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Dynamic Mechanisms Research on Knowledge Transfer Research in the Supply Chain

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Abstract: Supply chains are knowledge bases which are polymerized by these different and complementary knowledge resources which are obviously more abundant than any membe's knowledge. However, in the supply chain transferring knowledge is more difficult because of knowledge features of uncertainty and complexity. Most of research on knowledge transfer have focused on enterprise internal knowledge transfer at present. Methods which are used to deal with knowledge transfer problem within the enterprises can not be directly extrapolated to research on knowledge transfer in the supply chain. In the study, system dynamics model is used to solve the above problem. Using the model, this study not only analyze qualitatively influence factors of knowledge transfer and relation each other in the supply chain but also describes quantitatively process of knowledge transfer. In order to verify the applicability of the method, the study simulates knowledge transfer process of Huaan company and put forward the measures of improving the company's knowledge transfer efficiency.

Keywords: Knowledge transfer, supply chain, system dynamic model

INTRODUCTION

With the development of knowledge economy, knowledge has become the core resources that enterprises remain competitive advantage and maintain its sustainable development.So enterprises need continuously acquire new knowledge resources to enhance the innovation ability in order to consolidate its market position.It is a effective way to acquire new knowledge resources from outside the organization under the conditions that knowledge innovation risk and cost are higher and higher, while enterprise innovation ability is limited.Supply chain is the vertical enterprise network which is composed of raw materials and parts suppliers, manufacturers, distributors and retailers and end-users (Liu, 2004). Its main function is to complete supply process of products and services from customer demands to meeting customer demands.Supply chain is not only a material supply chain but also the knowledge supply chain where relation among members is that honour one and you honour them all and injure one and you injure them all.Knowledge transferring and sharing in the supply chain are more easy than that in other organization such as strategic alliance and virtual enterprises. Cost of the former is generally also significantly lower than that of the latter.Effective knowledge transfer in the supply chain can improve knowledge innovation efficiency, optimize and coordinate a knowledge level of among the members, further expand the knowledge stock and enhance the overall competitiveness of the supply chain. Therefore, method of knowledge transferring smoothly and quickly in supply chain enterprise is the main content of knowledge management.

At present, some scholars studied the knowledge transfer problem.But most of these studies had focused on enterprise internal knowledge transfer that involve knowledge features,communication barriers and effective ways etc. (Stollenwerk, 2001). Research methods were mainly some qualitative model such as case studies, empirical research and descriptive method. Literature (Wei and Wang, 2006) used Structural Equation Method (SEM) to analyze quantitatively the relationship of six influencing factor including trust,interpersonal relationship, incentive mechanism,attitude of decision maker, knowledge management system and knowledge absorptive capacity. Result showed that the main factors which affect the knowledge transfer within the enterprise were attitude of decision maker (importance: 0.71) and knowledge absorptive capacity(importance: 0.44). Zhang and Duan, (2004), Zhang *et al*. (2004) adapt differential dynamic model to study quantitatively the process and influencing factors of knowledge transfer within the enterprise (or enterprise groups). These results provided valuable experience for quantitative research development of knowledge transfer in the supply chain. However uncertainty and complexity transferring knowledge in the supply chain are higher than them within the enterprise (or enterprise groups). Above methods can not be directly extrapolated to research on knowledge transfer in the supply chain. Douligeris and Tilipakis (2006) introduced

a knowledge management paradigm in the supply chain and he examine how the new information and communications technologies have added value to this process. The new model of the semantic web is presented and the building of ontologies in a SCM environment is introduced as part of an effort to present a framework of semantic ontologies in the SCM sector. Fletcher and Polychronakis (2007) proposed a framework to capture and potentially disseminate knowledge in the supply chain.Based on a qualitative inquiry with thematic analysis, Wu (2008) analyze how organizational conditions, technology adoption, supplier relationship management and customer relationship management affect knowledge creation through Socialization-externalization Combination, Internalization (SECI) modes and various ba.The results show that these critical factors facilitate different types of knowledge conversion process in order to achieve successful knowledge creation in a supply chain. Literature (Fletcher and Polychronakis, 2007) review addresses a number of in?encinal scholars in the area and focuses in particular to the work of speciefic authors. The relevant field work is based essentially on the administration by interview of a questionnaire with a series of open and closed questions. Findings showed that conflcit exists over how knowledge should be captured, managed and disseminated by small to medium enterprises (SMEs) within any given supply chain.

