THE EFFECTS OF KNOWLEDGE MANAGEMENT STRATEGY OF AN ENTERPRISE ON THE KNOWLEDGE CREATION CAPABILITY OF R&D TEAM MEMBERS AND THEIR R&D PERFORMANCE

Jia-Sheng Lee
Associate Professor of Business Administration
Providence University
5 Lane 96, Pin-Der Road, Taichung, Taiwan 406, ROC
886-0926-581828
jslee@pu.edu.tw

Wan-Fai Chou
Program Manager, Commercial Aircraft Programs
Aerospace Industrial Development Corporation
38 Lane 3, Zhongzhen Road, Taichung, Taiwan 433, ROC
wanfaichou@ms1.aidc.com.tw

Abstract: The purpose of this research is to investigate the influences of knowledge management strategy of an organization on its individual or team knowledge creation capability, and analyze whether an individual's R&D performance can be improved through the enhancement of individual or team knowledge creation capability. After a survey of literature and interviewing of several businesses, we built the research structure and present the hypotheses. Questionnaire was designed to collect the empirical data, with High-Tech industries in Taiwan and their R&D teams as the population. In total, 500 questionnaires are sent out, and 152 complete questionnaires are returned (the effective return rate is 30%). We use SEM linear structure equation model, and LISREL 8.54 editions of software for data analyses, and verify our hypotheses. The empirical results show: 1.knowledge management strategy of an organization has significant influences on its individual or team knowledge creation capability. 2. Individual or team knowledge creation capability has positive influences on individuals' R&D performance. 3.Knowledge management strategy of an organization has significant influences on individuals' R&D performance through the enhancement of individual or team knowledge creation capability

Keywords：Knowledge management strategy, knowledge creation process, knowledge creation capability, R&D performance

INTRODUCTION

Knowledge in essence is very personal. It is very plentiful when stayed in the brain of a person. However, its vitality decreases whenever it leaves a person (Ruggles & Holtshouse, 1999). Since 1967, Polanyi separated knowledge as tacit and explicit knowledge, in which, tacit knowledge is highly context-specific, personalized, and hard to be formalized and communicated. It generally exists in the experience and behavior of a person (Nonaka, 1994). Comparatively, explicit knowledge can be expressed easily. It generally has obvious factual evidence, and can be codified as stated and systematic knowledge.

The generation of knowledge is very different from that of a traditional product which needs some specific raw materials, a kind of production process, and then gets a similar product, especially for that of tacit knowledge which exists in a person and can almost be understood by insight and hard to be expressed. Tacit knowledge is not so easily be copied and preserved separately as explicit knowledge. Thus, it is much easier to become the source of core competence. This is just the main reason why knowledge labor is so valued.

The creation of organizational knowledge is generally obtained from organizational learning, of which beginning and ending both turn back to personals (Argyris & Schon, 1978, 1996; Friedman, 2002; Nonaka & Takeuchi, 1995; Senge, 1990). The amount of knowledge reserve of an organization is decided by the quantity of all personal knowledge in that organization. However, the amount of knowledge reserve of an organization is not equal to its productivity of knowledge. If we cannot extract and develop the tacit knowledge of individual personals, and make use of it, then all will be in vain. Therefore, the capability of personal tacit knowledge transformation will be a key factor that influences the productivity of knowledge of a whole organization.

Most of previous studies discuss the influence of such factors as organizational strategies, structure, and culture to knowledge

management, of which the unit of analysis is an organization. In this study, we choose the knowledge intensive R&D groups as our research target and units of analysis. We discuss the influence of knowledge management strategies of an organization on the knowledge creation capability and R&D performance of an individual in a R&D team. We discuss from the aspects of knowledge creation capability of organizational individual: capabilities of internalization, externalization, socialization, and combination, and hopefully to give a different aspect of thinking for the management of an organization when making decision about knowledge strategies. Through the way to maximize individual knowledge transformation and knowledge creation capability, personal performance as well as organizational competitiveness might be enhanced.

The objectives of this study are as follows:

(1) To discuss the influence of the strategies of knowledge management on the knowledge creativity of members in the R&D teams in an organization.
(2) To discuss the influence of an individual knowledge creativity on his performance in R& D teams.
(3) To discuss whether knowledge management strategies of an organization affect individual R&D performance through his knowledge creativity in R&D teams.

