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Ranking the Methods of Technology Cross-Border Acquisition, Combining TOPSIS and ANP Approaches for Model Development

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Abstract. Simultaneous with the industries increasing growth, the companies must acquire the new technologies to achieve the core competency, survival and improvement and also effectiveness in market. Choosing the suitable acquisition mode of required technology is one of the critical strategic decisions in the field of technology management. Due to the importance of technology acquisition, the main objective of this study is to select an appropriate method of technology acquisition in car part industry by multi-dimensional factors of environmental, technological, capability and market. Hence, after extracting the factors from surveying the related literature and conforming the first kind of questionnaire by the cronbach's alpha, the elements was ranked by TOPSIS method to reduce the criteria and to choose the appropriate affecting elements in technology acquisition modes. In the next step regarding to ANP method second questioners spread between the experts in the car part industry in Iran and the modes were prioritized and the applied recommendations have been suggested.

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1. Introduction

Technology is considered as an important factor in progress or wane of industry which paying attention and investigation in it play a crucial role in industrialization, globalization and entering to global markets and connecting to WTO. Due to drastic changes in technology, developing countries are facing a serious struggle, so that most of these countries are seeking to acquire new technologies and are aware of the influence of this technology to their capability to build modern industries (reducing the gap between industry own findings and developed countries) and consequently entering to global markets. It is clear that developing countries needs to the technology for industrialization. (Feghhi Farahmand, 2004) Based on Burgers et al(2008) Although the changes are continuing and rapid, acquisition of Know-How to achieve new developments that provide innovation in the organization are continually required. Lanctat and Swan (2000) showed the capability of company to develop and exploit of the Know-How is one of the fundamental aspects of competition. According to Hagedron (1993) some categories are presented for describing the features of the technology acquisition methods. However, according to Cho & YU (2000) there are a variety of activities with respect to the degree of importance of different investment process in company, which can run with internal R & D and existing R & D in organizations or using experts in other organizations. Research also shows that a most important technology management issue, identifying the strategic plan for technological products (Nabil et al, 2009). Thus, according to Cho This is the best reason for why management of technology requires to study the internal conditions and environment to enable it to quickly adapt themselves to changing environments in order to strategic decisions. Several studies have classified technology acquisition methods. In the influencing factors in choice of technology acquisition mode Cho and yu has been proposed the integrated framework of internal and external

factors, including the characteristics of a firm that requires external environment and technology. Despite all of the researches, categories and evidences the main issue is ,how the company wants to acquire needed technology to be compatible with internal and external conditions of the project so that company does not has failed? On the other hand, this problem should be noticed that although many factors can affect the acquisition of technology, but all of these factors could not be noticed with the precision and efficiency in the organization or industry in the same time and according to the conditions and progress of the industry, factors that have the highest priority, should be considered.

2. Literature Review

Industrial development is an important factor in economic development and is a function of the technology variables. (Feghhi Farahmand, 2004) technology is defined as critical information for the design or production of a product or a service by a person or organization. Technology can be appeared as machines, products or services. This information can be caused from accumulated experiences in R & D, design, production and capital investment(Kondo, 2005). Technology transfer is also a chain of purposeful activities which are interconnected and other than "creation in initial place of technology" are exploited at points such in training, acquisition, development, Evolution, and wider application (Feghhi Farahmand, 2004). With respect to technology transfer (Figure 1), Nelson and Winter (1982) and Fine (1992) concluded that: The main features of the social and technical technology transfer process model, interaction of innovation and acquisition, and provider is which determine the key factors of learning and development. Learning and development includes institutional and individual learning. Using innovation is emphasized on the fact that the technology transfer should be adapted with possible continuous changes (Levin. M , 1993). On the other hand, Garegory (1995) emphasized the acquisition and localization of the technology in the five-stage technology management model. These steps are:

1. Identify technologies that are considered important for business
2. Choosing technologies that should be provided by the organization

3. Acquiring and adaption of selected technologies

4. Exploitation of technologies that is beneficial

5. Protect the proficiency and knowledge used in the manufacture of products and systems.

Garegory's model is related to other models such as the Sumanth Model (1996), which includes consciousness and assimilation, adaptation, development and progress and transfer. Therefore, in developing countries to reduce the gap between developed and developing countries as well as technology development. Management should transfer and acquire technology, using appropriate methods.

