Knowledge Transfer within the Organization for the Consideration of Disseminative Capacity, Absorptive Capacity and Individuals' Benefits

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Abstract
In the study, a conceptual model for knowledge transfer is proposed which focuses on the disseminative capacity, absorptive capacity, and benefits of actors including the knowledge sender and knowledge recipient when they exchange knowledge with each other. To deeply investigate the individuals' behavior, a network model is constructed to examine how the social benefits like status and respect stimulate the knowledge disseminative will or the knowledge absorptive will of actors during the knowledge transfer processes. The simulation results show that the incentive mechanism for individuals can promote the disseminative capacity of knowledge senders, accelerate the processes of knowledge transfer and improve the knowledge stock of the organization to a certain extent.

***Keywords*:** knowledge transfer, disseminative capacity, absorptive capacity, individuals' benefits

1. Introduction

Knowledge transfer is defined as a communication process with information processing activities, where the actors involved can carry out the transfer of knowledge using an appropriate mechanism [1]. Since knowledge transfer is pivotal to the improvement of knowledge stock and competence of the organization, it has been considered to be one of the important topics for knowledge management researchers as well as practitioners. It is believed that both the knowledge disseminative capacity of knowledge sender and the knowledge absorptive capacity of knowledge recipient have a great impact on the performance of knowledge transfer. Therefore, it is necessary for the organization to study the way to stimulate both knowledge senders and knowledge recipients.

Drawing on the relevant literature, knowledge disseminative capacity and absorptive capacity in relation to knowledge transfer have been paid much more attention and studied in different ways [2][3][4][5][6][7][8]. However, least research concerns how to promote the disseminative capacity of knowledge sender or absorptive capacity of knowledge recipient. In reality, these two kinds of capacity not only depend on the actors' knowledge level, but also depend on the actors' willingness to exchange knowledge to a great extent. In other words, the actor's disseminative capacity or absorptive capacity may rely on whether they can get some returns or benefits after they send or receive the knowledge. According to the theory on organization behavior [9], a group of human beings can be divided into two groups resulting from their different motivations: One group being "rational-economic" who can be motivated by material and monetary gains, and another group being "social" who can be motivated by social status and the respect from other people. In the study, we take the latter group into consideration. For those people, we believe that they do want to disseminate their knowledge to obtain some benefits like respect from others. Conversely speaking, they also want to absorb the knowledge from others to promote their knowledge level as a result they get a higher status. Based on this fact, we propose a conceptual model for knowledge transfer into which the social benefits of individuals are introduced. A simulation network model is therefore constructed to examine how the social benefits influence the knowledge disseminative capacity of knowledge senders and the absorptive capacity of knowledge recipients in the knowledge transfer processes by using the given knowledge exchange rules. For the sake of the length limitation, here only the disseminative capacity of knowledge senders and the corresponding simulation results are discussed and given in the following sections.

Two contributions of this study have been made: it reveals the relationships between knowledge disseminative capacity, absorptive capacity, individuals' social benefits and knowledge transfer; also, it indicates that individuals' social benefits such as status and respect can improve the disseminative capacity of knowledge senders, and accelerate the knowledge transfer within the organization.

2. The knowledge transfer model

2.1 The conceptual model

To express the relationships with knowledge senders, knowledge recipients, their disseminative capacity, absorptive capacity, and benefits as well as the knowledge exchange rule, a conceptual model for knowledge transfer is constructed by taking those factors and their relationships into consideration, as shown in Figure 1.

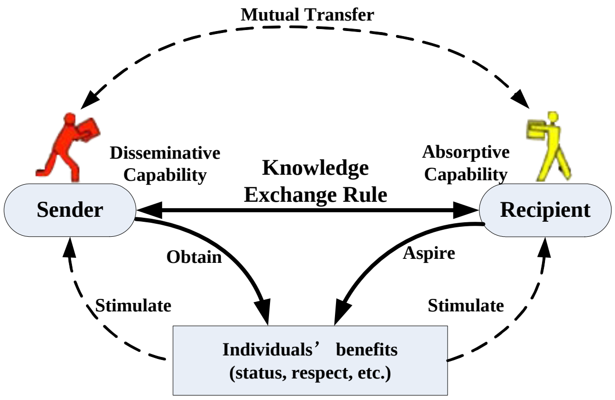


Fig. 1. Knowledge transfer model in organization

The above conceptual model is described in as follows.