LITERATURE SURVEY

Knowledge and Its Creation

Polanyi (1997) originally categorized knowledge as " tacit" and " explicit" , in which, tacit knowledge is in the human mind, behavior, and perception, and thus, it is difficult to be formalized and communicated. It evolves from peoples' interactions, and requires skills and practices. Comparatively, explicit knowledge can be easily formalized and documented. It is what can be captured and shared through information technology (Nonaka, 1995). Zack (1999) believes that the degree of tacit and explicit of knowledge should be consider absolutely as an issue in developing knowledge strategies.

Nonaka & Konno (1998) introduce the Japanese concept of *"ba,"* which roughly translates into the English word "place." They ground the concept of *ba* in an existentialist framework. The key platform of knowledge creation is the "phenomenal" place. Such a place of knowledge can emerge in individuals, working groups, project teams, informal circles, temporary meetings, e-mail groups, and at the front-line contact with the customer. If knowledge is separated from *ha,* it turns into information, which can then be communicated independently from *ba.* Information resides in media and networks. It is tangible. In contrast, knowledge resides in *ba.* It is intangible. Within an organization, knowledge-creating teams or projects play key roles in value creation. Value creation in knowledge-creating companies emerges from interactions within shared *ba* but is not restricted to the physical *ba.* The concept of *ba* unifies the physical space, the virtual space, and the mental spaces.

Leonard-Barton (1995) takes the point of view of organizational activity, and categorizes four kinds of activities that might create knowledge. 1. Solving problem together. As a problem occurs, it is better to let all the employees to give their wisdom to solve the problem. 2. Implement and combine new technology flow and instruments to enhance the operational effectiveness. 3. Proceed experimentation and prototype trial-manufacture style of organizational learning to create knowledge continually. 4. Input and absorb outer technological knowledge to enhance the power for creating organizational knowledge. Hedlund (1994) suggests that effective knowledge management is argued to require departures from the logic of hierarchical organization. The alternative N-form is characterized and suggested as more appropriate. It entails combination of knowledge rather than its division. Other attributes are: temporary constellations of people, the importance of personnel at 'lower levels', lateral communication, a catalytic and architectural role for top management, etc.

Davenport and Prusak (1998) regards experiences, facts, judgments, rule of thumbs, and intuition as knowledge components. They assume five methods for obtaining knowledge: 1.acquisition: knowledge can be obtained through procuring from outside the organization or generating from inside the organization; 2.division of labor: it would be helpful for an organization to create knowledge by assigning specific responsibility unit. 3.combination: through grouping people with different points of view to take the responsibility of a project or solve a problem, new knowledge could be created. 4.adaptation: a sense of crisis arises when changes occur in environments, an organization might generate new knowledge for adapting the changes to survive. 5.network: an informal network in an organization could be source of new knowledge, new knowledge might be generated through frequently interacting among people.

Nonaka and Takeuchi (1995) discuss the factors about why some Japanese companies success in his article " the Knowledge-Creating Company" , and propose their two different viewpoints about generation of knowledge: essence and cognition. In the aspect of essence, the authors emphasizes that only a personal can generate knowledge, an organization cannot generate knowledge unless through individuals. They classify knowledge generation as four levels: individual, group, organization, and inter-organization, but all the knowledge of organizations eventually come from individuals. In the aspect of cognition, as following the classifying of Polanyi (1967), knowledge can be classified as tacit and explicit. Knowledge by all means is created from the interaction of tacit and explicit knowledge. The modes of their conversion are socialization,

externalization, combination, and internalization. Through continuous conversion, new knowledge is created. This knowledge conversion, also called knowledge spiral, is the process of knowledge generation, and is called as SECI process.
Knowledge creation needs all theses four stages, and can not lack any one of it. On the part of knowledge sharing, a person needs to have the ability to express his knowledge clearly. Otherwise, other people can not make use of it. Personalized tacit knowledge must be shared with others, and further becomes a concept, a system and spreads around the organization. And then the knowledge will be internalized by other personals. Any of above stages is neglected will be incomplete. Therefore, knowledge creation is a process of self-surpass process, and organization is a place for such a knowledge creation. The organization needs to sufficiently support personals, because only personals are the source of tacit knowledge.

