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Modeling of Knowledge Transfer in logistics Supply Chain Based on System Dynamics

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Abstract

This paper builds the concept model of knowledge transfer based on analysis of characteristics and influencing factors in supply chain, and the system dynamics model of knowledge transfer based on system dynamics, testing the effectiveness of the supply chain knowledge transfer model on the Vensim software platform. Besides, further empirically analyzing the influencing factors of the supply chain by the evolution of the simulation and presenting the corresponding management.

Keywords*: component; Supply chain; Knowledge transfer; System dynamics; Evolution of Simulation*

1. Introduction

Nowadays the knowledge economy and information is becoming more and more developed, traditional supply chain management based on logistics and capital already can't adapt to the wave of globalization, knowledge management has become the important content and link of supply chain management. Only through knowledge transfer and absorption can supply chain enterprises improve supply chain knowledge innovation and application ability continuously and enterprise core competitive ability finally. Under the open innovation environment the symbiotic relationship of supply chain become an effective way that enterprises absorb external knowledge and do knowledge transfer and innovation. However the knowledge transfer between enterprises of supply chain is more complex than inter-enterprise and among general enterprises as the special business relationship and cooperation model between enterprises of supply chain. As a result, knowledge transfer between enterprises of supply chain becomes the important and difficult research of knowledge management of supply chain. Many researchers study knowledge transfer of supply chain from different perspectives and methods. Fu-jinlong (2010) analyzes the characteristics of supply chain knowledge transfer which contain complexity, dynamic, collaborative and interests correlation. Wu-bin（2008）analyzes the effecting factors of supply chain knowledge transfer which contain trust between supply chain members, the shared knowledge base of supply chain, knowledge gap, members' experience in knowledge transfer and incentive policy. Jiang-jihai (2011) empirically analyzes the effectiveness of knowledge transfer of enterprises using the structural equation model and the impact of the breadth, speed, density and degree of interaction on knowledge transfer. Zhang-huitao (2008) analyzes the main reasons supply chain knowledge loss, which contain knowledge itself, the agent of knowledge transfer and knowledge transfer context. Through the relevant literatures we can find the research on effecting factors of knowledge transfer of supply chain mainly focus on the qualitative description and concept model building of knowledge transfer process, model and effecting factors between supply chain empties. In a word, the traditional method is static. However, knowledge transfer between enterprises of supply chain is a dynamic process

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running on the complex network and that research is much less. This paper analyzes the process of knowledge transfer between enterprises and the effect that knowledge transfer on the knowledge stock of supply chain enterprises. Then, using system dynamics method to causal relationship and behavior dynamic evolution characteristics of knowledge transfer between supply chain enterprises. Finally, building evolutionary system dynamics model of knowledge transfer between supply chain enterprises and analyzing the simulation results which provide theory basis for the strategy of knowledge transfer between supply chain enterprises.

2. Supply Chain Knowledge Transfer Analysis

A. The Characteristics of Supply Chain Knowledge Transfer

Knowledge transfer of supply chain is a process that knowledge is send from sending enterprises of supply chain to receiving enterprises. In this process, enterprises absorb transferring knowledge and then remake and innovate it. Finally change transferring knowledge into useful knowledge that can create value to themselves. (Zhang-huitao, 2008) Knowledge transfer of supply chain has following features:

Supply chain management is overlapping knowledge transfer of supply chain. Supply chain management contains the management of the logistics, cash flow and information flow. If supply chain enterprises promote their technical level and production capacity, they must depend on knowledge transfer, knowledge share and knowledge innovation. So knowledge transfer is one of the basic requirements of supply chain management.

Supply chain knowledge transfer is difficult. The knowledge transfer of supply chain is different from general enterprises alliance. Supply chain is an organization form of relationship between enterprises, but alliance is an organization form that enterprises regulate their behavior. Before supply chain turn into supply chain alliance, the stability of the relationship between enterprises is weak and the organization of knowledge is poor. Besides, the structure of supply chain is dynamic, and its process of knowledge transfer is dynamic, too. So the knowledge transfer of supply chain is more difficult and complex.

