Factors Analysis and Countermeasure Research of Influencing Technology Transfer Across the Industry

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***Abstract*--Technology transfer across the industry is considered as one of the important issues in technology transfer research. By means of literature retrieval combined with expert investigation, firstly we find out factors influencing technology transfer across the industry. Secondly each factor is determined according to Fuzzy Analytic Hierarchy Process (FAHP) . Thirdly we make an analysis of mutual influence between key growth factors based on the method of DEMATEL. In order to put forward pertinence solutions for improving technology transfer across the industry, Attention & Recognition Matrix model is used to express how key growing factors come into play in current situation. Finally countermeasure study is made. The conclusion of the study lays a solid foundation for encouraging technology transfer across the industry and applications of technological achievements among several industries.**

I. KEY GROWTH FACTORS ANALYSIS OF NEW TECHNOLOGY TRANSFER ACROSS THE INDUSTRY

We explain the growth subjects (actors) that influence new technology transfer across the industry based on ANT theory. Each subject will involve many factors in the behavior process. Therefore, it will promote rapid growth of new technology transfer across the industry to identify the key factors from many growth factors.

A. The identification method of key growth factors

The factors influencing technology transfer are usually concluded into some concepts, such as mining capacity or identifying ability of application opportunities of new technologies. And judgment of the satisfaction degree of related factors is also vague, such as very strong, strong, weaker, weak etc. The subject of fuzzy evaluation are experts. Different experts' feelings for the same grade standard may be different. Even an expert in different situations about the same problem may also have different judgments. Simply using the method of expert opinions' average or median value may lead to ignoring a small amount of experts' opinions. But the Fuzzy Delphi Method (FDM) and the Fuzzy Analytic Hierarchy Process (FAHP) can well solve the corresponding problem.

New technology transfer across the industry belongs to technology transfer. Firstly papers about influencing factors of technology transfer or knowledge transfer are retrieved by the literature retrieval approach. Secondly related factors are screened as importance growth factors of new technology transfer cross the industry which are surveyed by FDM. Thirdly factors of high expert recognition degree are screened from related growth factors by using FDM. Fourthly the weight of each importance growth factor is given according to FAHP. Finally the key growth factors are determined using comprehensive evaluation, see Fig.1.

1) Obtaining factors of technology (knowledge) transfer based on bibliometric analysis

In order to determine growth factors of influencing technology transfer across the industry, the bibliometric analysis method is used in the paper. Firstly, we retrieve papers about influencing factors of technology transfer or knowledge transfer from journal papers or master's thesis or doctoral. Then we select papers studying the correlation of influencing factors from them. Because their analysis often bases on surveys or interviews, it can guarantee relative objectivity of results. Considering the aim of the study, we remove the papers whose objects are intra-organization or inner-enterprise in the literature retrieval process.

The retrieval process in detail follows below. In the CNKI database (only selected journals and thesis database) , retrieval method uses following expressions: (TI=technology transfer OR TI=knowledge transfer) AND (SU=influencing factors AND SU=correlation) NOT (TI= intra-organization OR TI= inner-enterprise) . The time period is from 1999 to 2013 (June 10, 2013) . 25 records were retrieved including 3 journal papers and 22 master and doctoral thesis. And there are 4 papers published in 2006, 2 in 2007, 3 in 2008, 2 in 2009, 6 in 2010, 3 in 2011 and 5 in 2012. Though reading each paper, the influencing factors of technology (knowledge) transfer were determined.

According to the retrieval method, the similar factors are combined and total 30 factors are collected (Tab 1).

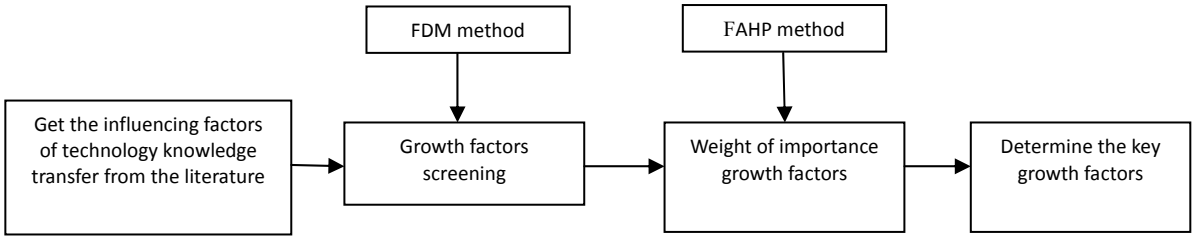

Fig.1 The process of analysis of the growth factors of new cross-industry technology transfer

TAB 1 FACTORS INFLUENCING TECHNOLOGY (KNOWLEDGE) TRANSFER

No.	Factors	No.	Factors	No.	Factors
1	Transfer willingness	11	Knowledge stickiness	21	Document delivery
2	Transfer ability	12	Knowledge distance	22	Personnel Exchange
3	Accept willingness	13	Relationship distance	23	Organizational culture
4	Absorptive ability	14	Geographic distance	24	Policy
5	Prior experience	15	Organizational distance	25	Economic conditions
6	Identification ability	16	Trust	26	Social Network
7	Mining ability	17	Seminar	27	Protection consciousness
8	Knowledge ambiguity	18	Motivation	28	Transfer cost
9	Knowledge embeddedness	19	Cooperation	29	Technology platform
10	Knowledge complexity	20	Training	30	Development strategy

By reading each retrieved paper combined with the concept interpretation of influencing factors of technology transfer in each paper, concept interpretation of the 30 factors is determined considering the characteristics and aim of this study. And it serves as the basis of FDM expert investigation in order to screen the importance growth factors. See Tab 2 for each factor' interpretation.

2) Screening step of growth factors based on FDM

The traditional Delphi method needs long time and high cost of implementation. And in order to meet the requirements of the convergence result, experts sometimes need to change their judgments. In order to solve the shortage of traditional Delphi method, Murry put forward Fuzzy Delphi method (FDM) by combining the fuzzy theory with traditional Delphi method[4]. The FDM requires only a small amount of samples, and can get objective and reasonable conclusion[5]. Therefore, it can be used for extracting influencing factors[6]. FDM analysis steps are as follows.

Firstly, solicit expert opinions and express expert opinions with triangular fuzzy number[5,7].

Tab 2 The definition of factors influencing technology (knowledge) transfer

No.	Factor	Explanation
1	Transfer willingness	The subjective desire of technology (knowledge) owners to spread the technology or knowledge to other areas.
2	Transfer ability[1]	Whether or not technology (knowledge) source can express the knowledge accurately in an appropriate manner and choose appropriate transfer channels to let technology (knowledge) receiver learn and absorb.
3	Accept willingness	Whether or not technology (knowledge) receiver have a definite purpose and a strong desire to accept and absorb technology (knowledge) from knowledge source , which reflects the strength of the attitude and expectation of accepting the knowledge initiatively by technology (knowledge) receiver.
4	Absorptive ability[2]	The ability of identifying, digesting and absorbing, applying and evaluating new technology (knowledge) by technology (knowledge) receiver.
5	Prior experience	Have successful experience of transferring technology (knowledge) from other fields.
6	Identification ability	The ability of identifying available technology (knowledge) from many technologies (knowledge) with similar functions.
7	Mining ability	The ability of judging the application prospects and opportunities of technology (knowledge) from relevant technology (knowledge) .
8	Knowledge ambiguity	It is very difficult to express technology (knowledge) through coding literature, patents etc.
9	Knowledge embeddedness	It is not easy to find technology (knowledge) in open information like literature, patent, internet etc.
10	Knowledge complexity	Technology (knowledge) includes multifunctional, multi professional background.
11	Knowledge stickiness[3]	The difficulty degree of technology (knowledge) transfer.
12	Knowledge distance	The similarity of knowledge between technology (knowledge) source and transferred receiver.
13	Relationship distance	A good communication and cooperation state between technology (knowledge) source and transferred receiver.
14	Geographic distance	The closeness between technology (knowledge) source and transferred receiver on the geographical position.
15	Organizational distance	The difference between organizations in business model, values, norms, culture etc.
16	Trust	The mutual trust degree between technology (knowledge) source and transferred receiver.
17	Seminar	A platform sharing technology (knowledge) .
18	Motivation	Measures taken by technology (knowledge) source and receiver to promote knowledge transfer or absorption.
19	Cooperation	Work with teams from different fields and with different background knowledge.
20	Training	Sharing of information on knowledge transfer by technology (knowledge) source and receiver.
21	Document delivery	A way of technology (knowledge) transfer.
22	Personnel Exchange	A way of transferring technology (knowledge) through exchanging persons.
23	Organizational culture	The commitment degree of organization on technology (knowledge) transfer.
24	Policy	Promotion or block made by organization environment on technology (knowledge) transfer.
25	Economic conditions	The macroeconomic condition of technology (knowledge) transfer.
26	Social Network	Technology (knowledge) innovators, users and the mutual relationship constituted by them.
27	Protection consciousness	The exclusive expectation degree of technology (knowledge) source on achievements.
28	Transfer cost	The cost of realizing technology (knowledge) transfer made by technology (knowledge) source and receiver.
29	Technology platform	Matching technology (knowledge) content related to technology (knowledge) transfer.
30	Development strategy	The future developing direction and position of different subjects of technology transfer (knowledge) .