Knowledge Creation Capability of an Individual

Nonaka and Takeuchi (1995) points out that only a personal can crate knowledge. And an organization can create knowledge only through personals. Above four transformation processes of knowledge: socialization, externalization, combination, and internalization are also motivated and implemented by individuals. Therefore whether individuals have this knowledge conversion capability is the key factors to influence an organizational knowledge creation. And knowledge conversion capability is closely related with the four modes of capabilities: socialization, externalization, combination, and internalization owned by individuals. The four capabilities are explained as follows:
(1) Capability of internalization
Capability of internalization is the ability to transform explicit knowledge to tacit knowledge. The explicit knowledge might be embodied in action and practice when internalizing, one can acquire the knowledge by fulfilling other's experience and internalize it to be part of his own tacit knowledge (Becerra-Fernandez & Sabherwal, 2001).
(2) Capability of externalization
Capability of externalization is the ability to transform tacit knowledge to explicit knowledge that others can easily understand. Just like a teacher delivers his knowledge to his students through clear and comprehensible means. It may not be by language, but also by metaphor, analogy, figure, or body language (Nonaka, 1994; Nonaka & Takeuchi, 1995).
(3) Capability of socialization
Capability of socialization is the ability to share one's tacit knowledge through common attending activities. For example, when an organization implements a kind of socializing activities, like employee's rotating among different departments, brain storming activities, cooperate project cross departments, or delivering knowledge by apprentice, one's ability to share and communicate his tacit knowledge.
(4) Capability of combination
Capability of combination is the ability to transform less complicated knowledge to more complicated knowledge. In other words, it is the ability such that an individual can organize, integrate, and spread knowledge. For example, when discussing a topic among people, an individual can induce the contents of discussion, and enhance the efficiency of discussion. It may also be the ability for combining old information with new ones to stimulate a new concept.
Simon (1969, 1991) argues that learning can take place in one's brain, but not in an organization. The organization requires its employees to absorb new knowledge, or introduce new knowledge via its new members. When their employees do not have such knowledge conversion abilities, it could not generate new knowledge. More than that, it might even be a problem when introducing new knowledge or technology from outside and utilizing them. It could be more essential for an R&D team, since it depends on knowledge generation to get performance, i.e., knowledge creativity of R&D members might decide their performance of R&D.
From another point of view, learning and knowledge creativity have self reinforcement mechanism (Cohen& Liventhal, 1990): when leaning and knowledge creativity accomplish results of R&D, R&D people will set even higher level of objectives, or aggressively find new opportunities arising in the environment, so that they can keep pace with the variation of environment, and get momentum for next R&D programs, and further enhance R&D performance. The knowledge creativity of the organizational members is an important organizational capability, since it might be very likely to develop a core competence of the organization, and enhance organizational competitive advantages (Coombs, 1996; Hill & Jones, 1998).

Knowledge Management Strategies

Plehans, Globe and Laugero (1999) defines knowledge from the standpoint of an enterprise. They assume that knowledge management might be the basis on which an organization could transform knowledge into useful actions. Knowledge management could deliver knowledge to proper people at proper time, in order to enhance productivity or decrease cost of the supply chain, and attain the aim to improve the competitive advantage of an enterprise.
Hansen, Norhira and Tierney (1999) studied the cases about business experiences in improving knowledge management, and summaries two kinds of knowledge management strategies as " codification" and " personalization" . These two kinds of knowledge management strategies could be applied in advisory industries as well as medical, high technology, and other

industries. Codification strategy is computer oriented, it emphasizes to codify knowledge and store it in databases, so people working in the company can easily retrieve. Personalization strategy is human oriented, it emphasizes to directly communicate with people for sharing knowledge since knowledge exists in people, and therefore computer is used for helping people in communicating knowledge not for storing knowledge.