Supply chain enterprises have interest's correlation. Supply chain is an organization that upstream and downstream firms have interest's relationship. In order to maximize the interests of the whole supply chain, each enterprise will transfer the redundant knowledge to upstream and downstream enterprises that have knowledge demand on the premise of protecting the core knowledge.

B. The Influence Factors of Supply Chain Knowledge Transfer

The process of supply chain knowledge transfer is realized by the network which consists of suppliers, manufacturers, distributors and customers. Knowledge under the influence of many external and internal factors in this process. This paper take these factors into two categories: transfer context and transfer ability.

Supply chain transfer context. Knowledge transfer happens in specific context which has important impact on it. Supply chain knowledge transfer context has external and internal context. External context mainly contains supply chain enterprise distance, trust, knowledge complexity and knowledge protection mechanism. Among these factors, trust is the basis of supply chain knowledge transfer. The relationship of supply chain enterprises easily leads to knowledge leaking (Andrew·Campbell,2000), supply chain enterprises have to bear the risk of knowledge leaking, which will make enterprises 's interests loss. So less trust, less the will of knowledge transfer.

Supply chain enterprises' knowledge transfer ability: knowledge sending ability and knowledge absorptive ability. Supply chain enterprises knowledge sending ability refers to explicit knowledge transfer ability and tacit knowledge externalization ability. Supply

chain enterprises knowledge absorptive ability refers to the ability of enterprises recognizing external knowledge value and applying it to commercial terminal.

3. System Dynamics Modeling of Causality Analysis of Knowledge Transfer

Supply chain knowledge transfer is in a system with clear boundary and the main body of supply chain knowledge transfer interacts with each other. Besides, its knowledge with growing dissipation characteristics. So supply chain knowledge transfer in conformity with the basic requirements of system dynamics modeling.

A. The Process of Supply Chain Knowledge Transfer

The cooperative relationship of supply chain upstream and downstream enterprises is very close, but the upstream enterprise is higher dependent on the downstream enterprises as downstream enterprise procurement option determines its strong position. (Lin-fang, 2007) Even though supply chain knowledge transfer is an interaction process of upstream enterprises and downstream enterprises, in order to facilitate discussion this paper only considers the downstream enterprises to upstream one-way transfer. The specific process shows as Figure 1.

Feedback 1 refers to accepting enterprises increasing their knowledge stock after absorption and innovation. Feedback 2 refers to sending enterprises choosing to transfer or not after knowledge transfer

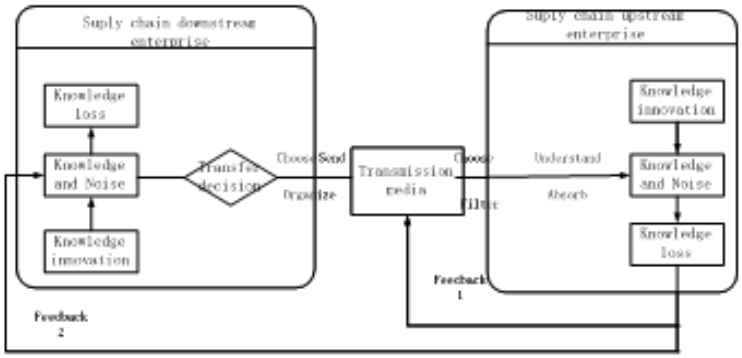

Figure 1. The Process of Supply Chain Knowledge Transfer

B. Causality Analysis of Supply Chain Knowledge Transfer

This paper assumes that C1 is a sending knowledge industry and C2 is a accepting knowledge industry in this supply chain. And the knowledge transfer causality of C1 and C2 as follow:

