Agent Based Simulation for Knowledge Management

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Abstract

Knowledge Management is the collection of processes that govern the creation, dissemination, sharing, and utilization of knowledge. The voluntary sharing of knowledge by individuals is a key element in the implementation and success of any knowledge management endeavor. Having gradually recognized this, the knowledge management community has theorized, examined, and implemented various incentive structure to promote knowledge sharing and systems use in organizations..

The central question in the theory and practice of knowledge management in order to voluntary sharing of knowledge is *why should a knowledge worker contribute to the shared knowledge of the organization if the cost of so doing for the individual is higher than its benefits?*.

This paper discuss about process of knowledge sharing which use agent based simulation to analyze factors that influenced those process. The advantage and the usefulness of this simulation model are to look a dynamical interaction process between agents and to trace the behavior of agents in the given condition.

Keywords: knowledge management, knowledge sharing, agent based modeling, learning organization.

I. Introduction

Knowledge Management is the collection of processes that govern the creation, dissemination, sharing, and utilization of knowledge. It is important to acknowledge that processes are not static, but change over time and evolve out of human interaction and organizational culture. To date, the goal of knowledge management has been to capture, codify, and distribute organizational knowledge (usually in centrally managed computer systems) so that an organization's knowledge workers in the field can share it [4]. By contrast, the educate and innovate strategy, while placing no less importance on sharing and informed decision making, grants a higher value to learning and knowledge creation. The voluntary sharing of knowledge by individuals is a key element in the implementation and success of any knowledge management endeavor. Having gradually recognized this, the knowledge management community has theorized, examined, and implemented various incentive structure to promote knowledge sharing and systems use in organizations. Organization and management scientists have long studied the role of incentives in organizational behavior. The dominant scientific management view, which held sway in the incentive systems of the time, was base on an economic model of rational human beings who seek to maximize their individual material gains. The next model is a *socioeconomic model* that studies human reaction to incentives in the context of their relationships with other human beings. The situation in knowledge management is obviously different from the factory floor situation. Not only are we dealing with a different work environment in terms of organization, management, culture, technology, and so on, we are facing a new type of economic agent, usually referred to as a "knowledge worker" in the literature. Although this term implies a different type of economic activity from earlier ones (e.g., factory work), it does not necessarily mean that knowledge workers have a totally novel psychology in their reaction to incentives. The central question in the theory and practice of knowledge management in order to voluntary sharing of knowledge is *why should a knowledge worker contribute to the shared knowledge of the organization if the cost of so doing for the individual is higher than its benefits?*. But, in dimensions of knowledge management, voluntary sharing of knowledge do not only causes by role of incentives. Governance or leadership and culture of organization have a role to increased efficiency and effectiveness process of knowledge sharing. Regression technique in statistic approach from previous research [3] can only found foundations that required for learning organization to work well. However, why should a knowledge worker contribute to the shared knowledge of the organization not yet be explained. Agent based modeling approach, want to trace an emerge questions to manage a knowledge especially related with the successful key of sharing knowledge, which is:

1. Why do people share, or not share information with co-workers?

2. What are the main barriers that an organization may face when trying to foster knowledge sharing among its employees?
3. What can an organization do to overcome those barriers?

The advantage and the usefulness of this simulation model are to look a dynamical interaction process between agents and to trace the behavior of agents in the given condition. The main goal of this simulation is to answer the third questions above and this result which could be use for determining success factors in knowledge management of organization and learning process of organization.

2. Dimensions of Knowledge Management

In this paper has five parts that explore various dimensions of knowledge management and opportunities for the field:

1. Knowledge Creation
2. Knowledge Capture
3. Knowledge Sharing and Exchange
4. Success Factors in Knowledge Management
5. Technology to Enable Knowledge Management

Knowledge Creation: Information, data, and knowledge can be found in a number of places in the organization. There is internal knowledge that resides in various places within an organization.

Knowledge Capture: As noted above, knowledge exists in various dimensions. Codified knowledge had been documented and captured in either writing or other formats. Tacit knowledge, however, is generally captured in the minds or heads of people. Knowledge is also either internal or external.

