



Research Article

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## Green supply chain knowledge sharing mechanism based on principal-agent theory

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### ABSTRACT

*This paper analyzed the research status of supply chain knowledge sharing, and pointed out that the deficiency of knowledge sharing research in green supply chain. On the basis of existing researches, this paper compared and analyzed the characteristics of the knowledge sharing between the enterprises in green supply chain. For these characteristics, the corresponding principal-agent model was established based on principal-agent theory; and with the analysis and design of the model, this paper explored that the influence of various parameters change on the contract formation conditions. Finally, about the green supply chain how to implement the knowledge sharing effectively, this paper put forward the corresponding strategies, and built the knowledge sharing mechanism. It has a positive and far-reaching practical significance for achieving the optimal allocation of resources to reduce business costs and accelerating technological innovation and knowledge innovation of green supply chain.*

**Keywords:** Green Supply Chain; Knowledge Sharing; Principal-agent model; Sharing Mechanism

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### INTRODUCTION

With the advent of the era of knowledge economy, knowledge has become one of the most important resources in the social development. The country's prosperity, the enterprise's flourish and the personal development are inseparable from the production, learning, innovation and application of knowledge. Knowledge and technical innovation is an important power source for human economic development, but also is the key factor to gain competitive advantage for enterprises<sup>[1]</sup>. In the increasingly fierce global market competition environment, the competition among enterprises has risen to the competition between supply chains, and the worsening ecological environment and the shortage of resources requires the environmental considerations integrated into the supply chain to achieve green supply chain management. Green supply chain management stressed that all member enterprises should participate in technical innovation, revolutionize the traditional end governance model, to improve the efficiency of resource among all members in the supply chain through technical innovation, and reduce the overall level of emissions of pollutants of the supply chain<sup>[2]</sup>. Technical innovation is a highly comprehensive activities, it needs to effectively combine and use a series of complementary resources<sup>[3]</sup>. Its every activity, in effect, is accompanied by the flow of knowledge, because the essence of technology is knowledge. The knowledge content of green supply chain is higher than the traditional supply chain, and the knowledge structure is more complex. In order to achieve complementary advantages of resources to accelerate adaptive capacity of green supply chain, and ultimately improve competitive advantage and economic efficiency of all member enterprises, so the knowledge sharing has greater significance for all member enterprises and the entire supply chain.

Currently, some scholars at home and broad have researched on the knowledge management of supply chain. For example, foreign scholars, BATENBURG et al<sup>[4]</sup> and KE et al<sup>[5]</sup> considered an important factor of supply chain

knowledge sharing is mutual trust between enterprises; ROPER *et al* <sup>[6]</sup> think the enthusiasm that node enterprises in supply chain participate in knowledge sharing is more important than the ability of knowledge sharing, and pointed out the importance of complementary knowledge for supply chain knowledge sharing. Mee-Shew Cheung studied that the role of knowledge sharing in the competitive advantage of supply chain, and further analyzed that establishing a sustainable knowledge-sharing network has a very important role in the development process of international supply chain <sup>[7]</sup>. In practice, the Toyota Motor Corporation built knowledge sharing mechanisms in its global supply chain, to share explicit knowledge and tacit knowledge resources with its suppliers and customers, and has been achieved success in practice <sup>[8]</sup>. Weng Li and other Chinese scholars analyzed the decision-making behavior of supply chain knowledge sharing under different conditions, and the impact factors of knowledge sharing behavior <sup>[9]</sup>. Ye Shifan constructed the dynamic evolutionary game model of supply chain knowledge sharing, and further researched the evolutionary trends of knowledge sharing in different situations <sup>[10]</sup>. Through the game analysis, Chen Jianxin studied the problem of distribution of the benefits generated by the knowledge sharing <sup>[11]</sup>. An' Xiaofeng researched the problems in supply chain knowledge sharing and proposed corresponding solutions <sup>[12]</sup>.