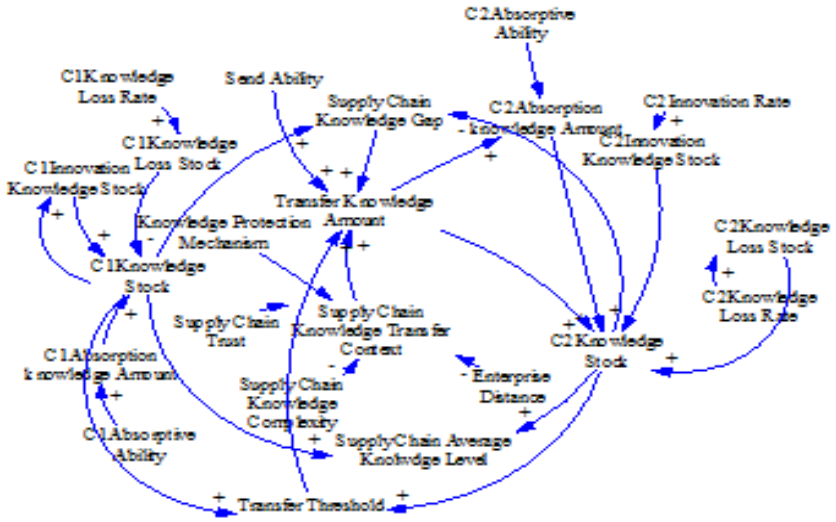

Figure 2. The Knowledge Transfer Causal Feedback Figure

The main factors that influence the knowledge transfer of C1 and C2 contain sending ability, transfer situation, knowledge gap, transfer threshold and absorption capacity. And the five factors are positively correlated with the knowledge transfer. The knowledge sending ability refers to the ability of transferring knowledge to other subjects. Knowledge transfer situation mainly includes the protection mechanism, the knowledge complexity, enterprise distance, trust, etc. Knowledge gaps, transfer threshold and knowledge absorptive capacity are key influencing factors that transfer external knowledge into knowledge stock. Besides, absorption capacity and absorption utility are positively correlated. In the figure, the main causality feedback paths as follows:

C1 knowledge stock →C1 innovation utility → C1 knowledge stock.

C2 knowledge stock →knowledge gap →transfer knowledge stock →C2 knowledge stock.

C2 knowledge stock →transfer threshold →transfer knowledge stock →C2 knowledge stock.

C2 knowledge stock→C2 innovation rate→C2 innovation knowledge stock→C2 knowledge stock.

C2 knowledge stock→C2 loss rate→C2 knowledge loss stock→C2 knowledge stock.

Considering the characteristics of knowledge, two concepts that knowledge innovation rate and knowledge loss rate are introduced in this paper. This paper considers knowledge innovation rate and knowledge loss rate are time function. Besides, there are many other concepts such as the average levels of knowledge of the supply chain and supply chain knowledge gap. The average knowledge levels reflects the average knowledge stock of both sides in the process of supply chain knowledge transfer. Supply chain knowledge gap refers to the difference between the stock of knowledge on both sides. If supply chain average knowledge stock increases and knowledge gap decreases, supply chain knowledge transfer efficiency is higher.

4. The System Dynamics Model of Knowledge Transfer between Enterprises of Supply Chain

A. Assumptions of the Model and System Flow Chart

- Assumptions of the model

The knowledge gap is the power of knowledge transfer in supply chain. This model assumes C1 knowledge stock is greater than C2, C1 knowledge stock is 100. In order to ensure C2 has knowledge absorptive capacity, we assume C2 knowledge stock is 1.

There is no knowledge transferring from outside to C2 and its increase of knowledge stock only depends on knowledge innovation. So C2 knowledge stock increases slowly and its knowledge loss rate also increases slowly. In order to facilitate discussion, we assume the C1 knowledge loss rate is constant. While C2 accepts C1 transfer knowledge and has independent innovation, its knowledge stock increases rapidly, so C2 knowledge loss rate changes significantly. This paper assumes C2 knowledge loss increases with time.

- system flow chart

It show as Figure 3. In this S-D model, C1 knowledge stock and C2 knowledge stock are flow variables. And the flow rate variable contains: C1 innovation knowledge stock, C1 knowledge loss amount, C2 collaborative knowledge stock, C2 knowledge loss amount and transfer knowledge stock. Besides, the others is constant, such as the protection mechanism of the knowledge, supply chain trust level, supply chain knowledge complexity, supply chain enterprises distance, C1 sending ability , C1 knowledge loss rate and C2 absorptive capacity.

