Analysis of Incentive Mechanism of Knowledge Sharing Based on Big Data and Principal Agent Theory

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Abstract — With the rapid application and development of Mobile Internet Technology, knowledge sharing has become a frequent behavior of network users. With the background of big data, it is very practical to analyze the knowledge sharing behavior and the trend of the knowledge sharing group, and to establish an appropriate incentive mechanism. In this paper, based on the traditional principal-agent theory, a model of knowledge sharing incentive mechanism which is acceptable for large data environment is established.

Keywords- Big Data Analysis; Knowledge Sharing; Principal-agent

I. INTRODUCTION

A. The Background of the Research

During the process of knowledge sharing, participants will probably gain fixed share returns, obtain performance incentives according to the sharing results, and get support as well as knowledge innovation benefits from other participants. In the traditional environment, the above-mentioned incomes and costs are estimated through the participants' experience and perception. This means that the decision-making behavior of the participants in knowledge sharing is lack of reasonable scientific basis [1]; meanwhile, managers in the knowledge sharing organization cannot effectively motivate the participants according to the quantitative index [2].

Due to the rapid development and popularity of the Internet, any individual behavior and intention, in a variety of social situations, will leave internet traces to some extent and thus derived from the concept of big data [3]. On one side, big data allows the knowledge share participants to predict the possibility of losing competitive advantage [5], the value of time cost, the performance incentives, the knowledge innovation benefits and the fixed return from their own historical behavior and knowledge sharing data[4]. Moreover, according to the comparison result of costs and benefits, participants are able to make more rational decisions and dramatically reduce risk result from experiences and perception bias. On the other side, knowledge sharing behavior has the characteristic of principal-agent and that allows the organization managers to predict individual behavior, to assess their knowledge level by using the big data analysis technology, as well as to combine with the traditional principal-agent model to take scientific incentive measures.

Based on the above background, this paper establishes a knowledge sharing principal-agent incentive model of single agent and multi-agent, and tries to clarify the impact of different parameters on knowledge sharing process by combining the characteristics of large data environment.

II. MODEL BUILDING

Assume that knowledge sharing within the organization and the organization of individual managers are risk neutral. Individual revenue sharing for the entire organization to bring the subject of pay depends on the degree of knowledge sharing and knowledge he has. Subject have knowledge sharing can be calculated level of knowledge and assessment of the full sample based on its previous share in and outside the organization all the time distribution of data and content data. Calculated on the basis big data technology and . Revenue uses functional form , which is obtained from individual.

factor is a shared pay level of the individual, the individual units of measure to share the amount of income pay the amount of organizations; indicates the individual level of knowledge sharing coefficient, can be used to share the importance of Organization's revenue measure on R; is a shared value fluctuations normal distribution. Organization managers can get knowledge sharing individual knowledge through the large range of data analysis techniques. Probability distribution function is and Probability density function is . From the above that, to some extent, the organization managers can not accurately assess the level of individual shared values shared throughout the organization.
process provided, which may generate trust and moral hazard risks and the problems of adverse selection.

Suppose sharing by individuals to pay costs is sharing individual knowledge sharing behavior in the cost factor. Suppose the manager to return the individual to participate in the organization of the sharing offer is a is a fixed income, is reward coefficient, represents additional performance incentives. Above all, Participation sharing of individual income is. Combined with the opportunity cost theory, the knowledge-sharing participants pay the same level of time and effort can get returns in other work. However, due to time and personal effort to pay it is not reversible, so you need to set a sharing level of minimum income individuals can receive knowledge sharing process is .

With the process of knowledge sharing , sharing individual know their true level of knowledge . According to knowledge sharing environment itself exhibited knowledge levels is . According to the level of knowledge sharing organization managers to develop optimal , Feedback optimal level of pay to knowledge sharing subject . This optimization problem can be expressed like this.

\[
\begin{align*}
\max_{(\varepsilon^*(\theta), \nu^*(\theta), \mu^*(\theta))} & \int E[R - Y] dF(r) \\
\text{s.t.} & \quad \varepsilon^* \in \mathbb{R} \quad \forall \theta \\
& \quad \nu^* \in \mathbb{R} \quad \forall \theta \\
& \quad E\mathbb{W}(\varepsilon, \nu, r)
\end{align*}
\]

