Using Analytic Network Process to Construct Evaluation Indicators of Knowledge Sharing Effectiveness in Taiwan's High-tech Industries

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Abstract

High-tech industry has been the principal economic source for Taiwan in recent years. The characteristics of high-tech industries in Taiwan are changeable product markets, short product life cycles and high company attrition rate. In the globalization trend, the high-tech industry has gradually increased corporate competitiveness and reached the goal of sustainable operations through knowledge management, knowledge sharing and new product research and development. Firms have aggressively strengthened and integrated their internal and external resources and enhanced knowledge sharing to increase industry operational performance. Effectively strengthening the knowledge management operation and performance evaluation of knowledge sharing in Taiwan's high-tech industry has become a critical issue. In the selection of knowledge sharing Key Performance Indicators (KPI), this research divided the knowledge sharing indicators into representative strategic indicators such as organizational knowledge learning, organizational knowledge resources, organizational information capacity and organizational knowledge performance through screening using Factor Analysis. The characteristics of the constructs were interdependent. This research calculated and adjusted the correlation among the key performance knowledge sharing indicators using ANP and determined the relative weight of knowledge sharing.

Key Words: Analytic Network Process, Factor Analysis, Knowledge Sharing, Performance Evaluation

1. Introduction

In the rapidly changeable time, knowledge has become the key of corporate growth and

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many firms have recognized the importance of knowledge management and promoted knowledge management and knowledge sharing. Effectively managing and evaluating the overall knowledge sharing performance has become a critical research subject. DeTienne and Jackson (2001) suggested that knowledge was saved in employee minds and knowledge could be transferred from the individual to the organization only when employees were willing to share their knowledge and learning experiences with others. For corporate organizations, performance evaluations are absolutely important. Through performance evaluation results, corporate organizations can access the efficiency and efficacy of their resource operations as criterion for decision-making when setting up operational strategic goals. Kaplan and Norton (1996) argued that an effectiveness evaluation is one of the critical functions of management control. Without effectiveness measurements, the operation and practice performance of corporate activities cannot be controlled. Evaluation indicator studies in the field of knowledge sharing are sparse. We must establish a set of effectiveness evaluation indicators and methods as the criterion for firms to measure knowledge sharing. The Analytical Network Process (ANP) proposed by Saaty (1996, 2001) was a method that did not assume the independence of the principles. However, it did consider the dependent relationships that solved the dependence among the principles. This research selected ANP to allow the weights between constructs and indicators to produce a performance evaluation. This research includes: (1) considering the characteristics of Taiwan's high-tech industry, analyzing the performance evaluation indicators of the constructs, establishing proper, objective and complete performance evaluation indicators for knowledge sharing; (2) applying factor analysis and effective screening mechanism of evaluation indicators; (3) acquiring the weights and priority of the indicators by ANP as the critical criterion of effectiveness evaluation indicators of knowledge sharing.

2. Literature Review

This research constructs performance evaluation indicators for knowledge sharing in Taiwan's high-tech industry. This research analyzed and explored the literature related to Taiwan's high-tech industry, knowledge sharing, performance evaluation and ANP.

2.1 Definition and characteristics of high-tech industries

Bleicher and Paul (1983) indicated that the high-tech industry is capital and technique intensive and emphasizes professional knowledge, the cultivation of R&D and technology talents with large economy of scale, high risk and high returns. Gould and Keeble (1984) argued that the high-tech industry should be evaluated using three indicators: the proportion of R&D expense in output, speed of technical innovation and managerial personnel and the

proportion of technical and R&D personnel. Shanklin and Ryans (1984) argued that the firms must have a powerful scientific skill base. New skills could immediately eliminate present skills and with the application of new techniques, market and demand could be constructed or changed. When firms fulfilled these three conditions, we call them "high-tech" companies. Chiu (2002), Tien *et al.* (2007) indicated the characteristics of Taiwan's high-tech industry included: (1) talent intensive; (2) capital intensive; (3) high technical level and complicated manufacturing process; (4) high degree of market concentration and (5) short product life cycles. Based on the above literature review, this research divided the characteristics of high-tech industries in Taiwan into: (1) integrated circuit industry; (2) computer and related industry; (3) communication industry; (4) optoelectronics industry; (5) precision machinery industry; (6) biotechnology as the targets of questionnaire survey in this research.

