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Empirical Study on the Incentive Model of Knowledge Sharing Within Project-oriented Organization Based on Knowledge Potential Theory

Shi Jiangang and Lin Lingna
School of Economics and Management, Tongji University, 200092, Shanghai, China

Abstract: Previous studies confirm that desired results may occur if knowledge can be effectively shared among members of Project-Oriented Organizations (POOs) by incentive mechanism. Nevertheless, the literatures do not provide sufficient theory and empirical supports for such organizations. The research reported here aimed to examine how different knowledge potential agents share their knowledge in POOs with incentive and whether or not the knowledge potential impacted on knowledge sharing. These issues were first established through incentive theory, specifically, incentive mechanisms for complementary knowledge sharing were designed for individuals being risk-averse under asymmetric knowledge. Then the related research hypotheses were worked out. The empirical data for this study were collected from 200 project members with a response rate of 67% (134 questionnaires). The main results showed that, firstly, Knowledge Distance (KD) had a high significant correlation with the impact of complementary knowledge (C) while it had no significant correlation with the effort level of knowledge sharing (SE). Secondly, knowledge stock (KS) had a significant correlation with the effort level of knowledge sharing. Thirdly, the impact of complementary knowledge had high significant correlation with the effort level of knowledge sharing and the level of organizational incentive (I). Finally, the effort level of knowledge sharing had a high significant correlation with the level of organizational incentive. This study has contributed towards advancing a theoretical guide for POOs to improve project value and enhance organizational knowledge potential.

Key words: Project-oriented organization, knowledge potential, knowledge sharing, incentive, complementary knowledge

INTRODUCTION

The power to drive most organizations to survive and prosper in ever-changing external environments is their effective projects operation (Bryde, 2000). Organizing work by projects allow organizations to respond flexibly to changing organizational needs but Project-Oriented Organization (POO) faces important challenges in reaching economies of scale, coordinating cross-project resources, facilitating organization-wide development and promoting organization-wide learning (Hobday, 2000). POO is a temporary organization by gathering the intellectual capital with complementary knowledge, which will be the future orientation of most organizations (Lundin and Steinthorsson, 2003) with projects. Most organizational core knowledge is created by their projects. Effective knowledge transferring and sharing among individuals in such organization are able to improve organizational knowledge value and enhance the industries' core competitiveness. However, the temporary and customized nature of every project makes it difficult for such organizations to learn and build up their knowledge capabilities from one project to another (Meyerson *et al*., 1996). At the end of a project, this virtual project team will be collapsed and knowledge in the team will be lost. The major barriers of knowledge sharing within project team are uncertainty, dispersion and complexity in knowledge, as well as the lack of effective incentive mechanism of knowledge sharing of temporary team. In spite of the barriers of knowledge sharing, organizations that can successfully share knowledge across individuals and projects may find that ideas and experiences in one project may frequently work out the problems of another (Davies and Brady, 2000). According to Boh (2007), the highly distributed space of projects, the different scale, as well as the task nature of POO diversify knowledge-sharing mechanisms.

Knowledge sharing in project-oriented intra-organization refers to members who come from different departments, or organizations even industries come together in order to complete a common task in a time-limited, resource constraint condition. Researches on knowledge sharing have been identified and classified into three levels, which are inter-organization,

Corresponding Author: Shi Jiangang, School of Economics and Management, Tongji University, 200092, Shanghai, China

intra-organization and individuals (Foss *et al*., 2010). In the level of inter-organizational knowledge sharing, Silipo (2008) indicates that the level of knowledge sharing incentive depends on the causes of the asymmetric relationship between partners and their cooperation level but not the symmetric or asymmetric relationship. Lee and Ahn (2007) study the different context on knowledge sharing incentive systems. They point out that the degree of knowledge sharing incentive in a team is lower than it is in individuals. In a team, member who owns high knowledge productivity is harder to sharing his/her knowledge. Wang and Shao (2012) study the incentive mechanism of complementary professional knowledge sharing in outsourcing based on principal-agent theory. In the perspective of intra-organization, Nonaka (1994) indicates that individual knowledge is able to convert into organizational knowledge through the team. And the cohesion force of intra-organization may promote this behavior (Reagans and McEvily, 2003). Under this circumstance, Nan (2008) designs a knowledge sharing incentive mechanism by introducing the degree of tacit knowledge and solves the knowledge sharing problems of employer and members under asymmetric information through different degree of incentive. In the perspective of individuals, researchers have different views about the relationships between incentive and knowledge sharing. For example, Kwok and Gao (2005) believe that individuals' knowledge sharing has nothing to do with the external incentive. The conclusion is in line with Huber (2001) who discusses individuals' knowledge sharing based on the psychological perspective and points out that it is hard to stimulate individuals' sharing behavior by organizational incentive. On the contrary, Kankanhalli *et al*. (2005) believe that promotion, high salary etc., can promote individuals to share knowledge based on the perspective of social exchange theory and social capital theory.