In China, the research on management mode and operation mode of green supply chain is still in its infancy, most of research is qualitative research, such as conceptual, descriptive, framework research, which did not form a complete theoretical system. And less research is on knowledge management of green supply chain. HU Jiling analyzed the knowledge which enterprise can be transferred and the barriers of knowledge transfer in green supply chain, and put forward some countermeasures <sup>[13]</sup>. Xu Li analyzed that the role of trust is for the regulation of knowledge sharing in green supply chain, and established the corresponding structural equation model based on trust adjustment, and further proposed the selection strategy on each node enterprise in green supply chain how to build trust <sup>[14]</sup>. In view of this, on the basis of previous studies, this paper analyzes the characteristics of knowledge sharing among enterprises in green supply chain, and establishes the corresponding model based on principal-agent theory. And through the analysis and design of the model, it explores the influence which brought by a variety of parameter changes, and then builds knowledge-sharing mechanism. It has a positive and far-reaching significance for the optimal allocation of resources to reduce enterprise cost, and effectively promoting the implementation of green supply chain.

## EXPERIMENTAL SECTION

### 2. The characteristic analysis of knowledge sharing between enterprises in green supply chain

In 1996, the Manufacturing Research Association of Michigan State University first proposed the concept of green supply chain: green supply chain is the efficient use of environmental awareness and energy resources, and the cross-integration of all aspects of the supply chain; it is the important means to achieve green manufacturing and enterprise sustainable development, which purpose is to make the resource use efficiency of the entire supply chain is highest, and the negative impact on the environment is minimal <sup>[15]</sup>. Green supply chain is developed on the basis of the traditional supply chain, so the green supply chain and traditional supply chain have many common characteristics, meanwhile there are obvious differences. Green supply chain management is more complex in the implementation of content, it not just integrate the environmental factors into the general supply chain on the surface, but when select the supply chain partners, each node enterprise is required to be with green features to ensure that the full life-cycle of products has minimal impact on the environment. In the strategic level, green supply chain require the each member enterprise keep a high degree of consistency, in addition to the basic goal of profit maximization, it also need to coordinate and optimize with the environment and resource. So it increases the principal-agent relationship of the social to green supply chain in the implementation process, making strategic management more complex. In the cost perspective, green supply chain also increases the social costs of environmental protection and product recycling, in addition to the human cost, logistics costs, capital costs which the traditional supply chain should pay. In the aspect of knowledge management, green supply chain pay more attention to knowledge activities within the system. Various activities which are involved in the process, such as technology innovation, green procurement, green design, green production, and green marketing process, need to build based on the knowledge flow. In the operation process of the green supply chain, the core enterprise as well as the member enterprise on the chain needs to attach great importance to the knowledge activities, meanwhile needs to engage in related activities such as technological innovation, in order to ensure the overall agility and green nature of the system.

At present, academia has no uniform standards for the classification of knowledge; the definition of knowledge from Ikujiro Nonaka is generally accepted in the field of knowledge management, knowledge is a dynamic process that personal knowledge tends to be the truth <sup>[16]</sup>. Different knowledge has different characteristics, such as observational nature, recessive trait, system nested, background dependence and so on. The knowledge sharing is a process, each knowledge subject disseminates and exchanges information, ideas, experiences and other explicit knowledge and tacit knowledge, and mutually transforms and repeatedly refines in order to produce synergistic value, thus improving the innovation ability and adapt ability of individual knowledge <sup>[17]</sup>. A complete knowledge sharing process is roughly

divided into two phases by Hansen<sup>[18]</sup>: knowledge seeking phase and knowledge transfer phase. According to Hansen's classification, in the implementation process of green supply chain operations, knowledge seeking phase is obtaining related knowledge, which is required when each node enterprise makes decisions, the related knowledge is like green knowledge, including the green degree test of raw materials procurement, green process design, green production technology, waste emissions targets and sewage treatment technology and so on, these all require the enterprise of implementing green supply chain to learn. Knowledge transfer is that knowledge supplier transfer the related knowledge which is sought through knowledge inquiry to knowledge demander, and eventually applies the knowledge to the actual operating decisions. Because of the great uncertainty of the market demand, especially the demand for green products which is more difficult to control, it requires the enterprise of implementing green supply chain establish the corresponding database through certain channels, such as the network platform to forecast demand information of green products, so the enterprise need to learn computer knowledge and technology. In addition, the enterprise also need to seriously study laws and regulations, and prohibitions relating to environmental protection.