2.2 Knowledge sharing

Hendrike (1999) suggested that knowledge sharing was the process of interaction and communication. The knowledge provider must be willing to deliver his knowledge through lectures, books, behavior or other methods. Knowledge demanders must absorb the knowledge needed by imitation, listening or reading. Senge (1998), Dixon (2000), Bartol and Srivastava (2002), Connelly and Kelloway (2003) suggested that knowledge sharing was a learning process that allowed others to acquire effective active capabilities. Through repetitive learning process, the learners could accumulate and create knowledge. Van den Hooff and Van Weenen (2004) indicated that knowledge sharing could be divided into knowledge giving and knowledge collection. Lee (2001) suggested that knowledge sharing was the activity that transferred or disseminated knowledge from individuals, groups and organizations to others. Ryu *et al.* (2003) suggested that knowledge sharing was a kind of delivery behavior through which the people in the organization acquired knowledge from others. Kearns and Lederer (2003) argued that each unit in the organization was a point. Knowledge dissemination through the channels among the points could increase the performance of the whole organization. Liebowitz (2001) suggested that knowledge sharing was confirmed as the focus of knowledge management. Knowledge sharing might be the force that could stimulate organizational knowledge creation and transfer. Hendrike (1999) indicated that knowledge management should focus on knowledge sharing and the scholars argued that only successful knowledge sharing could increase the share of intellectual capital and important resources. Knowledge sharing could be a kind of process, activity or behavior. Knowledge sharing might be a kind of behavior or process. Knowledge sharing among people was through different patterns or mechanism. Active individual knowledge sharing was the base of the successful knowledge sharing for groups or firms. Aggressive employees' knowledge sharing was based on the employees' "active" giving others their knowledge and "active" collection of the know-

ledge needed from others. Thus, the knowledge in the whole organization turned into a knowledge sharing circuit. Only activity revealed that knowledge providers sincerely passed on knowledge to the demanders and the knowledge demanders truly had the will to learn.

The American Productivity and Quality Center (APQC) defined knowledge sharing as below: "knowledge management is a kind of strategy that allows the proper people to acquire the proper knowledge at the proper time: through knowledge sharing, group intellect can be fulfilled which further increases the organizational responsive and innovative capacities". Quinn *et al.* (1996) indicated that upon two parties' knowledge sharing, two parties' information and experience acquisition would grow linearly. The empirical study by Lee (2001) with found that knowledge sharing was the principal predictive factor of corporate outsourcing activity results. Hong *et al.* (2004) argued that there was a significantly positive correlation between knowledge sharing and new product development. Through knowledge sharing, organizational competitive advantages could be established that might be the managerial capacities or techniques leading to organizational creativity and progress. Robbins (2003) suggested that the employees' had a subjective perception of organization characteristics such as the degree to which team work is valued and the employees are supported. These positive or negative perceptions influence employee performance and work satisfaction. When employee knowledge sharing constructs a culture different from other firms, the employees might acquire new knowledge that further increases their learning capacity in the continuous interaction with others due to the influence of this knowledge sharing culture. Because this process involves a learning atmosphere among coworkers, their learning motivation could be increased. Liao *et al.* (2004) suggested that a good relationship between the employees and the firm, the employees actively and unconditionally share their knowledge and experiences with their colleagues. Based on the descriptions of the above literatures, this research applied Factor Analysis to screen the complicated indicators and divided knowledge sharing indicators into the representative strategic indicators such as organizational knowledge learning, organizational knowledge resources, organizational information capacity and organizational knowledge performance as the constructs of knowledge sharing in this research.

2.3 Performance evaluation

Liebowitz and Chen (2001) argued that establishing a knowledge sharing effectiveness evaluation system was an important process for firms to promote knowledge sharing. Darroch (2003), Lee and Choi (2003), Taylor and Wright (2004), Liu *et al.* (2004, 2005) argued that the following could be the performance evaluation indicators of knowledge sharing: organizational knowledge acquisition capacity, knowledge absorption capacity, knowledge saving capacity, knowledge searching capacity, knowledge exchange capacity, knowledge quality increasing, knowledge sharing culture, degree of cooperation performance evaluation, knowledge

network measure, reward system, educational training project, work rotation, reduction in learning costs, acquiring competitive advantages, creative capacities, organizational reform capacity, acquisition capacity of external knowledge, controlling market information, creating the additional value for the customers and employees' trust degree.

Performance measurement or performance evaluation meant a system by which firms measure or evaluate through quantitative standards or subjective judgments the performance of daily operational activities. The operational performance evaluation could help firms understand if their strategies and organizational structures reached the planned goals. Venkatraman and Ramanujam (1986) proposed three conceptual performance evaluation indicators of corporate performance:

1. Financial performance: it meant to reach the corporate economic goals. The indicators commonly used referred to net Income after tax, operational income, growth in business, Return on Assets, Return on Capital and profit margin.
2. Operational performance: financial performance and business performance turned into corporate performance such as the non-financial indicators: product market share rate, product quality, additional value rate and marketing efficacy.
3. Organizational efficacy: it was the most general corporate performance. Conflict resolution, stakeholder satisfaction targets, employee morale, etc. Ven De Ven and Ferry (1980) suggested that the traditional financial performance was the most common indicator used by the researcher to evaluate the organizational results such as return on investment, revenue and profit margin. Among others, revenue was the most common one used by the researchers.