B. The Design and Illustration of Function

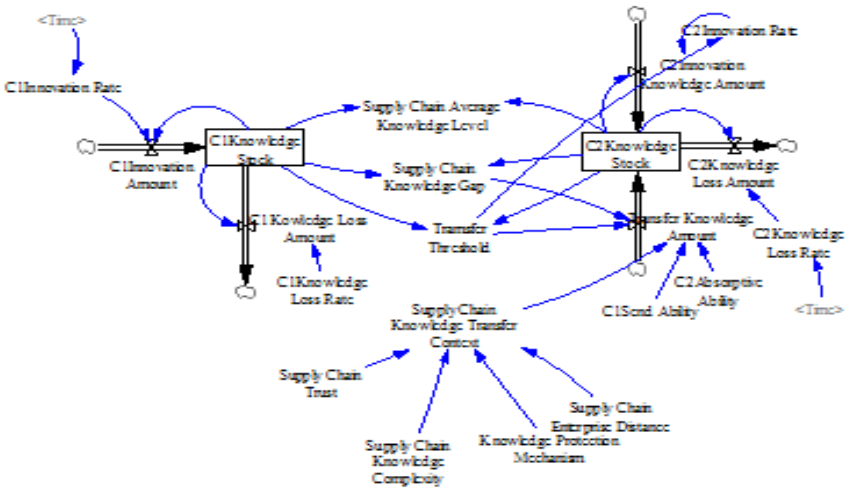

Figure 3. The Knowledge Transfer Flow Chart in the Supply Chain

- Supply chain average knowledge level=(C1 knowledge stock+C2 knowledge stock)/2
- Supply chain knowledge gap=C1 knowledge stock-C2 knowledge stock
- C1 innovation rate=WITH LOOKUP (Time,([(0,0)-(60,0.1)],(0,0.05),(60,0.006))). Supply chain enterprises' innovation rate has positive correlation with their knowledge stock, which will increase with time going. In order to facilitate discussion, this paper assumes the table function relation of C1 innovation level and time represents the relation of C1 innovation level and C1 knowledge stock. And in the simulation time, C1 innovation rate increase according to linear one percent.
- C1 innovation knowledge amount=C1 innovation rate*C1 knowledge stock.
- C1 sending ability=0.5.
- C1 knowledge stock=INTEG(C1 innovation knowledge amount-C1 loss knowledge amount,100).
- C1 loss knowledge amount=STEP(C1 knowledge stock*C1 loss rate,5). Knowledge loss needs a process, only after a period of time knowledge begins to fail. So this

paper uses step function to simulate the loss process of knowledge, knowledge began to fail after 5 simulation cycles.

- C1 knowledge loss rate=0.01.
- C2 innovation rate= WITH LOOKUP (Time,([(0,0)-(80,0.6)],(1,0.01),(60,0.04))). It needs a process that explicit knowledge changes into tacit knowledge and applying knowledge to practice(Ren-ling,2009). C2 accepting the transfer knowledge of C1 and applying it to practice also need a process, so C2 innovation rate is a increasing process.
- C2 innovation knowledge amount=C2 innovation rate*C2 knowledge stock.
- C2 absorptive capacity=0.5. In order to assure knowledge transferring smoothly, knowledge accepting enterprises need certain absorptive capacity.
- C2 knowledge stock=INTEG(C2 innovation knowledge amount+transfer knowledge amount-C2 loss knowledge amount,1)
- C2 loss knowledge amount=C2 knowledge stock*C2 knowledge loss rate
- C2 knowledge loss rate= WITH LOOKUP(Time,([(0,0)-(80,10)],(1,0),(5,0.01),(60,0.09))). With knowledge stock increasing, knowledge loss rate also increase.
- Knowledge transfer context=IF THEN ELSE(Supply chain trust*Knowledge protection mechanism>Supply chain knowledge complexity*Supply Chain distance, Supply chain trust*Knowledge protection mechanism-Supply chain knowledge complexity*Supply chain distance. In order to facilitate discussion, this paper considers supply chain trust and knowledge protection mechanism have positive relation with knowledge transfer context, supply chain knowledge complexity and supply chain distance have negative relation with knowledge transfer Context, and knowledge transfer context has positive relation with transfer knowledge amount.
- Transfer threshold=IF THEN ELSE(C1 Knowledge Stock/C2 Knowledge stock<0.9,C1 Knowledge Stock/C2 Knowledge stock,0.9). Transfer threshold refers to the degree of knowledge transfer and is equal to C1 Knowledge stock/C2 Knowledge stock. As knowledge transfer may lead to knowledge sending enterprises' advantage loss, supply chain knowledge sending enterprises send knowledge to other enterprises only when transfer threshold<0.9 to keep competitive advantage. Otherwise, stop knowledge transfer. In this paper, we assume the quantity of transfer threshold is 0.9.
- Transfer knowledge amount=DELAY1I(IF THEN ELSE(Transfer threshold<0.9, C1 sending ability*Supply chain knowledge gap*C2 absorptive ability*knowledge transfer context,0),5,0)
- Supply chain trust, supply chain knowledge complexity, supply chain enterprises distance and knowledge protection mechanism random value in [0, 1].
- Final time = 60 Units: Month.