1) Any individual in intra-organization can be regarded as a knowledge sender or knowledge recipient who has limited knowledge for the specific problem at one time.

2) Using the knowledge disseminative capacity D_i denotes the ability of the knowledge sender *i* to codify, articulate, communicate and teach knowledge to the knowledge recipients [7].

3) Each knowledge recipient *i* has a knowledge absorptive capacity A_i, which refers to the ability of individual for identifying, learning, absorbing, assimilating and applying the knowledge which comes from the knowledge senders.

4) Especially in our knowledge transfer model, we take individuals' social benefits into account, such as status, respect, and so on. During the knowledge transfer process, there exists a fact that the sender who has transferred the knowledge willingly to the recipient can obtain some benefits like respect. After that such benefits could stimulate him/her to have much more willingness and capacity to transfer knowledge to others again in order to get more benefits. In contrast, the knowledge recipient who aspires to gain the benefits on above will be stimulated to absorb more new knowledge and become a new sender for the next exchange. Both the knowledge sender and recipient continuously change their roles until they are at the same knowledge level. This makes a knowledge spiral process. To the end, the whole knowledge level or stock of the organization can be promoted.

2.2 The network model and the knowledge exchange rule

In the study, the organization is conceptualized as a two-dimensional grid of cells. Initially, each cell of the grid is randomly assigned with an agent who represents a member of the organization, and all the cells of the grid are occupied by agents. Then, an agent may interact and exchange the knowledge in some conditions with other agents located in its neighborhood each time. The neighborhood is defined as a region on the grid that includes four adjacent cells from north, south, east and west directions respectively, i.e. Von Neumann neighborhood structure (as shown in Figure 2).

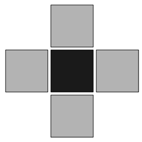


Fig. 2. Von Neumann neighborhood structure

The size of the structure is in accord with the number of agents which is set to be M in the study. Let $I = \{1,2,\cdots,M\}$ denote a finite set of agents. For any $i, j \in I$, define a binary variable $\chi(i, j)$ to take the value $\chi(i, j) = 1$ if a connection exists between i and j, and otherwise $\chi(i, j) = 0$. Therefore, an organization network can be built in terms of the given agents and their connections. The connection is represented as $C = \{\chi(i, j); i, j \in I\}$ which holds all pairwise relationships between agents. The neighborhood of i is denoted as a set $\Gamma_i = \{ j \in I : \chi(i, j) = 1\}$. Such simulation network based on the above specifications is similar to the cellular automata [10][11].

The state of each agent i at time t is characterized by its four attributes $\{X_i, D_i, A_i, R_i\}$. The first attribute X_i is agent i's knowledge stock represented by a knowledge vector $X_i = [x_{i,c_1}, x_{i,c_2}, \cdots, x_{i,c_l}]$, where $c=\{c_1, c_2, \ldots, c_l\}$ describes the different categories of knowledge. The second attribute $D_i = [d_{i,c_1}, d_{i,c_2}, \cdots, d_{i,c_l}]$ illustrates the disseminative capacity of agent i to transfer different categories of knowledge to others, which is proportional to one's knowledge stock initially. The third one $A_i = [a_{i,c_1}, a_{i,c_2}, \cdots, a_{i,c_l}]$ expresses the capacity of agent i to learn and absorb the specific knowledge, which mainly depends on the knowledge difference/distance of two interacted agents. The last attribute R_i is a scalar which represents the individual' benefits like social status or respect of agent i, which is also proportional to one's knowledge stock initially.