Constraints i. is incentive compatibility constraint sharing process, Constraints ii. is incentive compatibility constraint sharing process, Constraints iii. is the cost of individual rationality generating opportunities. The method of using the first-order condition to replace constraints i. Seeking knowledge sharing body pay levels the first derivative.

\[
\frac{dEW(v)}{dv} = \frac{\partial E\mathbb{W}(\varepsilon, \nu, u)}{\partial v}\bigg|_{\varepsilon=\varepsilon^*} + \frac{\partial E\mathbb{W}(\varepsilon, \nu, u)}{\partial \nu}\bigg|_{\nu=\nu^*}
\]

Of formula integration, combined with constraints iii. Can be shared expect net income of the individual:

\[
E\mathbb{W}(v) = W_0 + \int_0^v \beta b'(\bar{v}) d\bar{v}
\]

According to the formula, combined can be drawn under the circumstances, knowledge sharing managers expected utility is:

\[
EU_{\theta} = \int_0^v \left[ (\alpha u + \beta v) - \left( W + \frac{1}{2} \delta u^2 \right) \right] dF(v)
\]

With best pay level and sharing the expected return of individuals, can be obtained this:

\[
EU_{\theta} = \int_0^v \left[ \alpha b'(v) + \beta \right] dF(v) - \left[ W + \frac{1}{2} \delta u^2 \right] dF(v)
\]

The formula for the second part of partial integration, can get this:

\[
\int_0^v \beta b'(v) d\bar{v} = \beta \int_0^v (1 - F(v)) b(v) d\bar{v}
\]

Brought into the equation, seeking for first derivative, Knowledge sharing is the level of knowledge of the distribution function of individual risk rate . Then, further to seek the second derivative of b. Can be obtained, obviously, is optimal incentives.

Simultaneously, So far, the best mechanisms and organizational managers give optimal share individual reference pay levels are:

\[
a'(v) = W_0 + \int_0^v \beta b'(v) d\bar{v} + \frac{1}{2} \delta a^2(v) + b'(v)(au'(v) + \beta v)
\]

A. Model Analysis

According to the analysis of the previous subsection can be learned, When body tissue under certain extent shared by managers of large data analysis techniques have obtained the level of knowledge, which is, Organization managers will have no incentive to provide additional incentives to share body, Sharer will only give a fixed return. In this case, the degree of knowledge sharing body to pay for 0, That is the negative face knowledge sharing process. When the level of knowledge sharing body reaches a certain level, which is, Knowledge sharing organization managers will have an incentive to take additional performance incentive mechanism to encourage the sharing of individuals to pay more time and effort to share knowledge. The analysis can be learned through 4.3.2: Incentive coefficient relationship with the parameters as follows:

\[
\begin{align*}
\frac{\partial b''(v)}{\partial v} &= -\delta < 0, \\
\frac{\partial b''(v)}{\partial \beta} &= -\frac{\alpha^2 I(v)}{\alpha^2 I(v)} < 0, \\
\frac{\partial b''(v)}{\partial \delta} &= \frac{\alpha^2 I(v)}{\alpha^2 I(v)} > 0, \\
\frac{\partial b''(v)}{\partial \alpha} &= \frac{\alpha^2 I(v)}{\alpha^2 I(v)} > 0, \\
\frac{\partial b''(v)}{\partial \beta} &= \frac{\alpha^2 I(v)}{\alpha^2 I(v)} > 0
\end{align*}
\]

It can be learned from the above analysis, optimal knowledge sharing coefficient and shared body of...
knowledge and knowledge level of the coefficient. Cost factor inversely. Shared body of knowledge and pay levels coefficient. The level of knowledge of the risk rate is proportional to the level of knowledge and knowledge-sharing body. This also shows that managers found to be involved in the organization of knowledge sharing individual's level of knowledge after reaching a certain threshold, the organization managers need to give their respective performance incentives, and performance incentives should level with the body of knowledge sharing of knowledge supply level increase and a corresponding increase, otherwise an incentive is insufficient, leading to lack of power sharing body, eventually leading to reduced efficiency of knowledge sharing organization, sharing occurs not high heat conditions.