Whatever the level is, the individual is the carrier of knowledge, which leads individuals to have various relative power positions (Dierkes *et al*., 2001), this may reflect in all kinds of status of different knowledge potential. And no matter what types of incentives, monetary or non-monetary, knowledge sharing of individuals may happen in a certain environment (Wolfe and Loraas, 2008). Knowledge potential is an intrinsic nature of individuals, which drives individuals to interact with each other such as knowledge transferring, knowledge sharing or knowledge creating and so on. In the view of knowledge potential, Willcocks *et al*. (2004) study the IT industry and its business process outsourcing, discuss the changes of organizational knowledge potential when it outsources its business process. They present a framework for evaluating the knowledge potential within five different types of insourcing and outsourcing arrangements. Zeng *et al*. (2011) introduce the knowledge absorption coefficient to discuss the knowledge transferring effect among high potential individual, low potential individual and enterprise in the interest mechanism and analyze the knowledge transferring incentive mechanism of high potential individual in different payment subjects. Zhenhong (2012) builds a game model by combining with the unique behaviors and demands characteristics of university based on the principle and frame of potential knowledge sharing. Zheng and Zhang (2008) analyze the knowledge transfer and sharing dilemma in organization and establish a game theory of knowledge transfer and sharing. The result shows that different knowledge potential members should be stimulated by relative measures.

In POO, employees are mobile, organizational capability depends more upon the firm's mechanisms of integration rather than the extent of specialist knowledge which employees possess (Grant, 1996). Complementary knowledge in employees promotes the successful complementation of project task (Novak and Stern, 2009). Complementary knowledge is not only individuals' demands for their knowledge gap but also the inherent demand for organizations to improve their knowledge potential. Each member may have knowledge for others and knowledge dispersion in project team leads knowledge sharing in individuals is bidirectional, that is, the individual acts as two roles, knowledge supplier and knowledge receiver. If organization takes the same incentive mechanism in the different potential knowledge members, it may increase the incentive cost meanwhile causes high potential individuals to feel unfair for their knowledge sharing. Conversely, if the organization motivates the high potential individuals but ignoring the low one to share their knowledge, it may have undesired consequences such as the low potential individuals lose their confidence of cooperation and decrease their efforts to share knowledge. All of these are not conducive to high potential individuals to create knowledge and organization to update knowledge.

To sum up, study on knowledge sharing incentive mechanism based on knowledge potential has broken the previous researches limited to the knowledge sharing of individuals or organization and individuals, it combines both well. Besides, it focuses on project-oriented organization that is an innovative and particular form makes the study more representative. At present However, studys on knowledge sharing incentive of project-oriented organization based on the theory of

knowledge potential is are mostly in theory model, which lacks of empirical testing. This study takes individuals' complementary knowledge into account and builds a model of knowledge sharing incentive based on the theory of knowledge potential and principle-agent. By maximizing organizational benefit, each parameter in the model is worked out and the corresponding hypothesizes are presented. Last, the empirical analysis method is applied to examine the model results.

MATERIALS AND METHODS

Incentive model

Model building: Consider a POO with two knowledge workers, one is high potential knowledge (denotes by H), another is low potential (denotes by L). Their knowledge distance is in a certain critical range, which means two individuals have the complementary knowledge that another needs them. The temporary organization should stimulate these two individuals to share their knowledge not only for each other but for the whole project team. Suppose that knowledge sharing output of two individuals includes two parts, one output comes from individuals who share their knowledge to organization, another is from acquiring complementary knowledge from other individual.

Output function of knowledge-sharing: The knowledge sharing output functions of the two potential knowledge individuals are assumed, respectively as the form:

$$\pi_h = q_h a_h K_h + \vartheta_l q_l a_l K_l + \varepsilon_h \tag{1}$$

and:

$$\pi_l = q_l a_l K_l + \vartheta_h q_h a_h K_h + \varepsilon_l \tag{2}$$

where, ϑ_h and ϑ_l, respectively represent H and L's impact of complementary knowledge, which essentially reflect the degree of interdependence of these two different knowledge potential individuals when they are in the process of the project and $\vartheta_h, \vartheta_l \geq 0$. The q_h and q_l are rate of H and L's knowledge which can be shared, respectively. The α_h and α_l represent the effort level that these two individuals share each unit obtainable complementary knowledge, respectively. The K_h and K_l are H and L's knowledge volume. The ε_h and ε_l are exogenous random variable influencing these two individuals' knowledge-sharing output $\varepsilon_h \sim N(0, \sigma_h^2), \varepsilon_l \sim N(0, \sigma_l^2)$ and ε_h and ε_l are mutual independence.

Cost function of knowledge-sharing: Each person must pay certain costs for sharing knowledge. For convenient discussion, this study does not consider impacts that random noises on costs. So the cost functions of two individuals knowledge sharing are:

$$c_h = b_h a_h^2 / 2 \tag{3}$$

and:

$$c_l = b_l a_l^2 / 2 \tag{4}$$

respectively where, b_h and b_l are cost efficient of each other.