In 1965, Zadeh[8] proposed the fuzzy set theory. The analysis model satisfies the human reasoning process, and the theory provides the method to solve uncertain and complex problems. The fuzzy theory used the membership function and the membership degree to define attributes of concept. Given X be a domain (all the objects of study in the setting range) . If fuzzy sets A in X is for any $x \in X$, With a degree of $\mu_A(X)(\mu_A \in [0,1])$ the X belongs to the A. Expert opinions are set by the triangular fuzzy number.

Definition 1: A fuzzy number $\tilde{A}$ is in real number field R, and define a membership function: $\mu_A(X): R \to [0,1](x \in R)$, if the membership function is expressed as the formula 1:

$$\mu_A(X) = \begin{cases} 0; x < l \\ \dfrac{x-1}{m-1}; 1 \le x < m \\ \dfrac{x-u}{u-m}; m < x \le u \\ 0; x > u \end{cases} \quad (1)$$

$\tilde{A}$ is known as the triangular fuzzy number, denoted as $\tilde{A} = (1, m, u)$. Including $1 \le m \le u$.

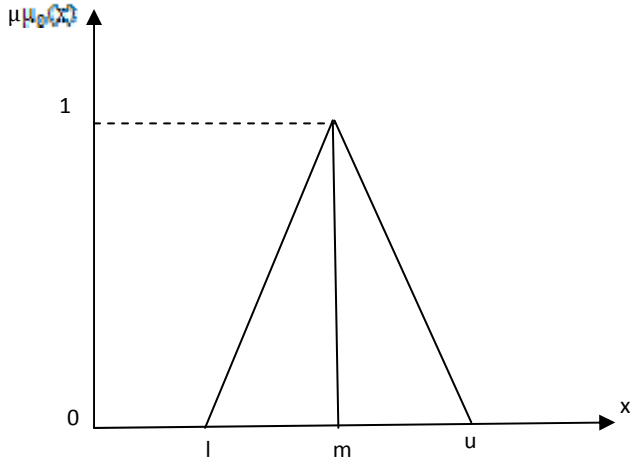

Fig.2 Triangle fuzzy number

Secondly, synthesize experts' opinions by using the triangular fuzzy numbers[9].

Each expert gives own triangular fuzzy evaluation value of each evaluation factor. l_{ik} is the most pessimistic value that expert K evaluate factor i. m_{ik} is the most possible value, and also is called the single value. u_{ik} is the most optimistic value. l_{ik}, m_{ik} and u_{ik} of all experts are summed, then the extreme value of two times the standard deviation is eliminated, and the triangular fuzzy number $\tilde{A}_{ik}$ is established by the surplus value. The method in detail is as follows. Based on the $\tilde{A}_{ik} = (l_{ik}, m_{ik}, u_{ik})$, the minimum of the most pessimistic, $C_l^i = \min(l_{ik})$, the geometric mean, $C_m^i = \sqrt[n]{\Pi_{k=1}^n u_{ik}}, k = 1,2,\ldots,n$, and the maximum, $C_u^i = \max(l_{ik})$ are given; the minimum of the most optimistic, $O_l^i = \max(u_{ik})$, the geometric mean, $O_m^i = \sqrt[n]{\Pi_{k=1}^n u_{ik}}, k = 1,2,\ldots,n$, and the maximum, $O_u^i = \max(u_{ik})$ are given; and the geometric mean of the most possible (the single value) , $M = \sqrt[n]{\Pi_{k=1}^n m_{ik}}, k = 1,2,\ldots,n$ is given.

Thirdly, compute expert evaluation consensus degree value G^i by using the double triangular fuzzy numbers analyze[10].

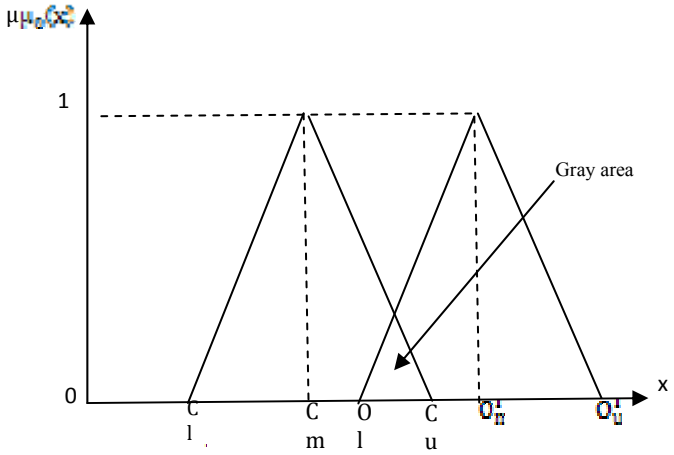

Fig.3 two triangular fuzzy numbers

Given: $D^i = C_u^i - O_l^i$ (2)

$$Z^i = O_m^i - C_m^i \quad (3)$$

Where $C_u^i \le O_l^i$, grey zone does not exist, then $G_i = \dfrac{C_m^i + O_m^i}{2}$ (4)

Where $C_u^i - O_l^i \le O_m^i - C_m^i$, $D^i - Z^i \le 0$, then grey zone exists, and G_i is computed according to formula (5) and (6) .

$$F^i(x_k) = \left\{ \int_x \left\{ \min\left[C^i(x_k), O^i(x_k) \right] \right\} dx \right\} \quad (5)$$

$$G^i = \left\{ x_k \mid \max \mu_{F^i}(x_k) \right\} \quad (6)$$

Where $C_u^i - O_l^i > O_m^i - C_m^i$, $D^i - Z^i > 0$, it explains expert opinions are too different and good consensus degree can't be formed. At the moment it needs to do expert investigation until making G^i be correct.

B. FDM analysis of growth factors influencing technology (knowledge) transfer across the industry

Firstly select the experts

1) Principles of selecting experts. They can accept the membership mode to answer questions and have an adequate understanding of research problems.
2) Determining the number of experts. Robbins[11] put forward that the group decision should have a reasonable scale, approximately 5-15 persons. According to the reference [12], this paper considers the group including 5-7 persons is the most effective to a certain degree.

In the FDM survey stage, this paper selected 7 experts; experts' age is from 27 to 56; the group has 3 men and 4 women; their occupation background contains enterprises (2 persons), research institution (1 person), colleges and universities (3 persons) and government (1 person); professional background includes Environmental Engineering, Chemical Engineering, Information and Communication Technology, Industrial Engineering, Management and Enterprise Management.

Secondly investigate questionnaire. According to Tab 2, the questionnaire is made and sent to experts.

Thirdly sum up questionnaire and compute expert evaluation consensus degree (Tab 3).

Fourthly remove factors that consensus degree is less than the threshold value and determine the screened results by FDM survey (Tab 3).

C. Determine the weight of every growth factor based on the Fuzzy AHP

After FDM's screening, 15 factors are retained and serve as the basis for further analysis. FDM is only used to screen factors but retained factors aren't ranked based on importance compared with each other. Lacking weight of related elements is difficult to determine the key growth factors and incentive mechanism of solving problems and promoting development is not easy to present. There are many ways to determine the weight of growth factor, such as Analysis Hieratic Process (AHP) suggested by Saaty. But the evaluation of growth factors often adopts fuzzy concept evaluation, e.g. important or more important. And experts are also used to use fuzzy language when considering importance of factors. Therefore, the Fuzzy AHP is more effective to get important rank for evaluation objects of fuzzy features.

1) FAHP method

In the early 1970s, Staaty, the America famous strategist, proposed Analytic Hierarchy Process (AHP) , realizing the combination of qualitative analysis and quantitative analysis of complex problems. Although experts using 1-9 scale method can express subjective evaluation of importance of differences between objects, it uses precise numbers after all. Hence, it is difficult to reflect subjective feeling exactly. So some scholars considered the combination of Zadeh's fuzzy theory and AHP method. Van Laarhoven[13] was the first man who used the fuzzy concept into AHP and used triangular fuzzy number to represent the relative importance between elements. He realized rank of evaluation criteria through the fuzzy weight computing. In 1985, Buckley[14] stated concept of composition of fuzzy judgment matrix, fuzzy membership function and fuzzy consistency. Since then, many scholars using FAHP do analysis and discuss problems of complex system[15-17].