5. The Evolutionary Simulation and Analysis of Knowledge Transfer between Industries in Supply Chain

The simulation of system dynamic model can verify the correctness and effectiveness of simulation results, analyzing whether it can correctly understand the problem to solve (Wang-qifan, 1994). This model builds and runs on Vensim software platform. In this simulation experiment, the simulation time is 60, the initial knowledge stock of C1 and C2 are 100 and 1 respectively. And we set knowledge sending ability coefficient as 0.5 and transfer threshold as 0.95. Besides,in the supply chain context,Supply chain trust, supply chain knowledge complexity, supply chain enterprises distance and knowledge protection mechanism random value in [0, 1]. The simulation results as follows, Figure 4.

From the simulation results of figure 4 we can see:The knowledge stock of C1 and C2 are on the rise and tend to balance finally. However, the knowledge stock of C2 is still

lower than C1 due to C1 just transfer redundant knowledge to C2. Knowledge transfer can threaten competitiveness of C1, so C1 only transfer redundant knowledge to C2 and still reserve core knowledge under the condition of intellectual property not be protected well.

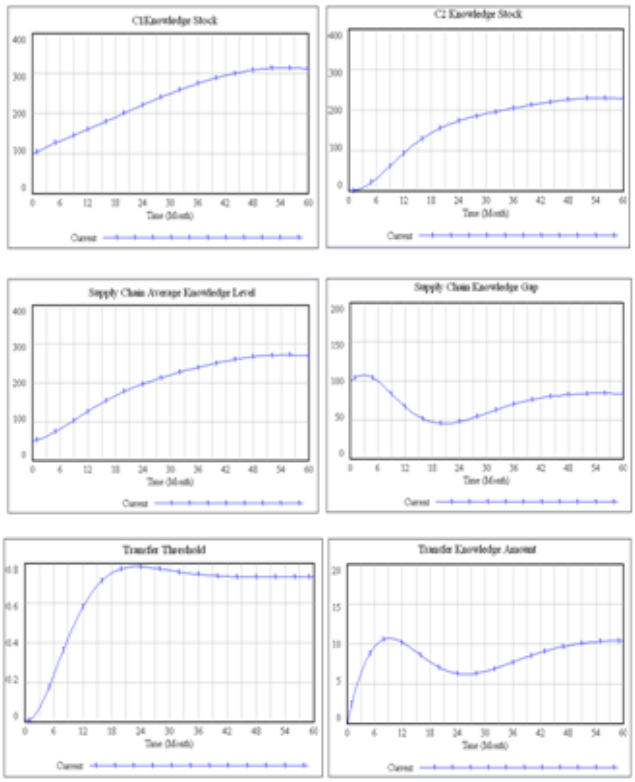

Figure 4. The Simulation Results

Transfer threshold starts with rapid increase and also tend to balance eventually. At the begin, the knowledge gap between supply chain industries is so big that knowledge transfer is difficult. With increase of knowledge stock of C2, knowledge absorptive ability of C2 is strengthening, then the increase speed of knowledge stock is higher, so transfer threshold increases rapidly in initial. However, with the knowledge stock gap of C1 and C2, the knowledge transfer power of C1 decreasing, transfer knowledge stock decrease and knowledge gap tend to balance, so transfer threshold also tend to balance finally.

