them out the economy era are also important. In this world of competition for scarce resources and growing population, we will have many problems if there isn't technology and we do not manage it well (Bagherzadeh&Mesbahi,2011).

Technology management makes it possible to gain competitive advantage in the market. Technology transfer is a subset of technology as an important and very technical subject, because the successful transfers lead to development and unsuccessful and non- technical transfer lead to fail. In fact technology transfer means the transfer of technical knowledge according to local conditions, along with its effective absorption within a country or from one country to another.

What can be seen in developing countries is the poor technology transfer and excessive technology diversity too. Because there were not certain strategies in these countries to select good technology transfer method and finally its development , so this trend caused to technology dependence and slow down its dynamic power and mobility on industries (Milleret al, 2011) .

The study of economical conditions in Iran during several past decades has been concluded that in spite of huge investment on technology transfer but we have not successes to transfer technology completely in country yet because of non – existence of the required bodies to assess different technology transfer, non–knowledge of it, weak management and organization; although in some areas there has been some success. It reveals the advantages and disadvantages of different technology transfer methods and the best method in different industry (Bagherzadeh & Meftahi, 2011).

The oil industry is one of such industries. Since the first decade of the twentieth century, when the oil well number one put into operation in Masjed Soleiman to now, the oil drilling has reached the considerable progress. The rapid development in oil technology and its coming in countries with oil could accelerated its excavation and distillation; so that today this technology has reached such development that the integrated platforms build globally to separate gas and other impurities and transfer oil into the oil floated tankers beside the same platform directly.

So, technology and development in oil industry has caused to facilitate drilling process (finally to increase wells) separation speed (at last to increase crude oil which is ready to exploit) distillation and its derivation (to meet people needs in regard to growing population and finally the growing rate of transmission network).

Since, the most oil-producing countries in the world are among underdeveloped countries, the increased oil production along with good management practices in these countries could lead to provide liquidity and finally this leads to economical development. Given that one of the ways to achieve technical knowledge is technology transfer which due to the type of technology and industry needs should be selected, it is necessary to survey different methods of technology transfer and then choose the optimal method (Abbaspour et al, 2006). In this research, we have tried to help in selecting the best technology by a classification method for technology transfer in the oil industry.

Literature Review

There are different definitions of the concept of technology transfer in different researches that we will refer some comprehensive and important of them:

- Technology transfer is a process which technology has changed from a geographical location toward the other location
- some transfers is done from a location inside the country or a part of industry to another part or from a country to other as internationally, which this transfer called horizontal transfer (Xuedong, 2006)
- The vertical transfer is a process that uses new technology and knowledge in country and then it applied in product and process and a new technology is born.
- Technology transfer as a chain is a series of purposed activities which technology elements applied in location except the first place of technology- making to train, attract and develop in more extensive applications.
- Technology transfer is transfer of knowledge and the ability to use the information when it is realized that the receiver will use it to transfer technology in order to meet their needs (Abzry & Karami, 2009).
- Technology transfer means technical knowledge transferring regard to local conditions, along with its effective absorption and diffusion within a country or from one country to another (Eskandari, 2006)

Many studies have been conducted about technology transfer and its methods, which we refer some of them .

Eskandari (2006) in his thesis surveyed the management process of technology transfer in Tehran Metro project. Therefore, he conducted field studies and interviews about Tehran Metro Company. He stated that the Tehran Metro Company has used different technologies such as technology transfer from Chinese company to Wagon Company and venture capital in it.

The results of data analysis showed that the best option to complete technology transfer is to provide venture capital approach by good political conditions and back ground that reduces the time, cost and improve quality of transfer. Only method provided in the agreement of purchase

and transfer of technology in a single contract, as a second priority, is more efficient. But , in general , the conclusion of the technology contract as separate process sis most common in spite of its weakness than above methods but due to government support and clear data about technology transfer rate in country . Naseri and NamdarZanganeh (2008), in their study surveyed the role of organizational capabilities on the effectiveness of technology transfer in the Iranian firms. To this end, he at first identified variables of organizational capabilities in the firms and then in order to identify the success of firm to attract technology, he determined the variables or parameters that form Iranian firm's effectiveness in technology transfer. And the total effects of organizational capabilities on the effectiveness of technology transfer variables measured on Iranian firms the results shown the organizational abilities have significant effect on technology transfer and among these effective factors, seven of them have more effect on technology transfer of Iranian firms.