As stated previously, suitable and accepted methods are not found to solve problem of knowledge transfer in the supply chain. knowledge transfer is system engineering involving many factors and complex relationship between factors which decide the process and effect of knowledge transfer. the most basic guiding ideology of system dynamics is the systematic and unique workflow of understanding and solving the problem by the way from coarse to fine, from the outside to the inside, several times cycling and deepening unceasingly (Zhang, 2004). In the study, we will adopt system dynamics to model the process and study quantitatively the influencing factors and their relation and simulate the above process.

FACTOR ANALYSIS OF KNOWLEDGE TRANSFERRING

Motivation of knowledge transfer: In the supply chain, knowledge of different companies holding is often different and complement each other, for example, suppliers have thorough understanding of the knowledge of product performance, manufacture and use. However, they lack the manufacturing knowledge and do not know how to reform once products not to meet customer demands. Manufacturers can not completely own the knowledge of special equipment use and repair. Through the coordination and integration of complementary knowledge resources of different enterprise, member companies can learn and master the external advanced knowledge, thereby enhance knowledge level and innovation ability of the whole supply chain. Innovation demands decide the knowledge transformation motivation and direction. According to the change of market environment, enterprise need adjust product innovation strategy. In this process a lot of problems need to be solved. Under the guidance of innovation demands, supply chain will be the first choice because "supply chain knowledge base" which is polymerized by these different and complementary knowledge resources is obviously more abundant than any member's knowledge. However, different and complement knowledge of supply chain members result in the incompatibility of knowledge. Suppliers and the core enterprise have different cultural backgrounds, knowledge structure, thinking mode, cognitive mode and culture etc. Large similarity between them benefit to knowledge transfer. If there is significant difference between them, knowledge transfer becomes very difficult.

Knowledge transfer platform: cooperation between enterprises in supply chain is not short-term behavior. So the strategic objectives should be consistence. Goal conflict among strategic partnership is difficult to avoid in the cooperation process. This requires that they often contacts and consultations and seek the method to compensate the difference and then ensure the smooth operation of supply chain. According to the expression forms, knowledge can be divided into the tacit knowledge and explicit knowledge. In the supply chain, transfer of explicit knowledge need build the platform or media for communication. Transfer of tacit knowledge occurs only under the condition of face to face communication. Relation among enterprises is closer, degree of tacit knowledge transfer is greater. Human behavior is mostly to be guided by two priority interest-economic interests and social interests. So is the enterprises behavior. Enterprises in the supply chain think that core enterprises should reduce prices of goods or give compensation once they provide knowledge to core enterprise because core enterprise is the builder and manager of supply chain and can obtain more benefit from knowledge transfer. In

addition, any enterprises including core enterprises don't want to transfer their knowledge, especially tacit knowledge because monopolies of knowledge will bring their monopoly interests which other enterprises don't own. Core enterprises must take corresponding incentive measures improve the enthusiasm of knowledge transfer. Incentive measures can enhance trust among members. Mutual trust plays a key role in the effective knowledge transfer. Degree of trust is higher, accessibility of knowledge transfer is higher and opportunities of knowledge transfer is larger. I nstead, distrust among members often lead to a protective behaviors occur, cooperation and exchange ruptures which hinder knowledge transfer. In addition, trust is premise of stable relationship. A stable cooperative relationship can make the knowledge transfer successfully.

Effect of knowledge transfer: Knowledge is characterized by fuzziness, implicit and dependency. Some knowledge can be used completely symbolic description. Degree of knowledge complexity is higher, knowledge transfer is more difficult. Description of complex knowledge requires a large amount of information and a long term. Knowledge complexity affects transfer ability and absorption capacity. Ability of knowledge transfer refers to knowledge integration and expressive power. Transmission of explicit knowledge can use medium such as document and video. Tacit knowledge is mostly a few scattered, disordered knowledge fragment. When enterprises transfer tacit knowledge, they must integrate systematically and deliberate deeply these knowledge fragment and then communicate these knowledge with other enterprises with a suitable way. Ability of knowledge transfer is stronger, speed of knowledge flow is faster and cost is lower. In addition, effect of knowledge transfer is closely related to knowledge absorptive capacity of receptors, including receptor learning ability, knowledge digestion and knowledge integration capability.