A pair of agents i and j can exchange the knowledge with each other if and only if there is a direct connection between them and a win-win condition. In detail, an agent who receives knowledge can improve its own knowledge stock and at the same time its disseminative capacity and social status will be promoted. In contrast, an agent who sends knowledge can obtain the social respect from others, which can stimulate it to have more willingness to transfer knowledge to others. Based on the above fact, the knowledge exchange rule can be defined by the following six steps.

1) The condition for knowledge exchange is that there is a knowledge distance between a pair of agents. For $j \in \Gamma_i$, let $n(i, j)= \#\{c : x_{i,c} > x_{j,c}\}$ be the number of knowledge categories in which $x_{i,c}$ is strictly larger than $x_{j,c}$. If $x_{j,c} > x_{i,c}$ and $n(j, i) > 0$, it means that the number of knowledge categories for $x_{j,c}$ is strictly larger than $x_{i,c}$. Therefore, the knowledge exchange can take place if and only if $j \in \Gamma_i$ and

$$\max\{n(i, j), n(j, i)\} > 0 \tag{1}$$

We assume the knowledge level between two agents being the same if their knowledge stock differs with a small value say less than 0.01.

$$0.99 < \frac{x_{i,c}}{x_{j,c}} < 1.01 \tag{2}$$

2) Calculate the knowledge distance between two agents. Suppose that agent *j* is superior to agent *i* in knowledge category c_1, the knowledge distance can be given as

$$dis_{c_1}(i,j) = x_{j,c_1} - x_{i,c_1}, x_{j,c_1} > x_{i,c_1} \tag{3}$$

3) Calculate the knowledge absorptive capacity of the agent. The absorptive capacity to knowledge c_1 for agent *i* at time *t* denoted by a_{i,c_1} which can be calculated by the following formula.

$$a_{i,c_1} = \begin{cases} 1, & dis_{c_1}(i,j) \le 0.1 \\ x_{i,c_1} / x_{j,c_1}, & 0.1 < dis_{c_1}(i,j) < 0.9 \\ 0, & dis_{c_1}(i,j) \ge 0.9 \end{cases} \tag{4}$$

4) Update the knowledge stock for agent *i* after some processes of knowledge transfer. The knowledge stock of agent *i* at time *t*+1can be measured by

$$x_{i,c_1}(t+1) = x_{i,c_1}(t) + d_{j,c_1} \times a_{i,c_1} \times [x_{j,c_1}(t) - x_{i,c_1}(t)] \tag{5}$$

where d_{j,c_1} represents the disseminative capacity of agent *j* to transfer knowledge c_1 to agent *i*.

5) Update the knowledge disseminative capacity for agents *i*. The knowledge disseminative capacity of agent *i* will be improved at time *t*+1for receiving knowledge from agent *j* which can be calculated by

$$d_{i,c_1}(t+1) = d_{i,c_1}(t) + \Delta x_{i,c_1}(t+1) \tag{6}$$

where $\Delta x_{i,c_1}(t+1) = x_{i,c_1}(t+1) - x_{i,c_1}(t)$ is the incremental knowledge after agent *i* receives knowledge c_1 from agent *j*.

6) Update the individuals' benefits for two agents. For agent *i* by receiving knowledge, its social status can be promoted. In contrast, agent *j* who sends the knowledge can obtain the social respect from others. Therefore, the individuals' benefits for two agents *i* and *j* can be measured respectively by the following formulas.

$$R_i(t+1) = R_i(t) + \sum\nolimits_c \Delta x_{i,c}(t+1) / l \tag{7}$$

$$R_j(t+1) = R_j(t) + n(j,i) \times \Delta r \tag{8}$$

while $\sum\nolimits_c \Delta x_{i,c}(t+1)/l$ is the average incremental knowledge for agent *i* after it receives knowledge *c* from agent *j*, and $\Delta r = 0.01$ is the obtained benefits like social respect for agent *j* sends the knowledge to agent *i* with one category of the knowledge.