Knowledge Sharing and Exchange: The community of organization generally relies on the exchange and sharing of knowledge through interpersonal interaction. The ultimate goal of knowledge sharing and exchange is to distribute the right content to the right people at the right time. The system, therefore, must enable users to find relevant information quickly and efficiently and expertise that can aid in decision-making and problem solving.

Success Factors in Knowledge Management: There are two success factors involved in knowledge management efforts. These factors, briefly discussed below:

1. Governance: Defining the leadership roles is critical to success. This factor has a role to increase the process of knowledge sharing.
2. Culture: Understanding the culture and the dynamics of human behavior are essential to success. This factor comprise two element of study infrastructure that is, organization structure and reward system.

Organization structure has a function as connecting between units of organization and to flows the information. We define reward system as formal acknowledgment for achievement individual working. The challenge in knowledge management probably not in the creation of knowledge, but is how to capture and share the relevant and important knowledge that can advance practice, policy and thought. In this paper, the process of knowledge sharing will involve five parts dimensions of knowledge management as mentioned above.

3. Process of Knowledge Sharing

The process of knowledge sharing in this paper is base on previous experiment in [1]. The experiment set up as follow: For a given time, each participant works in a six-person team on the task of calculating salaries of salespeople. Each salary is composed of two values: a base salary which is calculated in the first phase of a trial, and the provision, which is calculated in the second phase. In the *first phase* a subject earns $ X1 for each base salary s/he calculated. After each calculation a person has to decide whether s/he wants to contribute this result to the shared database. The transfer to the database costs time (TC sec.). Because the two phases are time-limited (T1 and T2 minutes), the more one contributes, the less base salaries one can calculate, and - consequently - the less one earns.

In the *second phase*, each group member has to calculate the *total salary* of as many salespeople as possible. In this phase a participant gets $ X2 for every total salary s/he calculated. But for the calculation of a salesman's total salary the base salary is needed. If a participant did not calculate it in the first phase, and if at least one of the other group members did not contribute this value to the database, s/he has to calculate it in the second phase.

By doing this s/he will lose time. Thus, being collaborative and contributing base salaries to the database in the first phase may facilitate the performance of the other group members in the second phase. But according to his/her own payoff, a person has no benefit from contributing a base salary to the database. (In the second phase a person has the base salaries s/he calculated in the first phase anyway). Concerning the benefit of the others, it is not sure if others really need a specific base salary because a person doesn't know which total salaries others will calculate in the second phase. Moreover, persons can't be sure that the information they contribute is unique because other group members could have calculated the base salaries of the same salesperson, too. So it is possible that the database contribution of a base salary has no use for others. Therefore, the experiment

reproduces a typical feature of knowledge exchange where the information a person has might be redundant or even unnecessary for others.

In the previous research participant of this experiment are university students and the research attempt to study public dilemma in knowledge sharing in the real world situations.

Based on description of the above experiment, we will generate a model of knowledge sharing which involve the five parts dimensions of knowledge management.

4. Agent Based Simulation of Knowledge Sharing Process

First, we assume that knowledge is the value of salary that had been calculating for each member from group. We define the calculation process of salary in both phases as knowledge creation, because the results of this calculation provide the information that can be use by the other people. We assume that information or knowledge that had been created as codified knowledge (people had contribute to database) or tacit knowledge (people did not contribute to database). In this model, the organizations consist of groups and each group consists of agent.

An agent has three attributes that is intellectual, emotion, and social. Intellectual attribute related with ability of agent for calculating salary of salesperson (speed of calculation). Emotion and social attribute related with willingness to share with the other. Range value of the intellectual attribute is 0 up to 100, whereas the range value of emotion and social is 0 up to 3 (4-array). At the beginning of simulation, these attribute is generate randomly. We call the first phase of the experiment above as knowledge creation and knowledge capture. We define period as a time in which every group must accomplish the first and second phase (three times in our simulation) and iteration as a time in which one period has finish (40 iterations in our simulation). At each iteration and for a given period, each agent in their group works in five-person team on the task of calculating salaries of salesperson (200 salesperson in our simulation). In the first phase, the task for calculating base salary is limited by 9 minute (540 second). The transfer to database cost is 15 second, and the information that agent transfer will exist at group database and organization database. An agent earns $. 0.25 for each base salary s/he calculated. In the second phase, the task for calculating total salary is limited by 12 minute (720 second), and an agent earns $. 0.3 for each total salary s/he calculated. Speed of an agent to calculate both kind of salary depends on intellectual s/he has. Rule of an agent will spent their time to calculate both kind of salary is following:

```
If (Agent Intellectual) < 20
        Spent of time ← 54 second
Else if  20 <= (Agent Intellectual) < 40
        Spent of time ← 42 second
Else if  40 <= (Agent Intellectual) < 60
        Spent of time ← 30 second
Else if  60 <= (Agent Intellectual) < 80
        Spent of time ← 18 second
Else
        Spent of time ← 6 second
```