SYSTEM DYNAMICS MODEL

As a continuous simulation technology, system dynamics model mainly study the factors and their relationships which influence the system stability and development trend. And that are used to analyze effects of certain policy and get the useful suggestions. The system has integrity, relativity, hierarchy and similarity. Feedback mechanism and the structure of system decide behavior characteristics. Any complex system is

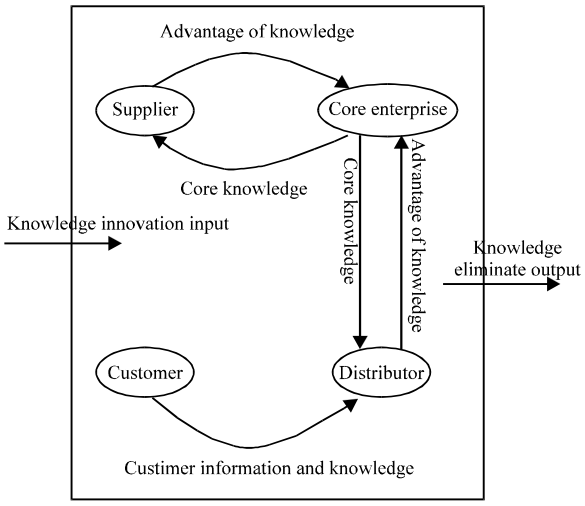

Fig. 1: block chart of knowledge transfer system

composed of many basic information feedback loop in some way. Internal feedback mechanisms usually can be expressed by causality diagram which can qualitatively reflect the relationship among factors and do not need to clear the elements of the mathematical definition. Knowledge transfer process is a system engineering which include many section and be affected by many factors. Factors and their relation determine the effectiveness of knowledge transfer.It is very suitable to use System dynamics model to study the process of knowledge transfer in the supply chain.Modeling process of system dynamic is divided into three steps.First is to build the causality diagram of knowledge transfer system of supply chain. Second is to definite the factors in the causality diagram using the characteristic symbol of system dynamics and build system flow chart reflecting the relationship between factors. Third is to use the special continuous simulation language to analyze the above chart quantitatively.

Block chart of knowledge transfer system in the supply chain: For simplicity, we assume that knowledge transfer system only involves the four section, :a core enterprise, a supplier, a distributor and many customers. Systems of a number of suppliers and distributor are the combination of the above systems. Relationship between them is as shown in Fig. 1.

Causality diagram of knowledge transfer: based on the Fig. 1 and the above factors analysis of knowledge transfer, a causal loop chart is built and showed as Fig. 2. The causality diagram contains six feedback loop. Loop is

