Evaluating Organization External Knowledge Acquisition Based on Scenario

BAO Zhengqiang, GAO Kaizhou, LI Xiangqing, GUO Lei, ZHONG Hui
Information Engineering College, Yangzhou University, Yangzhou, P.R. China, 225009
gaokaizh@yahoo.com.cn

Abstract

Knowledge can be acquired from organization inside and exterior. The knowledge inside organization is limited and the organization external knowledge is important to advance organization competition ability. Knowledge acquisition out of organization plays an extremely important role in organization knowledge management. This study proposed a knowledge acquisition evaluating method based on knowledge scenario. Scenario tree is defined and is used to describe the scenario of origination external knowledge. Scenario tree's dimensions and items are confirmed and their fuzzy weight is afforded. State interval of evaluating method is plot out. Evaluating matrix is proposed for computing the feasibility of organization external knowledge acquisition. The evaluating method is a recursion process among layers. A case is offered to demonstrate the availability of this approach in knowledge acquisition form organization exterior.

1. Instruction

With the arriving of knowledge economy times, knowledge management is becoming more and more important for organization. Knowledge is the source of organizational competitive advantage, and knowledge reserves and new knowledge directly determine the extent of the organization and the ability to change the competitive edge [1-2]. So, knowledge acquisition becomes the key of organization knowledge management. Organizational knowledge acquisitions have two ways [3]. One is internal knowledge accumulation; another is knowledge acquisition from origination external. Internal knowledge accumulation includes knowledge sharing, learning functions, cross-sectored and multi-level study and learning [4]. Organization external knowledge is broad and social, and knowledge acquisition will be restricted by organization self and exterior environment.

e-Forensics 2008, January 21-23, 2008, Adelaide, Australia.

At present, the researches on knowledge acquisition focus on such aspects as knowledge acquisition mode [5-7], factors which affect successful knowledge acquisition [8-10], and mechanism [11-12] which are based on Nanaka's SECI model and Szulanski's intercourse model. Many literatures have developed factors affecting knowledge transfer such as knowledge characteristics, the recipient, the contex and knowledge itself and so on. Successful knowledge acquisition is associated with several key variables and nine factors are proposed which influencing knowledge acquisition, they are embeddings distance of relational context, organizational, physical, knowledge and norm distance of relational context, project priority and learning culture of recipient context and activity context[13]. Knowledge acquisition mechanisms involve personal move, training, technology transfer, patent, and so on [12].

While knowledge acquisition plays an important role in organization knowledge management, the researches on knowledge acquisition are becoming more and more prevalent. Cohen and Levinthal state knowledge acquisition consists of conveying and absorbing capability [14]. Hamel attributes successful knowledge acquisition to three factors: intent, transparency and receptivity, and further expatiates the determinants of the factors [15]. These researches are analysis about knowledge acquisition method, effecting factors, and knowledge acquisition ability. The performance evaluating of knowledge acquisition is not involved. So this paper proposed an evaluating method for knowledge acquisition from organization external.

The evaluating method used in paper is based on knowledge scenario (*KS*). Outside knowledge constraints is mostly the knowledge scenario. *KS* is the environment and background where knowledge comes into being, and is applied, shared, transferred. *KS* is the basic in knowledge application, share and reuse process. Existed knowledge has knowledge scenario, and the knowledge used in actual case has also knowledge scenario [16].

This paper aims at facilitating the effectiveness of organization exterior knowledge acquisition. It involves two interrelated phases, namely knowledge scenario depicting with scenario tree and feasibility evaluating using evaluating matrix. By applying such an evaluating method, organization knowledge acquisition is more efficient and successful. At last a case is supplied to validate the effective of this method.

2. Knowledge scenario description with scenario tree

2.1 Scenario tree

Define1 **Scenario tree** (*ST*) is tree structure which is used to descript knowledge scenario. *ST* includes one root node (*RT*) which denotes whole scenario, multi-middle nodes for scenario dimensionality and multi-leaf nodes (*LN*) to give expression to scenario item. Apart from leaf nodes, every node has one or more sub-nodes and every node has a parent node except root node.

Define2 **Scenario dimensionality** (*SD*) is a sub-tree of scenario tree which expresses knowledge scenario embranchment or certain aspect.