(Bagherzadeh & Meftahi, 2011), in their study surveyed the technology transfer success of Iranian companies engaged in Screw Compressor Technology. In this study, a questionnaire was used to collect data. Statistical sample were Iranian managers who was done technology transfer in Screw Compressor Technology, they were about 20 Companies. The obtained results of the data analysis showed that 78.9 percent of people were mentioned the impact of management and economic conditions, 57.89% the environmental impact of the country, 73 percent the human resources (experts and technical staff) , 84.21% development and research role on the success or failure of technology transfer at a high level. In this study, the mean factor of manager was 4.1, the R & D 4, the operating and environmental conditions 3.7, the economic condition 8.3 and the HR was 4.2. Results were analyzed by ANOVA variance analysis and were found there are significant differences between the factors affecting on the success of technology transfer in Screw Compressor industry in Iran. So that Duncan's classification shown the effect of management, research and development and human resources than environmental and economic factors were more significant.

Bradley et al, 1995) studied the methods of technology transfer in the food industry in Northern Ireland. They used questionnaire to collect required data. The researchers analyzed data and investigated the previous technology transfer methods and finally they concluded that because the short of cash, the best way is to use direct foreign investment and in some cases direct investment and ownership of receiver technology. Researchers believe the most cost-effective way is the foreign direct investment in other forms of technology transfer.

(Borensztien et al, 1998) studied the relationship between technology transfer by direct foreign investment and economical growth among 60 developing countries during 70's and 80's decades and they concluded that there is a significant and positive relationship between direct foreign investment and economic growth. He also stated that economic growth is function of the supply of human capital, initial income and human capital also.

Other researcher also investigated the importance of research and development in industrial firms and technology transfer through foreign direct investment on economic growth in the Czech Slovakia during the period (1998-1995) .according to obtained results, he asserted internal research & development has more importance than foreign R&D on economical growth. Meanwhile he asserted if there is high economical aspect, foreign R&D than internal research & development has more effect on economical growth.

(Li & Liu, 2005) in their study examined the role of technology transfer through foreign direct investment on economic growth in 36 developing countries and 21 developed during (1999-1970), and they concluded that increased foreign direct investment will boost economic growth, but they noted that the size of this effect is a function of human capital accumulation. Also, the researchers stated that economic growth is function of population growth, human capital, interest rates and domestic investment in GDP.

(Branstetter & rong, 2006) were examined the impact of technology transfer and R & D on productivity growth in industry in Taiwan. They have performed comparative practical analysis about the impact of R & D expenditures and external technology acquisition on output and productivity of industries in Taiwan .the results verified the effect of R & D and expenditures of purchasing foreign technology on the growth of Taiwan companies.

(Miller, 2011 examined the role of science and technology parks, technology and effective communication between the receiver and transmitter technology on the effectiveness of technology transfer. He has used questionnaires, and exploratory analysis to collect data. Data gathered by technology experts and technology receivers and transmitter have shown that these professional centers (science and technology parks) has effective role in technology transfer. Also closer communication and sharing of information between the transmitter and receiver technology lead to the greater success of technology transfer.

In another study, Ustundag et al (011) investigated the factors affecting technology transfer. After collecting and analyzing necessary data by using phase techniques, they attained the following factors:

-income of technology acquisition

-industry support of technology transfer

-researchers support of technology transfer

-the cost of R&D in industry and universities

-investing on technology transfer and dissemination

- Economic Uncertainty

Landry & Amara(2012) studied how technology transfer organizations can make a value and transfer it. Several researchers investigated the transfer of knowledge and technology and research background in this field and they offered the value chain model of knowledge transfer and technology as the following:

Improved using of actual transfer determined identifying the potential opportunity of technology potential values opportunity or value transfer by third person in form of actual values based on technology transfer.

