

Game Analysis on the Influencing Factors of Knowledge Sharing among Employees in Enterprises

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Abstract: "Knowledge sharing" has become an indispensable key factor for any enterprise to enhance its core competitiveness. How to achieve knowledge sharing among internal employees is very critical to enhance the core competitiveness of enterprises. Based on the existing literature, this paper summarizes several main influencing factors of knowledge sharing among employees in enterprises. From the perspective of influencing factors, it establishes the benefit function and game model of knowledge sharing, obtains the key factors affecting knowledge sharing, and puts forward four methods to promote knowledge sharing.

With the rapid development of the world, knowledge plays an increasingly important role in enterprises. Employees' knowledge and innovation ability are inseparable. Studies by Japanese scholars Akihiro Nonaka and Hirotaka Takeuchi show that new knowledge always starts from individuals. Knowledge sharing is the first stage of knowledge innovation. Employees' knowledge sharing is the basis of organizational knowledge innovation ability [2]. In 1996, the United Nations Organization for Economic Cooperation and Development (OECD) published a report entitled "Knowledge-based economy". It put forward that knowledge creation and knowledge sharing are equally important, reflecting the importance of knowledge sharing in the process of creation. It is an important issue to promote knowledge sharing among employees in enterprises, so as to improve the core competitiveness of enterprises.

Starting with the method of game theory, this paper carefully studies the factors that affect knowledge sharing by consulting relevant literatures, and sets up several variables that affect staff knowledge sharing according to the factors, establishes the benefit function of knowledge sharing, obtains the model of knowledge sharing, and further analyses three kinds of ways that promote knowledge sharing. Methods The key variables affecting knowledge sharing were studied. Finally, some suggestions were put forward to promote knowledge sharing.

1. Influencing Factors of Knowledge Sharing Among Employees

There are many factors affecting knowledge sharing among employees. This paper consults many literatures. Ni Guodong and others believe that the unique factors affecting knowledge sharing mainly include: willingness to share, motivation to share, cost to share and ability to share [9]. Wang Juan thinks that the influencing factors of knowledge sharing can be examined from three aspects: knowledge sharing objects (knowledge), knowledge sharing carriers (knowledge providers, knowledge receivers, knowledge sharing transmission channels), knowledge sharing situations (trust, organizational culture). Based on the existing literature, this paper summarizes several main factors affecting knowledge sharing among employees in enterprises.

(1) Total knowledge. The total amount of knowledge represents the value of knowledge before knowledge sharing. The total amount of knowledge includes explicit knowledge that can be expressed in language and paper reports, and tacit knowledge such as personal skills, experience and know-how that can not be expressed.

(2) Knowledge absorption capacity. Employees' knowledge absorptive capacity represents the

ability of knowledge receivers to absorb knowledge shared by the transmitters, which is related to the success or failure of knowledge sharing. The higher the employee's knowledge absorptive capacity is, the higher the motivation of knowledge sharing is.

(3) Knowledge correlation coefficient. Employees' knowledge correlation coefficient represents the knowledge correlation degree between employees. If the knowledge correlation coefficient of two employees is lower, it shows that there are many new knowledge between them that can attract them to make knowledge sharing strategies.

(4) The amount of innovative knowledge. Employees' innovative knowledge represents that in the process of knowledge sharing, employees integrate and internalize the knowledge shared by each other, and eventually produce some new knowledge. Innovative knowledge plays a very important role in enhancing the core competitiveness of enterprises.

(5) Sharing costs. In the process of sharing, employees need to spend time, energy and resources to learn knowledge, and because the shared knowledge is absorbed by others, this part of knowledge is no longer their own proprietary knowledge, which will lead to knowledge loss. These are the costs of knowledge sharing. When the cost of knowledge sharing differs greatly from the benefit of knowledge sharing, it will affect employees' decision-making of knowledge sharing.

(6) Deception cost. Deception cost means that employees use deception to confuse each other with the cost of knowledge sharing, which also requires a certain amount of time, energy and resources, but in general, because they do not need to share, the cost of deception is less than the cost of sharing.