Incentive contract function of knowledge-sharing: In order to stimulate individuals to share knowledge, organization should have incentive contract function of knowledge-sharing which is restricted to be linear. So the total compensation is given by:

$$s = \alpha_h + \alpha_l + \beta_h \pi_h + \beta_l \pi_l \tag{5}$$

where α_h and α_l are fixed compensation organization gives and β_h and β_l are incentive coefficient of knowledge-sharing output, $0 \leq \beta_h \leq 1$ and $0 \leq \beta_l \leq 1$.

Expected-utility function of knowledge-sharing: Organization's actual benefit is:

$$\begin{aligned} w_o = \pi_h + \pi_l - S = -(\alpha_h + \alpha_l) + q_h a_h K_h (1 - \beta_h + \vartheta_h - \beta_l \vartheta_h) \\ + q_l a_l K_l (1 - \beta_l + \vartheta_l - \beta_h \vartheta_l) + \varepsilon_h (1 - \beta_h) + \varepsilon_l (1 - \beta_l) \end{aligned} \tag{6}$$

Assume organization is risk-neutral. Organization's expected-utility equals to expected-benefits:

$$\begin{aligned} EV(w_o) = -(\alpha_h + \alpha_l) + q_h a_h K_h (1 - \beta_h + \vartheta_h - \beta_l \vartheta_h) \\ + q_l a_l K_l (1 - \beta_l + \vartheta_l - \beta_h \vartheta_l) \end{aligned} \tag{7}$$

In this subsection, both H and L are risk-averse, that is, maximizing their own benefits, respectively. For risk-averse individuals expected-utility equals to expected-benefits. So net output of knowledge-sharing of H is:

$$\begin{aligned} w_h = \alpha_h + \beta_h \pi_h - b_h a_h^2 / 2 = \alpha_h + \beta_h \\ (q_h a_h K_h + \vartheta_l q_l a_l K_l + \varepsilon_h) - b_h a_h^2 / 2 \end{aligned} \tag{8}$$

and H's expected-utility is:

$$EU(w_h) = \alpha_h + \beta_h (q_h a_h K_h + \vartheta_l q_l a_l K_l) - b_h a_h^2 / 2 - \rho \beta_h^2 \sigma_h^2 / 2 \tag{9}$$

Net output of knowledge-sharing of L is:

$$w_1 = \alpha_1 + \beta_1\pi_1 - b_1a_1^2/2 = \alpha_1 + \beta_1(q_1a_1K_1 + \vartheta_h q_h a_h K_h + \varepsilon_1) - b_1a_1^2/2 \quad (10)$$

L's expected-utility is:

$$EU(w_1) = \alpha_1 + \beta_1(q_1a_1K_1 + \vartheta_h q_h a_h K_h) - b_1a_1^2/2 - \rho\beta_1^2\sigma_1^2/2 \quad (11)$$

Optimal incentive mechanism: After organization offers α and β, H and L maximize their benefits, respectively, that is:

$$\begin{aligned} &\max_{\alpha,\beta} EV(w_o) \\ &\text{s.t.} a_h \in \arg\max EU(w_h) \\ &\quad a_1 \in \arg\max EU(w_1) \end{aligned} \quad (12)$$

The above function can be expressed as:

$$\begin{aligned} &\max_{\alpha_1,\beta_1} -(\alpha_h + \alpha_1) + q_h a_h K_h(1 - \beta_h + \vartheta_h - \beta_1\vartheta_h) \\ &\quad + q_1a_1K_1(1 - \beta_1 + \vartheta_1 - \beta_h\vartheta_1) \end{aligned} \quad (13)$$

$$\text{s.t. (IR)} \begin{cases} \alpha_h + \beta_h(q_h a_h K_h + \vartheta_1 q_1 a_1 K_1) - b_h a_h^2/2 - \rho\beta_h^2\sigma_h^2/2 \geq \bar{w}_h \\ \alpha_1 + \beta_1(q_1a_1K_1 + \vartheta_h q_h a_h K_h) - b_1 a_1^2/2 - \rho\beta_1^2\sigma_1^2/2 \geq \bar{w}_1 \end{cases} \quad (14)$$

Model solution: According to the first-order optimal condition:

$$\partial w_h/\partial a_h = 0$$

and:

$$\partial w_1/\partial a_1 = 0 \quad (15)$$

the optimal effort-levels of H and L are, respectively:

$$a_h = \beta_h q_h K_h/b_h$$

and:

$$a_1 = \beta_1 q_1 K_1/b_1 \quad (16)$$

Substituting Eq. 14 and 16 into objective function the objective function can be expressed as:

$$\max_{\beta} w_o = \frac{2\beta_h q_h^2 K_h^2(1+\vartheta_h) - K_h^2 q_h^2 \beta_h^2}{2b_h} + \frac{2\beta_1 q_1^2 K_1^2(1+\vartheta_1) - K_1^2 q_1^2 \beta_1^2}{2b_1} - \frac{1}{2}\rho(\beta_h^2\sigma_h^2 + \beta_1^2\sigma_1^2) - (\bar{w}_h + \bar{w}_1) \quad (17)$$