Personalization strategy is a kind of strategic thinking starting from and around people. The business activities of these enterprises mainly depend on tacit knowledge of its employees, instead of the existing explicit knowledge. This kind of enterprises usually has business strategies to take new products (or services) as competitive tools of differentiation. The industries are advisory, restaurant, service industries, etc. For example, the management advisory company - HP of America offers business strategic advisory for its customers, it mainly depends on the tacit knowledge of its employees to run such a business. The knowledge management strategy of this company is a kind of personalization strategy which is from people - to - people. Although the departments of HP spread around the world, their advisory people and engineers always shuttle between different departments and exchange their ideas. The company rules that all their employees have to take the same flight when traveling so that their people might have more chance for interactions. The company even does not limit their budget on such actions. In addition, the company also encourages their employees to set up inter-department learning community as knowledge exchange platform to commonly use the best practices and skill around the company.

However, a very different choice might be available. Like the two advisory companies - Anderson and Ernst & Young, of which businesses are mainly to provide mature and standardized schemes through computer network system or knowledge management system, adopt very different knowledge management strategies named as " codification strategy" . Knowledge management systems in such companies are very important for their success. These two companies invested 500 million dollars in building knowledge management system. They adopted the model that is from " people - to - documents" to manage knowledge, in which knowledge can exist independently in the system and can be used repetitively all around their companies. Hence, all their employees can utilize the knowledge management system to create values for customers and have superior performance.

From the cases above, we find that it is very important to have a correct knowledge management strategy, so that an organization could proceed in effective knowledge management, and might not deviate from their directions. Choi & Lee(2002) discusses the influences of knowledge strategy to knowledge creation process from the sample of 58 Korean business cases in the article of " knowledge management strategy and its link to knowledge creation process" , and try to get the direction of knowledge management strategy evolution since 1995. They conclude that there are two knowledge management strategies, that is " system" and " human" oriented.

(1)System:

The knowledge management strategy implemented in an organization, that emphasizes knowledge codification, storing, information system, etc., and tries to share knowledge formally with information technology network, software, documents, etc.

(2)Human：

The knowledge management strategy implemented in an organization, that emphasizes dialogs between people in the social networks, and tries to recruit knowledgeable and experienced employees, emphasizes informally share knowledge in knowledge communities, discussion teams/confrontation meetings, etc.

Choi & Lee(2002) suggests in their empirical study, that the effect of socialization in the knowledge creation process is most evident if an enterprise totally emphasizes human strategy. The effect of combination in the knowledge creation process is most evident if an enterprise totally emphasizes system strategy. However, when an enterprise adopts a balanced strategy of which human and system strategies are both emphasized, the most effective results might be generated.

Both human and system oriented strategies are important strategies that might influence the activities of knowledge management. Whichever is emphasized, the knowledge conversion will be facilitated, and the knowledge spiral will be pushed forward. However, for a specific enterprise, it might be still a hard decision for choosing which part of activities being emphasized when implementing a knowledge management strategy. Nevertheless, an enterprise has to choose a proper knowledge management strategy, because a wrong choice or trying to stay in the middle might generate very negative effect for an enterprise. There are four layers of knowledge creation: personnel, group, organization, and inter-organizations, but all the creation of knowledge must be regressed to personnel. Therefore, this article will discuss what kind of knowledge management strategy an enterprise should adopt, based on the suggestion presented by Choi & Lee(2002) - two dimensions of human and/or system. In more specific, we want to analyze the relationship of knowledge management strategy and the knowledge creativity of organizational members during the process of knowledge creation process.

RESEARCH METHOD

Research Structure

Prior studies about knowledge management in an organization are most analyzed by the unit of organization to investigate the influence of organizational strategy, structure, and culture to organizational learning and organization management (Friedman, 2002), and overlook the role of individual person during the process of knowledge creation. In this study, we take individual as study unit, and choose the members of higher knowledge intensive R&D teams as our study population, and investigate influence of knowledge management strategy on personal knowledge creation capability and personal research performance in R&D teams. We also investigate the influence of personal knowledge creation capability on personal recognized research performance, and take the variables demography into consideration, to discuss their influence on personal knowledge creation capability. The concept structure of this study is as figure 1.