2. Game Model of Knowledge Sharing

According to the influencing factors of employee knowledge sharing obtained from the above analysis, six variables affecting employee knowledge sharing are set up according to the influencing factors. Finally, the benefit function of employee knowledge sharing within an enterprise is established. Assuming that A and B are two employees within the enterprise, and that P_A and P_B represent the total amount of knowledge that employees A and B before sharing, K_A represents employee A's absorptive capacity ($0 \leq K_A \leq 1$), When the absorptive capacity of employee A is 1, the knowledge shared by employee B is absorbed by employee A completely, λ_A represents the correlation coefficient between the total knowledge of A and B ($0 \leq \lambda_A \leq 1$), When the knowledge correlation coefficient of employee A is 1, the total amount of knowledge representing employee A and B is the same, D_A represents the amount of innovative knowledge acquired by employee A through internalization and communication with employee B in the process of knowledge sharing, On behalf of Employee A, the cost of knowledge sharing (sharing will consume their time and energy, and because the shared knowledge is absorbed by others, this part of knowledge is not for their own exclusive, which will lead to knowledge loss, these are the cost of knowledge sharing), S_A represents the cost of employee A's knowledge sharing by deceiving employee B. Specifically, the above symbol employees B and A are only marked differently. According to the above explanations, the benefit functions of various possible situations in the process of knowledge sharing among individuals are obtained;

$$Q_A = K_A(1 - \lambda_A)P_B + P_A + D_A - C_A \quad (1)$$

$$Q_B = K_B(1 - \lambda_B)P_A + P_B + D_B - C_B \quad (2)$$

$$R_A = K_A(1 - \lambda_A)P_B + P_A - S_A \quad (3)$$

$$R_B = K_B(1 - \lambda_B)P_A + P_B - S_B \quad (4)$$

$$M_A = P_A + D_A - C_A \quad (5)$$

$$M_B = P_B + D_B - C_B \quad (6)$$

$$\frac{\partial Q_A}{\partial K_A} = P_B (1 - \lambda_A) \geq 0 \quad (7)$$

$$\frac{\partial Q_B}{\partial K_B} = P_A (1 - \lambda_B) \geq 0 \quad (8)$$

$$\frac{\partial Q_A}{\partial \lambda_A} = -K_A P_B \leq 0 \quad (9)$$

$$\frac{\partial Q_B}{\partial \lambda_B} = -K_B P_A \leq 0 \quad (10)$$

(1) and (2) represent benefits shared by employees A and B, (3) and (4) represent the benefits of deceiving the other party to share knowledge, (5) and (6) represent the benefits of being deceived by the other party, (7) and (8) represent Q_A and Q_B increased with the increase of K_A and K_B , (9) and (10) represent Q_A and Q_B decreased with the decrease of λ_A and λ_B .

Based on the above analysis, the game model of knowledge transfer among individuals is obtained;

Table 1 Game Model of Knowledge Sharing among Employees in Enterprises

Employee A	Employee B		
		Share	Not sharing
	Share	$Q_A \quad Q_B$	$M_A \quad R_B$
	Not sharing	$R_A \quad M_B$	$P_A \quad P_B$

The model satisfies the following conditions at the same time:

$$R_A \geq Q_A \geq P_A \geq M_A$$

$$R_B \geq Q_B \geq P_B \geq M_B$$

According to this model, the only Nash equilibrium (not shared, not shared) can be obtained. The benefits of employee A and B are P_A and P_B . This is a typical prisoner's dilemma problem. However, how to solve this problem, that is, how to transform Nash equilibrium of the model into (sharing, sharing), is an urgent problem we need to solve.

3. Model Analysis

3.1 If Only One Game Is Played, the Prisoner's Dilemma Can Be Solved through the Trust between Employees.

In knowledge sharing, employees in enterprises are afraid of being deceived because they only care about their own interests and short-term interests, which makes it difficult for them to get out of the prisoner's dilemma in a game. We can solve this problem in a game through the trust between employees. Next, we use the game model of cooperative behavior evolution in short-term relationship created by Zheng Junjun and others.