To determine the agent effective choice on a move whether to contribute s/he information depends on emotion and social that s/he has. If emotion and social of an agent high (=3), then s/he choice is contribute and if emotion and social of an agent low (=0), then s/he choice is not contribute. When the emotion and social states are dissimilar than the agent choice depends on probability to contribute that determine as follow:

1- (C/NC) where C is amount of salesperson salary that s/he can calculating if s/he contribute s/he information (540/agent spent of time+15) and NC amount of salesperson salary that s/he can calculating if s/he not contribute s/he information (540/agent spent of time).

Rule of decision agent for contributing the result of calculation (information) is following:

```
If (Emotion High & Social High)
        Agent Action ← Contribute
If (Emotion Low & Social Low)
    Agent Action ← Not Contribute
Else
        If chance > probability to contribute
                Agent Action ← Contribute
        Else
                Agent Action ← Not Contribute
```

Where chance is random number between 0 and 1.

The group database and organization database is a technology to enable knowledge management and to help facilitate the sharing and exchange of knowledge.

We define three parameter to overcome success factor in knowledge management that is,

1. The threshold of organization structure (TOS) which related with the power of interaction to the other group. The value of this is the number between 0 and 1. The higher value of this threshold, the harder interaction between groups.
2. The threshold of gathering information from database (GI) which related with the power of accessing information from database. The value of this threshold is the number between 0 and 1.

The higher value of this threshold, the harder an agent to access the information from database.

3. The threshold of reward system (RS) which related with the power of organization to give a reward. The value of this threshold is the number between 0 and 1. The higher value of this threshold, the harder organization to give a reward.

In the second phase, each group member has to calculate the *total salary* of as many salespeople as possible. But for the calculation of a salesman's total salary the base salary is needed. However, in this simulation model, the agent can interact to other agent in their group or to other agent in another group to found information about base salary that s/he need. The interaction rule as following:

Let agent-j and agent-k in group-i (same group) will interact, than the rule is

If (Number of Contribution Agent-j) > (Average of Contribution Group-i) & (Number of Contribution Agent-k) > (Average of Contribution Group-i)
    Interact
Else
    Not Interact

This means that, interaction will happens if both agent have a number of contribution that greater than average number of contribution in their group, each agent perceive that s/he want to share s/he information.

If agent-j still not found the information of base salary that s/he need, s/he can made interaction with another agent in another group, depends on following rule:

If chance > TOS
    Chose one group for interaction (randomly and not same with s/he group)
    Chose one agent in that group
If (Number of Contribution Agent-j) > (Average of Contribution Group-i) & (Number of Contribution Agent-chosen) > (Average of Contribution chosen Group)
    Interact
Else
    Not Interact
Else
    Not Interact

Where chance is random number between 0 and 1.

In this rule, we include the threshold of organization structure because the interaction between another groups will happen depends on organization structure.

Finally, if agent-j still had not found the information of base salary that s/he need, s/he can search this information from group database and organization database, depends on following rule:

If chance > GI
    Search
Else
    Not Search

Where chance is random number between 0 and 1.

In this rule, we include the threshold of gathering information because the access to database will happen depends on facilitate of organization. We assume that process to found information or interact with another agent does not have cost time.

If all group have all ready accomplish the first and second phase, each agent will made evaluation for s/he earns during the two phase. All agent can increase their intellectual to improve the earns depends on following rule:

If (Earns Agent-j) <= (Average Earns Group-i)
    If (Earns Agent-j/Average Earns Group-i) > TRS
        Intellectual ← Intellectual + Intellectual*0.1
    Else
        Not Increase
Else
    Not Increase

Each agent can increase s/he emotion and social depends on following rule:

If (Number of Contribution Agent-j) > (Average of Contribution Group-i)
    emotion ← emotion+1
    social ← social+1
Else
    Not Increase

This means that, agent that make contribution greater than average contribution in their group filling happy.