Knowledge sharing in green supply chain is the process that each member enterprise use their knowledge advantages to produce and innovate knowledge, not the process of simple knowledge trading or dealing<sup>[19]</sup>. In the process of knowledge sharing activities, there are mainly the following characteristics:

(1) Dynamic. With the rapid development of economy and technology, each member enterprise in green supply chain need to constantly and dynamically adjust its technology R&D strategy in order to adapt the needs of low-carbon economy in different periods. Resulting in the knowledge demander and knowledge supplier is dynamically changing with it in the knowledge sharing; especially for complex knowledge, it require multiple passes and constant feedback in knowledge sharing, to make knowledge transfer completed successfully. So the knowledge sharing process is a dynamic, two-way, multiple transmission process.

(2)Confidentiality. Knowledge sharing and knowledge confidentiality itself is a contradiction, each member enterprise in the green supply chain has its core knowledge, and this knowledge is a key asset of the enterprise. In order to maintain their competitive advantage, and be able to reap excess profits, the core knowledge must be kept confidential. Thus, the degree and scope of knowledge sharing between enterprises has a certain limit. Meanwhile, the investment of knowledge capital is intangible, so it is difficult to assess its value in some extent.

(3) Risk. The node enterprises in green supply chain need to constantly strengthen cooperation and knowledge sharing to solve environmental problems jointly. However, a major characteristic of the supply chain is networked and crossed, in a particular period they are partners, but in the next period may become competitors. While knowledge is scarce, it will not lose the right of knowledge supplier to use because of sharing. But also knowledge is monopolistic, the core knowledge of some enterprises has the role of technical barriers, if this part of knowledge is shared, enterprise might lose its advantage, leading to the knowledge supplier reluctant to share knowledge. Therefore, in the case of asymmetric information, as well as unstable organization forms between enterprises, it cause knowledge sharing has a big risk.

(4) Synergy. In order to meet the diverse needs of customers, the design and production of green products can not be completed by a single enterprise, but rather node enterprises in the entire green supply chain constantly cooperate, and make all members participate in. It requires achieving heterogeneous knowledge complementary in the process of knowledge sharing between enterprises, realizing the constant innovation of knowledge. In order to accelerate the pace of knowledge innovation, enterprises need close cooperation, and establish a relatively stable and long-term cooperation relationship. Therefore, so as to gain competitive advantage, heterogeneous knowledge complementary and synergy is another important characteristic of knowledge sharing.

### **3. Three stage decision model of jack-up drilling platform design scheme**

#### **3.1 Model assumption and parameter design**

In modern economics, the principal-agent relationship is considered as a contract, it refers to any kind of transaction involved in asymmetric information, and who has the information superiority in transaction will become the agent, while the other will become the principal<sup>[20]</sup>. In the process of knowledge sharing between enterprises in green supply chain, each member enterprise is independent individual; they are in pursuit of maximizing their own interests, but because of the asymmetric information, knowledge demander cannot fully understand the knowledge value which is mastered by the knowledge supplier, and it is difficult to determine whether the other side is willing to share. While the knowledge supplier is afraid that knowledge demander will reap without sowing, and the risk of losing the core competitiveness, so the knowledge supplier is difficult to share knowledge initiatively. Thus, the typical principal-agent relationship is existed in the process of knowledge sharing between enterprises in green supply chain; the agent is the enterprise who has the information advantage, that is the knowledge supplier, and the principal is the enterprise who

does not have the information advantage, that is, the knowledge demander. Therefore, this paper use condition constraints of the principal-agent to solve the contract formation conditions of knowledge sharing which has many characteristics, such as the confidentiality.