The analysis procedure of FAHP method is as follows.

Firstly, make up the fuzzy judgment matrix

The fuzzy judgment matrix is made up of triangular fuzzy number by using 1-9 scale method. Define $\tilde{A}_{(ij)}$ be fuzzy judgment matrix,

$$\tilde{A}_{(ij)} = (\alpha_{ij}, \beta_{ij}, \gamma_{ij}), \alpha_{ij} \le \beta_{ij} \le \gamma_{ij}, and \alpha_{ij}, \beta_{ij}, \gamma_{ij} \in \left[\frac{1}{9}, 1\right] \cup [1,9]$$

$$\alpha_{ij} = \min_k (A_{ijk}), \beta_{ij} = Geomeank_k (A_{ijk}), \gamma_{ij} = \max (A_{ijk}),$$

A_{ijk} are evaluation values of i and j given by expert K.

$$\tilde{A}_{ij} = \begin{pmatrix} 1 & \tilde{a}_{12} & \cdots & \tilde{a}_{12} \\ \tilde{a}_{21} & 1 & \cdots & \tilde{a}_{2n} \\ \cdots & \cdots & \ddots & \cdots \\ \tilde{a}_{n1} & \tilde{a}_{n2} & \cdots & 1 \end{pmatrix} \quad (7)$$

$\tilde{A}_{(ij)}$ is a reciprocal matrix, and its value is:

$$\tilde{a}_{ij} = (1,1,1), \forall i = j \quad (8)$$

$$\tilde{a}_{ji} = \left(1/\gamma_{ij}, 1/\beta_{ij}, 1/\alpha_{ij}\right), \forall i \ne j \quad (9)$$

Secondly, defuzzification computing

Computing fuzzy weight vectors uses computation rule of triangular fuzzy number. It is as follows.

Given: $a=[a_1,a_2,a_3]$ and $b=[b_1,b_2,b_3]$ are positive triangular fuzzy number, then:

1) $a \oplus b = [a_1 + b_1, a_2 + b_2, a_3 + b_3]$ (10)
2) $a \otimes b = [a_1 b_1, a_2 b_2, a_3 b_3]$ (11)
3) $\alpha a = (\alpha a_1, \alpha a_2, \alpha a_3)$ (12)
4) $1/a = a^{-1} = \left[1/a_3, 1/a_2, 1/a_1\right]$ (13)

Because the fuzzy evaluation matrix is composed of triangular fuzzy number, importance of objects given a final judgment should be implemented the defuzzification computing. There are many methods of defuzzification, e.g. center of gravity method and α cut set method.

TAB 3 THE EXPERT FINDINGS OF GROWTH FACTORS USING FUZZY DELPHI METHOD

Factor	Optimistic value triangular fuzzy numbers			Pessimistic value triangular fuzzy numbers			Single value geometric averages	D^i	Z^i	Grey area test		G^i	Remarks
	O_l^i	O_m^i	O_u^i	c_l^i	c_m^i	c_u^i	M	$(c_u^i - O_l^i)$	$(O_m^i - c_m^i)$				
Transfer willingness	6	6.38	10	3	3.73	5	5.51	-1	2.65	N		5.1	Delete
Transfer ability	4	7.53	10	3	3.99	6	5.58	2	3.54		Y	5.4	
Accept willingness	5	7.34	8	2	3.95	5	5.67	0	3.39	N		5.6	
Absorptive ability	4	7.67	10	3	4.41	6	5.66	2	3.26		Y	5.4	
Prior experience	4	6.53	10	1	1.84	4	3.70	0	4.68	N		4.2	Delete
Identification ability	6	8.34	10	3	4.25	7	6.55	1	4.09		Y	6.5	
Mining ability	5	8.37	10	3	4.34	6	5.71	1	4.03		Y	5.7	
Knowledge ambiguity	4	5.66	9	1	2.00	3	3.68	-1	3.66		Y	3.8	Delete
Knowledge embeddedness	5	7.10	10	1	2.49	5	4.43	0	4.60	N		4.8	Delete
Knowledge complexity	4	5.64	9	1	1.79	5	4.02	1	3.84		Y	4.4	Delete
Knowledge stickiness	6	6.94	9	2	2.63	4	4.66	-2	4.32	N		4.8	Delete
Knowledge distance	5	6.63	8	1	2.58	4	5.07	-1	4.05	N		4.6	Delete
Relationship distance	5	7.30	9	2	3.36	5	5.24	0	3.94	N		5.3	Delete
Geographic distance	3	4.48	8	1	1.43	3	2.46	0	3.05	N		3.0	Delete
Organizational distance	5	4.28	6	1	2.28	3	3.41	-2	2.00	N		3.3	Delete
Trust	5	6.65	8	2	3.83	5	5.78	0	2.82	N		5.2	Delete
Seminar	6	7.84	10	2	3.07	5	5.93	-1	4.77	N		5.5	
Motivation	5	7.04	8	2	3.56	5	5.32	0	3.48	N		5.3	Delete
Cooperation	5	7.18	9	3	3.93	5	5.52	0	3.25	N		5.6	
Training	5	6.96	10	1	2.12	4	5.19	-1	4.84	N		4.5	Delete
Document delivery	3	5.42	9	1	1.60	3	3.92	0	3.82	N		3.5	Delete
Personnel Exchange	7	8.38	10	2	3.33	5	6.11	-2	5.05	N		5.9	
Organizational culture	6	8.29	10	3	3.80	5	6.46	-1	4.49	N		6.0	
Policy	7	8.92	10	3	4.23	6	6.38	-1	4.69	N		6.6	
Economic conditions	6	8.32	10	3	3.87	6	5.93	0	4.45		Y	6.1	
Social Network	4	8.08	10	2	3.58	7	5.85	3	4.49		Y	5.6	
Protection consciousness	6	7.52	9	3	3.71	6	5.64	0	3.81	N		5.6	
Transfer cost	7	8.93	10	1	4.06	7	6.90	0	4.87	N		6.5	
Technology platform	4	7.84	10	2	3.45	5	5.64	1	4.39		Y	4.9	Delete
Development strategy	7	9.21	10	3	4.29	7	7.06	0	4.91	N		6.7	
Threshold value (average of single value geometric averages) = $\frac{\Sigma M}{50}$							5.30			Retain factors whose $G^i \geq 5.3$			

Note:① Higher G^i, stronger the consistency of its expert evaluation. ② When grey area does not exist, $G_i = \frac{C_m^i + O_m^i}{2}$; When it does exist, calculate using formula (5-5) , (5-6

① Center of gravity method. It was proposed by Tzeng and Teng[18] and its advantage is that it is not affected by the preferences of decision makers. The specific computing process is as follows.

Given: $A_{ij}=(L_{ij},M_{ij},R_{ij})$, then defuzzificating

$$DF_{ij}=\frac{(R_{ij}-L_{ij})+(M_{ij}-L_{ij})}{3}+L_{ij}=\frac{L_{ij}+M_{ij}+R_{ij}}{3} \quad (14)$$

② α Cut set method[19,20]. It can better reflect the attitude of problem decision makers. See as follows:

$\forall\alpha\in[0,1]$, α cut set of fuzzy set $\tilde{A}$ is $\alpha\tilde{A}$.

$\alpha\tilde{A}=\left[(a_2-a_1)\alpha+a_1,a_3-(a_3-a_2)\alpha\right]=[\alpha a_l,\alpha a_r]$, see Fig.4. The α is greater, the consensus degree of expert evaluation is higher. So the consensus degree of expert evaluation is higher, the α can be chosen a larger value.