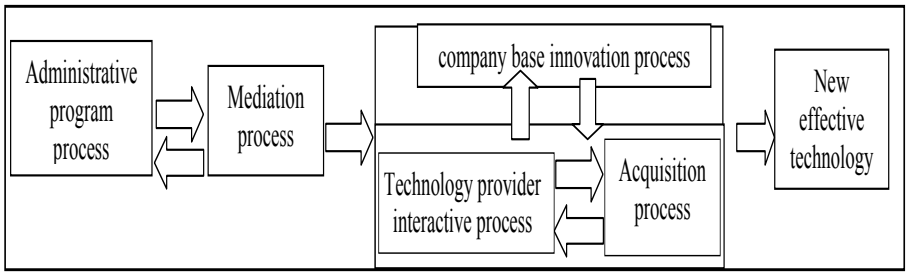

Figure 1. Development and technology transfer as a process of social-technical learning. (Levin, 1993)

Because of different reasons one company cannot extend all technologies by itself. (Gold, B, 1971) In kondo's view (2005) for optimization of technology levels in a country, 3 approaches can be taken into account:

1. Introducing and acquisition of foreign technology.

2. Improvement of existing technology.

3. Localizing of the new developed technologies by official R & D.

Acquisition of technology is one of the tasks of the technology management which is available through internal or external R & D (Brockhoff, K, 1992). Technology acquisition means complete understanding of its process and equipment designation so that the recipient country can achieve progress on the acquired technology. It is used by native needs to be transferred to other countries to a more sophisticated form.For example, countries like Japan and Korea have been able to organize

their industrial production and have entered to global markets. Based on the Japanese experience a fruitful transfer has a set of principles which briefly includes:

1. Technology should be chosen in according identifying national needs and resources, and existence conditions.

2. Imported technologies should be selected in accordance with environmental conditions.

3. Changes, imitation in manufacturing and introduced information technology must be implemented by the trained native troops. Technology transfer should be accompanied with the knowledge of using it. (Feghhi Farahmand, 2004).

On the other hand, Daim and Kocaoglu in their study consider the technology acquisition as an important process to effective development of technology innovation. So, technology acquisition is defined widely as attracting Know-How to develop new products and processes (Hemmert, martin, 2004).

Research shows that the most important technology management issues the identifying of strategic plan for technological products is (Nabil et al, 2009). Several studies have classified technology acquisition methods: spekman and Durrani Have identified the contract of technology as an important acquiring mode including the internal and external technology. Ford has identified 5variable of technology acquisition as buy, franchise, internal development, external R & D contracts, joint based on the R & D activities. Cui and Wang have divided techniques and methods of technology acquisition to internal and external modes (Lui, & Tao, 2009). Cho and Yu (2000) and Hammert (2004), acquiring of Know-How is possible from the following strategies:

1. Internal activities of the R & D activities type.

2. Collaborative activities with other organizations such as cooperative R & D projects.

3. Acquiring of the technology from external for example license agreements and R & D contracts (Hemmert, 2004). Based on involvement in R & D activities Cho and Yu have identified three ways of technology acquisition:

(1) R & D Cooperation: Cooperate includes various forms of co-

operation with other firms with or without equity involvement such as joint venture, joint R & D and alliance. (Lee, Lee, park 2008) In this way, a strong system of scientific value creator is created in the destination country. Using know-How and re-engineering, this knowledge can be transferred to manufacturing area. In this way imported knowledge can be re-created in a critical system and Due to this next trend (exchange of knowledge) will be done creative and easily (Ghane Basiri, 2000).

(2) In house R & D: In house R & D is the technology production. (Lee, Lee & Park, 2008). In this way, destination country creates a scientific value force creator and tries to manage the importing trend to industry through leading this force; hence result of R & D are leaded to the know-How. This process is the reverse of R & D Cooperation process, and the technology manufacture takes to explore the hidden knowledge (Ghane Basiri, 2000).

(3) External purchasing: Buy constitutes a form of R & D contract, acquisition, licensing, and outsourcing (Lee, Lee & Park, 2008). In this way, a scientific-market value creator force is created. This force tries to take a part in the activity to improve through acquisition of exchange and market discovery methods. Thus, market resources of a region are discovered and through market discovery forces and production mechanisms, facilities are provided to satisfy the new market (Ghane Basiri, 2000). There is a wide classification of features based on engagement in the area of R & D. Internal R & D in the R & D department, or often is done by setting up a team or work group. Hagedorn (1998) presented that there are various classification for describing of the methods characteristics. In this study, a large category of factors is defined based on engaging in the field of R & D. R & D cooperation between firms happens to participate in R & D efforts on specific projects. Technology acquisition can be defined as sourcing and acquiring know-how to develop new products and processes. Knowledge is acquired by (1) the internal R & D workings of the company (2) by the collective activities with people who are from outside of the company such as R & D collaboration project, and (3) acquisition of technology from abroad, for example, through license agreements, or R & D contract. Thus, acquisition of technology develops beyond the R & D so that on the one hand,

it covers the technology acquisition joint and foreign and on the other hand saving and exploitation of external technologies that are parts of the R & D function (Hemmert, martin, 2004).