Assumptions in the model:

- ① In the process of supply chain knowledge sharing, there are only the principal clusters and the agent clusters. In the principal-agent relationship, the principal shares the product demand information with the agent, and the agent shares the production technology and production process with the principle, this is a process of sharing knowledge mutually, the sharing information from the both sides is complementary;
- ② The decision-making process of knowledge sharing is under conditions of incomplete information, is the decision-making process which has the limited rational analysis feature.

In the green supply chain, the principal will take the  $x$  unit of products entrusted to the agent to produce, but the principal and agent will not form this relationship without any condition, the two sides will only enter into the contract after they all reach the expected utility. That is the utility acquired by the main body can compensate for the risk incurred by knowledge sharing. Then, after the principal-agent relationship of the two sides is determined, the principal can get the utility  $U_p$  from  $x$  units of products; while in normal production activities, even if the principal cannot know the production cost of the agents, the two sides also hold the same idea about this issue, namely: the total cost  $C$  is consist of two parts, fixed cost  $F$  and marginal costs  $L$ . But different agents has different efficiency, when the types of agents is unknown, the principal will have that the probability of  $p$  enter into a contractual relationship with high efficiency agent (Lh), while the probability of  $(1-p)$  will enter into a contractual relationship with the low efficiency agent (Ll).

$$C(x, L_h) = L_h x + F \quad p \quad (1)$$

$$C(x, L_l) = L_l x + F \quad (1-p) \quad (2)$$

For the production of green supply chain, it is has more emphasis on social problems than the production of common supply chain, green supply chain aims at going green and environmental protection in the entire production process of supply chain. Then we will again take the social problems as the relation, and it will generate the social welfare ( $U_s$ ) after the establishment of the relation, and it has a constraint condition that to ensure the agent's work has social value.

$$U_s = U_p - L x - F \geq 0 \quad (3)$$

Considering the utility  $U_a$  which the agent obtained, here we believe that the utility comes from the information advantages which the agent has than the principal, it is arising from the transfer payment  $T$  which the agent obtained ( $T_h$  represents the transfer payment which the high efficiency agent obtained,  $T_l$  represents the transfer payment which the low efficiency agent obtained), it is referred to as the information rent.

$$U_a = T - Lx \quad (4)$$

Before the two sides achieve a contractual relationship, as principal, firstly the optimal planning problems of the principal is should be considered, while also pay the information rent as less as possible.  $U_{ph}$  represents the utility which the principal obtained under the high efficiency agent;  $U_{pl}$  represents the utility which the principal obtained under the low efficiency agent.

$$\max p(U_{ph} - T_h) + (1-p)(U_{pl} - T) \quad (5)$$

Use the definition of the information rent (4), through variable substitution, the objective function of the principal becomes:

$$p(U_{ph} - L_h x) + (1-p)(U_{pl} - L_l x) - (pU_{ah} + (1-p)U_{al}) \quad (6)$$

Optimal planning problem of the principal is:

$$\max p(U_{ph} - L_h x) + (1-p)(U_{pl} - L_l x) - (pU_{ah} + (1-p)U_{al}) \quad (7)$$

Under normal circumstances, the principal and the agent only can sign the contract in advance, and then the principal can not know the type of the agent, by this time, the principal should have different programs for different types of the agent. This type can be identified as the degree of confidentiality of the agent resources, or that it is the risk factor of the knowledge sharing which may be undertaken. So we will discuss the different contract options under the assumptions of the risk of different agents and principal assumptions.

### 3.2 The agent model

From the perspective of the agent's attitude to the risk, the agent is divided into the risk-neutral agent and the risk-averse agent.