Define3 **Scenario item** (*ST*) is inseparable scenario dimensionality, and is corresponding with leaf node. *ST* sets out detailed and specific scenario information and knowledge.

In essence, scenario tree is a classification tool. In this paper, scenario tree is used to describe knowledge scenario. Knowledge scenario is decomposed to scenario dimensionality and scenario items. Fig.1 shows the structure of scenario tree and Tab.1shows the mapping between knowledge scenario and scenario tree.

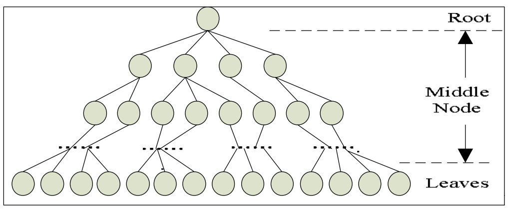

Fig.1 scenario tree

Tab.1 Mapping between scenario and scenario tree

Layer	*ST*	*KS*
1	*RN*	whole scenario
2	middle nodes	*SD*
3	middle nodes	*SD*
...	……	……
n	*LN*	*SI*

2.2 Scenario description for organization external knowledge

In this paper, the evaluating method lies on organizational knowledge and technology. That is to make organizational structure and condition as standard. So, existing organizational extended knowledge scenario includes four dimensionalities: 1) Relation dimensionality, it's the connection between knowledge resource and knowledge recipient; 2) Activity dimensionality, it includes the two sides' activity motivation and motivation strength etc; 3) Technology dimensionality, it includes knowledge and technology difference, knowledge complexity, modular degree and path dependence etc; 4) Environment dimensionality, environment factor in knowledge resource and knowledge recipient, knowledge value cycle and life cycle etc [17]. Scenario description for external knowledge is shown as Fig.2.

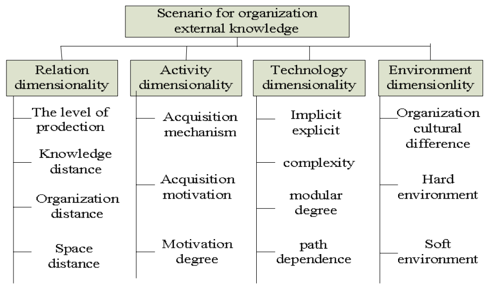

Fig.2 Scenario tree of external knowledge

3. The scenario analysis of knowledge acquisition from organizational external

This paper makes three-tier scenario tree as an example to analyze and evaluate knowledge acquisition feasibility from organizational external.

3. 1 State interval and fuzzy weight

3.1.1 State interval

The feasibility of knowledge acquisition is fuzzy conception. Fuzzy and rough sets theory is used to division the state interval of knowledge acquisition feasibility. The state interval includes five intervals as follow: Very-high feasible, High-feasible, Middle-feasible, Low-feasible and Very-low-feasible. They can be expression by set $V=\{V_1,V_2,V_3,V_4,V_5\}$. V_1= Very-high feasible, V_2= High-feasible, V_3= Middle-feasible,

V_4= Low-feasible and V_5= Very-low-feasible [18].

3.1.2 Accounting the fuzzy weight of scenario dimensionality and scenario item

Let $W = (W_1, W_2, ..., W_n,)$ be the set of scenario dimensionalities' weight. In this set, W_i is the weight of dimensionality D_i, where $i = 1,2,......,n$. Scenario dimensionality D_i includes scenario item SI_{ij}, and the weight of SI_{ij} is as follows:

$W_1 = (\omega_{11}, \omega_{12}, ..., \omega_{1j})$
$W_2 = (\omega_{21}, \omega_{22}, ..., \omega_{2j})$
$W_n = (\omega_{i1}, \omega_{i2}, \omega_{i3}, ..., \omega_{ij})$

Where, ω_{ij} is the weight of scenario item SI_{ij}.

In dimensionality D_i, the important of scenario item SI_{ij} is defined by $I_{ij} \in (0,1)$. When the value of I_{ij} is bigger, the scenario item SI_{ij} is more important. Now, the number of expert is n, and expert K reckons that the value of I_{ij} is I_{ij-k}. Then, the values of I_{ij-k} is show as Tab.2.