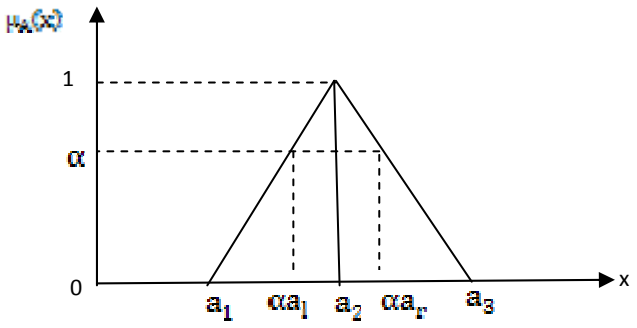

Fig.4 Manner of α-cut

Analyze weight decision of α in cut set method. Suppose $W_i=(W_i^l,W_i^m,W_i^u)$ be fuzzy weight vector, then define

$$W_i^l(\alpha)=(W_i^m-W_i^l)\alpha+W_i^l \quad (15)$$

$$W_i^u(\alpha)=W_i^u-(W_i^u-W_i^m)\alpha \quad (16)$$

The coefficient λ reflects the preference of decision makers. The λ is greater, the decisions tend to use lower limit evaluation value, showing pessimistic value having a greater role. The λ is smaller, the decisions tend to use upper limit evaluation value, showing optimistic value having a greater role. Compute as follows.

$$W_i(\alpha,\lambda)=\lambda W_i^l(\alpha)+(1-\lambda)W_i^u(\alpha),\forall\lambda\in[0,1] \quad (17)$$

$W_i(\alpha,\lambda)$ is in normalization processing, then the normalized weight vector, $W_i(\alpha,\lambda)$,is gotten, see formula 18. So it realizes importance rank of evaluation objects.

$$W_i(\alpha,\lambda)=W_i(\alpha,\lambda)\Big/\sum_i W_i(\alpha,\lambda) \quad (18)$$

2) Analysis of key growth factors of technology transfer across the industry based on FAHP

The fuzzy judgment matrix is made up of fuzzy number directly given by experts, but considering familiar and habit of experts for AHP and a lot of factors, this paper use the method in paper[20]. Accurate scores of 1-9 scale method given by experts are integrated into fuzzy judgment matrix by formula 7.

According to Tab 3, remained 15 factors are made into AHP questionnaire. 6 experts are hired and gave their scores, and six 15 order judgment matrix are gotten.

① The fuzzy judgment matrix based on FAHP

According to formula 7, expert opinions are integrated and the fuzzy judgment matrix is made (see Fig.5).

② Defuzzification

Center of gravity method. According to formula 14, DF_{ij}, judgment matrix of defuzzification is gotten.

$DF_{i,j}$

$$=\begin{bmatrix}
1 & 2.38 & 2.14 & 2.17 & 1.57 & 3.55 & 2.1 & 2.78 & 2.25 & 2.53 & 2.32 & 2.82 & 3 & 2.98 & 4.02\\
0.42 & 1 & 2.12 & 1.81 & 1.33 & 2.38 & 2.04 & 2.3 & 1.72 & 1.93 & 2.38 & 1.44 & 1.58 & 1.97 & 1.7\\
0.47 & 0.47 & 1 & 3.39 & 2.38 & 4.04 & 3.22 & 4.93 & 2.43 & 2.1 & 2.84 & 2.66 & 3.34 & 2.47 & 3.14\\
0.46 & 0.55 & 0.29 & 1 & 1.13 & 3.37 & 3.39 & 3.94 & 2.86 & 2.07 & 2.46 & 1.91 & 3.05 & 3.1 & 2.48\\
0.64 & 0.75 & 0.42 & 0.89 & 1 & 4.37 & 2.3 & 2.89 & 2.93 & 2.92 & 2.5 & 2.55 & 3.21 & 1.59 & 2.43\\
0.28 & 0.42 & 0.25 & 0.3 & 0.23 & 1 & 0.95 & 1.45 & 0.64 & 0.33 & 0.89 & 0.59 & 1.41 & 0.47 & 1.21\\
0.48 & 0.49 & 0.31 & 0.3 & 0.44 & 1.06 & 1 & 2.17 & 2.01 & 1.53 & 2.41 & 1.37 & 2.33 & 1.45 & 1.02\\
0.36 & 0.43 & 0.2 & 0.25 & 0.35 & 0.69 & 0.46 & 1 & 1.05 & 1.49 & 1.56 & 1.38 & 1.89 & 1.41 & 1.41\\
0.44 & 0.58 & 0.41 & 0.35 & 0.34 & 1.57 & 2.01 & 0.95 & 1 & 1.25 & 1.07 & 2.06 & 2.52 & 1.98 & 1.44\\
0.40 & 0.52 & 0.48 & 0.48 & 0.34 & 3.06 & 0.65 & 0.67 & 0.8 & 1 & 4.11 & 2.68 & 3.9 & 2.77 & 2.53\\
0.43 & 0.43 & 0.35 & 0.41 & 0.4 & 1.12 & 0.41 & 0.64 & 0.94 & 0.24 & 1 & 1.42 & 2.52 & 1.98 & 2.19\\
0.35 & 0.69 & 0.38 & 0.52 & 0.39 & 1.69 & 0.73 & 0.73 & 0.49 & 0.37 & 0.7 & 1 & 2.59 & 0.92 & 0.95\\
0.33 & 0.54 & 0.3 & 0.33 & 0.31 & 0.71 & 0.43 & 0.53 & 0.4 & 0.26 & 0.4 & 0.39 & 1 & 1.93 & 1.28\\
0.34 & 0.51 & 0.41 & 0.32 & 0.63 & 2.13 & 0.69 & 0.71 & 0.51 & 0.36 & 0.51 & 1.09 & 0.52 & 1 & 2.52\\
0.25 & 0.59 & 0.32 & 0.4 & 0.41 & 0.82 & 0.98 & 0.71 & 0.69 & 0.4 & 0.46 & 1.06 & 0.78 & 0.4 & 1
\end{bmatrix}$$

	Transfer ability	Accept willingness	Absorptive ability	Identification ability	Mining ability	Seminar	Cooperation	Personnel Exchange	Organizational culture	Policy	Economic conditions	Social Network	Protection consciousness	Transfer cost	Development strategy
Transfer ability	(1,1,1)	(1,2.13,4)	(0.25,1.16,5)	(0.33,1.16,5)	(0.5,1.20,3)	(0.5,2.13,8)	(0.16,1.14,5)	(1,2.32,5)	(0.14,1.60,5)	(0.14,0.43,7)	(0.2,1.76,5)	(1,1.44,5)	(0.2,1.79,7)	(2,2.94,4)	(2,4.06,6)
Accept willingness	(0.25,0.46,1)	(1,1,1)	(0.33,1.01,5)	(0.33,1.10,4)	(0.25,0.74,3)	(0.5,1.62,5)	(0.25,0.86,5)	(1,1.90,4)	(0.33,0.83,4)	(0.12,0.65,5)	(0.14,0.91,6)	(0.33,0.63,3)	(0.2,1.36,4)	(0.33,1.58,4)	(0.2,0.90,4)
Absorptive ability	(0.2,0.85,4)	(0.2,0.98,3)	(1,1,1)	(1,2.17,7)	(0.33,1.79,5)	(2,4.10,6)	(2,2.66,5)	(2,3.80,9)	(1,2.28,4)	(0.2,1.10,5)	(0.2,2.33,6)	(1,1.51,5)	(0.2,2.80,7)	(1,2.40,4)	(0.33,2.09,7)
Identification ability	(0.2,0.85,3)	(0.25,0.90,3)	(0.14,0.46,1)	(1,1,1)	(0.33,1.04,2)	(2,3.10,5)	(2,3.16,5)	(2,2.82,7)	(1,2.58,5)	(0.2,1,5)	(0.2,2.18,5)	(1,1.44,3)	(0.33,2.81,6)	(1,2.28,6)	(1,2.44,4)
Mining ability	(0.33,0.83,2)	(0.33,1.34,4)	(0.2,0.55,3)	(0.5,0.95,3)	(1,1,1)	(1,3.10,9)	(0.16,1.72,5)	(1,2.66,5)	(1,2.79,5)	(0.2,1.55,7)	(0.14,2.35,5)	(1,1.37,5)	(0.33,2.30,7)	(0.2,1.55,3)	(2,2.28,3)
Seminar	(0.12,0.46,2)	(0.2,0.61,2)	(0.16,0.24,0.5)	(0.2,0.32,0.5)	(0.11,0.32,1)	(1,1,1)	(0.2,0.63,2)	(0.2,1.15,3)	(0.25,0.66,1)	(0.2,0.28,0.5)	(0.2,0.46,2)	(0.25,0.43,1)	(0.33,0.89,3)	(0.12,0.28,1)	(0.16,0.47,3)
Cooperation	(0.25,0.87,6)	(0.2,1.15,4)	(0.2,0.37,0.5)	(0.2,0.31,0.5)	(0.2,0.57,6)	(0.5,1.57,5)	(1,1,1)	(1,1.51,4)	(0.25,0.76,5)	(0.14,0.44,4)	(0.2,1.03,6)	(0.33,0.64,3)	(0.33,1.64,5)	(0.5,0.84,3)	(0.2,0.85,2)
Personnel Exchange	(0.2,0.42,1)	(0.25,0.52,1)	(0.11,0.26,0.5)	(0.14,0.35,0.5)	(0.2,0.37,1)	(0.33,0.86,5)	(0.25,0.66,1)	(1,1,1)	(0.2,0.96,2)	(0.14,0.33,4)	(0.2,1.48,3)	(0.33,0.66,3)	(0.33,1.32,4)	(0.33,0.89,3)	(0.2,1.03,3)
Organizational culture	(0.2,0.62,7)	(0.25,1.20,3)	(0.25,0.43,1)	(0.2,0.38,1)	(0.2,0.35,1)	(1,1.51,4)	(0.2,1.29,4)	(0.5,1.03,5)	(1,1,1)	(0.2,0.55,3)	(0.33,0.87,2)	(0.25,0.70,5)	(1,1.57,5)	(0.25,0.68,5)	(0.33,1,3)
Policy	(0.14,2.28,7)	(0.2,1.52,8)	(0.2,0.90,5)	(0.2,1,5)	(0.14,0.64,5)	(2,3.54,5)	(0.25,2.24,7)	(0.25,3.01,7)	(0.33,1.79,5)	(1,1,1)	(0.5,2.82,9)	(0.5,2.54,5)	(1,3.68,7)	(0.2,1.10,7)	(0.2,1.38,6)
Economic conditions	(0.2,0.56,5)	(0.16,1.09,7)	(0.16,0.42,5)	(0.2,0.45,5)	(0.2,0.42,7)	(0.5,2.13,5)	(0.16,0.97,5)	(0.33,0.67,5)	(0.5,1.14,3)	(0.11,0.35,2)	(1,1,1)	(0.25,1.11,3)	(0.5,2.05,5)	(0.25,0.68,5)	(0.33,1.24,5)
Social Network	(0.2,0.40,1)	(0.33,1,3)	(0.2,0.50,1)	(0.33,0.57,1)	(0.2,0.60,1)	(1,1.90,4)	(0.33,1.28,3)	(0.33,1.25,3)	(0.2,1.08,4)	(0.2,0.39,2)	(0.33,0.98,4)	(1,1,1)	(0.2,1.55,6)	(0.2,0.55,2)	(0.2,0.63,2)
Protection consciousness	(0.14,0.55,5)	(0.25,0.73,5)	(0.14,0.35,5)	(0.16,0.35,3)	(0.14,0.43,3)	(0.33,1.12,3)	(0.2,0.60,3)	(0.25,0.75,3)	(0.2,0.63,1)	(0.14,0.27,1)	(0.2,0.48,2)	(0.16,0.49,5)	(1,1,1)	(0.2,0.58,5)	(0.2,0.62,3)
Transfer cost	(0.25,0.33,0.5)	(0.25,0.62,3)	(0.25,0.41,1)	(0.16,0.43,1)	(0.33,0.64,5)	(1,3.55,8)	(0.33,1.17,2)	(0.33,1.12,3)	(0.2,1.45,4)	(0.14,0.90,5)	(0.2,1.45,4)	(0.5,1.05,5)	(0.2,1.70,5)	(1,1,1)	(0.2,1.34,6)
Development strategy	(0.16,0.24,0.5)	(0.25,1.11,5)	(0.14,0.47,3)	(0.25,0.40,1)	(0.33,0.43,0.5)	(0.33,2.11,6)	(0.5,1.16,5)	(0.33,0.97,5)	(0.33,1,3)	(0.16,0.71,5)	(0.2,0.80,3)	(0.5,1.57,5)	(0.33,1.59,5)	(0.16,0.74,5)	(1,1,1)