#### (1) The risk-neutral agent

Assume that if the agent is risk-neutral, then the participation constraint of the contract establishment is:

$$pU_{ah} + (1-p)U_{al} \geq 0 \quad (8)$$

$U_{ah}$  represents the utility which the high efficiency agent obtained in the contractual relationship;  $U_{al}$  represents the utility which the low efficiency agent obtained in the contractual relationship. Participation constraint expresses that beforehand contract must ensure that expect information rent of the agent can not be negative, so as to achieve the contract. From the formula (6), it can be seen that the objective function of the principal is the decreasing function of the expect information rent of the agent. In fact, the optimal contractual relationship for the principal is that the information rent they give to the agent is 0. The principal makes ( $U^a \geq 0$ ) through adjusting the  $U^a$ .  $H$  represents the transfer payment which the principal can adjust. Realizing the incentive constraint is:

$$T_h - L_h x = U_{ph} - L_l x - H > T_l - L_l x = U_{pl} - L_l x - H \quad (9)$$

The principal can adjust the transfer payment to ensure the establishment of participation constraint in advance:

$$H = p(U_{ph} - L_h x) + (1-p)(U_{pl} - L_l x) \quad (10)$$

#### (2) The risk-averse agent

Still assume that the principal and the agent's contract is signed in advance. In this case, the incentive constraint which the agent requested has not changed, but the beforehand constraint becomes

$$pU_{ah} + (1-p)U_{al} \geq 0 \quad (11)$$

Optimal planning for the principal:

$$\max p(U_{ph} - L_h x - U_{ah}) + (1-p)(U_{pl} - L_l x - U_{al}) \quad (12)$$

$W$  is the degree of the knowledge sharing of the principal, referencing the utility function of the constant absolute risk-averse coefficient

$$u(x) = \frac{1 - \exp(-Wx)}{W}$$

$$U'(\Delta x) = L + \frac{p}{(1-p)} \Delta L \left( 1 - \frac{1}{p + (1-p)\exp(W\Delta L\Delta x)} \right) \quad (13)$$

In the case that the agents is risk-neutral, that is the care degree of the agent for the knowledge sharing is moderate, when the agent is high efficiency, the agents can get higher remuneration than expect information rents, then the agent will be happy to form a knowledge sharing contract, under the premise of sharing resources, agents also get the satisfaction of the expectancy award; but when the agent is high efficiency, he will be at a disadvantage in this contractual relationship, or even punished, which indicates the agents may not achieve knowledge sharing in this case, the formation of such a relationship may cause the cost of the agents is higher than the utility, even cause the loss of core competencies. The implementation of this punishment, in fact, can be used as a negative payment, and then it is required the legal responsibility can be detailed stated, also required the strong judicial protection when the contract is

signed in advance. At this point, the optimal incentive compatible contract can implement the Pareto optimal allocation. Distribution of information rents is inevitably with a certain risk, in the case of achieving Pareto optimal, the principal will transfer the earnings which brought by the contract relationship to the agent, and the agent will acquire all of the remaining, while he will undertake the distribution risk of the information rent that occurred by the establishment of the contract.

When the other side is a risk-averse agent, the agent holds the cautious attitude to the formation of knowledge sharing relationship; it is not only the issue of the satisfaction of the expected revenue, as well as the protection of their own resources, and the principle can not meet the expect information rent of the agent through totally depending on the distributions of the information rent to determine the contractual relationship. In order to ensure the agent participate in, the principal is necessary to bear part of the risk, then the risk-averse of the agent reduces the incentives strength that principal may give. At this time, the factor of the risk-averse coefficient will be taken into account. When the higher coefficient, the agents will be less willing to share their own resources with the other sides; when the risk-averse coefficient of the agent is particularly high, the utility convergence of the high efficiency agents and the low efficiency agents will be appeared, this convergence is that the contractual relationship may not be formed in advance, but afterwards the accomplishment effect of two sides is equivalent. Therefore, when determine the contract with the risk-averse agent, the agents' views on the knowledge sharing risk is a very important factor.

### 3.3 The principal model

Considering the risk assumptions of the different types of agents, meanwhile the risk propensity of the principal should be determined. Divide the principal into risk-neutral principal and risk-averse principal, and define the formation conditions of knowledge sharing relationship and make sure the formation of sharing relationship through further analysis of different types of principals.