According to the first-order optimal condition, the optimal incentive coefficients of H and L are, respectively:

$$\beta_h = q_h^2 K_h^2(1+\vartheta_h)/(K_h^2 q_h^2 + b_h\rho\sigma_h^2)$$

and:

$$\beta_1 = q_1^2 K_1^2(1+\vartheta_1)/(K_1^2 q_1^2 + b_1\rho\sigma_1^2) \quad (18)$$

Assuming:

$$A = \partial^2 w_o/\partial\beta_h^2,\ B = \partial^2 w_o/\partial\beta_h\beta_1,\ C = \partial^2 w_o/\partial\beta_1^2$$

so

$$B^2 - AC = -(K_h^2 q_h^2/b_h + \rho\sigma_h^2)(q_1^2K_1^2/b_1 + \rho\sigma_1^2) < 0 \quad (19)$$

According to the property of dualistic function extremum, it exists β_h and β_1 that makes w_o maximum. So the optimal incentive of POO to two individuals are, respectively:

$$\beta_h = q_h^2 K_h^2(1+\vartheta_h)/(K_h^2 q_h^2 + b_h\rho\sigma_h^2)$$

and:

$$\beta_1 = q_1^2 K_1^2(1+\vartheta_1)/(K_1^2 q_1^2 + b_1\rho\sigma_1^2) \quad (20)$$

For $0 \leq \beta \leq 1$, it is got that:

$$0 \leq \vartheta_h \leq b_h\rho\sigma_h^2/K_h^2 q_h^2 \quad (21)$$

and:

$$0 \leq \vartheta_1 \leq b_1\rho\sigma_1^2/K_1^2 q_1^2 \quad (22)$$

As shown in the equestions, too much complementary knowledge between H and L is not better. There is a critical range of knowledge distance in these two individuals. Only in a proper critical range that two individuals can share knowledge effectively, when it is more than or less than the critical range, knowledge will not move between them.

Substitute the optimal incentive coefficient into Eq. 16, which leads to:

$$a_h = q_h^3 K_h^3(1+\vartheta_h)/(b_h K_h^2 q_h^2 + b_h^2\rho\sigma_h^2)$$

and:

$$a_1 = q_1^3 K_1^3 (1+\vartheta_1)/(b_1 K_1^2 q_1^2 + b_1^2 \rho\sigma_1^2) \quad (23)$$

Hypothesis: The nature of individuals' knowledge potential: It is necessary to evaluate employee's characteristics of knowledge in a certain complicated organization, which is common to all the employees. The knowledge potential of employee determines his location in the knowledge field space, which can be shown in his knowledge region and knowledge stock. In knowledge region, the knowledge potential of employee is determined by his knowledge width and knowledge depth. For example, employee who is safety manager has more knowledge of safety than employee who is technician. But both of them play a critical role in POO. Indirectly, both of them are experts in their respective departments, while they are complementary in a project. In a various relative nature pressure, they will be formed into knowledge potential. Knowledge stock is the consequence of knowledge accumulation that reflects employees' knowledge potential essentially. It is one important factor that determines whether employees are able to share knowledge through informal and/or formal interpersonal interactions that facilitate and effectively organize the movement of knowledge between knowledge owners and knowledge seekers (He and Wei, 2009). Employees with different knowledge stock lead to their distance of knowledge potential and then form to the driving force and/or resistance of knowledge flow. There is inevitably knowledge potential distance among employees for their different knowledge width and knowledge depth. In the situation of asymmetric information of employees and organization and according to the first-order optimal condition of the Eq. 23:

$$\frac{\partial a_h}{\partial K_h} = \frac{q_h^5 K_h^4 b_h (1+\vartheta) + 3q_1^3 K_h^2 (1+\vartheta_h) b_h^2 \rho\sigma_h^2}{b_h q_h^2 K_h^2 + b_h^2 \rho\sigma_h^2} > 0$$

and:

$$\frac{\partial a_1}{\partial K_1} = \frac{q_1^5 K_1^4 b_1 (1+\vartheta_1) + 3q_1^3 K_1^2 (1+\vartheta_1) b_1^2 \rho\sigma_1^2}{(b_1 q_1^2 K_1^2 + b_1^2 \rho\sigma_1^2)^2} > 0$$

It shows that the effort level of different potential knowledge employee is increased following their knowledge stock. So here is the hypothesis:

H1: Knowledge stock of employees has a positive relation with their effort level

Knowledge distance and knowledge stock commonly determine the knowledge potential distance of employees (Wang *et al*., 2010). However, too much knowledge distance may cause the invalid knowledge flow for the knowledge receiver's limited absorptive capacity and understanding ability, while too little knowledge distance may lead to the parallel knowledge potential which may impede knowledge from transferring. Appropriate knowledge distance is the driving force for employees to share knowledge. In the perspective of the theory of knowledge potential, knowledge distance can be regarded as the driving force or resisting force of knowledge sharing in employees. The relation between knowledge distance and effort level is complicated. Within a critical range of knowledge distance, the effort level of knowledge sharing is increased following the knowledge distance. The effort level of knowledge sharing will be maximum when the knowledge distance is in a certain value. After this certain value of knowledge distance, the effort level of knowledge sharing will be decreased following knowledge distance. When the knowledge distance between two employees is far more than or far less than the critical range, there is not no knowledge sharing behavior within employees. So effort level and knowledge distance have the relation of inverse "U". Here is the hypothesis:

H2: Knowledge distance and effort level may have no significant relation for their complicated relevance

Indirectly, knowledge distance reflects the degree of knowledge overlapping between employees. And the overlapping knowledge between employees is their homogeneous or common knowledge. Complementing an employee's knowledge gap is from other's knowledge. The more the knowledge distance is, the more the complementary knowledge between employees have, that is, the more impact the complementary knowledge has. Here is the hypothesis:

H3: The knowledge distance between employees and their impact of complementary knowledge have positive correlation

Impact of complementary knowledge: Knowledge complementary is one of the reasons for benefits increasing in organization (Wang, 2002). The similar knowledge width (Cummings and Teng, 2003) and the complementary knowledge depth in project-oriented organization are the foundation for employees to learn and create knowledge. Compare with the benefit gained from the individual activity, organization's benefits from the complementary knowledge may be greater. The extreme division of professional knowledge may lead the

employees to lose their enthusiasm of working hard for the monotonous task. According to the first-order optimal condition of the Eq. 20:

$$\partial\beta_h/\partial\vartheta_h = q_h^2K_h^2/(K_h^2q_h^2 + b_h\rho\sigma_h^2) > 0$$

and:

$$\partial\beta_l/\partial\vartheta_l = q_l^2K_l^2/(K_l^2q_l^2 + b_l\rho\sigma_l^2) > 0$$

It means that the organization's incentive will be increased by the impact of complementary knowledge between employees. And according to the first-order optimal condition of the Eq. 23:

$$\partial a_h/\partial\vartheta_h = q_h^3K_h^3/(b_hK_h^2q_h^2 + b_h^2\rho\sigma_h^2) > 0$$

and:

$$\partial a_l/\partial\vartheta_l = q_l^3K_l^3/(b_lK_l^2q_l^2 + b_l^2\rho\sigma_l^2) > 0$$

that means the effort level will be increased through the impact of complementary knowledge. So here is the hypothesis:

H4: The impact of complementary knowledge and the organization's incentive have positive correlation

H5: The impact of complementary knowledge and the effort level have positive correlation

Effort level of knowledge sharing: The main influenced factors of the effort level of knowledge sharing in POO include the environment of knowledge sharing, the cost, the value of knowledge etc. The effort level of knowledge sharing between employees reflects their sharing desire. The more the sharing desire is, the more the effort level will be. According to the first-order optimal condition of the Eq. 16:

$$\partial a_h/\partial\beta_h = q_hK_h/b_h>0$$

and:

$$\partial a_l/\partial\beta_l = q_lK_l/b_l>0 \quad (16)$$

which mean that with the increasing of degree of organization's incentive, the effort level of knowledge sharing will increase. So here is the hypothesis:

H6: The effort level and the incentive degree have positive relation

Sample: In this study, the interviewers in POO focus on project managers, project technicians, safety managers, engineers *et al*., those people are familiar with the project schedule, quality and cost not only from the explicit knowledge such as various books, technical manuals but also from the tacit knowledge such as their work experience, skill etc. If those persons can share their knowledge in project team, it may promote knowledge in the whole project-oriented organization and individual knowledge stock. When the project is finished, individuals broke up and recombined into the next project, knowledge they got in the previous project could be used in the next project.

A convenience sample of employees from 19 firms located in Nanjing, Changzhou, Shanghai and Hangzhou in mainland of China, involved real estate industry, construction industry, supervision enterprise and so on (total N = 200), over a period of about 1 month, from the beginning of April to the end of May, 2013. With 134 questionnaires returned, providing a response rate of 67%. There are not missing cases in the returned questionnaires. The basic information and the knowledge stock of respondents are shown in Table 1.

RESULTS

Measurement model: According to Morkvenas *et al*. (2008), the members' knowledge potential is determined by eleven factors such as educational level, occupational experience, occupational level *et al*. Cohen and Levinthal (1990) measure the knowledge distance between employees by the similar technical ability and skill. Yi (2006) measures knowledge distance of employees through geographic distance, psychological distance and perceived distance. In this study, there are two dimensions of knowledge potential, knowledge stock and knowledge distance. The knowledge potential measuring items were taken from Morkvenas *et al*. (2008), Cohen and Levinthal (1990) and Han (2011). Some questions were modified to match the background of this study and put the knowledge stock items in the part of individual basic information. After a pre-survey six items on knowledge stock and three items on knowledge distance were obtained. The knowledge stock items were "working years (denotes by Y)", "working time at present projec (denotes by T)", "educational level (denotes by EL)", "occupational level (denotes by OL)", "the title of a technical post (denotes by TT)", "the number of participated projects in recent 5 years (denotes by NUM)". The knowledge distance items included: "Most persons have different experience, technical ability and skill with me in my project team (denotes by KD1)".