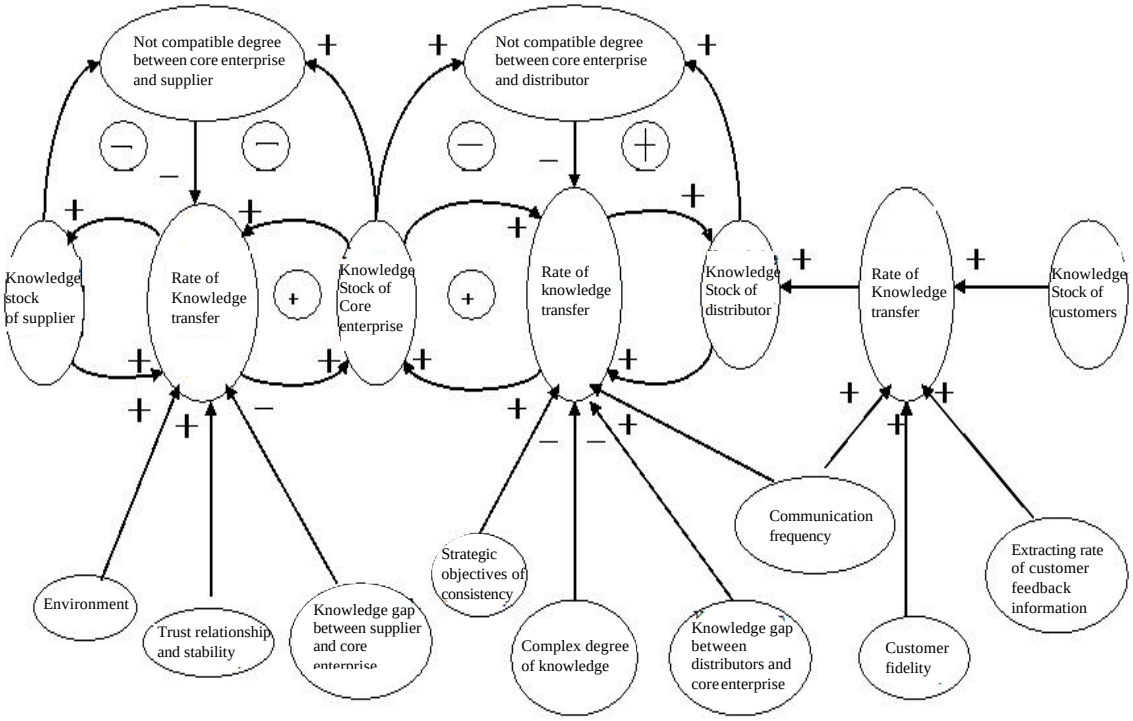

Fig. 2: Causal chart of knowledge transfer in supply chain

composed of knowledge stock of supplier, rate of knowledge transfer and knowledge stock of core enterprise. Rise of knowledge stock cause increase of knowledge potential difference between supplier and core enterprise which leads to higher rate of knowledge transfer. And rate is higher, knowledge gained by core enterprise is more. In turn, increase of knowledge stock of core enterprise speed up knowledge transfer from core enterprise to supplier. So loop is a positive feedback loop. Loop presents the relation of knowledge stock of core enterprise,rate of knowledge transfer and knowledge stock of distributor. Its feedback principle is same as the loop. Loop includes three sections which are knowledge stock of supplier, rate of knowledge transfer and no compatible degree between core enterprise and supplier. Knowledge stock of supplier is richer and no compatible degree of knowledge between core enterprise and supplier is larger.It result in reduction in rate of knowledge transfer between them,and then affect knowledge accumulation of supplier. So loop is a negative feedback loop. In the Loop, once increase of knowledge stock core enterprise may lead to larger no compatible degree which reduces the rate of knowledge transfer,and these make t increase of knowledge stock of core business become more difficult.

So loop is also a negative feedback loop.Feedback principle of loop and loop is similar to loop and loop. They are all negative feedback loop.

SIMULATION EXPERIMENT AND RESULTS ANALYSIS

In order to verify the applicability of the above method, knowledge transfer process of Huaan company is simulated.

Simulation programs: Expert evaluating methods are used to definite the factors values, Standard grades of expert evaluating are shown in Table 1.