(1) The risk-neutral principal

$$U_p - U_a - U_s \geq 0 \quad (14)$$

$$U_p = -Lx - F - U_s + WZ \quad (15)$$

W represents the shared intention of the principal, and Z represents the remuneration that obtained by the principal in the knowledge sharing.

In case that the principal is risk-neutral, the expected utility of the principal equals the expected revenue.

(2) The risk-averse principal

When the principal is the risk-averse, whether the agent is a high efficiency or low efficiency, the principal will get the safest expected revenue in case of the established relationship. At this point, there are the following constraints:

$$U_{ph} - L_h x - U_{ah} = U_{pl} - L_l x - U_{al} \quad (16)$$

$$pU_{ah} + (1-p)U_{al} = 0 \quad (17)$$

So the principal's optimal planning problem is:

$$\max p(U_{ph} - L_h x - U_{ah}) + (1-p)(U_{pl} - L_l x - U_{al}) \quad (18)$$

When the optimal output is  $\Delta x$ , the optimal utility  $U'$  will be achieved:

$$U'(\Delta x) = L_l + \frac{p(U_{pl} - L_h x - \Delta L \Delta x)}{(1-p)(U_{pl} - L_l x - \Delta L \Delta x)} \Delta L \quad (19)$$

Solved:

$$U'(\Delta x) = L_l + \frac{p}{(1-p)} e^{W(U_{pl} - L_l x - \Delta L \Delta x - U_{ph} + L_h x + \Delta L \Delta x)} \Delta L \quad (20)$$

When the principal is risk-averse, both sides enter into the contract in advance to realize the best incentive, that is, the implementation of the Pareto optimal allocation. The principals take the certain degree of insurance measures for their own knowledge sharing risk, due to the impact of  $W$ , the risk of knowledge sharing is minimized when its optimal allocation is achieved, and even the principal transfers the part of the risk to the agent.

The risk-averse of the principal is understandable, first, they disclose their sales information and the market demand information to the agents, and it may result in the risk of their own sales channels occupied by others. In addition, if the principals are constrained or controlled by the budget, or the high-risk industries need some other partners to share the risk, then it will have an impact on the degree of knowledge sharing of the principal, so as to affect the incentive effects of both sides. Regardless of the agent or principal, when his degree of the risk-averse is higher, the incentive effect of the other side is smaller. Therefore, in the case of incomplete information, the attitudes of knowledge sharing from both sides and the confidentiality degree of their resource advantage must be first taken into account before both sides sign the contract. Considering the related incentive factors of the knowledge sharing, it sets up the reasonable the value which will meet the expected utility, and to form the incentive and the contract. Both sides constitute the cooperation and trust relationship, and it makes the knowledge sharing relationship form a good operation mode to achieve the optimal allocation of resources.

#### **4. Building knowledge sharing mechanisms**

The above part builds the corresponding principal-agent model based on principal-agent theory. Through the analysis of the results, it is observed that companies are reluctant to share their knowledge initiatively, mainly because of the game relationship between risk-sharing and incentive, worrying that their core interests is damaged to lose competitive advantage. How to increase trust among the member enterprises, and take effective measures to encourage enterprises to overflow their knowledge actively, becomes the key issue of knowledge sharing and knowledge innovation of green supply chain. To solve these problems, this paper further proposes the countermeasures to build effective sharing mechanism from internal and external environment.

(1) Trust mechanism. Trust is the lubricant of knowledge sharing among enterprises in green supply chain, is the basis of voluntary cooperation among enterprises. Mutual trust among the member enterprises can reduce the negotiation costs and knowledge management costs when choosing each other. At the same time, the trust level decides the cohesion of green supply chain and the discretion of management efficiency. Therefore, to achieve effective knowledge sharing among enterprises, trust mechanism must be established firstly; and the effective communication and the accuracy and timeliness of information transfer are the foundation of increasing mutual trust. To establish the trust between each other, firstly member enterprises jointly develop the security system of trust under the guidance of the core enterprise, and then further develop into trust process based on reputation, and ultimately achieve self-conscious trust behavior.