Hung and Tang have surveyed communication of technological capability and size criteria, with technology acquisition methods. Cui and Wang Analyzed and categorized criteria to five influential factors including the technology life cycle, technology pattern, investment risk, and the necessity of technology and Technological position (Lui, & Tao, 2009). Overall, this article in the first step has paid attention to rank the factors affecting technology acquisition. Therefore after literature review, a number of factors were identified in Table 1.

3. Methodology

According to Kondo (2001) as one of the essential concepts in technology strategy, technology acquisition methods should be carefully selected. According to Lee and Park (2008), the selection of a suitable acquisition mode for required technology is a critical strategic decision to implement a technology strategy. Also, Cho and Yu (2000) suggest these factors may be resulted in different consequences due to comparison between various industries, across countries and the differences between SMEs and large firms. The data collection for this study was descriptive and non-experimental research because it involves a series of procedures that aim to explain the position of the investigated phenomena. This research is the applied research based on the objective. Applied research will lead to practical application of knowledge. The results of this research will facilitate decision-making. Since the aim of this research, investigation of the factors affecting technology acquisition is, it is descriptive study (Hafez Nia, 2008). MADM decision-making techniques have been used in the study. Topsis and ANP belong to MADM techniques. Based on Saaty (2001A) ANP is more general and more complete model of AHP that permits to analyze of the various questions by reciprocal relationship between factors. This interaction sometimes is called feedback system. He improved a technique to compute the weight of these questions that called Super matrix. (Saaty, 1996) Data analyzing

accomplished base on TOPSIS and ANP method.

Table 1: factores affecting TAM

	Authors	**Factors**
1	CHO and YO(2000) , Rosenbloom and Cusumano(1987)	Market size
2	Monart et al(1990), CHO and YO (1985) , Pisano (1990) . Nelson and Winter(1982)	experience R&D
3	Ford(1988), Lowe and Taylor(1998)	R&D activity
4	Chiesa (2001) , Hemmert(2004)	Availability of external sources
5	Walker and Webber (1987) CHO and YO(2000), Cui and Wang (2005) Dodgson(1992), Hamel et all (1989) , Chiesa and Manzini(1998), Baughn and Osborn(1990) , Mahoney(1992) , Llerena and Wolf(1994) , Veugelers (1997),Walker and Webber(1987)	Commercial uncertainty
6	H.K. Steen sma and K.G. Corley(2000)	Ease of imitate
7	CHO and YO(2000)	Government support system from R&D process
8	CHO and YO(2000), Pisano(1990), Lowe and Taylor(1998), Allred and Swan(2004) , Shan (1990) Perrino and Tipping,(1989)	Competitive intensity
9	CHO and YO(2000), Cui and Wang (2005) , Lowe and Taylor(1998). Roberts And Berry (1985), Moenaert et all (1990) , Tyler and Steensma (1995), Ford(1988)	Technology level
10	Park &Ghauri(2010)	Active assistance of foreign acquiring firms in technology management
11	Kurokawa (1997), Tyler and Stee nsma (1995), CHO and YO(2000), Teece(1986) , Veugelers and Cassiman(1999), Spence(1984)	Appropriability regime
12	Hung & Tang (2008), Park and Ghauri(2010)	Tendency to learning
13	CHO and YO(2000), Croisier(1998), Tyler and Stee nsma (1995),	Developing cost

4. Findings

Before analyzing the data the reliability of the firs questionnaire has been confirmed about 0.882. TOPSIS prioritizes and reduces the factors that the inputs of the next (ANP) step will be provided.

Steps of TOPSIS:

First: Normalizing: After collecting the questionnaires and calculating the geometric mean of the data, the data in Table 2 were obtained by using Euclidean Normalize

	cooperation R&D	**Buy**	**make**
1.	0.49	0.548	0.676
2.	0.585	0.562	0.583
3.	0.542	0.619	0.567
4.	0.469	0.689	0.552
5.	0.406	0.635	0.656
6.	0.541	0.561	0.625
7.	0.501	0.516	0.694
8.	0.583	0.544	0.602
9.	0.575	0.631	0.519
10.	0.491	0.689	0.531
11.	0.524	0.631	0.570
12.	0.458	0.669	0.584
13.	0.503	0.593	0.627

Second: the evaluation of weights of factors: According to the formula (3-9) and , k=0.3898, (TOPSIS Formula). Data were obtained according to the following table. At this stage, the table of weights has been obtained using the entropy.

Table 3: factors weights

	۱	۲	۳	۴	۵	۶	۷	۸	۹	۱۰	۱۱	۱۲	۱۳
E_j	.367	0.37	0.37	0.366	0.367	0.362	0.37	0.366	0.37	0.369	0.366	0.369	0.369
D_j	0.632	0.629	0.629	0.633	0.637	0.629	0.633	0.629	0.63	0.633	0.63	0.633	0.63
W_j	0.077	0.076	0.076	0.077	0.077	0.076	0.077	0.076	0.076	0.077	0.076	0.077	0.076

Third: Ranking of options (alternatives): According to Table 3, the

weights are close to each other, the criteria weights are 0.077 were selected. According to the ranking criteria based on distance from the negative ideal, options prioritize as Figure 1 would be: weight options to suit all standards for the make, buy and R & D cooperation, respectively, 0.591 and 0.565 and 0.357 is.