Methods

since this research has focus on previous techniques and principals and it is based on previous researches to find the most effective procedure and it considered the reasons less , so it is applied research and it aims to identify the current condition and to analyze it . This research aims not to determine the relationship and effect and in fact to find new methods in order to meet organizational purposes. It is research method to extract priority indices of technology transfer by using concepts and history of technology transfer methods used and the priority scheme of ANP techniques and application of Super Decision. The Shannon entropy and TOPSIS techniques will be used for weighting the criteria and priorities to provide dependable results .in this research, 25 methods of technology transfer identified to determine their effect, so a general questionnaire distributed between a large number of experts National Iranian Drilling Company and North Drilling Company in order to use a sampling method in limited society.

$$n = \frac{N \times Z_{\alpha/2}^2 \times \delta^2}{\varepsilon^2 (N-1) + Z_{\alpha/2}^2 \times \delta^2} \qquad \Rightarrow \qquad n = \frac{147 \times (1.96)^2 \times 0.316^2}{0.05^2 (146) + (1.96)^2 \times 0.316^2} = 75$$

Given the present population size of 147 is roughly equal to the population standard deviation of a preliminary sampling was used. For this study, questionnaires were randomly distributed among 39 individuals from population experts. SD of the results of the questionnaire survey suggests that most of the population standard deviation is equal to 0.316. Thus, the standard deviation of the maximum error was 5% for samples with 75 persons. 100 questionnaires

distributed, 91completed of them were based on analysis. It must be mentioned this questionnaire was used in t-student test, validity and reliability test and ANP dual comparison questionnaire were distributed between 14 of expert managers.

Findings

In this study, Cronbach's alpha coefficient was 0.986, which is equivalent to the high reliability of the survey instrument is approved. Factor analysis was used to assess the validity of the questionnaire. The results of the confirmatory factor analysis can be conducted on the data. More than 5/0 KMO statistic indicating sampling adequacy and Bartlett's test also indicates the confidence level of zero is properly cited factor model.

Table 1:KMO-Bartlett

Table 1. KMO and Bartlett's Test

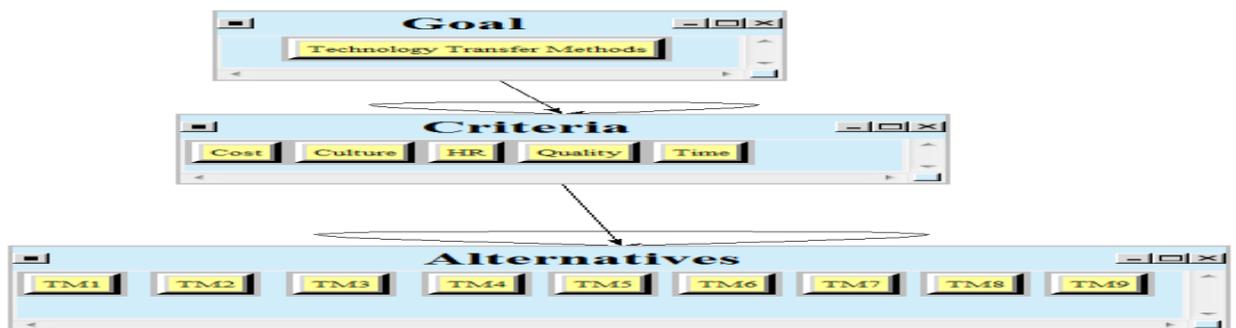| Kaiser-Meyer- Olkin Measure of Sampling Adequacy.		.980
Bartlett's Test of Sphericity	Approx. Chi-Square	1.739E4
	df	990
	Sig.	.000

Figure 1. Priority network of technology transfer in oil industry

Techniques for extracting meaningful impact and importance of technology transfer student t-test were used to avoid prolonging the results of the application. The result of this test is only 9 high importance of technology transfer in the oil industry as a result of using these techniques only ANP prioritieswill be categorized. To identify and measure the dependency between criteria and sub-factors, interviews and surveys of experts' interdependent criteria were identified.

Network structure selection criteria affecting technology transfer in this study are shown in the following diagram. The experts believed that the methods of technology transfer should be based on five criteria, time, cost, quality, human resources and corporate culture priority.

After collecting the questionnaires and collect the related matrices dependency among criteria, it was necessary to calculate the rate they are incompatible. Super Decisions software was used to calculate the rate of inconsistencies. According to the guide questions on the one hand and the presence of one researcher in the questionnaire and provide comments, if needed, the entire matrix of acceptable inconsistency rates (less than 1/0) had. The results are shown in the table below.