Fig.5 FAHP judgment matrix

According to the AHP, the weight vector of DF_{ij} is computed.

$W = (0.14, 0.1, 0.13, 0.1, 0.1, 0.03, 0.06, 0.04, 0.06, 0.07, 0.04, 0.04, 0.03, 0.04, 0.03)$

Though the consistency test, CR of DF_{ij} is less than 0.1, and its consistency can be accepted.

α Cut set method.

Given $\alpha = 0.5$, according to formula 15 and 16, W_i^L, lower bound, and W_i^U, upper bound, are gotten.

$$W_i^L = \begin{pmatrix}
1 & 1.57 & 0.71 & 0.75 & 0.85 & 1.32 & 0.65 & 1.66 & 0.87 & 0.29 & 0.98 & 1.73 & 1 & 2.47 & 0.3 \\
0.36 & 1 & 0.68 & 0.72 & 0.5 & 1.06 & 0.56 & 1.45 & 0.58 & 0.39 & 0.53 & 0.67 & 0.78 & 0.96 & 0.55 \\
0.53 & 0.59 & 1 & 1.59 & 1.06 & 3.05 & 2.33 & 2.9 & 1.64 & 0.65 & 1.27 & 1.49 & 1.5 & 1.7 & 1.21 \\
0.53 & 0.58 & 0.3 & 1 & 0.69 & 2.55 & 2.58 & 2.41 & 1.79 & 0.6 & 1.19 & 1.37 & 1.58 & 1.64 & 1.72 \\
0.58 & 0.84 & 0.38 & 0.73 & 1 & 2.05 & 0.95 & 1.83 & 1.9 & 0.88 & 1.25 & 1.32 & 1.32 & 0.88 & 2.14 \\
0.3 & 0.41 & 0.21 & 0.26 & 0.22 & 1 & 0.42 & 0.68 & 0.46 & 0.24 & 0.33 & 0.39 & 0.61 & 0.2 & 0.32 \\
0.56 & 0.68 & 0.29 & 0.26 & 0.39 & 1.04 & 1 & 1.26 & 0.51 & 0.29 & 0.62 & 0.56 & 0.99 & 0.67 & 0.53 \\
0.31 & 0.39 & 0.19 & 0.25 & 0.29 & 0.6 & 0.46 & 1 & 0.58 & 0.24 & 0.84 & 0.56 & 0.83 & 0.61 & 0.62 \\
0.41 & 0.73 & 0.34 & 0.29 & 0.28 & 1.26 & 0.75 & 0.77 & 1 & 0.38 & 0.6 & 0.59 & 1.29 & 0.47 & 0.67 \\
1.22 & 0.86 & 0.55 & 0.6 & 0.39 & 2.77 & 1.25 & 1.63 & 1.06 & 1 & 1.66 & 1.52 & 2.34 & 0.65 & 0.79 \\
0.38 & 0.63 & 0.3 & 0.33 & 0.31 & 1.32 & 0.57 & 0.5 & 0.82 & 0.23 & 1 & 0.63 & 1.28 & 0.47 & 0.79 \\
0.3 & 0.67 & 0.35 & 0.46 & 0.4 & 1.45 & 0.81 & 0.8 & 0.64 & 0.3 & 0.66 & 1 & 0.88 & 0.38 & 0.42 \\
0.35 & 0.49 & 0.25 & 0.26 & 0.29 & 0.73 & 0.4 & 0.5 & 0.42 & 0.21 & 0.34 & 0.4 & 1 & 0.39 & 0.41 \\
0.29 & 0.44 & 0.33 & 0.3 & 0.49 & 2.28 & 0.76 & 0.73 & 0.83 & 0.52 & 0.83 & 1.15 & 0.95 & 1 & 0.77 \\
0.21 & 0.68 & 0.31 & 0.33 & 0.39 & 1.23 & 0.83 & 0.65 & 0.67 & 0.44 & 0.5 & 1.04 & 0.97 & 0.45 & 1
\end{pmatrix}$$