Table 1: Basic information of the survey respondents

Information	Category	Proportion	Information	Category	Proportion
Working years (Y)	0-2 year(s)	23	Occupational level (OL)	Operator	37
	3-5 years	64		Supervisor	49
	6-10 years	39		Assistant manager in department/ Project assistant manager in company	36
	11 years and above	8		Senior manager in company	12
Working time at present project (T)	0-6 month(s)	47	Title of a technical post (TT)	No	50
	6 months-1year	55		Junior	24
	1-3 years	24		Middle	32
	3 years and above	8		Senior and above	28
Educational leve (EL)	Professional education and below	1	No. of participated projects in recent 5 years (NUM)	0-1	25
	Bachelor degree	89		2-3	55
	Master degree and above	44		4-5	17
				6 and above	37

"Compare with my present knowledge, knowledge obtains from others is different in structure and level (denotes by KD2)". "When I communicate with other members, they cannot understand what I say immediately (denotes by KD3)", with Cronbach's alpha (0.677).

The items of impact of complementary knowledge were taken from Lin and Huang (2010). Some questions were modified to match the background of this study and after a pre-survey five items were shown: "The team needs my skill and ability so it can complete successfully (denotes by C1)". "Sharing my knowledge is able to help our team to have more capacity to achieve its goal (denotes by C2)". "Sharing my knowledge is able to help our team to product more knowledge (denotes by C3)". "Sharing my knowledge is able to help our team to be close to the project (denotes by C4)". "Sharing my knowledge is able to help our team to operate well and effectively (denotes by C5)", with Cronbach's alpha (0.884).

The items of effort level of knowledge sharing were taken from Xing and Yaohua (2011) and Liebowitz and Chen (2001). Some questions were modified to match the background of this study and after a pre-survey three items were: "I am willing to share knowledge that cannot find be found from books (denotes by SE1)". "I am willing to share all the books or various documents I have to with other members (denotes by SE2)". "Members in our team are willing to share their knowledge that I cannot learn from the book to with me (denotes by SE3)", with Cronbach's alpha (0.819).

Organizational incentive is identified as a useful mechanism in motivating individuals to perform desired behaviors (Bartol and Locke, 2000). Based on the theory of social exchange, Blau (1964) suggests that sharing knowledge can be viewed as a form of reward whether it is extrinsic or intrinsic incentive, the process of knowledge sharing is essentially the exchange process of knowledge and incentive or reward. Therefore, in this study, the measuring items came from Blau (1964), Choi *et al.* (2008) and Wickramasinghe and Widyaratne (2012) and some questions were modified to match the background of this study and finally have three items which are, "In your present project team, organization has the input of resources about knowledge sharing in order to promote employees to share knowledge (denotes by I1)". "In your present project team, organization has made the mechanism of benefit distribution about knowledge sharing in order to promote employees to share knowledge (denotes by I2)". "When I share my knowledge to with others, organization praise me (denotes by I3)", with Cronbach's alpha (0.708).

All the variables were measured using a five-point Likert response scale ranging from '1' (strongly disagree) to '5' (strongly agree). Except for knowledge stock is used with dummy variable. There are different codes for different items in the variable of knowledge stock. For example, the items of "working year", "working time at present project", "occupational level", "the title of a technical post" and "the number of participated projects in recent 5 years" response options ranged from '1' to '4'. But the item of "educational level" response options ranged from '1' to '3'.

Descriptive statistics: The means, SD[1] and zero-order correlations for the study variables are shown in Table 2.

The means of the knowledge stock items were moderate. And the ones of the other dimensions were high. In this regard, Nooteboom (2000) states individuals' knowledge distance should be small enough that it's easy to understand for each other, yet it should be big enough that prevent from redundant knowledge. Creating a collective medium where all employees are able to find the gaps that might be fulfilled with their knowledge potential (Morkvenas *et al.*, 2008).

[1]SD is standard deviation

Table 2: Results of means, standard deviations and correlation analysis

Varibales		Means	SD	Pearson correlation coefficient									
				Y[3]	T[4]	EL[5]	OL[6]	TT[7]	NUM[8]	KD[9]	SE[10]	C[11]	I[12]
KS[2]	Y[3]	2.240	0.806	1.000									
	T[4]	1.950	0.878	0.570**	1.000								
	EL[5]	2.320	0.484	-0.063	0.110	1.000							
	OL[6]	2.170	0.938	0.741**	0.659**	0.242**	1.000						
	TT[7]	2.280	1.174	0.691**	0.561**	-0.003	0.727**	1.000					
	NUM[8]	2.490	1.088	0.799**	0.538**	0.040	0.741**	0.667**	1.000				
KD[9]		3.420	0.702	0.410**	0.263**	0.050	0.373**	0.289**	0.439**	1.000			
SE[10]		3.269	0.754	0.162	0.184*	0.078	0.193*	0.276**	0.134	0.154	1.000		
C[11]		3.494	0.663	0.501**	0.465**	0.074	0.578**	0.537**	0.535**	0.478**	0.406**	1.000	
I[12]		3.622	0.559	0.403**	0.399**	-0.002	0.416**	0.402**	0.445**	0.455**	0.388**	0.561**	1