The tend of supply chain average knowledge level is similar to knowledge stock of C1 and C2, which increases initially and tends to balance eventually. With the knowledge stock of C1 and C2 increasing, supply chain average knowledge level increases. However, with the knowledge gap deceasing, the increase speed decreases, so supply chain average knowledge level tends to balance eventually.

Knowledge gap increases firstly and then decreases, finally increases again and level out. In the initial process of knowledge transfer, the innovation knowledge amount of supply chain enterprise C2 is a little for its innovation ability is very low, and knowledge transferring from C1 is also very little. However, as supply chain enterprise C1 has more knowledge, it has higher knowledge innovation ability. Based on this ability, C1 can create new knowledge. So the knowledge gap of these two enterprises increases initially. After a period of time, both innovation knowledge stock and transfer knowledge stock of supply chain enterprise C2 increase, while the innovation knowledge stock of supply chain enterprise C1 decreases. The growth of C2's knowledge stock accelerates but C1 decelerates. Therefore, the knowledge gap decreases in the middle time. Eventually, with the knowledge stock of supply chain enterprise C2, the growth of knowledge transferring

from C1 to C2 decelerates by the control of transfer threshold. So knowledge gap increases again and level out.

The transfer threshold increases rapidly in initial and then level out. Initially, the knowledge stock gap of supply chain enterprise C1 and C2 is big, so the transfer threshold is very low. With the knowledge gap decreasing and level out, the transfer threshold increases and level out.

The amount of transfer knowledge increases in initial,then decreases and level out. Initially, the transfer threshold increases rapidly, the amount of transfer knowledge increases rapidly by the control of the transfer threshold. With knowledge transfer continuing, knowledge transferring from C1 to C2 decreases for their knowledge gap decrease. Eventually, the transfer threshold decreases and level, transfer knowledge increases again and level out.

6. The Simulation Results to Management Revelation of the Supply Chain Knowledge Transfer

In order to give management advices for realistic supply chain knowledge transfer and determine the influence of various parameters on supply chain knowledge transfer, we can change the parameter values of the main variables in the model to compare the result of the model output. Wang-lisheng(2007) thought absorptive ability had important effect on organizations throughout the entire process of digesting, integrating and creating new knowledge. Andrew Campbell(2000) thought the relationship inter-supply chain easily leaded to leak knowledge. So this paper sets absorptive ability and trust in the supply chain as variable parameters and analyzes its sensitivity.

A. Assumptions of the Model and System Flow Chart

As is depicted in the Figure 5, when absorptive ability parameter is 0.5, the simulation result is curve 3; when absorptive ability parameter is 0.6, the simulation result is curve 2; when absorptive ability parameter is 0.7, the simulation result is curve 1.

Management implications: increasing the absorptive ability of supply chain enterprises can increase the effect of supply chain knowledge transfer. Namely, increasing knowledge sending ability of supply chain enterprises can also increase the amount of transfer knowledge.

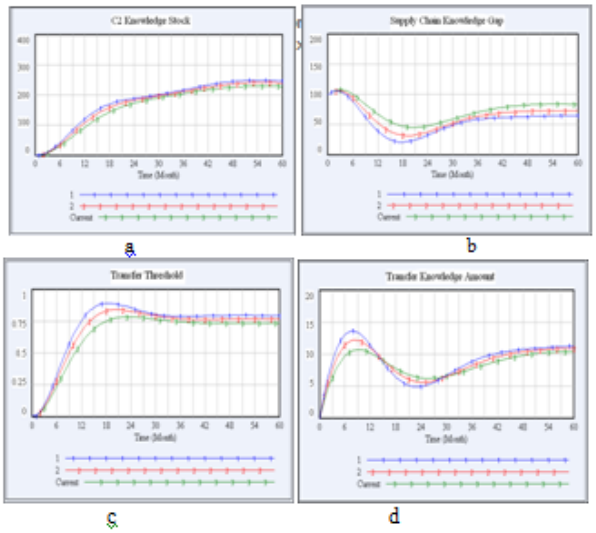

Figure 5. The Simulation Result when Absorptive Ability Parameter Value is 0.5, 0.6 and 0.7 Respectively

Supply chain enterprises should increase knowledge absorptive ability by increasing enterprises' knowledge base, attaching great importance to the R&D and talent, establishing learning organizations, increasing the degree of learning efforts.