Simulation programs are shown in the following:

```
R GHZHUANSU.KL=GONGCUN.K*
X HECUN.K*(GHCHAJU.K/100)
X *ZHUANHUAN
X *XINGUANWEN*(GHBUJIANDU/10)
R HFZHUANSU.KL=HECUN.K*
X FENCUN.K*(HFCHAJU.K/100)*
X ZHANMUYI*HFBUJIANDU
X *YINFUDU*(GOULV/100)
R FKZHUANSU.KL=FENCUN.K*
X KECUN.K*GOULV*KEZHONGDU*
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Table 1: Standard grades of expert evaluating

	Expert evaluation scores						
Influencing factors	Best	Better	Good	Medium	Bad	Worse	Worst
Environment of knowledge transfer	1	0.8	0.7	0.5	0.2	0.1	0
Trust relationship and stability	1	0.8	0.7	0.5	0.2	0.1	0
Customer fidelity	1	0.8	0.7	0.5	0.2	0.1	0
Strategic objectives of consistency	1	0.8	0.7	0.5	0.2	0.1	0
Communication frequency	1	0.8	0.7	0.5	0.2	0.1	0
Extracting rate of customer feedback information	1	0.8	0.7	0.5	0.2	0.1	0
Knowledge stock	100	80.0	70.0	50.0	20.0	10.0	0
No compatible degree of knowledge between enterprise	0	0.2	0.3	0.5	0.8	0.9	1
Complex degree of knowledge	0	0.2	0.3	0.5	0.8	0.9	1

Countinue:

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X (KETILV/100)
L GONGCUN.K=GONGCUN.J+DT*
X GHZHUANSU.JK
L HECUN.K=HECUN.J+DT*
X (GHZHUANSU.JK+HFZHUANSU.JK)
L FENCUN.K=FENCUN.J+DT*
X (HFZHUANSU.JK+FKZHUANSU.JK)
A GHCHAJU.K=MAX(GONGCUN.K-
X HECUN.K,HECUN.K-GONGCUN.K)
A HFCHAJU.K=MAX(HECUN.K-
X FENCUN.K,FENCUN.K-HECUN.K)
C ZHUANHUAN=0.2
C XINGUANWEN=0.5
C ZHANMUYI=0.8
C GOULV=0.7
C KEZHONGDU=0.7
C KETILV=0.5
C GHBUJIANDU=0.3
C HFBUJIANDU=0.5
C YINFUDU=0.8
N GONGCUN=70
N HECUN=100
N FENCUN=80
N KECUN=50
NOTE END
PLOT GHZHUANSU=□/HFZHUANSU=■/
X FKZHUANSU=▲/GONGCUN=×/
X HECUN=*/FENCUN=●
SPEC DT=1/LENGTH=7
RUN
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Simulation results and analysis: The simulation results are shown in Fig. 4. According to Fig. 4, decision variables and state variables are on the rise. Knowledge transfer in supply chain enhances the competitiveness of supply chain because of the increase of knowledge stock of each knowledge subject. In the 0-3 phase, each decision variable and state variable have the more uniform rise, but at a modest rate. And knowledge stock of core enterprise is greater than t knowledge stock of distributor which is greater than knowledge stock of supplier. Rate of knowledge transfer between distributor and customers is greater than rate between core enterprise and supplier. While rate of knowledge transfer between core enterprise and supplier is greater than rate between core enterprise and distributor. Beginning with third phase, rate of knowledge transfer between supplier and core enterprise begins to pick up and outperforms rate between distributor and customers. By the fifth phase rate of knowledge transfer between distributor and core enterprise is being accelerated and exceeds rate between distributor and customers. And beginning with fifth phase, curve slope of each decision variable and state variable get obviously big. That indicates they grow fast. By the seventh phase knowledge stock of supplier is beginning to exceed knowledge stock of distributor.

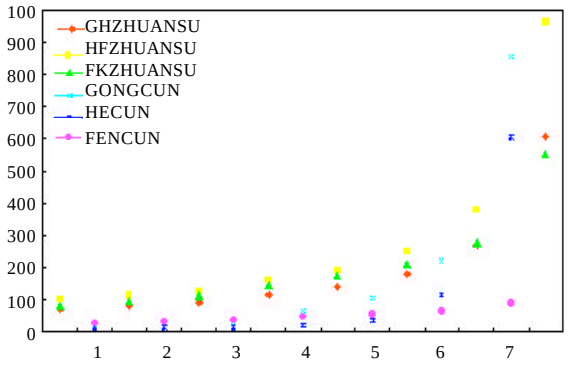

Fig. 4: Simulation results of knowledge transfer system in supply chain

CONCLUSION

The study builds a system dynamics model of knowledge transfer. Using the model, this study not only analyze qualitatively influence factors of knowledge transfer and relation each other in the supply chain but also describes quantitatively process of knowledge transfer.Simulation results indicate that core enterprises want to gain the knowledge from the supply chain,they must focus on the following three tasks. First is to biuld the suitbale platform for communication and contact among enterprises. Second is to make the suitable incentive mechanism enhance the trust among enterprises. Finally an example is used to verify this model effectiveness. The model has certain value for the study of effective knowledge development and knowledge utilization in the supply chain, establishment of a learning

organization and increase of organizational knowledge management.In additional model also can be used to study the culture communication problems.

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