Evolutionary Game of the Influence of Knowledge Hidden on the Formation Process of Interactive Memory System

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Abstract. Based on the formation stage of organizational interaction memory system, an evolutionary game model of interactive memory system considering two-party group strategy is constructed. The results show that: group initial strategy ratio, the cost of changing knowledge attitude, knowledge hiding excess utility and the risk coefficient that resists the change of knowledge attitude has a significant impact on the evolutionary strategies of both players. To develop a suitable interactive memory system, we must focus on the above factors.

1. Introduction
Increasingly fierce global competition and ever-changing technological advances have made organizations increasingly rely on teams to cope with challenges from all sides \cite{1}. Knowledge sharing has become an important way and important strategy for teams to gain competitive advantage \cite{2}. However, the high cost of knowledge acquisition, the high profitability of knowledge monopoly, the asymmetry of knowledge-owned information and the high risk of knowledge sharing determine that knowledge sharing behavior within the team does not necessarily occur \cite{2}. Transactive Memory System Theory provides a unique interpretation of the team's knowledge management, which helps to gain insight into the distribution, integration and application of knowledge within the team from a micro-process perspective\cite{3}. Previous studies have studied interactive memory systems from individuals, organizations, etc., but this paper believes that among the many factors affecting the formation of interactive memory systems, the group's resistance to knowledge (coefficient), cost of changing, and the proportion of different groups in the initial state has not been taken into consideration, and the corresponding quantitative research is blank.

2. Literature review
The interactive memory system, as a cooperative division of labor system for acquiring, storing and using information knowledge in different fields \cite{4}, has a positive effect on the organization in many aspects \cite{5}. From an individual perspective, The interactive memory system can not only improve the efficiency of team members \cite{6}, but also help team members to easily acquire knowledge, increase knowledge depth \cite{7}, and reduce the cognitive burden of members \cite{8}; from the organizational level, Zhang Gang and Xiong Li \cite{9} proposed and verified that the age-based team performance of the interactive memory system has a significant positive effect; Chen Wei \cite{10} and other scholars have found through empirical research that the interactive memory system has a positive adjustment effect on team effectiveness. The interactive memory system includes three dimensions, they are expertise (structural elements), credibility and coordination (behavior elements) \cite{11-13}. The three dimensions are both related and independent \cite{14}. Li Hao and others further proposed that the above three dimensions...
are progressive relationships \cite{15}. The basis of the interactive memory system is that each team member has a certain knowledge reserve in different fields \cite{16}, and is willing to share knowledge \cite{17}. However, the high cost of knowledge acquisition, the high profitability of knowledge monopoly, knowledge-owned information. The asymmetry and the high risk of knowledge sharing determine that knowledge sharing behavior within the team does not necessarily occur \cite{2}.

Knowledge hiding refers to the behavior of individuals in an organization who deliberately conceal or deliberately disguise their colleagues’ knowledge requests \cite{18}. Different from knowledge hoarding, knowledge hiding emphasizes intentional knowledge of existing knowledge through stupidity, evasiveness and rationalization. The reservation \cite{19} is different from the lack of knowledge sharing. With regard to the formation mechanism of knowledge hiding behavior, domestic and foreign scholars have carried out preliminary exploration and research using various theories in sociology, psychology and economics. The research and interpretation theory mainly has social exchange theory \cite{20} and territorial behavior theory \cite{21}, psychological ownership theory \cite{22}, adjustment focus theory \cite{20}, resource preservation theory, social learning theory \cite{20}, social dilemma theory \cite{23}, economic exchange theory and cost-benefit theory. Knowledge hiding can hinder the development of the organization. Research has shown that knowledge hiding has a hindrance to employee self-efficacy, the formation of team reciprocal atmosphere, team creativity \cite{24} and the formation of interactive memory systems \cite{15}.