Supply chain enterprises should increase knowledge sending ability. Firstly, supply chain enterprises make explicit knowledge systematically and stylized, which can be absorbed easily. Then, externalize the tacit knowledge.

B. The Simulation Result of Setting Trust as Variable Parameter

As is depicted in Figure 6, when trust parameter is 0.5, the simulation result is curve 3; when trust parameter is 0.6, the simulation result is curve 1; when trust parameter is 0.7, the simulation result is curve 2.

From a,b and c,we can see, with trust level increasing, supply chain average knowledge level and transfer threshold increase, but supply chain knowledge gap decreases. In these figures, the interval of curve 1 and 3 is smaller than curve 2 and 3. That is to say ,when the increasing trust reaches a certain extent, the positive effect that trust to supply chain will decrease. However, when trust decreases, its negative effect will increase. From Figure c and d, we can see, the higher the trust, the more volatile the fluctuation of curve. Vice versa. The higher the trust, the more knowledge enterprises will send, the faster the speed of knowledge transfer, the shorter the cycle of knowledge transfer. From figure d, we can see curve 1 volatility is the largest. When the simulation clock in 20 or so, the amount of knowledge transfer is lower than the simulation results of other trust. However, in other simulation time the simulation result is higher than other trust. Initially, the higher the trust of supply chain enterprise C1 to C2, the faster the increasing speed of transfer threshold, the stronger the transfer will, the more the amount of transfer knowledge. With the stock of C2 increasing fastly, the knowledge gap of supply chain decreasing and the transfer will of C1 decreasing, the transfer knowledge decreases rapidly when the simulation clock in 20 or so. However in other trust, the transfer threshold and the amount of transfer knowledge are quite gentle.

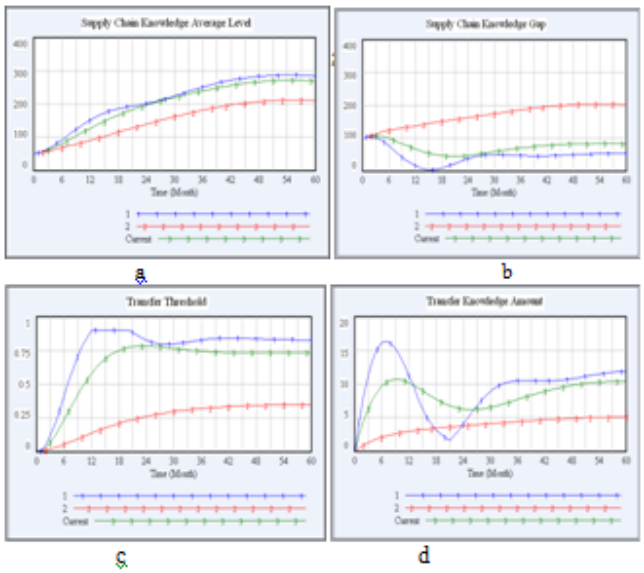

Fig.6 The simulation result when trust parameter value is 0.5, 0.6 and 0.7 respectively

Figure 6. The Simulation Result when Parameter Vallue is 0.5, 0.6 and 0.7 Respectively

Therefore, supply chain organizations can increase trust level between enterprises and improve the context of supply chain knowledge transfer, to reduce the difficulty of knowledge transfer and increase the efficiency of knowledge transfer.

Build organizational trust management mechanism. Supply chain builds a satisfactory rewards and punishment mechanism to achieve personal and organizational trust. Build supply chain contract, stipulate the behavior according to contract is successful and the behavior violating contract will be punished by contract.

Set up the mechanism of supply chain trust culture. Supply chain should foster Shared values and establish unified communication paradigm(Lei-xinhui,2009). Common values of the supply chain can help to form and consolidate supply chain trust mechanism, so it should form common values based on its characteristics of industry and member enterprises and nature of products. However, the formation of common values need a long process. In this process, however, knowledge transfer continues. So supply chain should establish a set of trustworthy paradigm that all members should comply with.

