Analysis of Information Sharing Mechanism in the Food Industry Green Supply Chain Management and Operation Process

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Abstract In order to effectively address the issues of environmental pollution and food safety in food industry, the green supply chain management should be used in the food industry. However, information sharing is the basis of supply chain management. For this purpose, on the basis of describing the connotation of food industry green supply chain management, the paper introduces the contents and the effects of information sharing mode in detail. It focuses on the barriers of the implementation of information-sharing mechanisms in the food industry green supply chain management and operation process and analyzes the necessity of using information sharing mechanism among the members of the food industry green supply chain management mode by game theory, so as to strengthen the competitiveness of enterprises through supply chain management.

Key words Food industry, Green supply chain management, Information sharing, China

In information society, information is an important resource related to enterprise's survival and development. It is especially important under supply chain management. Because, to the enterprises in supply chain, the abundant information and information sharing between enterprises are of vital importance in production, control and circulation. It is just like scholar Ma Shihua considered that the core of supply chain management is embodied in centralized information processing based on information sharing. So that enterprises in supply chain can directly get the demand information of final users and minimize the uncertainty. Moreover, enterprises can obtain the integral resources information of supply chain in time as well as draw up a plan and organize production based on the constraint of integral resources[1]. However, due to the existence of risk in supply chain(uncertainty), the information sharing may come across many barriers during implementation process (such as barriers in cooperation and technology), thus make an enormous influence to the performance of the whole supply chain. There are times of trade in the food industry green supply chain operation process. However, the degree of information possession of the two parties is asymmetrical. For example, there are information asymmetry in the trade between the suppliers and retailers, the retailers and consumers and so on. The most obvious reflection of information asymmetry in the food industry green supply chain operation process is the information possession condition among suppliers, retailers and consumers. Suppliers and retailers are fully or basically aware of the quality information and safety information of food industry green supply chain. However, to the consumer, because of the information searching cost, there information possession is few.

For this reason, the author makes a brief introduction of how to apply the advanced management idea into the food industry, analyzes the information sharing mechanism of the food industry green supply chain management, in order to provide theoretical reference for the management of food enterprises, make the enterprises improve the food quality constantly and satisfy people's demand of low-carbon environment protection idea.

1 Overview of theory

1.1 Food industry green supply chain management So far, the connotation of Green Supply Chain Management (GSCM) is still in unceasing development and without a certain and authoritative definition. Scholars usually think that Green Supply Chain Management is, under the guidance of sustainable development, a modern enterprise management mode that comprehensively takes into account the environmental effect and resources efficiency in the whole supply chain. It is based on the supply chain management technology and related to suppliers, manufacturers, distributors, retailers, logistics merchants and so on as well as the final users. Its target is to make a triple unification of economic growth, environmental protection and resources saving in the whole supply chain management including purchase of raw material, manufacturing, distribution, transport, storage, consumption and recovery processing[2].

By consulting the existing research findings, the paper defines the Green Supply Chain (GSC) as the collection of purchase of raw material, manufacturing, distribution, transport, storage, consumption and recovery processing from resource development to product consumption with the target of optimal allocation of resources, welfare improvement and compatibility

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to the environment as well as the principle of intergenerational equity and intragenerational equity. It is a system consists of suppliers, manufacturers, distributors, retailers, consumers, environment, regulation, culture and so on. it is the integration of logistics, information flow, capital flow, knowledge flow and other motions. Correspondingly, we can get the definition of Green Supply Chain Management (GSCM). It is with the guidance of the basic principles of sustainable development theory and supply chain management and proceeds plan, organization, leading, coordination and control to the logistics, capital flow and information flow among the participant behavioral agents in the whole green supply chain. It is aimed at realizing resources optimal allocation, improving welfare and achieving compatibility with the environment through optimizing and increasing the speed, certainty and friendly degree to the environment of relevant activities.

Food Industry Green Supply Chain Management, FI-GSCM, is the specific application and development of green supply chain management in food industry. Its target is optimizing resources allocation of food industry, increasing food safety, promoting welfare and achieving mutual compatibility. It not only emphasizes the industrial optimal allocation of resources and food safety but also include the thought of sustainable development. The constitution of FI-GSCM system is complicated, mainly includes four subsystems-production system, consumption system, environment system and society system. The operation of FI-GSCM is built on the basis of the motions like logistics, information flow, capital flow and knowledge flow. It particularly emphasizes the knowledge flow in the supply chain.

1.2 Information sharing mechanism The enterprises join into the food industry green supply chain in the form of dynamic alliance, with information as the communication carrier. Therefore, smooth flow of information is the key to normal operation of supply chain management mode.

Lee (2000), for the first time, puts forward that information sharing mode is the structure of information transfer among panel points and divides the supply chain information sharing mode into information transfer mode, the third-party mode and information centre mode[3]. Liangjing and others, based on the above classification, puts forward that information sharing consists of three aspects of the content of shared information[4], the scope of shared information and the structural model of shared information, and presents support for coordinated-decision information sharing mode[5].