Chakravarthy (1986) suggested that with regard to the operational performance categorization and measurement, there were 4 principal categories: (1) operational goals: they referred to the corporate operational plans, such as the accomplishment degrees of annual budget, capital increase, plant expansion, joint venture and acquisition; (2) productivity: the use situations of the plants and facilities; (3) profits: it meant the proper operation of corporate capital was shown on return on investment that could be calculated according to earning growth rate; (4) long-term priority resources: they were the bases of the sustainable operation and continuous growth of the firms. De Brentani (1989) indicated that he combined the literatures of product creativity and service marketing and treated 115 different kinds of firms as the investigation targets. The result showed that the characteristics of services and products results in different performance evaluations. Kaufman (1988) suggested that performance indicator was the measurement to identify and prove if the planned targets were fulfilled. The criterion of measurement or evaluation was called performance criterion. Fortuin (1988) treated performance indicator as a kind of variable to assess the efficiency or efficacy of the whole or part of the system in the organization in order to understand if the

business process met the planned targets. In the knowledge sharing effectiveness evaluation process, we also faced uncertain decision-making issues that were not easy to quantify. This research combined ANP and proposed a set of evaluation models and knowledge sharing effectiveness measures to help firms to evaluate their knowledge sharing performance.

2.4 Analytic Network Process (ANP)

2.4.1 Characteristics of ANP

ANP is an extension of AHP. There are some similarities between these two methods (Lin *et al.*, 2008). Many assumptions in AHP (Saaty, 1977, 1980a) are supported in ANP. There are many decision-making issues that cannot be clearly shown using a structural hierarchy because there is inner influence and dependence between the upper and lower levels. It is not simply a linear relationship from top to bottom. Instead, it is similar to a network relationship framework. Saaty (1980a, 1980b) indicated that the inner dependence relationship between the clusters and elements could be analyzed and described using graphs. The elements in the graphs should be connected and not be separated into two or more unconnected graphs. ANP allowed both inner dependence in the clusters and outer dependence among the clusters. It provided a complete framework that included the connection between the clusters and elements. This research studied the whole process using the method expected by the decision makers. This approach allows the decision maker to find the mutual influence between the elements and clusters from the problems and infer the scale of the project priority. The ANP characteristics include: (1) network framework model; (2) connection among the factors; (3) the most significant characteristic of ANP was the "dependent relationship"; (4) calculation upon Supermatrix, etc.

2.4.2 Basic hypotheses of ANP

The basic ANP hypotheses are shown below:

(1) A system could be divided into various classes or components which constructed the hierarchical directed layer structure.
(2) In the hierarchical structure, each hierarchical element was assumed to be independent.
(3) The elements of each hierarchy could be evaluated upon some or all elements in the previous hierarchy.
(4) When comparing the evaluation, we could change the absolute value scale into a ratio scale.
(5) After pair-wise comparison, we could manage positive reciprocal matrix.
(6) The preference relationship satisfied transitivity. The relationship of priority satisfies transitive principle (A was better than B, B was better than C and A was better than C). The priority degrees of the elements were acquired upon weighting principle; intensity

relationship also satisfied transitivity (When A was better than B by two times, B was better than C by three times, A was better than C by six times).

(7) It was not easy to have complete transparency; thus, because of incomplete transparency, the degree of consistency should be tested.

(8) The elements in the hierarchical framework, regardless of their priority, were regarded as related to the entire evaluation framework. We did not examine the independence of the hierarchical structure.

3. Research Method

3.1 Research process

This research framework was divided into two stages. The first stage was the selection of performance evaluation indicators. The researcher first reorganized the initial performance evaluation indicators from the related literature and information from knowledge management executives, scholars and expert perceptions toward the importance of the indicators using a questionnaire survey. The researcher then analyzed the data and screened the key performance indicators (KPI). The second stage explored the relationships among the key performance indicators through an expert questionnaire and ANP and determined the relative weights. Finally, the research proposed the conclusions and suggestions.

3.2 Establishing the evaluation model of knowledge sharing effectiveness

3.2.1 Establishing the evaluation constructs of knowledge sharing effectiveness

This research used the results upon questionnaire survey and extracted knowledge sharing effectiveness evaluation constructs and indictors by factor analysis. The description is shown below:

(1) Designing the questions of questionnaire

Based on knowledge sharing effectiveness evaluation indicators, this research designed 20 questions to assess the participants' perception degrees toward the evaluation indicators. The content of each question was reorganized as Table 1. The scale of the questions was based on Likert 7-point scale (1: totally disagree; 7: totally agree).