Tab.2 the value of I_{ij} (expert K)

S-item	SI_{i1}	SI_{i2}	……	SI_{ij}
I_{ij-k}	I_{i1-k}	I_{i2-k}	……	I_{ij-k}

Then Eq. (1) can define the relation of importance degree among difference scenario items.

$$\eta_{ipq-k} = \begin{cases} 1, \rightarrow If \ \dfrac{I_{ip-k}}{I_{iq-k}} > 1 \\ 0, \rightarrow If \ \dfrac{I_{ip-k}}{I_{iq-k}} \le 1 \end{cases} \quad p, q = 1,2,3,..., j \qquad (1)$$

Where, η_{ipq-k} is the relation of importance degree between SI_{ip} and SI_{iq}, if $\eta_{ipq-k} = 1$, SI_{ip} is more important than SI_{iq}.

$\eta_{ipq} = \sum_{k=1}^{n} \eta_{ipq-k}$ is the total of η_{ipq-k} by experts.

So Tab.3 shows the value of η_{ipq} for scenario item SI_{ij} in scenario dimensionality D_i.

Tab.3 the value of η_{ipq} for scenario item

Scenario item	SI_{i1}	SI_{i2}	SI_{i3}	….	SI_{ij}
SI_{i1}	η_{i11}	η_{i12}	η_{i13}	….	η_{i1j}
SI_{i2}	η_{i21}	η_{i22}	η_{i23}	….	η_{i2j}
….	….	….	….	….	….
SI_{ij}	η_{ij1}	η_{ij2}	η_{ij3}	….	η_{ijj}

Then, $\eta_{ip} = \sum_{q=1}^{j} \eta_{ipq}, q = 1,2,3,..., j$ shows the importance of scenario item SI_{ip} from Tab.3, and

$$Max - \eta_{ij} = \max\{\eta_{i1}, \eta_{i2}, \eta_{i3}, ..., \eta_{ij}\}$$
$$Min - \eta_{ij} = \min\{\eta_{i1}, \eta i2, \eta_{i3}, ..., \eta_{ij}\}$$

Now, the weight of scenario item can be supplied: $\omega_{ij} = \dfrac{\eta_{ip}}{\sum \eta_{ij}}$, and all items' weight in dimensionality is D_i as Eq.(2):

$$W_i = \left(\frac{\eta_{i1}}{\sum \eta_{ij}}, \frac{\eta_{i2}}{\sum \eta_{ij}}, \frac{\eta_{i3}}{\sum \eta_{ij}}, ..., \frac{\eta_{ij}}{\sum \eta_{ij}} \right) \qquad (2)$$

The weight of scenario dimensionality D_i can also be computed as the same to above $W = (W_1, W_2, W_3, ..., W_i)$.

3.2 Matrix and knowledge acquisition

3.2.1 Ascertaining evaluating matrix

For scenario item SI_{ip} in dimensionality, the number of expert is $M_{ip\mu}$, who think the state interval of scenario item is V_μ. Then Eq.(3) expresses the probability of scenario item in state V_μ.

$$P_{ip\mu} = \frac{M_{ip\mu}}{n}, (\mu = 1,2,3,4,5) \qquad (3)$$

Where n is the number of expert

And the evaluating matrix of scenario item SI_{ip} includes probability of all state intervals, which is expressed as Eq.(3).

$$PR_{ip} = (P_{ip1}, P_{ip2}, P_{ip3}, P_{ip4}, P_{ip5}) = \left(\frac{M_{ip1}}{n}, \frac{M_{ip2}}{n}, \frac{M_{ip3}}{n}, \frac{M_{ip4}}{n}, \frac{M_{ip5}}{n} \right)$$

Then, evaluating matrix R_i of all scenario items in scenario dimensionality D_i can be supplied as Eq. (4):

$$R_i = \begin{bmatrix} PR_{i1} \\ PR_{i2} \\ PR_{i3} \\ ... \\ PR_{ij} \end{bmatrix} = \begin{bmatrix} P_{i11} & P_{i12} & P_{i13} & P_{i14} & P_{i15} \\ P_{i21} & P_{i22} & P_{i23} & P_{i24} & P_{i25} \\ P_{i31} & P_{i32} & P_{i33} & P_{i34} & P_{i35} \\ ... & ... & ... & ... & ... \\ P_{ij1} & P_{ij2} & P_{ij3} & P_{ij4} & P_{ij5} \end{bmatrix} \qquad (4)$$

Where, i is the number of scenario dimensionality, j is the number of scenario item in dimensionality.