Since everyone is a unique individual, the trust between them is different. Now let's assume that employee A thinks that employee B's credibility is α ($0 \leq \alpha \leq 1$), employee A considers that the probability of employee B adopting sharing strategy in a game is α , and the probability of employee B adopting non-sharing strategy is $1 - \alpha$, thus:

The benefit value of employee A's sharing strategy is:

$$V_1 = \alpha Q_i + (1 - \alpha) M_i \quad (11)$$

Employee A's earnings from non-sharing strategy are as follows:

$$V_2 = \alpha R_i + (1 - \alpha) P_i \quad (12)$$

If $V_1 - V_2 > 0$, then employee A will adopt a shared strategy, then there are $\alpha Q_i + (1 - \alpha) M_i > \alpha R_i + (1 - \alpha) P_i$ the solution of inequality is obtained as follows:

$$\alpha > \frac{P_i - M_i}{Q_i + P_i - R_i - M_i} = \frac{C_i - D_i}{S_i} \quad (13)$$

Now let's assume that employee B thinks that employee A's credibility is β ($0 \leq \beta \leq 1$), based on the above analysis, it can be concluded that:

$$\beta > \frac{C_j - D_j}{S_j} \quad (14)$$

In the above formula, we can see that the trust degree among employees is closely related to the three variables of sharing cost, innovation knowledge quantity and deception cost. The lower the sharing cost, the easier the two conditions (13) and (14) are to be met with the same amount of innovation knowledge and deception cost. In addition, we can also change multiple variables at the same time to achieve the desired results, such as reducing the cost of sharing and increasing the amount of innovative knowledge while the cost of deception remains unchanged. From the side, it can also be reflected that the higher the trust between employees, the more familiar they will be with each other, the lower the cost of sharing and the higher the amount of innovative knowledge. In the case of a very good relationship between the two sides, once they deceive each other, the cost of deception is also very high.

It can be concluded that when the trust between employees satisfies the two conditions of (13) and (14), employees A and B will adopt the strategy of sharing, then (sharing, sharing) becomes the only Nash equilibrium, thus solving the prisoner's dilemma.

3.2 In the Long-term Cooperation, the Prisoner's Dilemma Can Be Solved through Infinite Repeated Games.

In the real world, assuming that the game of knowledge sharing among employees in a short period of time is not one-off, that is to say, in long-term cooperation, there will be infinite repeated games, and both sides will adopt "cold strategy". If the first stage Employee A adopts the strategy of sharing, then employee B will adopt the strategy of sharing. Strategy, and will always take a cooperative strategy: If employee A in the first stage adopts the strategy of not sharing, employee B will always take the strategy of not sharing to retaliate in the later stage. Suppose the discount factor of this game is δ ($0 \leq \delta \leq 1$).

If employee A adopts the strategy of sharing in the first stage, his total benefit is as follows:

$$T_1 = Q_i + \delta Q_i + \dots = \frac{Q_i}{1 - \delta} \quad (15)$$

If in the first stage A adopts the strategy of not sharing, his total benefit is as follows:

$$T_2 = R_i + \delta P_i + \dots = Q_i + \frac{\delta P_i}{1 - \delta} \quad (16)$$

In the first stage, when the benefits shared are greater than those not shared, that is, when $T_1 > T_2$, Employee A will adopt the sharing strategy and draw the conclusion that:

$$\delta > \frac{R_i - Q_i}{R_i - P_i} = \frac{C_i - D_i - S_i}{K_i (1 - \lambda_i) P_j - S_i} \quad (17)$$

According to the above analysis, when employee B adopts sharing strategy, it must satisfy:

$$\delta > \frac{C_j - D_j - S_j}{K_j (1 - \lambda_j) P_i - S_j} \quad (18)$$

Through the conclusions of (17) and (18), we can see that the discount factor is closely related to the sharing cost, the amount of innovative knowledge, the cost of deception, the correlation coefficient, the absorptive capacity and the total amount of knowledge of employees. By changing a

single variable and keeping the remaining variables unchanged, it is beneficial to satisfy (17) and (18). Such as improving the absorptive capacity of employees or increasing the total amount of knowledge of employees. In addition, we can also change multiple variables to satisfy (17) and (18) conditions at the same time. For example, we can improve employee's absorptive capacity and innovative knowledge while reducing the knowledge correlation between employees when sharing costs, deception costs and total knowledge remain unchanged. From the above conclusions, we can see that in the long-term sharing process, the variables that affect employee sharing are obviously more than those that are shared at one time, but we need to pay special attention to them.