$$W_i^U = \begin{pmatrix}
1 & 3.07 & 3.08 & 3.08 & 2.1 & 5.07 & 3.07 & 3.66 & 3.3 & 3.72 & 3.38 & 3.73 & 4.4 & 3.47 & 5.03 \\
0.73 & 1 & 3.01 & 2.55 & 1.87 & 3.31 & 2.93 & 2.95 & 2.42 & 2.83 & 3.46 & 2.0 & 2.68 & 2.79 & 2.45 \\
2.43 & 1.99 & 1 & 4.59 & 3.4 & 5.05 & 3.83 & 6.4 & 3.14 & 3.05 & 4.17 & 3.49 & 4.9 & 3.2 & 4.55 \\
1.93 & 1.59 & 0.73 & 1 & 1.52 & 4.05 & 4.08 & 4.19 & 3.79 & 3 & 3.59 & 2.37 & 4.41 & 4.14 & 3.22 \\
1.42 & 2.67 & 1.78 & 1.98 & 1 & 6.05 & 3.36 & 3.83 & 3.9 & 4.28 & 3.68 & 3.32 & 4.65 & 2.28 & 2.64 \\
1.23 & 1.31 & 0.37 & 0.41 & 0.66 & 1 & 1.32 & 2.08 & 0.83 & 0.39 & 1.23 & 0.76 & 1.95 & 0.64 & 1.74 \\
3.44 & 2.58 & 0.44 & 0.41 & 3.29 & 3.29 & 1 & 2.76 & 2.88 & 2.22 & 3.52 & 1.89 & 3.32 & 1.92 & 1.43 \\
0.71 & 0.76 & 0.38 & 0.43 & 0.69 & 2.93 & 0.83 & 1 & 1.48 & 2.17 & 2.24 & 1.9 & 2.66 & 1.95 & 2.02 \\
3.81 & 2.1 & 0.72 & 0.69 & 0.68 & 2.76 & 2.65 & 3.02 & 1 & 1.78 & 1.44 & 2.96 & 3.29 & 2.84 & 2 \\
4.64 & 4.76 & 2.95 & 3 & 2.82 & 4.27 & 4.62 & 5.01 & 3.4 & 1 & 5.91 & 3.77 & 5.34 & 4.05 & 3.69 \\
2.78 & 4.05 & 2.71 & 2.73 & 3.71 & 3.57 & 2.99 & 2.84 & 2.07 & 1.18 & 1 & 2.01 & 3.53 & 2.84 & 3.12 \\
0.7 & 2 & 0.75 & 0.79 & 0.8 & 2.95 & 2.14 & 2.13 & 2.54 & 1.2 & 2.49 & 1 & 3.78 & 1.28 & 1.32 \\
2.78 & 2.87 & 2.68 & 1.68 & 1.72 & 2.06 & 1.80 & 1.88 & 0.82 & 0.64 & 1.24 & 2.82 & 1 & 2.79 & 1.81 \\
0.42 & 1.81 & 0.71 & 0.72 & 2.82 & 5.78 & 1.59 & 2.06 & 2.73 & 2.95 & 2.73 & 3.4 & 3.35 & 1 & 3.67 \\
0.37 & 3.06 & 1.74 & 0.7 & 0.47 & 4.06 & 3.08 & 2.99 & 2 & 2.86 & 1.9 & 3.29 & 3.3 & 2.87 & 1
\end{pmatrix}$$

Given $\lambda = 0.5$, according to formula 17 and 18, the weight vector is gotten.

$W = (0.14, 0.1, 0.13, 0.1, 0.1, 0.03, 0.06, 0.04, 0.06, 0.07, 0.04, 0.04, 0.03, 0.04, 0.03)$

Comparing the weight vector based on center of gravity method and α cut set method, it illustrates that the rank of the former six growth factors is consistent, therefore, the key growth factors can be determined.

③ Judge the key growth factors.

According to the concept of key success factor (KSF or critical success factor) , the key growth factor can be analyzed. The key success factor was the first proposed by Daniel (1961) . He pointed out most enterprises have 3 to 6 decision factors for success. If the enterprise can transform these factors, it would obtain success. We combine this concept into the key growth factor analysis. The former six factors are regarded as the key growth factors which are transfer ability, willingness to accept, absorptive capacity, identification, mining capacity and policy.

Actor network analysis allows us to grasp the main of new technology transfer across the industry. And analysis of key growth factors enables us to understand the key influencing factors of the subject behavior. Although we can obtain the importance weights of different growth factors by using of expert method, the importance weights can guide allocation of decision resources and determine the scheme of the incentive behavior. In analysis of actual problems, the influence of various factors is not independent and there are interactions between elements. Therefore, the interaction between growth factors may increase the application probability of technology across the industry, and cross impact analysis is effective to solve this kind of problems.

II INTERACTION ANALYSIS BETWEEN KEY GROWTH FACTORS OF NEW TECHNOLOGY TRANSFER ACROSS THE INDUSTRY

Key growth factors is obtained by the FAHP, but in this process experts only considered factors directly affecting target and didn't analyze interaction between factors that may affect target indirectly. There are interactions between key growth factors. The result of interaction may not only lead to changing the weight of factors, but also it is more effective to determine and incentive countermeasures of technology transfer across the industry. The DEMATEL method can be used to make interaction analysis between them.

A. The analysis procedure of interaction based on the DEMATEL

The procedure is as follows[21].

(1) Determine influencing factors. According to the relevant information and the result of system analysis, we set up the preliminary index system, given $F_1, F_2, \ldots, F_n$.

(2) Determine the relationship between influencing factors. Though the expert investigation, we determine the direct relationship between factors and use the directed graph to express orientation. And impact degree is expressed with 0 to 4 (or other digital representation level) . 0 represents no direct interaction between factors; 1 represents low; 2 represents moderate; 3 represents high and 4 represents higher.

(3) Build the direct influence matrix. The matrix represents the effect relationship between factors. Given $X=(x_{ij})n\times n$ is the matrix of n order. If the F_i has a direct effect on F_j, $x_{ij}=1$ (2、3、4) is defined; or $x_{ij}=0$, expressing there no direct effect.

$$X=\begin{bmatrix} 0 & x_{12} & \ldots & x_{1n} \\ x_{21} & 0 & \ldots & x_{2n} \\ \vdots & \vdots & \ldots & \vdots \\ x_{n1} & x_{n2} & \ldots & 0 \end{bmatrix}.$$ it, x_{ij} (i=1，2，...n；j=1，2，...n；i≠j) , expresses F_i has a direct effect on F_j. If i=j, $x_{ij}=0$.

(4) Standard direct influence matrix G ($G=(g_{ij})n\times n$)

$$G=\frac{1}{\max\limits_{1\le i\le n}\sum\limits_{j=1}^{n}x_{ij}}X \tag{19}$$

It is easy known $0\le g_{ij}\le 1$, and $\max\limits_{1\le i\le n}\sum\limits_{j=1}^{n}g_{ij}=1$.

(5) Compute integrated influence matrix. In order to analyze indirect relationship, T, integrated matrix, is computed. T is formed by a series interaction, and the procedure is:

$$\begin{aligned} T&=\sum_{m=1}^{\infty}G_i=G+G^2+G^3+\ldots+G^m \\ &=G\left(1+G+G^2+\ldots+G^{m-1}\right) \\ &=G(1-G)^{-1}(1-G)\left(1+G+G^2+\ldots+G^{m-1}\right) \\ &=G(1-G)^{-1}\left(1-G^m\right) \\ &=G(I-G)^{-1}=(t_{ij}) \end{aligned} \tag{20}$$

In formula 20, I is unit matrix.

(6) Analyze influencing factors. Direct and indirect impact of factors are obtained by analyzing T. And they are used as the basis of further correction weight of key growth factors and incentive countermeasures.

B. The analysis of the interaction based on the DEMATEL

This paper combines literature analysis[21-25] and expert investigation to get direct impact of key growth factors, see Tab 4.

TAB 4 DIRECT INTERACTION BETWEEN KEY FACTORS

Factor	Factor					
	Transfer ability F_1	Accept willingness F_2	Absorptive ability F_3	Identification ability F_4	Mining ability F_5	Policy F_6
Transfer ability F_1	0	0	0	1	1	0
Accept willingness F_2	0	0	2	1	1	0
Absorptive ability F_3	3	0	0	1	0	0
Identification ability F_4	2	0	1	0	2	0
Mining ability F_5	2	0	2	2	0	0
Policy F_6	4	4	3	2	3	0

According to the procedure of the DEMATEL, the direct matrix of influencing factors is obtained, then it is normalized by formula 19, and G is gotten.

$$G = \begin{array}{c} \\ F_1 \\ F_2 \\ F_3 \\ F_4 \\ F_5 \\ F_6 \end{array} \begin{array}{c} \begin{array}{cccccc} F_1 & F_2 & F_3 & F_4 & F_5 & F_6 \end{array} \\ \begin{pmatrix} 0 & 0 & 0 & 0.0625 & 0.0625 & 0 \\ 0 & 0 & 0.125 & 0.0625 & 0.0625 & 0 \\ 0.1875 & 0 & 0 & 0.0625 & 0 & 0 \\ 0.125 & 0 & 0.0625 & 0 & 0.125 & 0 \\ 0.125 & 0 & 0.125 & 0.125 & 0 & 0 \\ 0.25 & 0.25 & 0.1875 & 0.125 & 0.1875 & 0 \end{pmatrix} \end{array}$$

According to formula 20, T is gotten.

$$T = \begin{array}{c} \\ F_1 \\ F_2 \\ F_3 \\ F_4 \\ F_5 \\ F_6 \end{array} \begin{array}{c} \begin{array}{cccccc} F_1 & F_2 & F_3 & F_4 & F_5 & F_6 \end{array} \\ \begin{pmatrix} 0.0209 & 0 & 0.0137 & 0.0738 & 0.073 & 0 \\ 0.0461 & 0 & 0.1397 & 0.0836 & 0.0758 & 0 \\ 0.2015 & 0 & 0.0077 & 0.0784 & 0.0224 & 0 \\ 0.1618 & 0 & 0.0819 & 0.0326 & 0.1392 & 0 \\ 0.1730 & 0 & 0..1379 & 0.1481 & 0.0293 & 0 \\ 0.3572 & 0.25 & 0.2634 & 0.2109 & 0.2518 & 0 \end{pmatrix} \end{array}$$

T is used as the interaction coefficient β_{ij} between key growth factors.

