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

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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 Steinhorsson, 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,
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, studies on knowledge sharing incentive of project-oriented organization based on the theory of
knowledge potential is 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 hypotheses 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:

\[ \eta_i = a_i a_i K_i + \theta_i a_i K_i + \xi_i \]  

(1)

and:

\[ \eta_i = a_i a_i K_i + \theta_i a_i K_i + \xi_i \]  

(2)

where, \( \theta_h \) and \( \theta_l \), 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 \( \theta_h, \theta_l > 0 \). The \( \eta_i \) and \( \xi_i \) are rate of H and L’s knowledge which can be shared, respectively. The \( \alpha_i \) and \( \alpha_l \) represent the effort level that these two individuals share each unit obtainable complementary knowledge, respectively. The \( K_h \) and \( K_i \) are H and L’s knowledge volume. The \( \epsilon_i \) and \( \xi_i \) are exogenous random variable influencing these two individuals’ knowledge-sharing output \( \epsilon_i \sim N(0, \sigma^2) \) and \( \xi_i \) and \( \xi_i \) 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:

\[ c_i = b_i \frac{a_i^2}{2} \]  

(3)

and:

\[ c_i = b_i \frac{a_i^2}{2} \]  

(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:

\[ s = \alpha_h + \alpha_l + \beta_h \eta_h + \beta_l \eta_l \]  

(5)

where \( \alpha_h \) and \( \alpha_l \) are fixed compensation organization gives and \( \beta_h \) and \( \beta_l \) 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:

\[ w_r = \eta_h + \eta_l - s = (\alpha_h + \alpha_l) + a_s a_s K_s (1 - \beta_h + \beta_h \beta_l) \]

\[ + a_s a_s (1 - \beta_l + \beta_l \beta_h) + \epsilon_i (1 - \beta_l) + \xi_i (1 - \beta_l) \]  

(6)

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

\[ EV (w_r) = (\alpha_h + \alpha_l) + a_s a_s K_s (1 - \beta_h + \beta_h \beta_l) \]

\[ + a_s a_s (1 - \beta_l + \beta_l \beta_h) \]  

(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:

\[ w_s = \alpha_h + \beta_h \eta_h - b_h \frac{a_h^2}{2} = \alpha_h + \beta_h \]  

(8)

\[ (a_s a_s K_s + \eta_i a_h K_s + \xi_i) - b_h \frac{a_h^2}{2} \]

and H’s expected-utility is:

\[ EV (w_s) = \alpha_h + \beta_h (a_s a_s K_s + \eta_i a_h K_s + \xi_i) - b_h \frac{a_h^2}{2} - p \beta_h \sigma^2 / 2 \]  

(9)

Net output of knowledge-sharing of L is:
\[ w_i = a_i + \frac{3}{2} \beta_i \sigma_i^2 + b_i a_i^2 / 2 = a_i + \beta_i (q_i a_i K_i + \delta_i q_i a_i K_i - b_i a_i / 2 - \rho \sigma_i^2) / 2 \]  
(10)

L’s expected-utility is:

\[ EU(w_i) = a_i + \beta_i (q_i a_i K_i + \delta_i q_i a_i K_i - b_i a_i^2 / 2 - \rho \sigma_i^2) / 2 \]  
(11)

**Optimal incentive mechanism:** After organization offers \( \alpha \) and \( \beta \), \( H \) and \( L \) maximize their benefits, respectively, that is:

\[
\max_{a_i} \text{EV}(w_i) \quad \text{s.t.} \quad a_i \in \arg \max_{a_i} \text{EU}(w_i) 
(12)
\]

The above function can be expressed as:

\[
\max_{\alpha_i, \beta_i} \left( \alpha_i + \beta_i (q_i a_i K_i + \delta_i q_i a_i K_i - b_i a_i^2 / 2 - \rho \sigma_i^2) / 2 \right) \quad \text{s.t. (IR)} \quad \left\{ \begin{array}{l}
\alpha_i + \beta_i (q_i a_i K_i + \delta_i q_i a_i K_i - b_i a_i^2 / 2 - \rho \sigma_i^2) / 2 \geq w_i \\
\alpha_i + \beta_i (q_i a_i K_i + \delta_i q_i a_i K_i - b_i a_i^2 / 2 - \rho \sigma_i^2) / 2 \geq w_i
\end{array} \right.
\]  
(13)