According to the above conclusions, as long as the discount factor is large enough to satisfy both (17) and (18) conditions, employees can be attracted to make shared, and ultimately Pareto optimal results can be achieved.

3.3 Change the Benefits in the Model.

From the model, we can see that in order to get out of the prisoner's dilemma, we must meet the following conditions: $Q_i > R_i$, $Q_j > R_j$, $M_i > P_i$ and $M_j > P_j$, further analysis, we can get: $D_i - C_i + S_i > 0$, $D_j - C_j + S_j > 0$, $D_i - C_i > 0$ and $D_j - C_j > 0$, finally, we can get the conditions for both sides to share: $D_i - C_i > 0$, $D_j - C_j > 0$. Next, we can get out of the prisoner's dilemma from two perspectives.

(1) Reward employees for sharing

If we reward employees who share knowledge, the reward value is A , and conditions $D_i - C_i + A > 0$ and $D_j - C_j + A > 0$ are met, we can conclude that (sharing, sharing) becomes the only Nash equilibrium.

(2) Changing the amount of innovative knowledge and sharing costs of employees

We can satisfy $D_i - C_i > 0$ and $D_j - C_j > 0$ by increasing the amount of innovative knowledge and reducing the cost of sharing, and finally get out of the prisoner's dilemma.

4. Strategies to Promote Knowledge Sharing

4.1 Increase Employees' innovative Knowledge and Reduce Sharing Costs.

From model analysis, it can be clearly seen that the variables affecting employee knowledge sharing include the amount of innovative knowledge and the cost of sharing. Therefore, enterprises need to adopt strategies to change these two variables, such as inviting experts and scholars who can improve employee innovation ability to give speeches, or organizing knowledge exchange forums to reduce the cost of employee private sharing.

4.2 Establishing Learning Organization.

Among the factors that promote the sharing, the employee's ability to absorb knowledge, the knowledge correlation coefficient and the ability to innovate knowledge need to be improved in learning. For example, enterprises can organize employees to exchange and learn from some excellent companies, absorb some advanced experience and technology, reduce the knowledge relevance of employees, and often hold experience exchange forums, invite some experts and scholars to teach the shared experience, improve the absorptive and innovative ability of employees.

4.3 Establish a Strict Reward and Punishment System for Knowledge Sharing.

In the process of sharing, the punishment for betrayal is very small, which will lead to prisoners' dilemma. For this phenomenon, we can establish a strict reward and punishment system, such as giving material and spiritual rewards to the employees who share, promoting the positions of the employees who contribute more, and giving fines or notifying criticism if employees betray their colleagues.

4.4 Enhance Trust Among Employees.

It can be concluded from model analysis that trust has a great impact on getting out of the

prisoner's dilemma. For this reason, we can organize various activities in the enterprise, such as dinner, sports meeting and building a corporate culture of mutual help, which help to improve the trust between colleagues.

5. Conclusion

Based on the influencing factors of employee knowledge sharing, this paper establishes a game model. Through the analysis of the model, no matter which method we use to solve the "Prisoner's Dilemma", the sharing cost and the amount of innovation knowledge are the most important factors, and enterprises should pay special attention to it. These two factors, this conclusion has important guiding significance for enterprises to promote employee knowledge sharing. Finally, we also propose several strategies to promote knowledge sharing among employees within the enterprise according to the model analysis. These strategies have a very positive effect on the enterprise. If the enterprise can adopt it, it will help to stimulate the potential of employees and improve the independent innovation ability of the enterprise.

Of course, there are also many shortcomings in this paper. The limitation lies in the empirical nature of the research. For example, sharing costs and innovative knowledge, it is difficult to find measurable metrics, and it is difficult to conduct empirical research. The empirical research on the game model of the factors affecting employee knowledge sharing in the enterprise is the next research of the author.

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