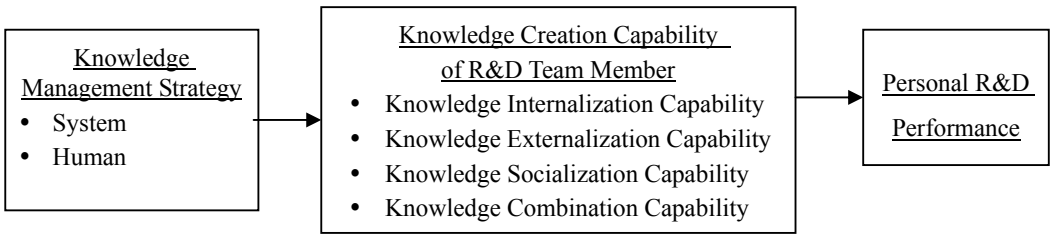


Figure 1: Concept Research Structure

Research Hypotheses

Choi & Lee(2002) differentiates knowledge management strategies as two dimensions which are system orientated and human oriented, and discusses their influence on each phase of organizational knowledge creation. They found that whichever dimension an enterprise may emphasize, it might affect knowledge creation. Since organizational knowledge creation usually comes from organizational learning, and the starting and ending point of organizational learning have to go back to individual (Argyris & Schon, 1978, 1996; Friedman, 2002; Senge, 1990). Therefore, we give the hypothesis as follows:

H1：Organizational knowledge management strategy has significant influence on personal knowledge creation in R&D team

Nonaka & Takeuchi(1995) points out that only individuals can create knowledge, an organization cannot create knowledge except through individuals. Organizational knowledge creation capability comes from the extent of using socialization, externalization, combination, and internalization during knowledge creation process of individuals. Simon(1969, 1991) thought that learning happens in one' s brain, not in an organization. An organization can introduce knowledge through learning new knowledge of its members or hiring new employees with new knowledge. If the members of R&D teams do not have the four knowledge creation or conversion capability, they can not create new knowledge; even more they could not introduce or utilize new knowledge or technology. Hence, knowledge creation capabilities of individuals have strong relationships with their R&D performance. Therefore, we give the hypothesis as follows:

H2：Personal knowledge creation capability in R&D team has significant influence on his R&D performance

We infer from the relationship among organizational knowledge management strategy, personal knowledge creation capability and personal R&D performance, and give the hypothesis as follows:

***H3*：Organizational knowledge management strategy has significant influence on personal R&D performance in R&D team through his knowledge creation capability**

Measurement of Variables

We design the measurement questions about the variable of "personal knowledge creation capability in R&D team" by modifying the " personal knowledge conversion capability" measurements developed from referring Nonaka and

Takeuchi(1995)“ Knowledge Creation Theory by Wang, S.F., Hwang, J.C. and Jeng, L.M.(2002) . Each question is measured by Likert 5 point scale, 1 represents most disagree, 5 represents most agree. In the questionnaire, 4 questions are designed to measure capability of internalization, 5 questions are designed to measure externalization, 6 questions are designed to measure socialization, and 5 questions are designed to measure combination.

We design the questions of measuring organizational knowledge management strategy by modifying the questionnaire of Choi & Lee(2002) in which variation of organizational knowledge management strategies is discussed since 1995. We also differentiate organizational knowledge management strategies as two dimensions, i.e., system oriented and human oriented. All questions are measured with Likert five point scale, among which 4 questions are about measuring system strategy dimension and 4 are about measuring human strategy dimension.

We design the questions about personal R&D performance by modifying Hwang, J.T.(2004), in which depth, vertical relationship, contribution and total satisfaction are measured. The questions about depth are“ I can solve important R&D issues for the team”,“ My personal R&D results can help our company to surpass competitors”. The question about vertical relationship is“ My R&D results can help development of next generation of new products”. The question about vertical contribution is“ I have very important contribution to the R&D results of our team”. At last,“ In total, I feel satisfied with my R&D results”. All questions are measured with Likert five-point scale.

Population and Sample

The population of this study is team members of the R&D departments of enterprises in high-tech industries. High-tech industry has the characteristics of high R&D budgets, higher level of technology, more high education employees, short product life cycle, high speed of industrial growth, etc. The industries that we investigated are the industries with the characteristics mentioned above, e.g., IC design industries, semi-conductor industries, information service industries, and photoelectric industries. The questionnaires of this study were mailed to the enterprises sampled by convenience. In total, 500 questionnaires are sent out, and 152 complete questionnaires are returned, the effective return rate is 30%.