3. Model construction

It is assumed that the group A is mainly based on knowledge hiding, and the group B is mainly based on knowledge sharing. Strategic space for both parties are $S$\{changed, do not change\}, and are all ”limited rationality”; the evolutionary game model is constructed by the strategies and effects of both parties, and the evolutionary behavior is analyzed according to the dynamic process of gene replication.

3.1. Model Hypothesis

(1) If both Groups A and B do not change their attitudes towards existing knowledge, they retain their original knowledge, the basic utility of the two groups is $V_i$ and $V_j$.

(2) If the group A changes its knowledge and attitude, and recognizes the knowledge and attitude of the class B, or we say group A is affected by category B and is willing to share knowledge. Due to the emergence of Class B knowledge attitude, it will cause some promotion or hindrance to the utility of the Class A. The excess utility caused by the change of attitude of group A is recorded as $W_i$, and the cost from knowledge hiding to knowledge sharing change is recorded as $C_i$, and the probability that class A group resists knowledge sharing is recorded as $P'_i$ (0 ≤ $P'_i$ ≤ 1). The utility of the group A became $V_i + W_i - P'_i C_i$, and the group B did not change its attitude, and the utility was still $V_j$.

(3) If the group B changes its cognitive attitude and recognizes the knowledge hiding of category A. The utility caused by the change of body attitude is recorded as $W_j$, and the cost paid by the B group from the knowledge sharing to the knowledge sharing hidden process is recorded as $C_j$. The probability of the knowledge hiding by the B group is recorded as $P'_j$ (0 ≤ $P'_j$ ≤ 1). The utility of the B group becomes $V_j + W_j - P'_j C_j$, and the group A does not change the attitude, and the utility is still $V_i$.

(4) If both groups A and B are willing to absorb the other's attitude towards knowledge. Due to the different incentives for promoting the formation of interactive memory systems, the risk factors of the two groups resisting the change of knowledge attitude will change, which are respectively recorded as $P_i$ and $P_j$, and the group utility, the group utility becomes $V_i + W_i - P_i C_i$ and $V_j + W_j - P_j C_j$, respectively.

(5)$\theta$ and $\gamma$ are the probabilities that the attitudes of group A and group B change (the proportion of individuals who choose to change attitude in the group), and 1-$\theta$ and 1-$\gamma$ are the probability that the attitudes of group A and group B do not change.

According to the variable hypothesis made by the above several cases, the payment matrix of the evolutionary game of the team interaction memory system is obtained, as shown in Table 1.
3.2. Analysis of the utility of two types of cultural groups

The utility of the group A chooses to change attitudes, does not change attitudes, and the average utility are:

\[ U_{11} = \gamma(V_i + W_j - P_j C_j) + (1 - \gamma) (V_i + W_j - P_j C_j) \]  

\[ U_{12} = \gamma V_i + (1 - \gamma) V_i \]  

\[ U_{01} = 0 U_{11} + (1 - \theta) U_{12} \]

In the same way, the effect of the group B on changing attitudes, not changing attitudes, and the average utility are:

\[ U_{21} = \gamma(V_j + W_i - P_i C_i) + (1 - \gamma) (V_j + W_i - P_i C_i) \]  

\[ U_{22} = \gamma V_j + (1 - \gamma) V_j \]  

\[ U_{02} = 0 U_{21} + (1 - \theta) U_{22} \]

The differential equations for the dynamic process of gene replication in the evolutionary game of Groups A and B are:

\[ F(\theta) = \frac{\partial}{\partial \theta} \begin{pmatrix} U_{11} - U_{12} \\ U_{21} - U_{22} \end{pmatrix} = \begin{pmatrix} \gamma(V_i + W_j - P_j C_j) + (1 - \gamma) (V_i + W_j - P_j C_j) \\ \gamma V_i + (1 - \gamma) V_i \end{pmatrix} \]  

\[ F(\gamma) = \frac{\partial}{\partial \gamma} \begin{pmatrix} U_{11} - U_{12} \\ U_{21} - U_{22} \end{pmatrix} = \begin{pmatrix} \gamma(V_j + W_i - P_i C_i) + (1 - \gamma) (V_j + W_i - P_i C_i) \\ \gamma V_j + (1 - \gamma) V_j \end{pmatrix} \]  