Table 2. Comparison of normalized decision matrix, selection criteria, test methods, technology transfer

Time of technology transfer	Cost of technology transfer	Quality of technology transfer	Organizational culture	Human resource	**Purpose :select method ,select technology**
1	0.87	0.57	0.62	0.72	Time of technology transfer
1.15	1	0.57	0.63	0.57	Cost of technology transfer
1.75	1.75	1	0.85	1.07	Quality of technology transfer
1.62	1.59	1.18	1	0.92	Organizational culture
1.38	1.75	0.94	1.08	1	Human resources
0.0045					**Incompatibility rate**

The next step in the process of network analysis techniques information is Super matrix. Markov chain process is similar to the concept Super matrix. To obtain the final priorities in an interdependent system that is affected, according to local priority vectors are entered in the columns of the matrix-matrix is known as Super matrix. According to the chart before Super Matrix study was as follows:

$$W_n = \begin{bmatrix} 0 & 0 & 0 \\ w_{21} & w_{22} & 0 \\ 0 & w_{32} & w_{33} \end{bmatrix}$$

Super matrix the potential to become a Super matrix find ¬ change, it means that the sum of each column of the matrix. The approach proposed by the hour (1996) to determine the relative importance of those categories Super matrix column (block) as part deals with the controller. Thus the nonzero rows columns blocks in a block, that block the effects columns are compared. Using paired comparisons matrix row with the column can get a special vector. The process to obtain a special vector for each block column is done. For each block column, especially the first vector is multiplied in first block of the same column vector latter especially in all the blocks column is multiplied and it continues until the end. Super matrix thereby blocks in each column, are lightweight and therefore it is possible that the heavy Super matrix said. Exponentiation of a matrix for each of them, the impact will be relatively long. To achieve convergence of relative weights, which has 2k +1 k Super matrix to be a great favorite of the new matrix is called Super matrix bound. Bound Super matrix weight was as a form, but all the columns are bound Super matrix. Normalized to each of the blocks with the Super matrix, the priority of all   matrix can be achieved. Results in Table (3) shown

Table 3. Super matrix formation Bound

TM1	TM2	TM3	TM4	TM5	TM6	TM7	TM8	TM9
	Cost	Culture	HR		Quality	Time	Goal	
TM1	0.14421	0.14421	0.14421	0.14421	0.14421	0.14421	0.14421	0.14421
	0.14421	0.14421	0.14421	0.14421	0.14421	0.14421	0.14421	
TM2	0.13803	0.13803	0.13803	0.13803	0.13803	0.13803	0.13803	0.13803
	0.13803	0.13803	0.13803	0.13803	0.13803	0.13803	0.13803	
TM3	0.13926	0.13926	0.13926	0.13926	0.13926	0.13926	0.13926	0.13926
	0.13926	0.13926	0.13926	0.13926	0.13926	0.13926	0.13926	
TM4	0.14133	0.14133	0.14133	0.14133	0.14133	0.14133	0.14133	0.14133
	0.14133	0.14133	0.14133	0.14133	0.14133	0.14133	0.14133	
TM5	0.10316	0.10316	0.10316	0.10316	0.10316	0.10316	0.10316	0.10316
	0.10316	0.10316	0.10316	0.10316	0.10316	0.10316	0.10316	
TM6	0.07373	0.07373	0.07373	0.07373	0.07373	0.07373	0.07373	0.07373
	0.07373	0.07373	0.07373	0.07373	0.07373	0.07373	0.07373	
TM7	0.08852	0.08852	0.08852	0.08852	0.08852	0.08852	0.08852	0.08852
	0.08852	0.08852	0.08852	0.08852	0.08852	0.08852	0.08852	
TM8	0.10554	0.10554	0.10554	0.10554	0.10554	0.10554	0.10554	0.10554
	0.10554	0.10554	0.10554	0.10554	0.10554	0.10554	0.10554	
TM9	0.06623	0.06623	0.06623	0.06623	0.06623	0.06623	0.06623	0.06623
	0.06623	0.06623	0.06623	0.06623	0.06623	0.06623	0.06623	
Cost	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000			
Culture	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000			
HR	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000			
Quality	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000			
Time	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000			
Goal	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000			