RESULTS

Characteristics of the Sample

The characteristics of the sample are shown in Table 1.

Table 1: Characteristics of the Sample

characteristics	categories	number	percentage (%)	characteristics	categories	number	percentage (%)
sex	female	21	13.82	position	non-manager	128	84.21
	male	131	86.18		lower-level manager	12	7.89
age	18-29	52	34.21		middle-level manager	10	6.58
	30-39	95	62.50		others	2	1.32
	40-49	5	3.29	work experience	lower than 5	116	76.32
education	high school	4	2.63		5-10	28	18.42
	college	12	7.90		11-15	8	5.26
	university	31	20.39	team experience	Less than 5	128	84.21
	master	103	67.76		5-10	20	13.16
	doctor	2	1.32		11-15	4	2.63

Reliability and Validity Analysis

We use SPSS10.0 statistics software package to compute the Cronbach's α of each variable as in table 2. For each variable, its Cronbach's α is greater than .7, hence the reliabilities are accepted. For measuring construct validities, we use confirmative factor analysis and LISREL software to test the validity of each variable; since all t values are above .5, the validities of all the variables are acceptable. The results of reliability and validity analyses are shown in Table 2.

Table 2: Reliability and Validity Analysis

item measured	λx	λy	t	Cronbach's α
exogenous variables:				
organizational knowledge management strategy				0.72
system(X_1)	0.56		5.51***	
human(X_2)	0.54		5.41***	
endogenous variables				
personal knowledge creation capability				0.86
Internalization capability(Y_1)		0.55	-	
Externalization capability(Y_2)		0.75	5.25***	
Socialization capability(Y_3)		0.77	5.32***	
Combination capability(Y_4)		0.76	5.27***	
personal R&D performance		0.51	4.92***	0.88

+p < .1(1.645 □t < 1.96) ; *p < .05(1.96 □t < 2.58) ; **p < .01(2.58≦ t < 3.29) ; ***p < .001(t≧ 3.29)

The Structural Equation Modeling

The structural equation modeling and LISREL 8.7 of software for data analyses are used to verify the hypotheses. All the model-fit indexes in Table 3 show that the model is fitted well.

Table 3:Model-Fit Evaluation

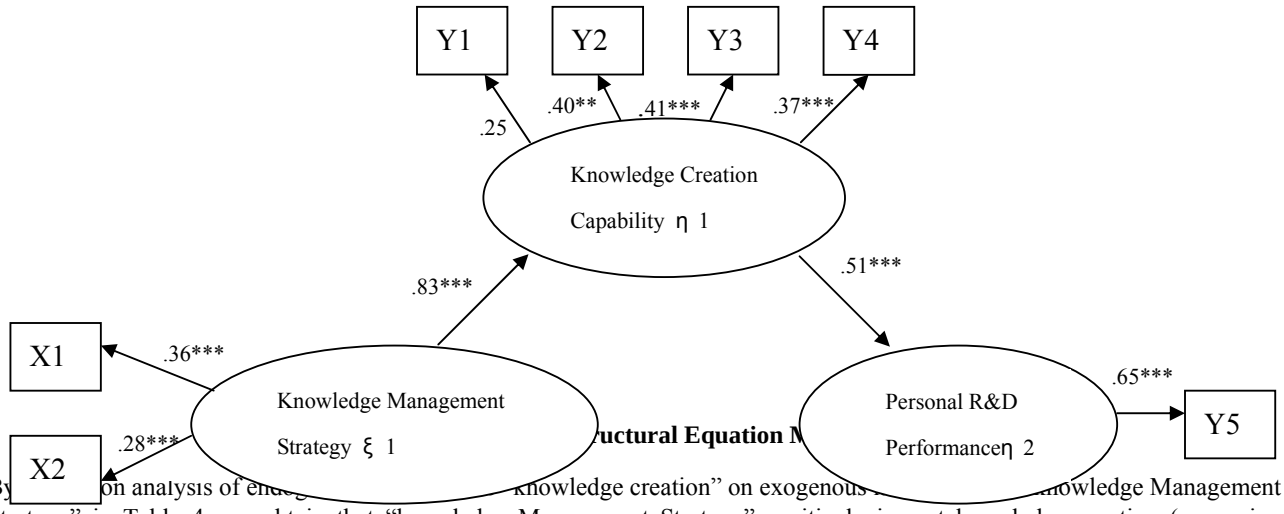
Model-Fit Index	Index value	Criteria
Degree of Freedom(d*f*)	58	
χ^2	20.2	
χ^2/d*f*	1.55	< 2
GFI	0.96	> .90
AGFI	0.92	> .90
NNFI	.97	> .90
CFI	0.98	> .95
RMSEA	0.06	< .05(Ho,2002) ; < .06(Hu&Bentler,1999)
SRMR	0.043	< .08