III. MULTI-AGENCY BODY OF KNOWLEDGE SHARING INCENTIVE MODEL

A. The basic model Selecting a Template (Heading 2)

Suppose a knowledge-sharing organization headed by a manager and two organizations share player 1 and 2 constitute. These three members are risk neutral. From the perspective of managers view, the aim is to increase revenue for the organization of knowledge sharers brings, Wherein is triggered by proactive sharers of, And to promote the sharing of benefits by paying their own time and effort and for the organization to bring. is the exchange and sharing of knowledge by triggering sharers, promote and enhance their ability to post gains knowledge of organizations. Return set up the organization's managers shared by participants may be expressed in the form of linear equations. Where is the manager of the organization to participate in a fixed return Party i share offer, Organization managers use big data analysis techniques derived performance incentives participants shared knowledge sharing i previous level of value and contribute value in the organization taken, referred to as i incentive factor. In addition, in order to build a knowledge-sharing environment, investment managers will organize funds, resources, hardware, facilities and other aspects, to facilitate the analysis, these inputs will be recorded as a unified Iq.

Sharing process, assuming 1 sharers tend to learn, sharers 2 tend to impart knowledge, and in the sharing and exchange process and pay the cost of each output is independently separable. Based on the above assumptions, it can be shared by paying process referred to as , Each share were paid in the process of knowledge sharing costs , Where is the knowledge-sharing participants in the communication process effort cost coefficient. Participants in i net income of model

\[ R = \sum_{i=1}^{2} \left[ R_{ip} (u_{ip}) + R_{iq} (u_{iq}) + e_i \right] \]

In the above formula, it represents the knowledge sharing process in a single shared body by itself worth the time and effort to pay arising. It represents a single new value share within the body of others through sharing of knowledge and outputs. Represented by a single individual knowledge sharing random variable output, assuming its normal distribution.

1) Individual organizations share gains achieved through effort

Based on the above assumptions, knowledge sharing can be established in the case of an individual optimization of the effort:

\[ \max_{a_{ip}, b_{ip}} \sum_{i=1,2} (1 - b_{ip}) [R_{ip} (u_{ip}) - \alpha_{ip}] \]

s.t.

\[ \max \alpha_{ip} + b_{ip} [R_{ip} (u_{ip}) - \alpha_{ip}] - C_{ip} (u_{ip}) \geq W_i \]

By (Equation 10) can be obtained at individual knowledge sharing efforts to pay when the revenue function of the first order conditions lead:

\[ b_{ip} = \frac{C_{ip} (u_{ip})}{R'_{ip} (u_{ip})} \]

By (Equation 11), based on the derivative can be obtained:

\[ \frac{\partial b_{ip}}{\partial u_{ip}} = \frac{C''_{ip} (u_{ip}) - C'_{ip} (u_{ip}) R''_{ip} (u_{ip})}{R'_{ip} (u_{ip})^2} \]

Then by (Equation 9) derivative, and make it equal to zero, combined with the relationship (Equation 12) shows that:

\[ (1 - b_{ip}) \beta'_{ip} (u_{ip}) \beta''_{ip} (u_{ip}) - a_{ip} \left[ \frac{C'_{ip} (u_{ip}) R''_{ip} (u_{ip})}{R'_{ip} (u_{ip})^2} \right] = 0 \]

Simplify available:

\[ b_{ip} = 1 - \]

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The results bring to the formula (Equation 10), you can get every knowledge sharing participants pay the best efforts of u*ip degree. Best of Creative Commons and then the manager can get the best of pay level knowledge sharing participants expect output u*ip. Finally, the optimum output value into (Equation 9) and (Equation 10) can be drawn R*P total revenue effort throughout the organization under the circumstances in all participants.

2) The share of individual income absorbed by tissue and knowledge innovation achieved

Suppose knowledge sharing process, the organization due to the expected return of knowledge sharing and exchange of knowledge obtained is Rq, And Rq major study by the knowledge-sharing participants knowledge and level of effort to impart knowledge of the extent of the efforts jointly decided.Suppose herein such as Douglas utility function form:

\[ R_q = (u_{1q})^x (u_{2q})^{1-x} \]