For the dynamic replication system composed of (7) and (8), five equalization points are obtained:

\((0,0), (0,1), (1,0), (\theta^*, \gamma^*) = (\frac{P_j C_j - W_j}{(P_j - P_i) C_j}, \frac{P_i C_i - W_i}{(P_i - P_j) C_i})\), (1,1). The corresponding Jacobian matrix is:

\[ J = \begin{pmatrix} \frac{\partial F(\theta)}{\partial \theta} & \frac{\partial F(\gamma)}{\partial \theta} \\ \frac{\partial F(\theta)}{\partial \gamma} & \frac{\partial F(\gamma)}{\partial \gamma} \end{pmatrix} = \begin{pmatrix} (1-\gamma)(\gamma P_i C_i - P_j C_j) & \theta \gamma (P_i C_i - P_j C_j) \\ (1-\gamma)(\gamma P_j C_j - P_i C_i) & \theta \gamma (P_j C_j - P_i C_i) \end{pmatrix} \]

The results of the rows and traces of the Yabik determinant of the five equilibrium points are shown in Table 2. Because \(\theta\) and \(\gamma\) also represent the proportion of individuals in a group of players who choose a strategy, there is a solution to the above formula: \(\theta = \frac{P_j C_j - W_j}{(P_j - P_i) C_j} \leq 1\) and \(0 \leq \gamma = \frac{P_i C_i - W_i}{(P_i - P_j) C_i} \leq 1\), the corresponding constraint are:

\[
\begin{align*}
(P_j - P_i)(P_j C_j - W_j) & \geq 0 \\
(P_i - P_j)(P_i C_i - W_i) & \leq 0 \\
(P_j - P_i)(P_j C_j - W_j) & \geq 0 \\
(P_i - P_j)(P_i C_i - W_i) & \leq 0
\end{align*}
\]
According to the stability analysis method, the relationship between the parameters $P_i$, $P'_i$, $P_j$ and $P'_j$ needs to be discussed to determine the symbols of $\det J$ and $\text{tr} J$ (see Table 3).

### Table 2 System Yabike determinant analysis

| Local equilibrium point | $\det J$ | $\text{tr} J$ |
|-------------------------|----------|---------------|
| A (0, 0)                | $-W_iP'_iC_i+W'_iP'_jC_j$ | $W_iP'_iC_i+W'_iP'_jC_j$ |
| B (0, 1)                | $-W_iP'_iC_i+W'_iP'_jC_j$ | $W_iP'_iC_i+W'_iP'_jC_j$ |
| C (1, 0)                | $-W_iP'_iC_i(W'_i-P'_jC_j)$ | $-W_iP'_iC_i+W'_iP'_jC_j$ |
| D (1, 1)                | $(W'_iP'_iC_i(W'_i-P'_jC_j))$ | $-W_iP'_iC_i+W'_iP'_jC_j$ |
| E ($\theta^*$, $\gamma^*$) | $(P'_iC_j-W'_j(W'_i-P'_jC_j)) \times (P'_iC_j-W'_j(W'_i-P'_jC_j))$ | 0 |

### Table 3 Equilibrium point stability analysis

| condition | I: $P_i \geq P'_i$ , $P_j \geq P'_j$ | II: $P_i \equiv P'_i$ , $P_j \equiv P'_j$ | III: $P_i \geq P'_i$ , $P_j \equiv P'_j$ or $P_i \equiv P'_i$ , $P_j \geq P'_j$ |
|-----------|-----------------|-----------------|-----------------|
| equilibrium point | $\det J$ | $\text{tr} J$ | result | $\det J$ | $\text{tr} J$ | result | $\det J$ | $\text{tr} J$ | result |
| A (0, 0) | + | + | unstable | + | - | ESS | - | / | uncertain |
| B (0, 1) | + | - | ESS | + | + | unstable | - | / | uncertain |
| C (1, 0) | + | - | ESS | + | + | unstable | - | / | uncertain |
| D (1, 1) | + | + | unstable | + | - | ESS | - | / | uncertain |
| E ($\theta^*$, $\gamma^*$) | - | 0 | saddle point | - | 0 | saddle point | Unbalanced point |