Table 4:Gamma

	Knowledge Management Strategy
Knowledge Creation Capability	0.83**

Table 5:Beta

	Knowledge Creation Capability
Personal R&D Performance	.51***



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By on analysis of end Knowledge creation" on exogenous Knowledge Management Strategy" in Table 4, we obtain that "knowledge Management Strategy" positively impact knowledge creation (regression coefficient = 0.83, t = 4.98, p< .001), i.e., H1 is supported, i.e., "organizational knowledge management strategy has significant influence on personal knowledge creation capability in R&D team". By regression analysis of endogenous latent variable on endogenous latent variables (Standardized) in Table 5, we obtain that "knowledge Creation Capability" positively impact Personal R&D Performance (regression coefficient =.51, t = 4.92, p< .001) i.e., H2 is supported, i.e., "personal knowledge creation capability capability in R&D team has significant influence on his R&D performance" The indirect effect of "organizational knowledge management strategy" on "personal R&D performance" = .83 × .51 = .42. H3 is supported, i.e., " organizational knowledge management strategy has significant influence on personal R&D performance in R&D team through his knowledge creation capability capability"

CONCLUSION AND MANAGEMENT IMPLICATIONS

In this study, we examine whether organizational knowledge management strategy has significant influence on personal knowledge creation in R&D team and directly helpful for his organizational innovation performance. Based on structural equation modeling and LISREL 8.7 of software for data analyses, we obtain the conclusions:

1. Organizational knowledge management strategy has significant influence on personal knowledge creation capability in R&D team. This result is consistent with the conclusion of Choi & Lee(2002) in which 58 enterprises were surveyed about the influence of knowledge management strategy on their knowledge creation process. They found that a balanced strategy with human orientation as well as system orientation is the most effective strategy, i.e., both " human" and " system" related knowledge management activities are important. In our study, we found that both " human" and " system" knowledge management strategy could affect knowledge creation capability significantly. In other words, the more an enterprise emphasizes either kind knowledge management strategy, the higher its personnel knowledge creation capability might be. Therefore, an enterprise needs to emphasize the importance of knowledge coding, storing, and repetitive use, and make best practice circulate. At the same time, it also needs to emphasize the chances of interaction of employees, building interdisciplinary knowledge communities make tacit knowledge circulate. Both alternatives need the management to pay attention and investigate their knowledge management platform and necessary investment. Hopefully, it could facilitate the transformation of tacit and explicit knowledge, precede knowledge creation spiral, and create new knowledge and enhance R&D performance.
2. Personal knowledge creation capability in R&D team has significant influence on his R&D performance. As explained above, personal knowledge creation capability in R&D team is closely related with the four modes of capabilities: socialization, externalization, combination, and internalization owned by individuals. Therefore, each mode of knowledge creation capability for R&D team member needs to be noticed and trained. In other words, the more personal knowledge creation capability the member in R&D team has, the higher his R&D performance might be. Organizational knowledge management strategy has significant influence on personal R&D performance in R&D team through his knowledge creation capability. When an enterprise emphasizes knowledge management strategy, either human or system oriented, it might generate positive influence on personal knowledge creation capability in R&D team, and further affect his R&D performance. In other words, knowledge management strategy, either human or system oriented, might enhance personal knowledge creation capability in R&D team as well as his R&D performance.

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