1.2.1 Information sharing mode

1.2.1.1 Information transfer mode. Information transfer mode is a kind of mode that one enterprise put the information transferred from other enterprises into the data base which is built by the partners in the green supply chain management mode, so as to realize information transfer conveniently and expressly and make a decision based on the information[6].

1.2.1.2 Information centralized management mode. Information centralized management mode is to centralize the shared information of the green supply chain management mode in a public data base. Each member enterprise undertakes operation based on the permissions to complete the information communication with partners. Divided according to the provider of public data base, this mode can also divide into the third-party mode and information platform mode.

The third-party mode is to collect information, keep information by a third-party enterprise outside the chain and provide services for the enterprises on the supply chain. It is required to provide users specific information in specific time and demand.

Information platform mode uses the information platform to displace the third-party enterprise. The data transmission and processing between the enterprises' internal information database and the information platform database are complete automatically by the computer. The information service provider just maintains the operation of the platform or develop new functional module according to users' demand. They do not provide specific information service. The kinds and demands of shared information are decided through consultation by the enterprises in each panel points of green supply chain management. The fairness and safety of information sharing get a certain degree of guarantee[7].

1.2.1.3 Information center mode. Information center mode is similar to the third-party information management mode. Their difference is the third-party information system displaces the third-party enterprise and its information system, because it is virtual. Through the virtual information system platform, the partners of green supply chain realize the information sharing[3].

1.2.2 Ways of information sharing mode.

1.2.2.1 Unidirectional transmission. In this mode, information can only transmit in one way. The other side doesn't need to reply the received information, or at least, doesn't need to give real time response. *e.g.*, E-mail transmission, web surfing and so on.

1.2.2.2 Database access. In this mode, users input data in to the data-entry form to access the individual information of the database, such as items status enquiry, sending out private application and order and so on.

1.2.2.3 Data interchange. This mode mainly uses message-switching technique which is based on electronic data interchange to share information. Electronic data interchange is a group of standard for trading partners to carry on transactions. When purchase, transportation and other transactions happening among trading partners, they adopt standardized message form or transmission standards but not paper to transmit transaction data.

1.2.2.4 Sharing program. This mode can make different subject share program besides only the data. But he main parts must formulate standard for mutual communication and shared program. At present, the most usual mode is B/S system structure based on Internet/Intranet. It can access several servers and databases without changing software and program, so that the information sharing is simpler, more rapid and more flexible.

1.2.3 Achieving information sharing in green supply chain management mode can solve the major problem effectively.

1.2.3.1 Reducing the uncertainty of information. Enterprises

in the green supply chain management mode have intimate cooperative partnership relations. But, due to their different target, their working patterns are different because of different management patterns, thinking modes and organized cultures. It brings enormous uncertainty to food industry green supply chain management mode. Specifically, it mainly includes uncertainty of product quality, uncertainty of product green strength, uncertainty of the time and quantity of orders submitting and uncertainty of delivery lead time of supplier, delivered quantity, transportation time of product an transportation condition. The reason is, enterprises of green supply chain management mode can't get communication or achieve information sharing effectively, thereby, the effect of information as communication carrier is weakened, leading to decrease efficiency of the whole green supply chain. If the information sharing of the green supply chain can be achieved, the problem will be readily solved.

1.2.3.2 Decreasing the information risk comes from consign-agent mechanism. Enterprises of green supply chain management mode have cooperative relations, it mainly expresses as consign-agent relation. In this kind of relation, the consignor is usually in a disadvantageous position. Therefore, the agent often obtains the maximum benefit from the partner by increasing in formation asymmetry. We suppose that there is one supplier and one producer in green supply chain management mode. Producer consigns a part of business to the supplier for concentrating himself in marketing survey, product design, sales and services and production management of his enterprise. Because both enterprises are independent benefit subject, they are lack of mutual trust. So, in the consign-agent relation, there may show up two kinds of agent problem. The first one is adverse selection. That is, when the producer (consignor) chooses supplier (agent), supplier gets some information that producer doesn't know and may be unfavorable to the producer. So, the supplier signs a contract with the producer which is beneficiary to the supplier. The producer suffers the loss, so that the "averse selection" comes out-producer makes a mistake to select a supplier that isn't suited to its practical situation. The second one is immoral behavior. We suppose that the information is symmetrical when signing the contract, but after signing the contract, producer can't observe the supplier's some behavior or the change of outside environment is just known by the supplier. In this situation, some suppliers may take some behaviors that is disadvantageous to the producer under the guarantee of contract, and then the producer's benefit is harmed. There the "immoral behavior" comes. The appearance of the above problems is because the enterprises of green supply chain management mode can't achieve necessary information in time. It leads to be in a disadvantageous position in cooperation, and then the activity of cooperation is injured. It is unfavorable for the improvement of the efficiency of the whole supply chain. Therefore, information asymmetry makes food industry green supply chain management mode information sharing become the necessary condition for enterprises to operating supply chain successfully.