W_s is the influencing weight.

$$W_s = \frac{\sum_{j=1}^{n} \beta_{ij} w_j}{\sum_{i=1}^{n}\sum_{j=1}^{n} \beta_{ij} w_j} \quad (21)$$

Considering the mutual influencing, the weight of every factor is recalculated.

$$W_{is} = \frac{1}{2}\left(W_i + \frac{\sum_{j=1}^{n} \beta_{ij} W_j}{\sum_{i=1}^{n}\sum_{j=1}^{n} \beta_{ij} W_j} \right) \quad (22)$$

According to formula 21 and 22, the initial weights are redefined, see Tab 5.

After considering the mutual influencing, the importance weight of policy is significantly improved. After considering the mutual influencing of key growth factors, it not only modified the importance weight of each factor, but also it laid the foundation of effectively determining incentive countermeasures of technology transfer across the industry. The influencing degree and influenced degree analysis of the DEMATEL can provide better analysis basis.

The influencing degree and influenced degree. D_i is obtained by computing the sum of each row of T. It is the sum of direct and indirect effects of F_i effecting on others, called the influencing degree of F_i. R_j is obtained by computing the sum of each column of T. It is the sum of direct and indirect effects of F_i effected by others, called the influenced degree of F_i.

$$D_i = \sum_{j=1}^{n} t_{ij} \quad (i = 1,2,...,n) \quad (23)$$

$$R_j = \sum_{i=1}^{n} t_{ij} \quad (j = 1,2,...,n) \quad (24)$$

The sum of row and column of T is computed respectively, see Tab 6.

TAB 5 WEIGHT CONSIDERING THE INTERACTION BETWEEN KEY FACTORS

Factor	F_1	F_2	F_3	F_4	F_5	F_6	Sum of mutual influence	Weight of mutual influence W_s	Initial weights W_i	Sum of weights W_s+W_i	Weight standardization W_{is}	Original weight sort	Adjusted weight sort
Initial weights	0.22	0.16	0.2	0.16	0.16	0.1							
F_1	0.0209	0	0.0137	0.0738	0.073	0	0.0308	0.0536	0.22	0.2736	0.1368	1	5
F_2	0.0461	0	0.1397	0.0836	0.0758	0	0.0636	0.1105	0.16	0.2705	0.1353	3	6
F_3	0.2015	0	0.0077	0.0784	0.0224	0	0.062	0.1078	0.2	0.3078	0.1539	2	3
F_4	0.1618	0	0.0819	0.0326	0.1392	0	0.0795	0.1382	0.16	0.2982	0.1491	3	4
F_5	0.1730	0	0.1379	0.1481	0.0293	0	0.094	0.1635	0.16	0.3235	0.1617	3	2
F_6	0.3572	0.25	0.2634	0.2109	0.2518	0	0.2453	0.4264	0.1	0.5264	0.2632	6	1

TAB 6 INFLUENCE DEGREE AND INFLUENCED DEGREE OF KEY FACTORS

Factor	F_1	F_2	F_3	F_4	F_5	F_6	Row sum D_i
F_1	0.0209	0	0.0137	0.0738	0.073	0	0.1814
F_2	0.0461	0	0.1397	0.0836	0.0758	0	0.3452
F_3	0.2015	0	0.0077	0.0784	0.0224	0	0.3100
F_4	0.1618	0	0.0819	0.0326	0.1392	0	0.4155
F_5	0.1730	0	0.1379	0.1481	0.0293	0	0.4883
F_6	0.3572	0.25	0.2634	0.2109	0.2518	0	1.3333
Column sum R_j	0.9605	0.25	0.6443	0.6274	0.5915	0	3.0737

According to the computing result, the highest influencing degree for other factors is F_6, policy factor. The second highest one is F_5, ability of excavation. Third is F_4, identification ability. Fourth is F_2, willingness to accept. Fifth is F_3, absorbing ability. The last is F_1, transfer ability. Factors having higher influencing degree can influence the target by effecting on others. So they become the priority analysis object of incentive countermeasures. According to the computing result of influenced degree, the highest influenced degree by other factors is F_1. The second one is F_3. Third is F_4. Fourth is F_5. Fifth is F_2. F_6 is the last and its value is 0. It illustrates that the policy isn't influenced by the other five factors. And policy incentive for technology transfer across the industry has the most significant impact. While the transfer ability has effect on others, it mainly shows that it is improved though others' impact.

III. THE GROWTH STRATEGIES OF NEW TECHNOLOGY TRANSFER ACROSS THE INDUSTRY

Factors of high influencing and influenced degree are obtained by interaction analysis, and it lay the foundation for decision-makers to improve effect of influencing factors. For technology transfer across the industry, the effect of key growth factors exists objectively. And in this paper we find and determine them by literature analysis. After determining the importance weight of each factor by the FAHP, key growth factors are determined. Because of interaction relationship between factors, influencing and influenced degree between key growth factors are measured and evaluated by the DEMATEL, which provides the basis of putting forward growth incentive countermeasures. But we not only need to analyze importance and influence degree of key growth factors, but also analyze the current status of them. If the study of relevant influence factors has got enough attention and the results are satisfactory, it is not difficult to predict the phenomenon of forming technology transfer across the industry. In order to analyze the current status of key growth factors, we propose the method of building "attention -recognition degree matrix" by indexes of attention and recognition degree. On the basis of analyzing the current research status of them, the target growth strategies can be put forward.

A. The analysis of the current status of key growth factors based on attention-recognition degree matrix

Indexes of attention and recognition degree are defined and they are used as abscissa and ordinate respectively to build "attention-recognition degree matrix". The role of each factor is determined through the matrix. And the reality and pertinence of countermeasure are guaranteed.

(1) Attention degree index (A_i) . It refers to the attention degree of key growth factors and it is computed by the ratio of the number of literature of the factor and the number of literature of all factors.

The research area is technology transfer. Set the total documents for P. L_i represents the number of literature of six key growth factors respectively, (i= 1，2，3，4，5，6) . Then attention degree is as follow.

$$A_i = \frac{L_i}{P} \quad (i = 1,2,3,4,5,6) \quad (25)$$

(2) Recognition degree index (S_i) . It refers to the recognition degree of the specific recognition factors and it is measured by the number of cited literature. Higher recognition degree represents that the recognition of the factor in the theoretical and practical cycle is more consistent.

C_i is defined as total citations of literature of each key growth factor (i= 1，2，3，4，5，6) . Then recognition degree is as follow.

$$S_i = \frac{C_i}{L_i} \quad (i = 1,2,3,4,5,6) \quad (26)$$

(3) The current status of matrix based on attention-recognition degree. The attention degree is on the horizontal and the recognition degree is on the vertical. And the attention and recognition average is the axis cross origin. The result is divided into four regions.

We make the hypothesis before the analysis. If the factor has high attention degree, we can assume that it has poor performance in reality and has a large potential to be perfect and optimized. If the factor's attention degree is low, we can assume that it has good performance or its importance has not become a common concern. So it needs to be further observed, practiced and strengthened. If the factor's recognition degree is high, we can assume that the consistency of its relative factors analysis is stronger and the countermeasure is more convergent.

I: High attention degree and high recognition degree. If factors are in this region, their function needs to be further improved. But the cognitive similarity of incentive measures makes the study pay attention to find the causes of adverse effects and enhance optimization space of effect, relevant countermeasures are to improve the implementation of the key role of growth factors.

II: Low attention degree and high recognition degree. If

factors are in this region, they need to be further observed and the causes of low attention degree need to be analyzed. It results in low attention degree because it has good effect and its improved space is limited. So the existing incentive measures can be maintained. If the important function of the factor has not got sufficient attention, practice should be strengthened and actors are promoted to join. New countermeasures are proposed.

III: Low attention degree and low recognition degree. If factors are in this region, they need to be further researched and strengthened. And incentive measures need to be redesigned to enhance their function.

IV: High attention degree and low recognition degree. If factors are in this region, the causes of poor function need to be analyzed. The incentives effect survey needs attention and incentive measures need to be improved.

B. The current status matrix of key growth factors of technology transfer across the industry

Technology transfer across the industry belongs to the category of technology transfer, but technology transfer, technology diffusion, knowledge transfer and knowledge diffusion have overlapped in concept. In order to understand the current status of related factors roundly, we retrieve literatures with " technology transfer ", " technology diffusion "," knowledge transfer " and " knowledge diffusion " respectively as the title in CNKI, "journals", "proceedings paper" and "the thesis" as literature type, time from 2003 to 2012, data download time in September 28,2013. finally 3631 literatures are obtained that is to say P=3631.