Suppose that an agent has a communication preference, and it is much more pleased to exchange knowledge with its neighbor who has a higher social respect than others. Then, the above six processes will be implemented until all exchange chances have been exhausted, that is there is no any knowledge gaps between all pairs of agents. It can be described as $\forall i, j \in I, j \in \Gamma_i, \max(n(i,j), n(j,i)) = 0$. This corresponds to a steady state of the transferring process. The six-step procedure makes a knowledge exchange rule as shown in Figure 3(a) called “Rule A”.

In order to find and compare the effect of incentive mechanism of individuals’ benefits on the performance of knowledge transfer processes, we give one more rule named “Rule B” based on Cowan model [12] which is lack of consideration on transfer returns for individuals’ social benefits. It supposes that the agent prefers to exchange knowledge if and only if it can simultaneously obtain some knowledge from its neighbors. In other words, only knowledge gain has been considered in Rule B. The procedure of knowledge exchange based on Rule B is shown in Figure 3(b).

Rule B is different from Rule A in three aspects as follows.

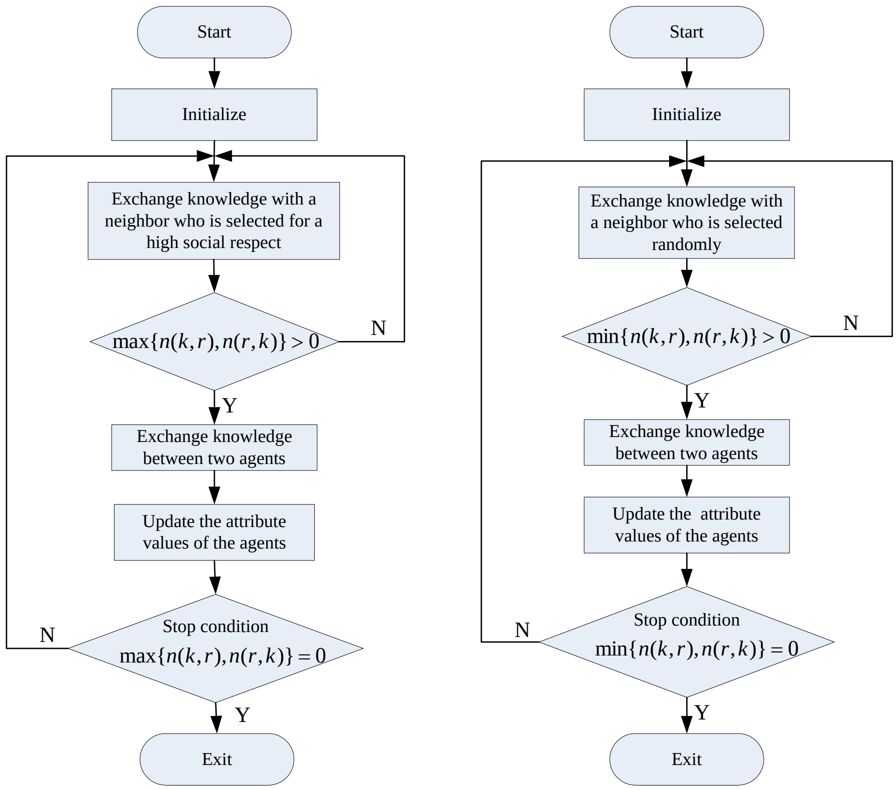
First, the agent does not have any communication preference. Each time it will exchange knowledge with its neighbor which is selected randomly.

Second, the knowledge exchange can take place between a pair of agents if and only if $j \in \Gamma_i$ and

$$\min\{n(i, j), n(j,i)\} > 0 \tag{9}$$

That means when $n(i, j)>0$, agent j prefers to exchange the knowledge with agent i. Moreover, agent i would like to ask exchange the knowledge with agent j if $x_{j,c} > x_{i,c}$ and $n(j,i) > 0$. Therefore, a pair of agents i and j can exchange the knowledge with each other if and only if there is a direct connection between them and a win-win solution for knowledge transfer.