### Figure 1 System dynamic evolution process diagram under condition I

### Figure 2 System dynamic evolution process diagram under condition II

### 3.3 Result analysis

When the condition I ($P_i \geq P'_i$ , $P_j \geq P'_j$), two of the five equilibrium points are the evolutionary stability strategy (ESS), indicating that the group can be reset in the process of evolution, ensuring that in the case of individuals with reverse selection (deviating from rational strategy, the lower the better), the proportion of the two ESS is limited as the evolution process becomes more and more intense, the two ESSs are $B(0,1)$ points and $C(1,0)$ satisfying $\text{Det } J > 0$ and $\text{Tr } J < 0$ conditions, the corresponding strategy is {no change, change} and {change, no change}. $A(0,0)$ and $D(1,1)$ are unstable points, and $E(\frac{P'_iC_j-W'_j}{(P'_i-P'_j)C_j}, \frac{P'_iC_j-W'_j}{(P'_i-P'_j)C_j})$ is the saddle point. The polylines of these three points converge to the critical line of different modes. The analysis shows that the dynamic game process will eventually converge to the change of culture in the group A, the choice of the group B does not change the culture, or the group A does not change the culture, and the group B changes the culture. It can also be understood that in condition I, one kind of knowledge attitude will be merged by another attitude.

When Condition II ($P_i \equiv P'_i$ , $P_j \equiv P'_j$), the other 2 points of the 5 equilibrium points are ESS, which
are A(0,0) and D(1,1). They satisfy the condition of Det J > 0 and Tr J < 0, and the corresponding strategies are {no change, no change} and {change, change}. B(0,1) and C(1,0) are unstable points, and E\((P_j^{c}\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\![5] 

4. Conclusion

(1) The level of the internal interactive memory system is related to the initial group strategy. According to the evolutionary game theory, the probability that the group chooses to change the knowledge attitude is equal to the proportion of individuals in the group that choose to change the attitude. Whether the group changes the attitude toward the existing knowledge is influenced by the relevant groups in the organization.

(2) Choosing appropriate incentives and removing barriers of knowledge sharing is the basic guarantee for improving the formation and stability of interactive memory systems. Changes in knowledge and attitude will inevitably encounter contradictions. The organization should assess, understand, adapt, and transform knowledge management activities in response to differences in attitudes, and find a balance point suitable for the two groups. Exploring the feasible ways to narrow down or even eliminate knowledge hiding, and seek the identification effect of maximizing the benefits of knowledge sharing. There is no “general model” for the integration of interactive memory systems. Only by choosing the right integration method can ensure the development of interactive memory systems be stabilized.

(3) How to reduce the formation cost of the interactive memory system and improve the formation level of the interactive memory system are the factors that the organization needs to consider. Every group chooses to make changes and expects to get better benefits. Therefore, the integration of organizational knowledge should adhere to the principle of “mutual benefit, harmonious development” and balance the interests of all parties. Organization leaders should pay attention to knowledge integration, mention it to the height of organizational strategy, and develop a knowledge program to supervise the implementation of integration work.

5. Insufficient research and prospects

In addition to the above aspects, there are still many factors that affect the game process of the interactive memory system. Since some factors are difficult to quantify, this article is not listed in the model. At the same time, the degree of influence of the parameters needs further empirical or simulation test. In addition, multi-party group integration will occur during the formation of organizational interaction memory system. At this time, the evolutionary game model will become more complicated and needs further research.

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