Wherein \( x \) is to learn the extent of the efforts in knowledge sharing and knowledge exchange in the proportion, \( 1-x \) is to impart knowledge sharing and exchange of knowledge in proportion. Large data from the background, although the main body of knowledge sharing and transfer of knowledge involved in learning process with a certain amount of randomness, but here still assume big data analysis techniques can be shared by all of the body of knowledge generated in the whole network behavior recording and analysis of data. Get more precise \( x \). Thus, this article will continue to analyze the organization of the total revenue generated due to knowledge sharing based on this assumption. Suppose silver knowledge sharing and the total revenue generated by the three organizations to teach party managers, knowledge, learning and knowledge side to share, and assume shared knowledge and learning coefficient for the side, Sharing knowledge transfer coefficient side is level of effort to learn the knowledge of its request by the formula (Formula 16) and (Equation 17) guide, and transfer knowledge expected revenue side, relative to its efforts to impart knowledge of the extent of derivation, and so both are zero, you can get:

\[ b_{1q} x (u_{1q})^x (u_{2q})^{1-x} - \delta u_{1q} = 0 \]

\[ b_{2q} (1-x) (u_{1q})^x (u_{2q})^{1-x} - \delta u_{2q} = 0 \]

Joint above two formulas can be obtained:

\[ \frac{(u_{1q})^x}{u_{2q}} = \left( \frac{b_{1q}}{b_{2q} x} \right) \]

Through further analysis can be obtained:

\[ u_{1q} = \frac{1}{x} (\chi b_{1q})^\frac{x}{2} ((1-\chi) b_{1q})^{\frac{1-x}{2}} \]

\[ u_{2q} = \frac{1}{x} (\chi b_{2q})^\frac{x}{2} ((1-\chi) b_{2q})^{\frac{1-x}{2}} \]

Then the formula (Formula 22) and (Equation 23) (Equation 15), the optimization problem into equation expressed as:

\[ \max \frac{b_{1q}}{b_{2q}} \frac{1}{x} (1 - b_{1q}) \]

\[ b_{2q} (\chi b_{2q})^\frac{x}{2} ((1-\chi) b_{2q})^{\frac{1-x}{2}} \]

And the derivation of the formula, and to make it zero, we obtain the following two equations are:

\[ (1 + x) b_{1q} = \chi (1 - b_{2q}) \]

\[ (1 - \chi) (1 - b_{2q}) = (2 - \chi) b_{2q} \]

Unified Vertical (Equation 24) and (Equation 25) can be obtained:

\[ b_{1q} = \frac{X}{2} \]

\[ b_{2q} = \frac{1 - X}{2} \]

Then formula (Equation 26) and (Equation 27) into Equation (Equation 22) and (Equation 23) can be obtained:

\[ u_{1q} = \frac{1}{25} X b_{1q} \]

\[ u_{2q} = \frac{1}{25} X^2 (1 - X) b_{2q} \]

Then formula (Equation 26) and (Equation 27) and (Equation 28) (Equation 29) into Equation (Equation 15) and
(Equation 16) can be obtained knowledge sharing within the organization managers, knowledge transfer side the maximum expected revenue side of knowledge and learning, as follows:

\[
R^*_k = \frac{1}{2} \left( \frac{1}{2^6} X^q(1 - \chi)^{1-x} \right)^2 - l_p
\]

\[
U^*_k = \frac{X}{2} [1 - \delta(1 - \chi)] \left( \frac{1}{2^6} X^q(1 - \chi)^{1-x} \right)^2 - l_p
\]

\[
U^*_k = \frac{1 - X}{2} \left[ 1 - \delta(1 - \chi) \right] \left( \frac{1}{2^6} X^q(1 - \chi)^{1-x} \right)^2
\]

B. Model analysis

Through the analysis of the results of the previous section, you can get the main organizations involved in knowledge sharing knowledge sharing during the sharing process may reach the optimum level pay ,Optimal sharing coefficient is ,relationships and participants expected return value between the respective coefficients.Analysis of the significance of knowledge sharing organization managers comprising: combining various types of behavior of large data analysis and prediction of the result data full knowledge of participants, can be extracted from the precise parameters associated with this model, and by taking this model participants shared incentive measures for different types of knowledge.

(1)Optimal pay Level:

By (Equation 22) and (Equation 23) shows that knowledge sharing in the organization knowledge transfer best pay level and with proportional share coefficient and side and Knowledge Learning parties.That is, when knowledge sharing participants and increases when the body will participate in knowledge sharing to increase its share of enthusiasm, when knowledge-sharing effort cost coefficient increases, participate in knowledge sharing individual's enthusiasm will hit.