7. Conclusion

This paper builds system dynamics concept model of knowledge transfer between supply chain enterprises based on analyzing the characteristics, influence factors and the proceed of supply chain knowledge transfer. This model simulates the proceed of supply chain knowledge transfer under the restriction of many factors, assumes certain external situation of supply chain knowledge transfer, supply chain enterprises' knowledge innovation rate, knowledge absorptive capacity and loss rate and describes the supply chain characteristics and influence factors of knowledge transfer, to provide theory basis for supply chain knowledge transfer. The model simulation results provide corresponding management for supply chain knowledge transfer practices, so it has a certain practical significance. Besides, there are also some limitations in this paper. It doesn't give a comprehensive supply chain practice background of knowledge transfer, the experimental process of the applications bases on simple assumptions and it doesn't provide a realistic data as an experimental basis. The future study of relevant content will make up for the inadequacy of the above. It will further consider the influence of various factors on the supply chain enterprise knowledge transfer and build a more complex and real system dynamics model based on practical data.

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References

[1] A. Campbell, Strategic synergy, Mechanical press, **(2000)**.
[2] B. Yang, "Knowledge transfer evolutionary model and simulation based on the modeling of system dynamics", Library and Information Service, vol. 18, **(2010)**, pp. 89-94.
[3] R. Batenbure, "Managing Innovation in Regional Supply Networks:A Dutch Case of Knowledge Industry Clustering", Supply Chain Management, vol. 8, no. 3, **(2003)**, pp. 263-270.
[4] R. Chanvarasuthp, "Absorptive Capacity and Strategic Alliances in the Supply Chain Context", IEEE International Engineering Management Conference, **(2003)**; New York.
[5] H. M. Khamseh and D. R. Jolly, "Knowledge transfer in alliances:determinant factors", vol. 12, **(2008)**, pp. 37-45.
[6] W. L. Ke and K. K. Wei, "Factors Affecting Trading Partners' Knowledge Sharing:Using the Lens of Transaction Cost Economics and Socio-political Theories", Electronic Commerce Research and Applications, vol. 6, no. 3, **(2007)**, pp. 297-308.
[7] L. Fang and H. J. Huang, "The stable study of dependency that Upstream and downstream enterprises in the supply chain", Industrial Engineering, vol. 1, **(2007)**, pp. 43-47.

[8] X. H. Lei and L. F. Yu, "The research of building trust system in supply chain management", Contemporary Finance & Economics, vol. 9, **(2009)**, pp. 78-81.
[9] R. Ling, "The research of inter-enterprises cooperation innovation based on knowledge management", Chinese PHD thesis database, 8, **(2009)**.
[10] S. H. Xu and S. J. Xu, "Modeling and simulation of knowledge sharing in agriculture supply chain based on system dynamics", Journal of Heifei University of technology, vol. 11, **(2013)**, pp. 1381-1386.
[11] B. Wu, Z. Y. Liu and L. D. Zhao, "The knowledge transfer study of supply chain collaboration", Journal of information, vol. 1, **(2008)**, pp. 15-20.
[12] L. S. Wang, "The research of social capital and absorptive capacity on the effect of knowledge acquisition and innovation performance", Chinese PHD thesis database, **(2007)**.
[13] Q. F. Wang, "System Dynamic", Tsinghua university press, **(1994)**.
[14] Z. X. Wang, "The hierarchical model in the process of knowledge transfer", Chinese Journal of Management Science, vol. 3, **(2006)**, pp. 122-126.
[15] H. T. Zhu, "The effect research of knowledge sending impact on knowledge communication effectiveness", Library and Information Service online version, vol. 6, **(2012)**, pp. 9-12.
[16] H. T. Zhang, "Research on knowledge damage and countermeasures in knowledge transfer between enterprises of supply chain. Science-Technology and Management", vol. 6, **(2008)**, pp. 45-48.
[17] X. M. Zhang, W. Zhang and Y. X. Zhang, "An empirical study of factors affecting knowledge sharing between supply chain enterprises", Journal of management, vol. 10, **(2009)**, pp. 1296-1300.