The evaluating matrix of whole scenario can also be supplied by the same way.

3.2.2 Knowledge acquisition evaluating

In this paper, knowledge acquisition in scenario dimensionality D_i can be evaluated by fuzzy mathematical model Eq. (5).

$$W_i \bullet R_i = R_{Di} \quad (5)$$

Then, Eq.(6) is derivable from Eq.(2) and Eq.(4).

$$(\omega_1, \omega_2, ..., \omega_j) \begin{bmatrix} P_{i11} & P_{i12} & ... & P_{i15} \\ P_{i21} & P_{i22} & ... & P_{i25} \\ ... & ... & ... & ... \\ P_{ij1} & P_{ij2} & ... & P_{ij5} \end{bmatrix} = [D_{i1}, D_{i2}, D_{i3}, D_{i4},, D_{i5}] \qquad (6)$$

Fuzzy set $R_{Di} = (D_{i1}, D_{i2}, D_{i3}, D_{i4}, D_{i5})$ is the state interval of scenario dimensionality D_i in knowledge acquisition.

Now, the evaluating matrix R of the whole scenario can be supplied from scenario dimensionality D_i as Eq. (7).

$$R = \begin{bmatrix} R_{D1} \\ R_{D2} \\ \dots \\ R_{Di} \end{bmatrix} = \begin{bmatrix} D_{11} & D_{12} & \dots & D_{15} \\ D_{21} & D_{22} & \dots & D_{25} \\ \dots & \dots & \dots & \dots \\ D_{i1} & D_{i2} & \dots & D_{i5} \end{bmatrix} \quad (7)$$

On the other hand, the weight of dimensionality D_i in whole scenario is $W = (W_1, W_2, W_3, \dots, W_i)$. So, Eq. (8) defines the evaluating model for whole scenario in knowledge acquisition, and Eq. (9) is derivable from Eq. (7).

$$W \bullet R = Rs \quad (8)$$

$$(W_1, W_2, \dots W_i) \begin{bmatrix} A_{11} & A_{12} & \dots & A_{15} \\ A_{21} & A_{22} & \dots & A_{25} \\ \dots & \dots & \dots & \dots \\ A_{i1} & A_{i2} & \dots & A_{i5} \end{bmatrix} = (Rs_1, Rs_2, Rs_3, Rs_4, Rs_5) \quad (9)$$

Matrix $Rs = (Rs_1, Rs_2, Rs_3, Rs_4, Rs_5)$ is the evaluating result of whole scenario in organization knowledge acquisition. Based on the maximum membership grade principle, $Max - RS_\lambda, (\lambda = 1,2,3,4,5)$ is the pivotal item in Rs. Interval V_λ is mapping with RS_λ and V_λ is the state interval of organization knowledge acquisition based on knowledge scenario [19].

4. Application example

The method in this paper is used by an automobile enterprise to acquire engine fault knowledge from vehicle Maintenance Company. Tab.4 shows some engine fault of a car and Fig.3is the scenario tree of engine fault.

Tab.4 engine fault

Fault / component	Common fault
Crankshaft link	Piston ring fracture, Bearing off、The main bearing oil rejection, Inverted gas, Broken crankshaft, connecting rod bending, valve spring break, Aspiratory doors closed lax, channeling oil
Gasoline Injection	The electronic fuel injector failure, increased fuel consumption, to throttle off, tempering blasters, engine speed up bad, not rated power, fuel injection
Fuel System	The fuel shortage, accelerating pump piston cup fault, idling too high, not aspiratory carburetor, by blocking filter
Lubrication, cooling	The water temperature suddenly escalate, pumps leaking water tanks swing, oil pressure suddenly dropped, oil-foot channeling oil, do not apply Valve
Ignition System	Ignition operations, covered by the electrical breakdown, ignition coil electrical leakage, generators belt too loose, sub-cylinder line interpolation wrong, when the ignition unrighteousness
Exhaust Purification	Ventilation device failure, EGR fault, catalytic purifier Fault