Finally, the process continues until $\min(n(i, j), n(j,i)) = 0$, and the agent with the higher knowledge stock will become reluctant to send the knowledge to others although there still exists a knowledge gap between them, which results from the fact that an agent can not get any benefits including the knowledge from its neighbor.



(a) Knowledge exchange process for Rule A (b) Knowledge exchange process for Rule B

Fig. 3. Knowledge exchange processes and the corresponding flowcharts

3. Evaluation measure

We measure the performance of knowledge transfer in two aspects: the growth of knowledge stock and the adequacy of knowledge transfer.

For a single agent, its average knowledge stock can be defined as $\overline{x}_i(t) = \sum_c x_{i,c}(t)/l$, where l is the total of knowledge categories. Hence, the average knowledge stock $\varpi(t)$ of the organization at time t can be calculated by the formula.

$$\varpi(t) = \sum_{i \in I} \overline{x}_i(t)/M \tag{10}$$

where M is the number of members within the organization.

The adequacy of knowledge transfer is judged by the variation of knowledge stocks. To some extent, one of the purposes of knowledge transfer is to narrow the gap of knowledge stocks among individuals. The variance which can be calculated by the formula (11) is used to measure the degree of discrepancy in knowledge stocks.

$$\sigma^2(t) = \frac{1}{M}\sum_{i \in I} \overline{x}_i^{2}(t) - \varpi^2(t) \tag{11}$$

In addition, the average knowledge disseminative capacity $\overline{d}_i(t)$ for a single agent can be defined as the following formula.

$$\overline{d}_i(t) = \sum_c d_{i,c}(t)/l \tag{12}$$

4. Simulations and discussions

We consider a population of M=900 agents with Von Neumann neighborhood structure (as shown in Figure 2). In the study, we assume that each agent has five categories of knowledge. It is initialized by a 5-dimensional knowledge vector $x_{i,c}(0)$ taking values from $U[0,1]$ for $c=\{c_1, c_2, \ldots, c_l\}$, where l=5 denotes the number of knowledge categories. The initial knowledge disseminative capacity satisfies $d_{i,c}(0) \propto k \cdot x_{i,c}(0)$, and the coefficient of the proportion is set to be k=0.8. The initial social benefit $R_i(0)$ of an agent equals to its knowledge stock. Then, we make a simulation to evaluate the performance of knowledge transfer processes by using two kinds of rules mentioned above.

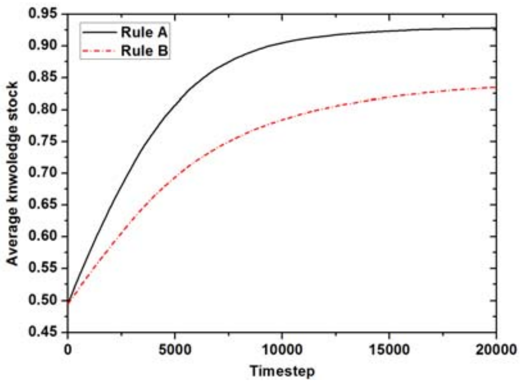


Fig. 4. A comparison of average knowledge stock changes by using two "Rules"

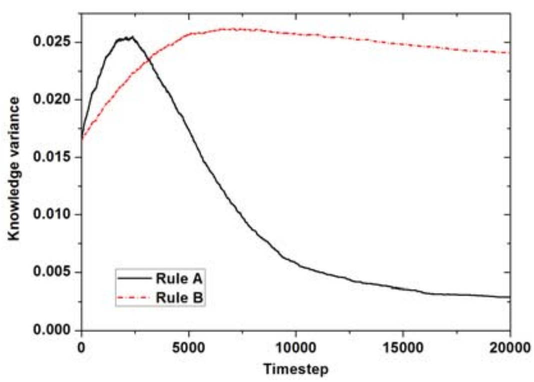


Fig. 5. A comparison of knowledge variance changes by using two "Rules"

Figure 4 shows the different changes on the average knowledge stock by using Rules A and B, respectively.