In each group in organization has a leader, and the leader has a level of care (LC). The value of this level is the number between 0 and 1. This level related with existence of the leader in groups to shelter their members. The higher value of this level, the higher desire the leader shelter their members. So, the leader can shelter their member depends on following rule:

If (Number of Contribution Agent-j) > (Average of Contribution Group-i)
    If chance < LC
        If (Number of Contribution Agent-j)/(Average of Contribution Group-i) > TRS
            Attribute Increase
        Else
            Attribute not Increase

Where chance is random number between 0 and 1.

Observe that, an agent want to increase s/he attribute depends to TRS organization.

5. Simulations Result

We conducted three sets of simulation in the varying of three parameter (TOS, GI, and TRS). The organization consists of five groups, and each group consist five agents. All agents attribute and level of carelessness for each leader initialized randomly. The simulation had been running in 40 iterations and each iteration we set 3 periods. In the first simulation we set TOS=1, GI=1, and TRS=1, thus the organization has not to facilitate process of knowledge sharing. Figure 1 to 3 showed the result of this simulation.

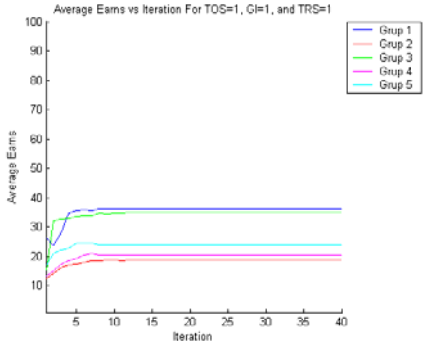

Figure.1 Average Earns of Group (First simulation)

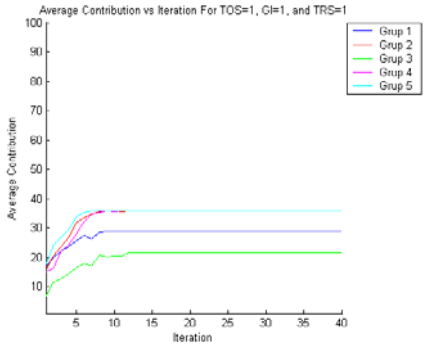

Figure.2 Average Contribution of Group (First Simulation)

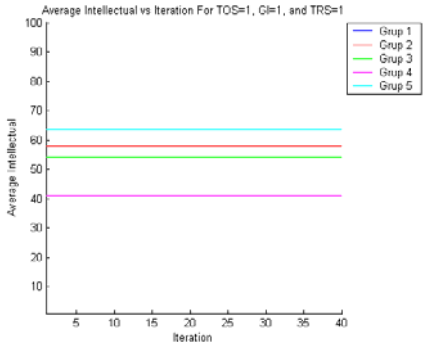

Figure.3 Average Intellectual of Group (First Simulation)

As seen from the above figure, all groups have their own average value that reflects all group is not share their information (no interaction to another agent and group and no access to database) to the other group so that, each group try to increase their own earns. And the average of contribution showed that not all information is share, the average intellectual remain constant all the time was caused by no reward from organization and leader factor not influence too.

In the second simulation we set TOS=0, GI=0, and TRS=0, thus the organization has facilitate process of knowledge sharing completely. Figure 4 to 6 showed the result of this simulation.

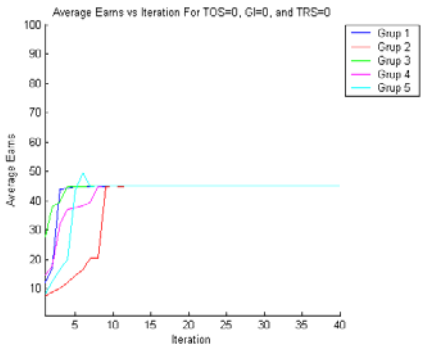

Figure.4 Average Earns of Group (Second Simulation)