**Significant at the 0.01 level (two-tailed); *Significant at the 0.05 level (two-tailed), [2]Knowledge stock, [3]Working years, [4]working time at present project [5]Educational level, [6]Occupational level, [7]Title of a technical post, [8]No. of participated projects in recent 5 years, [9]Knowledge distance, [10]Effort level of knowledge sharing, [11]The impact of complementary knowledge, [12]Organizational incentive

Table 3: Factor analysis and varimax rotation of four variables

Variables	Items	1	2	3	4
Impact of complementary knowledge (C)	C4[13]	**0.827**	0.059	0.176	0.105
	C5[14]	**0.797**	0.084	0.219	0.226
	C3[15]	**0.763**	0.279	0.091	0.162
	C2[16]	**0.748**	0.286	0.127	0.191
	C1[17]	**0.708**	0.125	0.354	0.174
Effort level of knowledge sharing (SE)	SE1[18]	0.192	**0.858**	0.023	0.133
	SE2[19]	0.163	**0.840**	0.001	0.024
	SE3[20]	0.143	**0.778**	0.108	0.137
Knowledge distance (KD)	KD1[21]	0.199	0.079	**0.799**	0.213
	KD3[22]	0.250	-0.174	**0.714**	-0.064
	KD2[23]	0.134	0.188	**0.680**	0.146
Organization incentive (I)	I3[24]	0.273	0.033	-0.060	**0.863**
	I2[25]	0.260	0.168	0.395	**0.694**
	I1[26]	0.157	0.317	0.377	**0.535**

Black body represents the loading values of all the factors (>0.500) after variables rotating, [13] "Sharing my knowledge is able to help our team to be close to the project" [14] "Sharing my knowledge is able to help our team to operate well and effectively" [15] "Sharing my knowledge is able to help our team to product more knowledge" [16] "Sharing my knowledge is able to help our team to have more capacity to achieve its goal" [17]"The team needs my skill and ability so it can complete successfully" [18] "I am willing to share knowledge that cannot find from books" [19]"I am willing to share all the books or various documents I have to other members" [20] "Members in our team are willing to share their knowledge that I cannot learn from the book to me" [21] "Most persons have different experience, technical ability and skill with me in my project team" [22] "When I communicate with other members, they cannot understand what I say immediately" [23] "Compare with my present knowledge, knowledge obtains from others is different in structure and level" [24]"When I share my knowledge to others, organization praise me" [25] "In your present project team, organization has made the mechanism of benefit distribution about knowledge sharing in order to promote employees to share knowledge" [26]"In your present project team, organization has the input of resources about knowledge sharing in order to promote employees to share knowledge"

The correlation between knowledge distance and the impact of complementary knowledge and incentive were positive and significant. Correlation between effort level of knowledge sharing and the impact of complementary knowledge and incentive were positive and significant. There were no significant relationship between knowledge distance and effort level of knowledge sharing. In knowledge stock, working years had no significant correlation with effort level of knowledge sharing. Educational level had no significant correlation with other four dimensions.

Factors analysis and scale reliability: For all measurement scales, standardized Cronbach's alpha was examined and principal components factors analysis (varimax rotation) was conducted. The criteria adhered to are: the loadings should be 0.50 or greater to be considered practically significant; Cronbach's alpha values of overall measure should be greater than 0.7.

The items were tested for validity using factor analysis with principle components analysis and varimax rotation. Convergent validity was assessed by checking loading to see if items within the same construct correlated highly amongst themselves. Discriminant validity was assessed by examining the factor loadings to see if questions loaded more highly on their intended constructs than on other constructs (Cook and Campbell, 1979). Tabachnick and Fidell (2000) suggest that loadings should be at least 0.32 and loadings from 0.45 to 0.54 are considered fair, 0.55-0.62 are considered good, 0.63-0.70 are considered very good and above 0.71 are considered excellent. Factor analysis yielded four components with eigenvalues above 1. These four variables corresponded to the four constructs and cumulative variance explained is 69.27% (Table 3).

Confirmatory factor analysis: Here the Confirmatory Factor Analysis (CFA) was conducted to assess the

Table 4: Comparison between the model results and the empirical testing

	Relationship	
Variables	Model results	Testing
H1	Knowledge stock of employees has a positive relation with their effort level	Most support
H2	Knowledge distance and effort level may have no significant relation for their complicated relevance	Support
H3	Knowledge distance between employees and their impact of complementary knowledge have positive correlation	Support
H4	Impact of complementary knowledge and the organization's incentive are positive correlation	Support
H5	Impact of complementary knowledge and the effort level have positive correlation	Support
H6	Effort level and the incentive degree have positive relation	Support

psychometric characteristics of the measure using the overall model's chi-squared, the Comparative Fit Index (CFI), the Tucker-Lewis Index (TLI). The fit indexes were χ^2 (72) = 114.202; CFI = 0.947; TLI = 0.933; RMSEA = 0.066; Cronbach's alpha of the whole items was 0.873.