(2) Sample data collection

The researcher collected the samples by mails to proceed with questionnaire survey. This research used the top 1,000 high-tech firms in Taiwan as the targets. The respondents were mainly high-ranking executives and knowledge management executives from these firms. One

thousand questionnaires were distributed, with 600 returned and 550 valid samples. The valid return rate was 55%.

(3) Factor analysis

This research applied factor analysis and turned several evaluation indicators into few evaluation constructs through the shared factor findings. It proceeded with statistical analysis using SPSS 12.0 for Windows software and applied Varimax Rotation. The result of each factor analysis is shown in Table 2.

(4) Factor naming

According to the factor analysis result, this research generalized the evaluation indicators influencing knowledge sharing effectiveness into 4 constructs. According to the characteristics of each construct evaluation indicator, the researcher respectively named the constructs as follows: organizational knowledge learning construct, organizational knowledge resources construct, organizational information capacity construct and organizational knowledge performance construct.

(5) Reliability analysis

This research assessed the consistency degrees of the same construct in different questions by internal consistency factor (Cronbach's α). According to the result of Table 2, Cronbach's α of the constructs all reached the standard of over 0.7. The study of Nunnally (1978) suggested that in the basic study, as long as reliability was at least 0.7, it was acceptable. Reliability of this research was at least 0.7. Thus, the reliability was reliable. Reliability of each variable in this research and the evaluation indicator factor analysis results are shown in Table 2.

3.2.2 Establishing an evaluation model for knowledge sharing effectiveness

Effectiveness evaluation indicators of knowledge sharing did not refer to one aspect or one level. They dealt with the issues on multiple levels. When the participants were filling in their personal perception (such as their views on effectiveness indicators of knowledge sharing), there were more differences in terms of personal subjective factors and their perception toward the meanings of the questions and the evaluation process did not necessarily follow a linear pattern. Therefore, the past linear-additive model could not effectively reveal the fuzziness of personal subjective evaluation. This research planed to propose an effectiveness evaluation model of knowledge sharing effectiveness upon ANP to evaluate the whole knowledge sharing effectiveness as the criterion for the firms to measure the promotion result of knowledge sharing. The evaluation model is shown in Figure 1.

Table 1. Evaluation indicator questionnaire

No.	Evaluation indicators	Evaluation indicator questionnaire
1	Knowledge acquisition capacity	The employees could effectively control the sources and channels of new knowledge.
2	Knowledge absorption capacity	The employees could apply or transform the knowledge absorbed into useful knowledge in the organization.
3	Knowledge saving capacity	The corporate core knowledge and techniques were saved in written or electronic files.
4	Knowledge searching capacity	The firm had screening and classification using a knowledge database that could accelerate knowledge searches.
5	Knowledge exchange capacity	The employees generally used the computer tools for communication, negotiation and knowledge exchange.
6	Knowledge quality upgrading efficacy	Because of knowledge sharing promotion, the employees in the firm could acquire higher-quality knowledge.
7	Knowledge sharing culture	When the employees had new ideas or knowledge, they would actively share it with other members in the organization.
8	Performance evaluation efficacy	The firm included knowledge sharing in the employee performance evaluation indicators which stimulated knowledge sharing.
9	Knowledge network application	The employees would share knowledge using knowledge network tools (such as e-mails and message board).
10	Practice of reward system	The firm's reward system makes employees value creativity or knowledge sharing.
11	Educational training project	The firm provided complete resources to support various educational training.
12	Work rotation plan	The firm practiced work rotation to allow the employees properly diffuse and transfer the employees' knowledge.
13	Knowledge learning capacity	Because of knowledge sharing promotion, the employees in the firm increased their knowledge learning capacity.
14	Acquiring competitive advantages	Because of the practice of knowledge sharing, the firm further strengthened the organizational competitive advantages.
15	Organizational creativity R&D capacity	The firm promoted knowledge sharing and increased the creative capacity of the organization.
16	Organizational reform capacity	Because it encouraged knowledge sharing, the firm accumulated the organizational capacity to continue reform.
17	External knowledge acquisition capacity	The firm would actively learn or absorb the useful knowledge from the external firms (such as customers or suppliers).
18	Controlling market information	The firm would actively hire the personnel with professional knowledge or practical skills to establish knowledge database.
19	Creating the additional value for the customers	The firm could increase the additional value to the customer service because of the employees' proper knowledge sharing.
20	Employees' trust degree	The employees considerably trusted each other and got along with each other well. They were willing to share knowledge to each other.