The curves indicate that the speed of knowledge transfer with Rule A is faster than Rule B has, and the further knowledge stock goes up to a higher value. That means organization members motivated by the individuals' social benefits have more initiative and willingness to transfer the knowledge. The corresponding knowledge variance is displayed in Figure 5, which is used to measure the degree of the knowledge allocation in equilibrium. The curves demonstrate that there is a larger knowledge gap between organization members at the beginning. However, the knowledge variance has a sharp decline after 2,500 time steps and tends to be stable to a small value after 20,000 time steps by using the given Rule A. Whereas the knowledge variance becomes stable with a larger value reached in case of using the Rule B, which illustrates that there still exists a large knowledge gap among the organization members. The stimulation results show that the knowledge can be transferred and shared more sufficiently and effectively when social benefits are seriously considered.

Finally, we make a simulation to examine the relationships between the individuals' benefits like social status or respect and the average knowledge disseminative capacity of knowledge senders in the knowledge transfer processes.

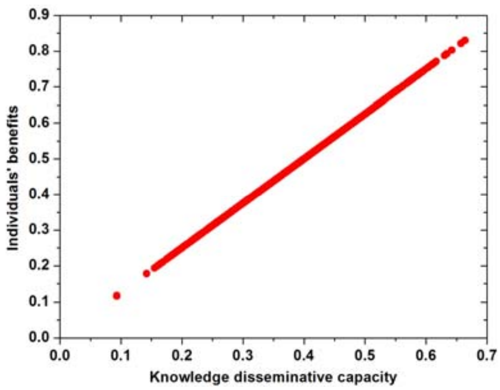


Fig. 6. Relation between the average knowledge disseminative capacity and individuals' benefits at initial time

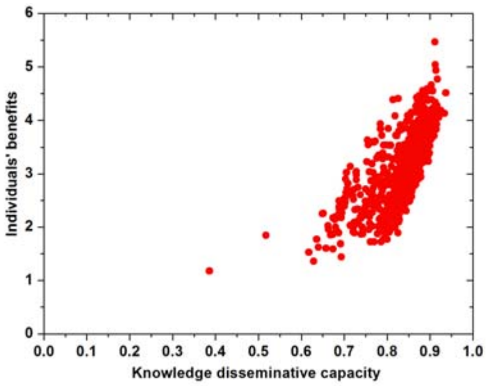


Fig. 7. Relation between the average knowledge disseminative capacity and individuals' benefits after 20,000 time steps

From Figure 6, we find that there is a linear relationship between the average knowledge disseminative capacity and benefits of individuals at the initial time. It depends on the hypotheses in section 2.2 that both knowledge disseminative capacity and individuals' benefits are proportional to individual's knowledge stock. Figure 7 shows the final relationship after a simulation with 20,000 time steps. It indicates that with the increase of the average knowledge disseminative capacity, the social benefits obtained by individuals is also enriched; conversely, with more aspiration to gain the benefits, the knowledge sender tries to promote his/her knowledge disseminative capacity to a higher level.

5. Conclusions

This paper contributes two aspects. In one aspect, a knowledge transfer conceptual model is proposed, which aims to reveal the relationships between knowledge disseminative capacity, absorptive capacity, individuals' benefits and knowledge transfer. In another aspect, a network model is constructed to examine the way how the social benefits like social status and respect influence the knowledge disseminative capacity of knowledge senders in the knowledge transfer processes by using the given knowledge exchange rules.

In the study, the social benefits of individuals have been seriously considered. And the simulation results show that the incentive mechanism of individuals' benefits can enhance the disseminative capacity of knowledge senders, accelerate the knowledge transfer and further improve the knowledge stock of the organization. These findings are helpful for the organization to make decisions on knowledge transfer and knowledge share.

Acknowledgements

This work is fully sponsored by both the National Natural Science Foundation of China under Grants 70771019, and the National High Technology Research and Development Program of China under Grants 2008AA04Z107.

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