Regression analysis: To test the expectations, regression coefficients and significance levels were calculated. Here the items of the main variables of knowledge distance, effort level of knowledge, impact of complementary knowledge and incentive were averaged to produce a mean score for the each construct.

The regression analysis between knowledge stock and the effort level of knowledge. According to the model summary, most of the control variables were significant with effort level of knowledge sharing, such as "working time at present project" (β = 0.184, R^2 = 0.034, p = 0.033); "occupational level" (β = 0.193, R^2 = 0.037, p = 0.026); "the title of a technical post" (β = 0.276, R^2 = 0.076, p = 0.001). While "working years" (β = 0.162, R^2 = 0.026, p = 0.062); "educational level" (β = 0.078, R^2 = 0.006, p = 0.371) and "the NUM of participated projects in recent 5 years" (β = 0.134, R^2 = 0.018, p = 0.123) were not significant correlation with effort level of knowledge sharing. From the result, there were parts of significant correlation with effort level of knowledge sharing in knowledge stock, which was mostly in line with the previous hypothesis of the model. It supports H1 mostly.

The regression analysis between knowledge stock and the impact of complementary knowledge. All the items of knowledge stock (p = 0.000) except "educational level" (β = 0.074, R^2 = 0.005, p = 0.396) had significant correlation with "impact of complementary knowledge". It showed that the more knowledge stock was, the greater the impact of complementary knowledge between individuals would be. The result was mainly consistent with the model.

The regression analysis between knowledge distance and the effort level of knowledge. "Knowledge distance" (β = 0.154, R^2 = 0.024, p = 0.075) had not a significant correlation with "effort level of knowledge". Because effort level and knowledge distance had the relation of inverse "U". It needs to be discussed in different ways following the critical range. It supported H2.

The regression analysis between knowledge distance and the impact of complementary knowledge. "Knowledge distance" (β = 0.478, R^2 = 0.229, p = 0.000) had a significant correlation with "impact of complementary knowledge", which meant with the increasing of knowledge distance, the impact of complementary knowledge between individuals was increased. The result was in line with the model. It supported H3.

The regression analysis between the impact of complementary knowledge and the effort level of knowledge. "Impact of complementary knowledge" (β = 0.406, R^2 = 0.165, p = 0.000) had a significant correlation with "effort level of knowledge". It meant that the greater the impact of complementary knowledge was, the greater the effort level of knowledge would be. The result was in line with the model. It supported H5.

The regression analysis between the effort level of knowledge and organizational incentive. "Effort level of knowledge" (β = 0.388, R^2 = 0.15, p = 0.000) had a significant correlation with "organizational incentive". The greater the effort level of knowledge was, the more the incentive of organization would be. The result was in line with the model. It supported H6.

The regression analysis between impact of complementary knowledge and incentive. "Impact of complementary knowledge" (β = 0.561, R^2 = 0.314, p = 0.000) had a significant correlation with "incentive". The greater the impact of complementary knowledge was, the more the incentive of organization would be. The result was in line with the model. It supported H4.

To sum up, Table 4 showed the comparison between the model results and the empirical testing.

DISCUSSION

The study has introduced considered the knowledge potential into in the effort level of knowledge sharing, the impact of complementary knowledge and organizational incentive.

Knowledge potential influences knowledge sharing under different incentive mechanisms (Zeng *et al*., 2011; Bivainis and Morkvenas, 2012). Data from this survey revealed that some knowledge potential items had significant impact on the effort level of knowledge. The

findings clarified the items of "working time at present project", "occupational level" and "the title of a technical post" had significant impact on the effort level of knowledge. In practice, some unexperienced project managers usually are not willing to share their knowledge because they fear a threat after they do. However, most of experienced project managers are willing to share their knowledge. Any organization that in form of project teams would express interests in individuals' sharing their knowledge during the process of completing project tasks as well as sharing knowledge that is inherent within the team members before it disbands to be used for new projects. At the early stage of a project, members' heterogenous knowledge makes them different in knowledge stock (Caniels and Verspagen, 2001). POO needs to encourage such heterogenous members to share their complementary knowledge in order to achieve project value. Complementary knowledge-sharing enhances knowledge potential both agents and organization. Sometimes such complementary effect may augment the synergy effect (Bivainis and Morkvenas, 2012). The relationship between the organizational incentive and the impact of complementary knowledge found by Wang and Shao (2012) implies the importance of complementary knowledge resource of POO members. It suggests that organizations should pay more attention to the appropriate proportion of high-potential members and low-potential members selected at the early stage of a project.

This study also has some limitations. First, scale of samples is relatively small, may bias the findings to some degree. Second, project-oriented organization involves various fields. This study focuses on construction field. The conclusions may be different with other fields. Future studies include comparing with project-oriented organizations of different fields and has more samples.

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