(2)optimal sharing coefficient:

By (Equation 26) and (Equation 27) can be learned, knowledge transfer and best way to share knowledge and learning side of the coefficients and are half of them in the process of knowledge sharing effort coefficient and .If a higher degree of knowledge and learning efforts parties, that is ,This sharing knowledge and learning coefficient party will be larger.If the party's role in imparting knowledge to impart greater, that is ,This sharing of knowledge transfer coefficient party will be larger.It can draw a small conclusion: When Knowledge Sharing organizers want to analyze the degree of participation in knowledge sharing participants can share frequency data sharing knowledge sharing participants in the process of leaving based on the knowledge, data and other content length , obtained through the large data analysis system knowledge-sharing effort coefficient participants, combined with the analysis of the parties involved come to share coefficient (ie, the degree of willingness to share).

(3) Creative Commons expected utility:

The organizers were willing to invest in knowledge-sharing terms are organizational management side can get a positive expected return from the knowledge sharing behavior and the process, that is, to meet the following conditions:

\[
\left[ \frac{1}{2^6} X^q(1 - \chi)^{1-x} \right]^2 > l_p
\]

From the above analysis can be learned, knowledge sharing organization managers more investment in knowledge sharing, knowledge sharing environment better, learning party and the organization's management knowledge sharing knowledge sharing and exchange of wishes will be more intense, also it will make it easier knowledge sharing occurs.

IV. Conclusion

Based on the individual's knowledge sharing individuals were studied and analyzed, and found that when knowledge-sharing participants to some extent the level of knowledge , knowledge sharing organization's management has no incentive to motivate the participant; Throughout the process of knowledge sharing, such participants can only get in return a fixed amount. Not because of the extra effort to contribute their knowledge and obtain the appropriate performance incentives. Meanwhile, participants in this state because of lack of additional performance incentives will choose 0 degree of effort. Only when knowledge sharing knowledge participants reach a certain level , managers have motivation Creative Commons shared values generated by performance incentives for their knowledge, promote the sharing of knowledge sharers. When a high level of knowledge of participants, when sharing knowledge, organization managers who will share with the higher incentives in return coefficient. Due to the large data technologies available to predict the characteristics and full data analysis features, knowledge sharing organizers can participate in all kinds of parties based on knowledge sharing knowledge sharing platform retained behavioral data, to analyze the dynamic level of knowledge of participants, combined with their respect positioning knowledge sharing organization, take appropriate incentives and disincentives, has reached the best shared utility status. In the case of multiple share participation, this chapter is mainly knowledge-sharing participants will be divided into three categories: organizational managers, in favor of knowledge and learning of participants and tend to impart knowledge of participants. First, the combination of big data background, knowledge sharing when the organizers want to analyze the degree of participation in knowledge sharing participants can share frequency data sharing knowledge sharing participants in the process of leaving based on the knowledge, content length data etc., obtained knowledge-sharing effort coefficient participants, combined analysis of this chapter share coefficients obtained by the parties involved in big data analysis system.Under this assumption, shared by analysis that factor in the increase of time, willingness participants will increase knowledge sharing,When the exchange and
communication costs when knowledge sharing coefficient increases occurred during the fight against the wishes of knowledge sharing participants. At the same time, through the study found that knowledge of this chapter learning and knowledge transfer side square optimal sharing coefficient and are one of their share in the process of knowledge sharing and exchange coefficients and the two share points. The larger the individual knowledge sharing in knowledge sharing in the role, his share will be higher coefficient. In the best case, all the participants and organizations managers share gains stations half of total revenue. In addition, the organization of knowledge sharing process managers greater the amount of investment, knowledge sharing environment better, to share knowledge and willingness to share knowledge will be stronger exchange between participants and managers.

With the advent of the era of big data, whether individual or organizational behavior from the predictable to the direction of the progressive development of the original unpredictable. In this context, factors of knowledge sharing process had not controlled or unquantifiable because of wide application of large data technology becomes quantifiable and predictable. It also makes the process of knowledge sharing incentives have focused more and operability; In this paper, knowledge sharing incentives are briefly discussed and research, and draw knowledge sharing incentives in major factor. If your organization's managers to front the organization's own members present in the process of excitation shared problems, combined with the means big data analysis techniques to accurately locate the demand characteristics and personality traits of participants, the adoption of incentives encourage innovative all-round knowledge participants shared knowledge sharing, and will certainly make more robust development organizations.

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