Table 2. Factor analytical result and reliability analysis of evaluation indicators

No. Evaluation indicators	Factor 1	Factor 2	Factor 3	Factor 4	Names of factors	Cronbach's α
1 Knowledge acquisition capacity	0.774	0.196	0.281	0.251	Organizational knowledge learning construct	0.9135
2 Knowledge absorption capacity	0.711	0.306	0.189	0.268		
3 External knowledge acquisition capacity	0.704	0.234	0.252	0.279		
4 Knowledge learning capacity	0.662	0.296	0.268	0.170		
5 Practice of reward system	0.266	0.766	0.278	0.139	Organizational knowledge resource construct	0.8992
6 Performance evaluation efficacy	0.183	0.743	0.228	0.282		
7 Educational training project	0.195	0.717	0.312	0.263		
8 Work rotation plan	0.291	0.648	0.149	0.172		
9 Knowledge saving capacity	0.211	0.321	0.765	0.279	Organizational information Capacity construct	0.8869
10 Knowledge searching capacity	0.286	0.297	0.748	0.160		
11 Knowledge exchange capacity	0.232	0.284	0.558	0.166		
12 Knowledge network application	0.289	0.163	0.528	0.141		
13 Organizational creativity R&D capacity	0.303	0.356	0.134	0.736	Organizational knowledge performance construct	0.9065
14 Organizational reform capacity	0.334	0.318	0.273	0.701		
15 Knowledge quality upgrading efficacy	0.403	0.297	0.281	0.582		
16 Knowledge sharing efficacy	0.278	0.173	0.328	0.502		
Eigen value	3.498	3.225	3.021	2.783		
Explained variance (%)	26.488	25.123	20.090	28.297		
Accumulated explained variance (%)	26.488	51.611	71.701	91.998		

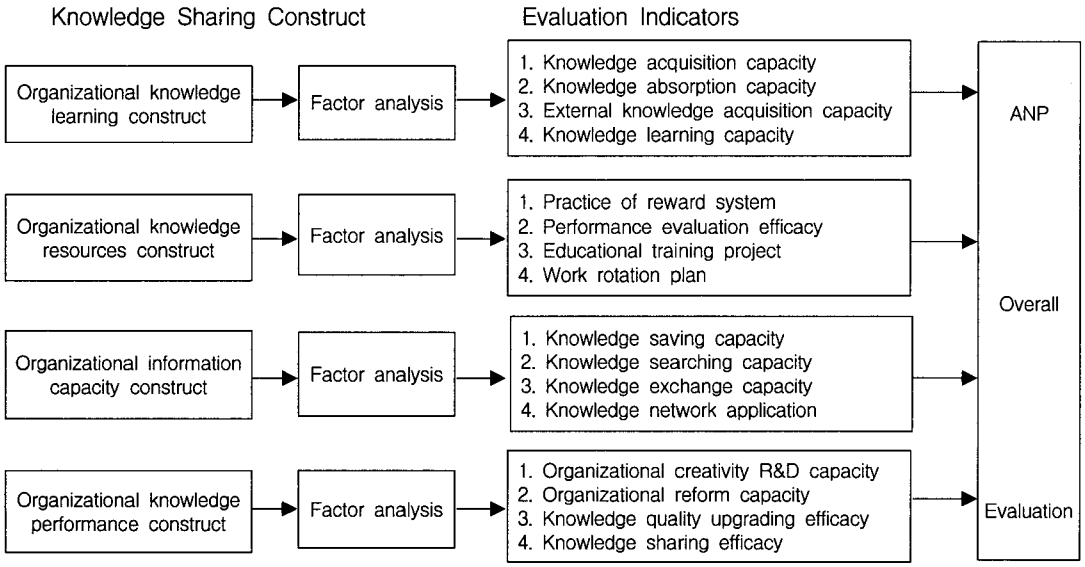

Figure 1. Effectiveness evaluation model of knowledge sharing

3.3 Confirming the weights of key performance evaluation indicators by ANP

The principal ANP calculation steps are shown below:

1. Establishing the network hierarchical framework of knowledge sharing: this research applied ANP to acquire the overall relative weight of evaluation indicators in the mutual influences of performance evaluation constructs and established the ANP network hierarchical framework using the key performance evaluation indicators for four principal constructs: organizational knowledge learning, organizational knowledge resources, organizational information capacity and organizational knowledge performance and assumed that the indicator of each evaluation construct was affected by other construct indicator.
2. ANP questionnaire design and completion: the questionnaire treated the performance evaluation indicators as the criterion of evaluation and managed the critical evaluation of pair-wise comparison on the evaluation indicators of the constructs.
3. Establishing pair-wise comparison matrix: it was the first step of questionnaire analysis. It integrated and normalized ANP questionnaire and transformed the integrated questionnaire result into Pairwise Comparison Matrix.
4. Integrating the experts' preference: When there was one decision maker, the judgmental result was not connected with the integration of preference. However, when the decision-making group evaluated the situation, since every respondent had different perceptions toward the questions, the judgmental values of pairwise comparison were different. The importance degrees of performance evaluation indicators were different. Thus, the researcher must integrate the experts' preference. There were various methods to integrate the preference. With the consideration of easy judgment and simple calculation, this research integrated the experts' preference using the average of the decision-making group figures. The calculation methods of average included Arithmetic Mean and Geometric Mean. According to the suggestion of Saaty (2001), Geometric Mean was the better method. This research integrated and normalized the experts' pairwise comparison matrix to establish the pairwise comparison matrix after integration.
5. Calculating Eigen value and Eigen vector: After pairwise comparison, upon the acquisition of Eigen value and Eigen vector of the pair wise comparison matrix, the researcher could further obtain the relative weights of the factors. However, when the order of matrix was higher, the calculation became more complicated; thus, the researcher could acquire eigen value and eigen vector by near eigen value solution. The solution acquired was close to the precise value. The description is shown below:

When pair wise comparison matrix of n items (A_1, $\cdots$, A_i, $\cdots$, A_n) was $A = [a_{ij}]$, the researcher first acquired the total of row vector T_i:

$$T_i = \sum_{j=1}^{n} a_{ij}, \quad I = 1, 2, \cdots, n$$

And the total of row vector T:

$$T = \sum_{i=1}^{n} T_i = \sum_{i=1}^{n} \sum_{j=1}^{n} a_{ij}$$

Subsequently, the researcher acquired the weight W_i of item $A_{i\ y}$ by the following normalization

$$W_i = \frac{T_i}{T} = \frac{\sum_{j=1}^{n} a_{ij}}{\sum_{i=1}^{n} \sum_{j=1}^{n} a_{ij}}, \quad I = 1, 2, \cdots, n$$

The researcher then found maximum eigen value by the following formula λ_{max}.

$$\lambda_{\max} = \sum_{i=1}^{n} \frac{(AW)_i}{n W_i}$$

6. Consistency test: The decision makers or the experts filling out the questionnaire might have inconsistent judgments or random answers since they were not clear about the questions. However, the complete theoretical consistency of the decision makers' judgments was an extremely difficult task. Thus, after the return of ANP questionnaire, the researcher must manage the process of consistency test. The fulfillment of the principle of consistency test could satisfy the priority relationship of the principle of ANP and the transitivity of intensity relationship to ensure the usability of questionnaire and satisfying judgments of the participant experts.
7. Supermatrix operation: it was to deal with the correlation relationship among the elements of the question structure. ANP was based on more unique matrix structure which was called Supermatrix for calculating the relative weights of the factors. The supermatrix consisted of many sub-matrices as shown in Figure 2. Constructs A and B revealed external and internal dependent relationships. The matrix is shown below:

$$M' = \begin{array}{c} \\ \text{Construct A indicator} \\ \text{Construct B indicator} \end{array} \begin{array}{c} \begin{array}{cc} \text{Construct A indicator} & \text{Construct B indicator} \end{array} \\ \begin{bmatrix} X & Z \\ Y & W \end{bmatrix} \end{array}$$

Figure 2. Description of Supermatrix

Matrix X: the pair wise comparison matrix of the indicators of construct A under the influence of the said construct.

Matrix Y: the pair wise comparison matrix of the indicators of construct A and B under the influence of the construct A.

Matrix Z: the pair wise comparison matrix of the indicators of construct A and B under the influence of construct B.

Matrix W: the pair wise comparison matrix of the indicators of construct B under the influence of the said construct.

Among others, M' was "Unweighted" Supermatrix. Since the matrix row values might not comply with the random principle (such as the total of row values was not 1) a specific process must be used for transformation. After multiplying the evaluation construct, maximum eigen value was acquired for matrix operation which led to weighted supermatrix (M). Through the above transformation process and Limiting operation and after multiplying M' and M to root of $2k+1$ (k was the value upon subjective decision), the dependence relationship would be gradually converged and relative weights among the factors could be acquired.

8. Questionnaire survey and data analysis

This research evaluated the firms' knowledge sharing performance from four constructs: organizational knowledge learning, organizational knowledge resources, organizational information capacity and organizational knowledge performance. It focused on 20 important representative strategic indicators. Besides, in order to avoid the situation in which multiple indicators resulted in the complicated questionnaire of "applying ANP to construct key performance indicator weights" at the next stage, this research screened 16 items as the evaluation indicators of key knowledge sharing performance.

9. Establishing the network hierarchical framework of the questions

According to four principal constructs: organizational knowledge learning, organizational knowledge resources, organizational information capacity and organizational knowledge performance, this research established the network hierarchical framework. In the figure, we found the indicator for each evaluation construct was influenced by the said construct and other construct indicators. This research established ANP model by Super Decision software shown in Figure 3.