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

\[
\partial w_i / \partial a_i = 0
\]

and:

\[
\partial w_i / \partial a_i = 0
\]  
(15)

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

\[ a_i = \beta_i a_i K_i / b_i \]  
and:

\[ a_i = \beta_i a_i K_i / b_i \]  
(16)

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

\[
\max_{\beta_i} w_i = \frac{2 \beta_i K_i q_i^2 (1 + \delta_i) - K_i^2 q_i^2 \sigma_i^2}{2b} + \frac{2 \beta_i K_i q_i^2 (1 + \delta_i) - K_i^2 q_i^2 \sigma_i^2}{2b} - \frac{1}{2} \rho \sigma_i^2 (\sigma_i^2 + \rho \sigma_i^2) / (w_i + w_i)
\]  
(17)

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

\[ \beta_i = q_i^2 K_i^2 (1 + \delta_i) / (K_i^2 q_i^2 + b_i \rho \sigma_i^2) \]

and:

\[ \beta_i = q_i^2 K_i^2 (1 + \delta_i) / (K_i^2 q_i^2 + b_i \rho \sigma_i^2) \]  
(18)

Assuming:

\[ A = \partial^2 w_i / \partial a_i^2, \quad B = \partial a_i / \partial a_i, \quad C = \partial a_i / \partial a_i \]

so

\[ B^2 - AC = -K_i^2 q_i^2 (b_i + \rho \sigma_i^2) (q_i^2 K_i^2 + b_i \rho \sigma_i^2) \times 0 \]  
(19)

According to the property of dualistic function extremum, it exists \( \beta_h \) and \( \beta_l \) that makes \( w_i \) maximum. So the optimal incentive of POC to two individuals are, respectively:

\[ \beta_h = q_i^2 K_i^2 (1 + \delta_h) / (K_i^2 q_i^2 + b_i \rho \sigma_i^2) \]

and:

\[ \beta_l = q_i^2 K_i^2 (1 + \delta_l) / (K_i^2 q_i^2 + b_i \rho \sigma_i^2) \]  
(20)

For \( 0 < \beta < 1 \), it is got that:

\[ 0 \leq \delta_i \leq b_i \rho \sigma_i^2 / K_i^2 q_i^2 \]  
(21)

and:

\[ 0 \leq \delta_i \leq b_i \rho \sigma_i^2 / K_i^2 q_i^2 \]  
(22)

As shown in the equations, 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:

\[ s_i = q_i^2 K_i^2 (1 + \delta_i) / (b_i K_i^2 q_i^2 + b_i \rho \sigma_i^2) \]

and:
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 FOQ. 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 an 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:

\[
\frac{\partial a_i}{\partial x_i} = \frac{q_i K_i^3 (1 + 8_i) + 3q_i K_i^2 (1 + 8_i) b_i' \rho \sigma_i^2}{b_i q_i K_i^2 + b_i' \rho \sigma_i^2} > 0
\]

and:

\[
\frac{\partial a_i}{\partial x_i} = \frac{q_i K_i^3 (1 + 8_i) + 3q_i K_i^2 (1 + 8_i) b_i' \rho \sigma_i^2}{(b_i q_i K_i^2 + b_i' \rho \sigma_i^2)} > 0
\]

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

$$\frac{\partial \beta}{\partial \gamma} = \frac{q_i \sigma_{i}^2}{(K_i^2 \sigma^2 + b_i \rho \sigma_i^2)} > 0$$

and:

$$\frac{\partial \gamma}{\partial \beta} = \frac{q_i \sigma_{i}^2}{(K_i^2 \sigma^2 + b_i \rho \sigma_i^2)} > 0$$

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.

$$\frac{\partial a}{\partial \delta} = \frac{q_i \sigma_{i}^2}{(b_i \sigma^2 + b_i \rho \sigma_i^2)} > 0$$

and:

$$\frac{\partial \delta}{\partial \gamma} = \frac{q_i \sigma_{i}^2}{(b_i \sigma^2 + b_i \rho \sigma_i^2)} > 0$$

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 PPO 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:

$$\frac{\partial a}{\partial \delta} = \frac{q_i \sigma_{i}^2}{b_i \rho \sigma_i^2} > 0$$

and:

$$\frac{\partial \delta}{\partial \gamma} = \frac{q_i \sigma_{i}^2}{b_i \rho \sigma_i^2} > 0$$

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 PPO 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 OIL)”, “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

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

“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 can 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 produce more knowledge (denotes by C3)”. “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 Widyantrum (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 N1)”. “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 N2)”. “When I share my knowledge to with others, organization praise me (denotes by N3)”, 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, SD1 and zero-order correlations for the study variables are shown in Table 2.