(2) Incentive mechanism. In the operation process of green supply chain, knowledge sharing between enterprises only depended on the will and trust is far from enough; it is unrealistic that the knowledge supplier free provides the knowledge but can not get the corresponding value in return. At present, many developed countries generally give the rich economic compensation to the knowledge supplier in the process of establishing the knowledge sharing mechanism. This will make enterprises feel the benefits brought by the knowledge sharing outweigh monopolizing the knowledge, thus enterprises are willing to actively participate in the knowledge sharing. Therefore, the establishment of an effective incentive mechanism becomes a core issue. In the knowledge sharing process, it can design the strategy which combines the internal and external incentive mechanisms, meanwhile build the equitable distribution of benefits and salary system. Generally, it is difficult to achieve effective knowledge sharing with one time incentive, and it requires multiple iterative incentives to reach a predetermined goal.

(3) Coordination mechanism. Establishing the good coordination mechanism is needed to ensure to achieve the goal of knowledge sharing between enterprises in green supply chain. In order to meet the diverse needs of customers timely and improve the agility of the green supply chain operation, it needs that member enterprises keep highly consistent, that is, they need high coordination from strategic level, tactical level and operational level, to accelerate the speed of knowledge transfer and improve the efficiency of knowledge sharing. In the knowledge sharing process, in order to make better coordination for enterprises, firstly the capability of knowledge sharing must be improved. This can be achieved by the establishment of the coordination group and the organization of regular training for industry associations, also through the establishment of learning teams, strengthening the explicit knowledge transfer; and building knowledge base, database, interacting with each other through the network platform for effective coding knowledge to store; meanwhile, focusing on the importance of tacit knowledge for competitive advantage, and strengthening the externalization of tacit knowledge.

(4) Risk-control mechanism. Because of the change of factors, such as asymmetric information, information distortion, market uncertainty, political, economic and legal factors, knowledge sharing between enterprises in green supply chain will be led to the existence of a variety of risks. In order to avoid and prevent the risks that may exist in knowledge sharing, it must take the certain measures to establish the effective risk-control mechanism. First, it should strengthen the daily management of the risk, and establish the early warning evaluation system, and then it can send out the warning signal timely when faced with the risk; after the early warning signal is sent out, there must have the emergency response capacity, as far as possible to avoid to bring the serious consequences to the member enterprises in green supply chain, and to make the actual losses to a minimum. While it also must strengthen the protection of knowledge base and database, and prevent the leakage of core knowledge through the encryption and permissions settings.

## RESULTS AND DISCUSSION

In the face of the increasingly serious situation of environmental pollution, the governments and public pay more attention to environmental protection than ever before; the global consumer market is also constantly shifting to green market; and the enterprise must deal with the relationship with environment if it wants sustainable development; therefore, the effective implementation of green supply chain becomes the focus of study for many scholars currently. The knowledge sharing has more realistic significance for green supply chain operations, if knowledge resources cannot be fully shared and complementary advantages, it will lead to increase the corporation cost, and reduce the overall economic efficiency of green supply chain, and even result in disintegrating the chain. Knowledge sharing can accelerate technology innovation, to make the idle knowledge from one side transformed or passed to the enterprise who is in need, the value which developed by these knowledge may become the core knowledge of the other side. At the same time, the knowledge sharing between enterprises effectively avoid the repetition of knowledge development, also can save resources and protect the environment and to reduce the cost. In view of the deficiency of the research on the green supply chain how to effectively implement knowledge sharing, this paper analyzed the characteristics of green supply chain knowledge sharing through the comparative analysis between the green supply chain and traditional supply chain. On these bases, it builds the model based on the principal-agent theory, and provides the basis for the effective implementation of the green supply chain through the result analysis of the model. Further more, this paper builds the knowledge sharing mechanism, to provide further theoretical support for the effective implementation of green supply chain. In the future, we will go deep into the study of the formation of the knowledge sharing mechanism and how to promote the technology innovation, and carry on the practice test combining with the actual case.

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