The next step is to select the best option. If Super matrix was formed in the previous step, the network covers, the priority weights of the alternatives can be found in the column normalized Super matrix options. Based on these calculations, the results of measurement methods and technology transfer decision-making criteria in Table (4) is shown

Table 4. Prioritization Criteria weighting methods for technology transfer.

weight	criteria
0.156815	**cost**
0.230065	**culture**
0.246885	**Human resources**
0.135343	**time**
0.230792	**quality**

Table 5. Priority of technology transfer

Alternatives	Total	Normal	Ideal	Ranking
Staff training in advanced industrial countries.	0.1442	0.1442	1.0000	1
Establishing research centers in industrialized countries, R & D projects of common	0.1380	0.1380	0.9571	4
Establishment of research centers and "high level" within the	0.1393	0.1393	0.9657	3
Strategic partnerships or mergers	0.1413	0.1413	0.9800	2
FDI capital	0.1032	0.1032	0.7153	6
Turnkey approach	0.0737	0.0737	0.5113	8
Contracts to buy and sell goods and services, equipment, supplies and services	0.0885	0.0885	0.6138	7
Recruit and hire for deign experts and technicians, the migration of skilled man power and trained, holding in ternal training programs for personnel commerce companies, etc.	0.1055	0.1055	0.7319	5
Offshore outsourcing tech	0.0662	0.0662	0.4593	9

Table 6**.** Weight prioritization criteria for technology transfer methods using Shannonentropy

weight		criteria
0.2104		**cost**
0.2198		**culture**
0.2198		**Human resources**
0.1301		**time**
0.2198		**quality**

After weighting the evaluation criteria of technology transfer methods, TOPSIS decision matrix was designed. The results of Technology Transfer prioritization techniques using TOPSIS methods are given below.

Table 7. Decision Matrix TOPSIS

	X1	*X2*	*X3*	*X4*	*X5*
A1	4.67	5.33	4.25	3.5	4.17
A2	4.67	4.75	4.25	3	3.33
A3	4.44	4.25	4.25	4	3.67
A4	4.12	4.25	4.5	4.5	4.17
A5	4.23	4.25	3.25	3.25	3.33
A6	3.65	3.67	2.75	3	4
A7	4.68	3.75	3.25	2.67	3.25
A8	3.33	3.67	4	3.33	4.17
A9	3.45	3.67	2.67	2.25	2.67
Wj	**0.2104**	**0.2198**	**0.2198**	**0.1301**	**0.2198**

Table 8. Prioritization methods for technology transfer

rank	Cci	Distance to Negative distance	Distance to Positive distance	Technology transfer methods	rank
1	0.0782	0.18	2.07	Staff training in advanced industrial countries.	1
4	0.0718	0.16	2.08	Establishing research centers in industrialized countries, R & D projects of common¬	2
3	0.0721	0.16	2.08	Establishment of research centers and "high level" within the	3
2	0.0752	0.17	2.07	Strategic partnerships or mergers	4
6	0.0644	0.14	2.09	FDI capital	5
8	0.0609	0.14	2.1	Turnkey approach	6
7	0.0630	0.14	2.1	Contracts to buy and sell goods and services, equipment, supplies and services	7
5	0.0664	0.15	2.09	Recruit and hire foreign experts and technicians, the migration of skilled man power and trained, holding internal training programs for personnel commerce companies, etc.	8
9	0.0562	0.12	2.12	Offshore outsourcing tech	9

Prioritizing Methods of TOPSIS technique results suggest that the method of training employees in industries in developing countries is a priority.

Discussion

After identifying the standards and methods of technology transfer technology transfer methods were used for prioritization methods. In the first method, the hierarchical tree study was painted prioritization technology transfer methods. This tree is three levels. In the first level, the study evaluation criteria in the second level and third level are the methods of technology transfer. The relationship between standards and methods in the study of the