4. Research Results and Analysis

4.1 Result analysis of confirming performance evaluation indicator weights using ANP

Through the steps and process of ANP, this research reorganized the relative weights of

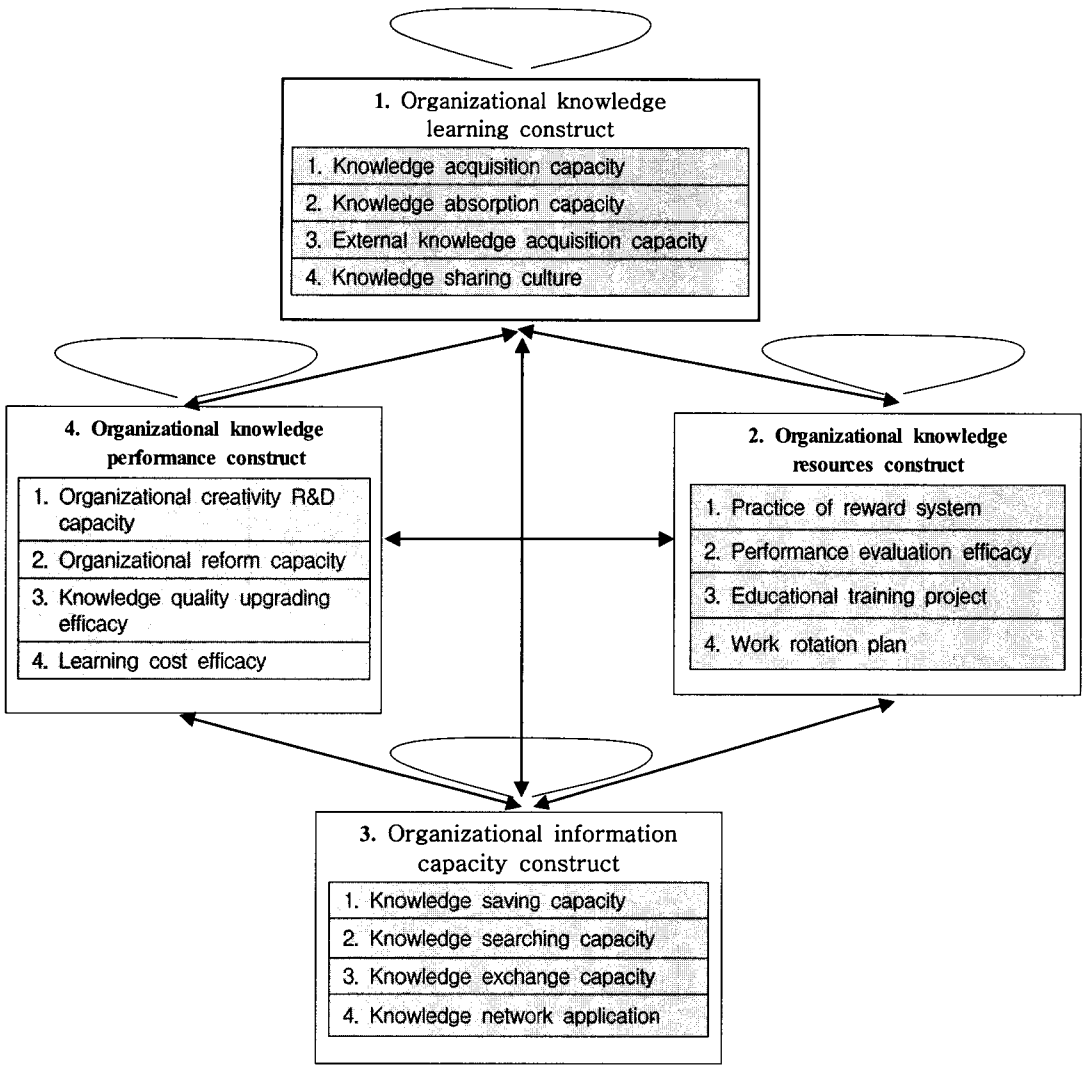

Figure 3. ANP model of decision-making software in this research

each key performance evaluation indicator of knowledge sharing shown in Table 3. The weight of Organizational knowledge learning construct was 0.329, organizational knowledge resources construct was 0.564, organizational information capacity construct was 0.251, and organizational knowledge performance construct was 0.693.