Table 1: Basic information of the survey respondents

The means of the knowledge stock items were moderate. And the ones of the other dimensions were high. In this regard, Nootteboom (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 (Morkveras et al., 2008).
Table 2: Results of means, standard deviations and correlation analysis

<table>
<thead>
<tr>
<th>Variables</th>
<th>Means</th>
<th>SD</th>
<th>T1-4</th>
<th>EL2</th>
<th>OL2</th>
<th>TL1</th>
<th>NUM1</th>
<th>KD1</th>
<th>SE11</th>
<th>C11</th>
<th>E11</th>
</tr>
</thead>
<tbody>
<tr>
<td>KS</td>
<td>2.240</td>
<td>0.806</td>
<td>1.000</td>
<td></td>
<td></td>
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<td></td>
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<td></td>
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<tr>
<td>T</td>
<td>1.950</td>
<td>0.778</td>
<td>0.570*</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EL</td>
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<td>0.484</td>
<td>-0.065</td>
<td>0.110</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OL</td>
<td>2.170</td>
<td>0.938</td>
<td>0.741**</td>
<td>0.659**</td>
<td>0.242**</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TL</td>
<td>2.280</td>
<td>1.174</td>
<td>0.691**</td>
<td>0.561**</td>
<td>-0.003</td>
<td>0.727**</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NUM</td>
<td>2.490</td>
<td>1.088</td>
<td>0.799**</td>
<td>0.588**</td>
<td>0.040</td>
<td>0.741**</td>
<td>0.667**</td>
<td>1.000</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>KD</td>
<td>3.420</td>
<td>0.702</td>
<td>0.410**</td>
<td>0.263**</td>
<td>0.050</td>
<td>0.732**</td>
<td>0.288**</td>
<td>0.450**</td>
<td>1.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SE</td>
<td>3.269</td>
<td>0.754</td>
<td>0.162</td>
<td>0.184*</td>
<td>0.078</td>
<td>0.193*</td>
<td>0.276*</td>
<td>0.134</td>
<td>0.154</td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>3.494</td>
<td>0.663</td>
<td>0.501**</td>
<td>0.465**</td>
<td>0.074</td>
<td>0.578**</td>
<td>0.537**</td>
<td>0.553**</td>
<td>0.478**</td>
<td>0.406**</td>
<td>1.000</td>
</tr>
<tr>
<td>E</td>
<td>3.622</td>
<td>0.559</td>
<td>0.403**</td>
<td>0.399**</td>
<td>-0.002</td>
<td>0.416**</td>
<td>0.402**</td>
<td>0.445**</td>
<td>0.455**</td>
<td>0.388**</td>
<td>0.561**</td>
</tr>
</tbody>
</table>

**Significant at the 0.01 level (two-tailed); *Significant at the 0.05 level (two-tailed); #Knowledge stock, Working years, Working time at present project; Educational level, Occupational level, Title of a technical post, No. of participated projects in recent 5 years; Knowledge distance, Effort level of knowledge sharing, The impact of complementary knowledge, Organizational incentive.