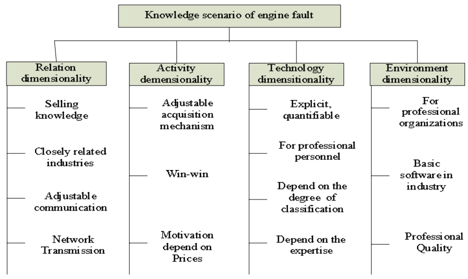

Fig.3 Knowledge scenario of engine fault

Pursuant to **Session 2**, the value of η_{ipq} can be computed in dimensionality D_i. And Tab.5 is the value of η_{ipq} in dimensionality D_1 and D_2.

Tab.5 (a) the value of η_{ipq} in D_1

Scenario item	SI_{11}	SI_{12}	SI_{13}	SI_{14}	η_{ip}
SI_{11}	0	3	5	5	13
SI_{12}	7	0	8	8	23
SI_{13}	5	2	0	6	13
SI_{14}	5	2	4	0	11

Tab.5 (b) the value of η_{ipq} in D_2

Scenario item	SI_{21}	SI_{22}	SI_{23}	η_{ip}
SI_{21}	0	4	4	8
SI_{22}	6	0	5	11
SI_{23}	6	5	0	11

So, the weights of scenario items in D_1 and D_2 can be calculated by Eq. (2).

$$W_1 = (0.22, 0.37, 0.22, 0.19)$$
$$W_2 = (0.27, 0.365, 0.365)$$

By the same way, the weights of scenario items in D_3 and D_4 can also be computed as follow:

$$W_3 = (0.18, 0.26, 0.34, 0.22)$$
$$W_4 = (0.33, 0.29, 0.38)$$

Then, the weight of D_i in whole scenario is as follows:

$$W = (W_1, W_2, W_3, W_4) = (0.28, 0.24, 0.31, 0.17)$$

Through Eq. (4) in **Session 2.2**, evaluating matrix of dimensionality is shown as follow:

$$R_1 = \begin{bmatrix} 0.2 & 0.1 & 0.2 & 0.4 & 0.1 \\ 0.1 & 0.3 & 0.1 & 0.3 & 0.2 \\ 0.3 & 0.1 & 0.2 & 0.3 & 0.1 \\ 0.1 & 0.1 & 0.1 & 0.4 & 0.3 \end{bmatrix}$$

$$R_2 = \begin{bmatrix} 0.1 & 0.1 & 0.4 & 0.3 & 0.1 \\ 0.3 & 0.1 & 0.3 & 0.2 & 0.1 \\ 0.1 & 0.3 & 0.3 & 0.2 & 0.1 \end{bmatrix}$$

Now, R_{D1} and R_{D2} of D_1 and D_2 can also be supplied.

$$R_{D1} = (0.166, 0.174, 0.144, 0.341, 0.175)$$

$R_{D2} = (0.173, 0.173, 0.327, 0.227, 0.100)$

By the same way,

$R_{D3} = (0.182, 0.225, 0.286, 0.201, 0.106)$

$R_{D4} = (0.170, 0.204, 0.316, 0.187, 0.123)$

Then, the evaluating matrix of whole scenario includes R_{D1}, R_{D2}, R_{D3} and R_{D4}.

$$R = \begin{bmatrix} R_{D1} \\ R_{D2} \\ R_{D3} \\ R_{D4} \end{bmatrix} = \begin{bmatrix} 0.166 & 0.174 & 0.144 & 0.341 & 0.175 \\ 0.173 & 0.173 & 0.327 & 0.227 & 0.100 \\ 0.182 & 0.225 & 0.286 & 0.201 & 0.106 \\ 0.170 & 0.204 & 0.316 & 0.187 & 0.123 \end{bmatrix}$$

Finally, the value of Rs is counted by Eq. (8):

$Rs = (0.1733, 0.1947, 0.2612, 0.2240, 0.1268)$

0.2612 is the largest number in Rs and 0.2240 is the second largest number in Rs. The state interval is High-feasible or Middle-feasible. So, the knowledge acquisition based on scenario is efficient and successful.