The subject retrieval is done respectively with "transfer", "accept", "absorption capacity", "recognition", "mining" and "policy" based on P, see Tab 7.

According to formula 25, attention degree of every key growth factor is computed, see Tab 8.

Citation frequency of each key growth factor is counted respectively. And then according to formula 26, satisfaction degree is computed, see Tab 9.

The current status matrix of key growth factors based on attention degree and recognition degree is built, see Fig .6.

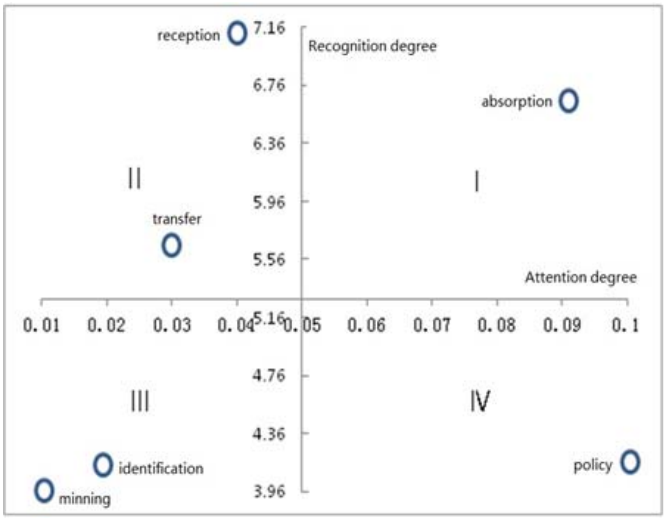

Fig.6 Attention—recognition matrix

TAB 7 LITERATURE SEARCHING RESULTS RELATED TO KEY FACTORS

Year	Literature numbers						
	Technology transfer P	Transfer ability L_1	Accept willingness L_2	Absorptive ability L_3	Identification ability L_4	Mining ability L_5	Policy L_6
2012	496	19	24	57	17	8	49
2011	553	18	16	42	11	5	48
2010	511	18	22	47	10	9	58
2009	483	23	18	58	11	11	50
2008	455	10	13	39	5	3	40
2007	390	11	16	37	4	5	42
2006	282	6	16	24	3	4	37
2005	224	2	9	5	1	0	25
2004	130	1	4	5	2	2	18
2003	107	1	3	5		0	14
Sum	3631	109	141	319	64	47	381

TAB 8 RESEARCH ATTENTION OF KEY GROWTH FACTORS

Growth factor	Technology transfer	Transfer ability	Accept willingness	Absorptive ability	Identification ability	Mining ability
Attention A_i	0.03	0.04	0.09	0.02	0.01	0.1

TAB 9 RESEARCH RECOGNITION OF KEY GROWTH FACTORS

Growth factor	Technology transfer	Transfer ability	Accept willingness	Absorptive ability	Identification ability	Mining ability
Total cited times C_i	640	1009	2081	263	186	1537
Acceptance S_i	5.87	7.16	6.52	4.11	3.96	4.03

C. Study on the growth strategy of technology transfer across the industry

In order to promote actors to implement technology transfer across the industry and according to the research status of related problems, the incentive countermeasures need to be discussed. Based on the analysis of key growth factors and the current status of matrix, the following countermeasures about the new technology transfer across the industry should be made, which ensures new technology transfer smoothly across the industry.

Firstly, we aim at the factors in region III —the analysis of identification ability and mining capacity. The factors in region III have low attention degree and low recognition degree. According to the survey, technology transfer across the industry requires interdisciplinary knowledge base. Whether recognition or mining, they should have access to technology achievements from different technical fields and have ability to judge their availability. Recognition and mining of big data both need methods and tools, but the development of related tools is in its infancy, so the reason of low attention degree is mainly the lower ability of people's attention and understanding. The low recognition and mining ability has become the biggest obstacle for technology transfer across the industry. In this paper we put forward countermeasures as follows.

① Encourage of published technological innovation and patent applications. It is the basis of recognition degree improvement and identification of transferable applied technology that makes innovating knowledge dominance and intelligibility. Technology can be understood and mastered by more fields' staff in the continuous promotion process, and it can also be used to solve problems different from its initial industry.

② Develop, use and master different tools and methods of technology identification. According to the TRIZ theory, most problems have been encountered and resolved in other fields. If we can quickly identify the methods of solutions to similar problems in other industries, it will undoubtedly improve the efficiency of solving problems and reduce the cost and risk of innovation.

③ Reduce the cost of mining tools, provide more and better database platforms, strengthen training of information analysis method and improve the ability of knowledge mining. According to Tab 6, it is known that the importance weight of mining ability is improved in consideration of the mutual influencing. Because the transfer characteristics of existing knowledge contains a number of laws that all contain a lot of warning or signal guide, such as the citation and cited of literatures and patent, co-occurrence of keywords, author cooperation, intellectual property litigation and trading. And cyber source is a rich knowledge database. It will undoubtedly expand our knowledge source and effective solutions are obtained from much more existing technology application industries.

Secondly, we aim at the factors in region II —the analysis of the willingness to accept and transfer ability. The factors in region II have low attention degree and high recognition degree. According to the survey, the role of willingness to accept for technology transfer has reached the consensus, for example Davis's Technology Acceptance Model (TAM) was fully verified and widely used since it had been put forward[26]. Therefore, it is the key to solve the problems that attracts and recruits more actors to involve in. As the biggest influenced factor, the impact of transferability is mainly reflected in the result of other factors, so the countermeasures are designed as follows.

① Encourage the innovative activities of users' participating. The only functional availability of new technology is not enough to make its applications across the industry become a reality, the receivers' attitude determines the prospect of technology transfer across the industry, and users' early intervention will help to improve the willingness to accept of technology, and it will accelerate the pace of technology transfer across the industry.

②Concern the communication with leader users and build user experience platform and communication channels. The effect of lead users' guidance and driving force can help to shorten the time of innovative products accepted, encourage enterprises' innovation desire and make search innovation achievements from multi-angle.

Thirdly, we aim at the factors in region IV —the analysis of policy. The factors in region IV have high attention degree and low recognition degree. According to the survey, its incentive role is undoubted but the lever of policy implement is uneven. a widely recognized policy measures have not yet be formed. So many problems of policy incentives need to be studied and discussed. The following countermeasures can be considered.

① Strengthen policy research and improve the quality of policy research. The number of related research literatures about policy issues has reflected that researchers have realized its importance, but cited frequency of current literatures is low. It shows that consensus conclusions or results are limited. However, policy influence degree is very high and many factors may be improved and strengthened by policy guidance and promotion. Therefore, what kind of policy is more effective depends on the analysis of the policy influence force firstly. High quality policy research will also undoubtedly contribute to the relevant policy departments when making decisions and it will encourage more actors to join the network and promote technology transfer across the industry to realize.

② Highlight the pertinence of policy and strengthen the construction of laws and regulations. The technical knowledge is opened through policy, such as the effect of papers and patents is promoted by related policy. Technical knowledge open is the foundation to promote realization of technology transfer across the industry. Encouraging cooperation development, personnel exchanges and interdisciplinary team research will benefit the collision and blend of different knowledge fields. The use of innovative achievements is uncertainty and risky, so regulations are

prerequisites. The study on related policy as well as related laws is very important.

Finally, we aim at the factors in region I —the analysis of attracting capability. The factors in region I have high attention degree and high recognition degree. The study on attracting capability is in multi-angle, such as personal, organization or nation perspective. The research content includes the analysis of influencing factors and the measurement of absorption capacity. Absorption ability can be improved by increasing investment in R&D and improving organizational mechanism and learning method. Research in multi angles makes it improve continually. From the perspective of technology transfer across the industry, how to improve the ability of innovators' absorption capacity from different industries is the key problem. The following policies are put forward.

① Improve the ability of the fusion of technical staff. Application of technology transfer should combine technology base in organization with personnel knowledge constitution. The mastering ability of interdisciplinary knowledge and application of technical stuff has a direct influence on the new technical understanding and judgment. Teamwork, innovation thinking training and integrated innovation ability have been proved to be effective method.

② Cultivate interdisciplinary talents. Not only scientists' occasional exploration and experiment, but also more search of a full range of solutions to a higher degree that make technology transfer across the industry emerging. It requires researchers' multidisciplinary knowledge accumulation and interdisciplinary talents. It will promote researchers' innovative ideas, the level of absorbing new knowledge and knowledge absorption capacity of enterprises and organizations.

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