technique of ANP for the transfer of technology prioritization technology transfer methods were used in the oil industry. When there is an internal relationship between the criteria, ANP technique offers more accurate results. Then after collecting opinions of experts in the form of paired comparisons matrices, a matrix formed with Super decision software tests.
The results obtained by weighting the decision criteria in the form (3) are shown.
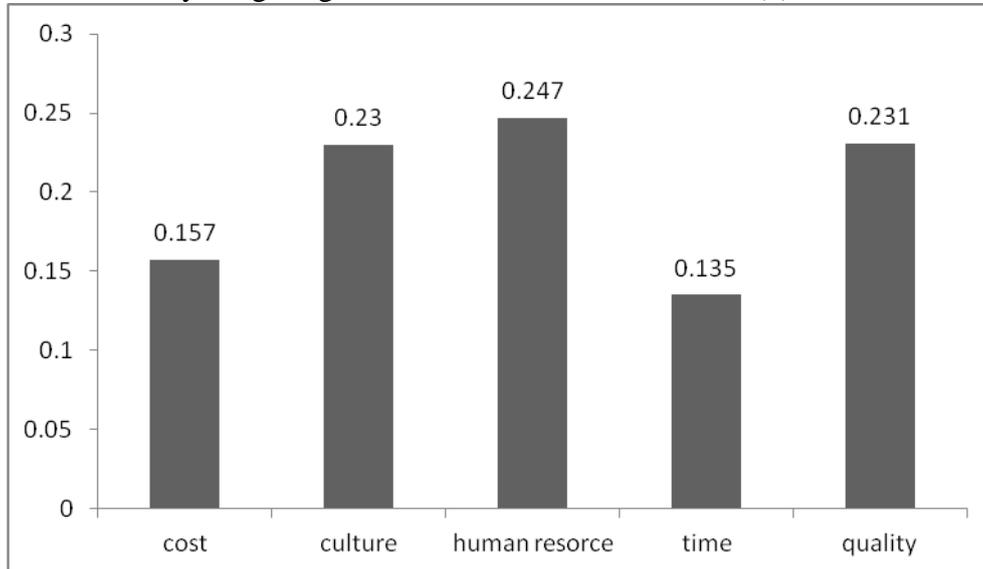

Figure 3. The weight of the evaluation criteria forms of technology transfer

The results suggest that the views of industry experts, the most important criteria for evaluating methods in the industry is technology transfer, human resources. The human resources, quality, culture, time and money are important, respectively. After weighting the criteria, the results were presented prioritization technology transfer methods. The results of this prioritization is as follows:

1. Staff training in advanced industrial countries.
2. Co-integration
3. Establishment of research centers and "high level" within the
4. Establishing research centers in industrialized countries, R & D projects of common
5. Recruit and hire foreign experts and technicians ¬ migration of skilled and trained manpower, conducting internal training programs for employees, business firms, etc.
6. FDI capital
7. Contracts to buy and sell goods and services, equipment, supplies and services
8. Turnkey approach
9. Offshore outsourcing tech ¬

The second method of Shannon's entropy and TOPSIS technique for combining prioritization methods were used for technology transfer. Shannon entropy techniques were used to determine the weight of evaluation criteria. The results of the prioritization methods ANP technique was exactly the same. But Shannon's entropy technique with ANP weights obtained were different. Table (9) shows this.

Table 9. Comparison of Shannon entropy weight method and the ANP

ANP	Shannon entropy	Criteria
0.156815	0.2104	cost
0.230065	0.2198	Culture
0.246885	0.2198	Human Resources
0.135343	0.1301	time
0.230792	0.2198	Quality

As the above table shows the results of the Shannon entropy weight method, three criteria, organizational culture, human resources and quality are equal. there is a distinction between the three weights in ANP technique. This can be considered due to the fact that Shannon's entropy technique, standard criteria to determine the relationship between the distributions of responses is not considered significant in ¬. If the internal relations among the variables considered in ANP technique and the results are more accurate. ANP and TOPSIS technique results suggest that industry experts, technical staff training procedures in developed countries, industries, institutes and research cooperation and the establishment of integrated "high level" within the first three countries are priority

Technological capabilities at the lowest possible level to the highest level of research and development before going to take advantage on relying machine hardware and software is less important and more human resources.

The final product will be about the role and value added of the tendency of the rate increases. The role will be marginal. Conversion of natural resources into finished products in the same trend is significant. The final result will be about the role and addedvalue of the tendency of the rate increases.This is true in most industrialized countries. Asia's newly industrialized countries where most industrial companies, its employees systematic way of teaching modern foreign companies are sending. Thus, engineers and technicians dispatched at the technology and operations experiences are foreign corporations and also with those devices, industrial, technical and marketing they are familiar.

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