4.2 Result analysis of the key knowledge sharing performance indicators

Through Supermatrix, this research calculated the relative weights of the factors and the priority vectors among all factors and arranged the key knowledge sharing performance indicator order according to the proportions of the constructs, as shown in Table 4. From

Table 3. Reorganization of evaluation values and weights of the constructs of knowledge sharing effectiveness

Evaluation constructs	Evaluation indicators	Evaluation value	Weights	λ value	Construct evaluation value	Weights of constructs
Organizational knowledge learning construct	Knowledge acquisition capacity	0.590	(0.698)	-0.9995	0.484	0.329
	Knowledge absorption capacity	0.551	(0.641)			
	External knowledge acquisition capacity	0.501	(0.639)			
	Knowledge learning capacity	0.451	(0.698)			
Organizational knowledge resources construct	Practice of reward system	0.501	(0.548)	-0.9773	0.578	0.564
	Performance evaluation efficacy	0.551	(0.551)			
	Educational training project	0.590	(0.691)			
	Work rotation plan	0.501	(0.451)			
Organizational information capacity construct	Knowledge saving capacity	0.789	(0.590)	-0.9775	0.385	0.251
	Knowledge searching capacity	0.789	(0.590)			
	Knowledge exchange capacity	0.699	(0.658)			
	Knowledge network application	0.789	(0.648)			
Organizational knowledge performance construct	Organizational creativity R&D capacity	0.451	(0.690)	-0.882	0.817	0.693
	Organizational reform capacity	0.402	(0.603)			
	Knowledge quality upgrading efficacy	0.640	(0.602)			
	Knowledge sharing efficacy	0.699	(0.801)			

Table 4. Relative weights of key performance indicators of knowledge sharing

Constructs	Evaluation indicators	Priority vectors among all factors	Order	Proportions of the constructs	Order
Organizational knowledge learning construct	Knowledge acquisition capacity	(0.02801)	2	12.83%	3
	Knowledge absorption capacity	(0.01209)	4		
	External knowledge acquisition capacity	(0.01974)	3		
	Knowledge learning capacity	(0.05863)	1		
Organizational knowledge resources construct	Practice of reward system	(0.04297)	3	24.47%	2
	Performance evaluation efficacy	(0.13506)	1		
	Educational training project	(0.04745)	2		
	Work rotation plan	(0.03942)	4		
Organizational information capacity construct	Knowledge saving capacity	(0.04038)	2	7.50%	4
	Knowledge searching capacity	(0.00925)	3		
	Knowledge exchange capacity	(0.00803)	4		
	Knowledge network application	(0.02789)	1		
Organizational knowledge performance construct	Organizational creativity R&D capacity	(0.15568)	2	55.17%	1
	Organizational reform capacity	(0.15549)	3		
	Knowledge quality upgrading efficacy	(0.14826)	4		
	Knowledge sharing efficacy	(0.19245)	1		

Table 4, we found the order of effectiveness for the knowledge sharing evaluation indicators was: (1) organizational knowledge performance construct was 55.17%; (2) organizational knowledge resources construct was 24.47%; (3) organizational knowledge learning construct was 12.83%; (4) organizational information capacity construct was 7.50%.

5. Conclusions

The sorting result for the knowledge sharing evaluation indicators acquired by this research using Super Decision software showed that the proportions of "organizational knowledge performance" and "organizational knowledge resources" were higher. It revealed that with regard to knowledge sharing, the firms treated knowledge sharing efficacy, organizational creativity and R&D capacity promotion, providing performance evaluation efficacy and educational training project as the prior targets. The proportions of the weights of "organizational knowledge performance" and "organizational knowledge resources" were higher than the other two constructs. According to the evaluations by experts and executives, how the organization improved their relationships with the users, carried out knowledge sharing measure and increased the customers' trust and satisfaction with the organization was extremely important. This result also showed that in the present environment the overall organizational performance evaluation direction considerably focused on organizational knowledge performance and organizational knowledge resources.

(1) As to "organizational knowledge learning", the indicator importance degrees in order were knowledge learning capacity, knowledge acquisition capacity, external knowledge acquisition capacity, knowledge absorption capacity, etc.
(2) As to organizational knowledge resources, the indicator importance degrees in order were performance evaluation efficacy, educational training project, practice of reward system, work rotation plan, etc.
(3) As to organizational information capacity, the indicator importance degrees in order were knowledge network application, knowledge saving capacity, knowledge searching capacity, knowledge exchange capacity, etc.
(4) As to organizational knowledge performance, the indicator importance degrees in order were knowledge sharing efficacy, organizational creativity R&D capacity, organizational reform capacity, knowledge quality upgrading efficacy, etc.

After this research applied ANP to analyze and explore the knowledge sharing effectiveness evaluation constructs, it found that knowledge sharing efficacy played extremely critical role in high-tech industries in Taiwan. Therefore, establishing proper and objective performance indicator construction and evaluation with respect to knowledge sharing was consid-

erably important for the competitiveness of high-tech industries in Taiwan. Through factor analysis and ANP, this research established the evaluation weights and priority for knowledge sharing indicators and functioned as extremely important reference for the high-tech industries in Taiwan to introduce knowledge management and the evaluation of knowledge sharing effectiveness.

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