Figure 2. Ranking acquisition methods using TOPSIS method based on 13 factores.

After ranking the primary criteria and extraction of key criteria by TOPSIS method in the first part, in this section will be discussed to rank the options according to the paired comparisons of elements. General steps for network analysis is as follows:

1. Network design for ranking and selection of appropriate technology acquisition method (Figure 2).

2. The questionnaire was designed based on paired comparisons Network.

3. The questionnaires were distributed that is designed based on Al Saati's matrix and collect them.

4. Entering the questionnaires one by one to survey the reliability and they were corrected.

5. Calculating of Group ANP by the geometric mean for each matrix based on following formula:

$$(x'_{ij}) = (\prod_{l=1}^{k} x_{ijl})^{\frac{1}{k}} = (x'_{ij}) = \sqrt[k]{x_{ij1} \times x_{ij2} \times ... \times x_{ijk}}$$

6. Entering the result of the geometric mean of each pair comparison between elements in Super decision software.

7. Entering the geometric mean results of each pair comparison between clusters in the Super decision software to prioritize each of the criteria and calculate their weights.

8. Formation of Not weighted Super matrix with combination of pair comparison matrix and also weighted super matrix using the extracted weights (multiplying the weight of clusters in each element of not weighted super matrix).

9. Organizing the Super matrix constrained or weighted matrix using Markov process (super matrix exponentiation to stabilize the super matrix to obtain equal numbers in each row).

10. To obtain priority over other options.

Table 4: Resulted output from super decision software

Graphic	Alternatives	Total	Normal	Ideal	Ranking
	1A-make	0.165	0.33	0.83	2
	2A-buy	0.137	0.27	0.69	3
	3A-R&D	0.197	0.39	1	1

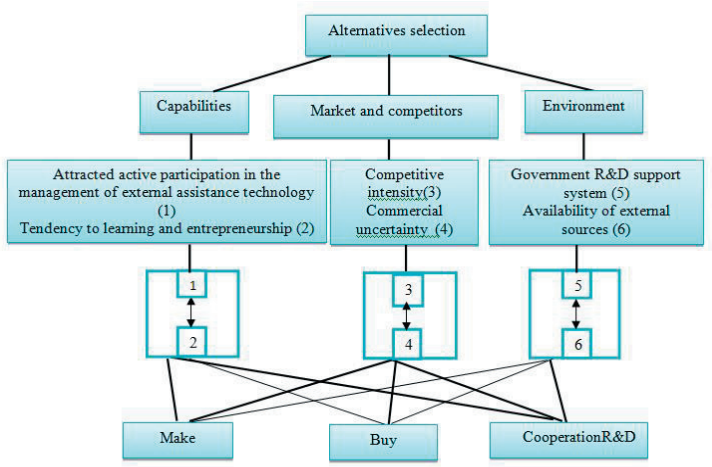

Figure 3. Network of selection of technology acquisition modes based on 6 key factors in car part industry

5. Conclusion

Despite all the challenges, receive and acquire of technologies is the inevitable alternative in developing countries to achieve sustainable economic growth and development. Naturally, constituting of the requisite and flexible legal infrastructure and selection of the efficient methods to technology acquisition to reduce the gap between developed and developing countries, is an important issue to choose appropriate strategies at the national level. Based on the selected model, the first step of choosing the proper method of institutional acquisition is analyzing of the acquisition requirements. After determining these cases organizational assimilation priorities should be determined based on different criteria. In the first section, attracted active participation in the management of external assistance technology, Tendency to learning and entrepreneurship, Competitive intensity, commercial uncertainty, Government support system R & D, Availability of external resources were selected by car par industry experts. according to final resulted output includes: R & D cooperation with a weight of 0.39 is in the first rank, make and buy options put respectively, 0.33 and 0.27 in second and third. Sensitivity analysis can be used to identify and suggest how will change one dependent variable (technology acquisition method) through increasing or decreasing in the independent variables. Thus it can be predicted to change the options on the industry, what factors should be improved. For example, in according to Purpose of this study that is selection of appropriate methods of technology acquisition, if capabilities factor progress, R & D alternative will not be changed but making and buying possibility reduces. It must be noticed, in all cases, the mechanism of technology development through investment in R & D and technology diffusion should be addressed between the main players in the industry. Since Technology entering to the country without its propagation, which is one of the main functions of the innovation systems, will not be able to make industry development.

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