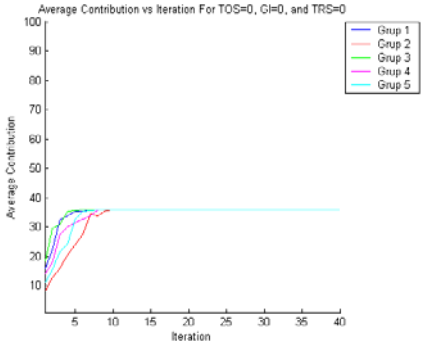

Figure.5 Average Contribution of Group (Second Simulation)

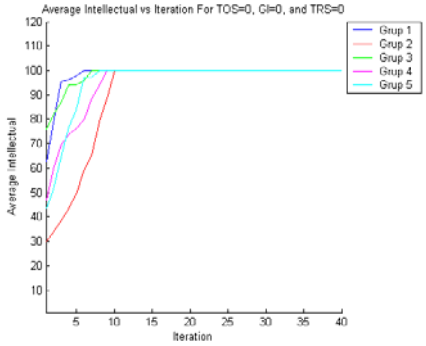

Figure.6 Average Intellectual of Group (Second Simulation)

As seen from the above figure, all groups have a same average value that reflects all group is share their information to the other group so that, each group can get the information from the other group (knowledge sharing). And the average of contribution showed that all information is share, the average intellectual increase all the time was caused by there is reward from organization and the leader factor is influence to increase intellectual members of group in organization. The level of care from each leader is 0.6848, 0.0851, 0.3213, 0.8486, and 0.0998. The level of care from the fourth leader (0.8486) is higher but average intellectual from his/her member is lower so that the process of knowledge sharing slowly than another group with the lower level of care.

In the third simulation we set TOS=0.5, GI=0.5, and TRS=0.5, thus the organization has facilitate process of knowledge sharing moderately. Figure 7 to 9 showed the result of this simulation.

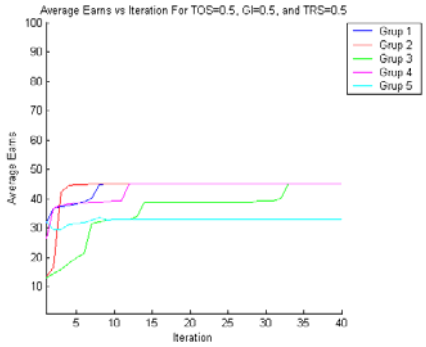

Figure.7 Average Earns of Group (Third Simulation)

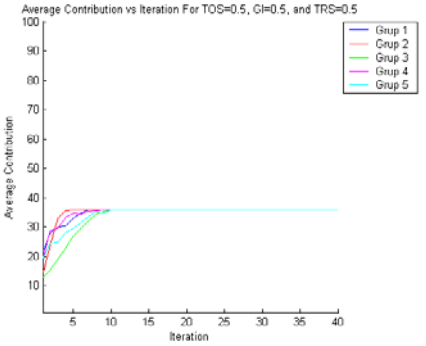

Figure.8 Average Contribution of Group (Third Simulation)

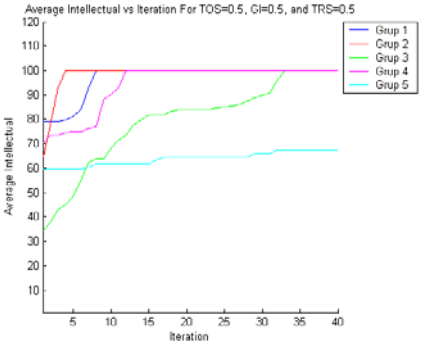

Figure.9 Average Intellectual of Group (Third Simulation)

As seen from the above figure, there is one group (group 5) which have not same average value and the average of contribution showed that all information is share. The average of intellectual is increase all the time except for group 5. The level of care from each leader is 0.8405, 0.4895, 0.2303, 0.6190, and 0.0119. As can be seen the level of care from the fifth group is lower (0.0119) than the other group, so the average value of earns and intellectual not increase all the time. The leader has a little of care to the member of group.

6. Conclusion

Based on an experiment which has been done, the process of knowledge sharing is influenced by three factors that is organizational structure, access to get the information, and reward system of organization. People willing to share information to the other if the organization implement the above of three factors. The existence of leader is important to increase competency (intellectual, emotion and social)of members in their group.

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