5. Conclusion

This paper proposes an evaluating method for knowledge acquisition from organizational external. Through this method, organization can gain the state interval of knowledge acquisition. By this way, organization knowledge acquisition from external is more efficient and successful.

Acknowledgements

The authors would like to thank the Natural Science Foundation of Jiangsu Education Department of China No. 07KJB520139 and the Postgraduate Innovation Foundation of information college, Yangzhou University (Coll of Inf 2007[40]).

References

[1] Pender J. Organizational Knowledge, Collective Practice and Penrose Rents [J]. *International Business Review*. 1 99 4, 3(4): 353 - 367.

[2] Kogut B. The Network as Knowledge: Generative Rules and the Emergence of Structure [J]. *Strategic Management Journal*. 2000, 21(3, Special Issue: Strategic Networks): 405- 425.

[3] Reagans R, Mcevily B. Network Structure and Knowledge Transfer: The Effects of Cohesion and Range [J]. *Administrative Science Quarterly*. 2003, 48(2): 240-224.

[4] Cohen W M, Levinthal D A. Absorptive Capacity: A New Perspective on Learning and Innovation [J]. *Administrative Science Quarterly*, 1990, 3 5 (1): 12 8.

[5] Nonaka, I., Takeuchi, H.: The Knowledge- Creating Company, Oxford University Press, New York(1995)

[6] Gilbert, M.., Cordey-Hayes, M.: Understanding the Process of Knowldege Ransfer to Achieve Successful Technological Innovation. Technovation. Vol. 16, 6(1996) 301-312

[7] Szulanski, G.: Exploring Internal Stickiness: Impediments to the Transfer of Best Practice wityin the Firm. Strategic Management Journal. 17(summer special issue) (1996) 27-43

[8] Chang, L., Zou, S.G, Li, S.C.: Research of Influential Elements on Knowledge Diffusion Based on Chian. Science Research Management. Vol. 22, 5(2001) 122-127

[9] Szulansik, G.: The Process of Knowledge Transfer: A Diachronic Analysis of Stickiness. Organizational Behavior and Human Decision Processes. Vol. 82, 1(2000) 9-27

[10] Reagans, R., McEvily, B.: Network structure and knowledge transfer: The effects of cohesion and range. Administrative Science Quarterly. Vol. 48 (2003) 240-267

[11] Mowery, D.C., Oxley, J.E., Silverman, B.S.: Strategic Alliances and Inter-firm Knowledge Transfer. Strategic Management Journal. 17(winter special issue) (1996) 77-91

[12] Luo, P.L., Zhou, Y., Guo, H.: A Literature Review on the Mechanism of Knowledge Transferring among Virtual R&D Organization. R&D management. Vol. 16, 5(2004): 18-25, 81 in Chinese

[13] Cummings, J.L., Teng, and B.S.: Transferring R&D knowledge: the key factors affecting knowledge transfer success. J. Eng. Technol. Manage. Vol. 20(2003) 39-68

[14] Cohen, W.M., Levinthal, and D.A.: Absorptive Capacity: A New Perspective on Learning and Innovation. Administrative Science Quarterly. Vol. 35, 1(1990) 128-152

[15] Hamel G.. Competition for competence and inter-partner learning within international strategic alliances. Strategic Management Journal. Vol. 12. (1991) 83-103

[16] Zhengqiang BAO, Kaizhou GAO, Wenyu BIAN, Xingguo SHI. Study on Knowledge Reuse Based on Knowledge Scenario. *Proceedings of International Conference on Innovative Computing, Information and Control,* September 5-7, 2007. Kumamoto, Japan.

[17] Meliha Yetisgen-Yildiz, Wanda Pratt. Using statistical and knowledge-based approaches for literature-based discovery. *Journal of Biomedical Informatics* 39(2006) 600-611.

[18] Shun-Chieh Lin, Shian-Shyong Tseng, Chia-Wen Teng. Dynamic EMCUD for knowledge acquisition. *Expert Systems with Applications* (2007).

[19] Biao Huang, Steven X. Ding and Nina Thornhill. Practical solutions to multivariate feedback control performance assessment problem: reduced a priori knowledge of interactor matrices. *Journal of Process Control*, Volume 15, Issue 5, August 2005, Pages 573-583.