Table 3: Factor analysis and varimax rotation of four variables

<table>
<thead>
<tr>
<th>Variables</th>
<th>Items</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Impact of complementary knowledge (C)</td>
<td>C4</td>
<td>0.827</td>
<td>0.059</td>
<td>0.176</td>
<td>0.105</td>
</tr>
<tr>
<td></td>
<td>C5</td>
<td>0.797</td>
<td>0.084</td>
<td>0.219</td>
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<tr>
<td></td>
<td>C6</td>
<td>0.763</td>
<td>0.279</td>
<td>0.091</td>
<td>0.162</td>
</tr>
<tr>
<td></td>
<td>C7</td>
<td>0.748</td>
<td>0.286</td>
<td>0.127</td>
<td>0.191</td>
</tr>
<tr>
<td></td>
<td>C8</td>
<td>0.708</td>
<td>0.125</td>
<td>0.354</td>
<td>0.174</td>
</tr>
<tr>
<td></td>
<td>C9</td>
<td>0.679</td>
<td>0.162</td>
<td>0.217</td>
<td>0.169</td>
</tr>
<tr>
<td></td>
<td>C10</td>
<td>0.658</td>
<td>0.238</td>
<td>0.216</td>
<td>0.154</td>
</tr>
<tr>
<td></td>
<td>C11</td>
<td>0.636</td>
<td>0.290</td>
<td>0.181</td>
<td>0.136</td>
</tr>
<tr>
<td></td>
<td>C12</td>
<td>0.636</td>
<td>0.290</td>
<td>0.181</td>
<td>0.136</td>
</tr>
<tr>
<td></td>
<td>C13</td>
<td>0.658</td>
<td>0.238</td>
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</tr>
<tr>
<td></td>
<td>C14</td>
<td>0.708</td>
<td>0.125</td>
<td>0.354</td>
<td>0.174</td>
</tr>
<tr>
<td></td>
<td>C15</td>
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<td>0.127</td>
<td>0.191</td>
</tr>
<tr>
<td></td>
<td>C16</td>
<td>0.763</td>
<td>0.279</td>
<td>0.091</td>
<td>0.162</td>
</tr>
<tr>
<td></td>
<td>C17</td>
<td>0.827</td>
<td>0.059</td>
<td>0.176</td>
<td>0.105</td>
</tr>
<tr>
<td></td>
<td>C18</td>
<td>0.797</td>
<td>0.084</td>
<td>0.219</td>
<td>0.226</td>
</tr>
<tr>
<td></td>
<td>C19</td>
<td>0.708</td>
<td>0.125</td>
<td>0.354</td>
<td>0.174</td>
</tr>
<tr>
<td></td>
<td>C20</td>
<td>0.679</td>
<td>0.162</td>
<td>0.217</td>
<td>0.169</td>
</tr>
<tr>
<td></td>
<td>C21</td>
<td>0.658</td>
<td>0.238</td>
<td>0.216</td>
<td>0.154</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Variables</th>
<th>Model results</th>
<th>Testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1</td>
<td>Knowledge stock of employees has a positive relation with their effort level</td>
<td>Most support</td>
</tr>
<tr>
<td>H2</td>
<td>Knowledge distance and effort level may have no significant relation for their complicated relevance</td>
<td>Support</td>
</tr>
<tr>
<td>H3</td>
<td>Knowledge distance between employees and their impact of complementary knowledge have positive correlation</td>
<td>Support</td>
</tr>
<tr>
<td>H4</td>
<td>Impact of complementary knowledge and the organization’s incentive are positive correlation</td>
<td>Support</td>
</tr>
<tr>
<td>H5</td>
<td>Impact of complementary knowledge and the effort level have positive correlation</td>
<td>Support</td>
</tr>
<tr>
<td>H6</td>
<td>Effort level and the incentive degree have positive relation</td>
<td>Support</td>
</tr>
</tbody>
</table>

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 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” ($\beta = 0.184, R^2 = 0.034, p = 0.033$), “occupational level” ($\beta = 0.193, R^2 = 0.037, p = 0.026$), “title of a technical post” ($\beta = 0.276, R^2 = 0.076, p = 0.001$).

While “working years” ($\beta = 0.162, R^2 = 0.026, p = 0.062$), “educational level” ($\beta = 0.078, R^2 = 0.006, p = 0.371$) and “the NUM of participated projects in recent 5 years” ($\beta = 0.134, R^2 = 0.018, p = 0.123$) 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” ($\beta = 0.074, R^2 = 0.005, p = 0.389$) 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” ($\beta = 0.154, R^2 = 0.024, p = 0.075$) 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” ($\beta = 0.478, R^2 = 0.229, p = 0.000$) 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” ($\beta = 0.406, R^2 = 0.165, p = 0.000$) 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” ($\beta = 0.388, R^2 = 0.15, p = 0.000$) 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” ($\beta = 0.561, R^2 = 0.314, p = 0.000$) 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 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 inexperienced 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). POM 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 POM 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.

REFERENCES