1.2.3.3 Remitting bullwhip effect. "Bullwhip effect" is an issue that arouses enterprise attention all the time. At the beginning of 1990s, Procter & Gamble Company of America find that one of their products – "Pampers" has a steady final market demand. But, the orders from retailers to wholesalers fluctuate a lot, and the fluctuating quantity of the orders of raw material from suppliers is more amazing. The products demand is a lot more than practical sales volume in the information transmission from the down stream of supply chain to the upstream of the supply chain. This phenomenon is said by people as "bullwhip effect"[8].

Along with the increase of enterprises in the green supply chain management mode, the bullwhip effect is more obvious. Although bullwhip effect is inevitable, the negative impact of it can be reduced by some advanced management methods or technologies. To the enterprises, achieving information sharing with the support of internet technology is the basic and effective way to reduce bullwhip effect. For, ultimately, bullwhip effect is created by information distortion in the information transmission process. Exactly, green supply chain management mode information sharing can decrease information time delay and information distortion in the transmission process.

1.2.3.4 Coordinating goal conflict of green supply chain management mode. Solving the goal conflict of green supply chain management mode relies on the coordinated mechanism of green supply chain management mode. However, the establishment and operation of coordinated mechanism relies on the abundant, in-time and effective information communication among enterprises in the green supply chain management mode. Therefore, achieving green supply chain management mode information sharing and reaching consensus in benefit distribution mechanism on the basis of coordination can lessen or even eliminate the divergence and mistrust among enterprises of green supply chain management mode, so as to unify the goal of each members to improve the competitiveness of the whole supply chain.

2 The barrier existing in the information sharing of food industry green supply chain management operation

It can be seen from the content and effect of information sharing mentioned above that the information sharing mechanism has a great significance to the enterprises, but it faces a many barriers in implementation process, including barriers of coordination and technology. Only after detailed understanding of possible barriers, we can adopt specific measures to guarantee successful implementation of information sharing mechanism.

2.1 Coordinated barriers Firstly, the competitiveness of food industry green supply chain management mode is not confined among enterprises, it will extend to chains to chains. Therefore, the problems of information transferring to whom, operating by whom, how to adjust information management strategy and how to make scientific prediction and decision need mutual coordination and cooperation among each links of supply chain to optimize information transmission channel and

make necessary business process reengineering.

Secondly, the cooperative enterprises have their respective benefit, their motivations has obvious differences sometimes. It leads to competition happening at the same time of cooperation. Especially, the produces get less direct benefit or even no benefit. Thus the problem of how to mobilize producers to provide clients demand information initiatively is existed.

Finally, the cooperative enterprises worry about the sharing of their information, especially business secret, will make themselves in disadvantageous position and lose the strength of competition. So, they don't want to get information sharing with other cooperators, it generates a lot of difficulties in practical implementation.

2.2 Technological barriers Green supply chain management makes effective management to the information from a brand new height. It starts from the demand of clients and emphasizes information sharing inter- or intra-enterprises is a integration management of the information of suppliers, manufacturer, wholesalers, retailers and the final consumers. In supply chain management, realizing information sharing has a high requirement for information technique, the main technological barriers express as the following four points.

The first one is the information technique should ensure completely and correctly transmit various kinds of shared information. The information in supply chain is often complicated and contains abundant content. For instance, in information technological system of supply chain based on EDI, the processed information contains goods quantity, quality, green degree, order information, clients information and other content. Which kind of message to be adopted, how to simplify and form corresponding standard system and how to ensure the certainty and integrity of information are still problems objectively existing.

The second one is information technology should ensure real-time and in-time shared information transmission. In the days with drastically competition, and there are many links in the supply chain, so the rapid and in-time transmission of shared information is especially important. Moreover, the operation efficiency of the whole supply chain relies on the timely transmission of shared information.

The third one is information technology should guarantee the safety of shared information. Under the condition of EDI, e-business, internet/intranet, the safety of shared information is especially important. If the business secret in practical trading is revealed, it must bring serious consequence to the enterprises.

The fourth one is the standardization of shared information. The shared information of green supply chain management is extremely complicated. Therefore, the collection, storage format and transmission of shared information, information disposal of each module, the information after disposal and other things should all have corresponding standard. In order to realize the information sharing of supply chain management, a necessary premise is the using language in each link of information communication must be the same and standard to make all members correctly transmit and read. Meanwhile, formulating shared information standard should not only be corresponding to the international standard but also consider the practical conditions of our country.

Thus it can be seen that implementation of information sharing mechanism is very difficult to enterprises. It needs to overcome the barriers from coordination and technology. So the enterprises are required to not only pay attention to cooperation but also improve technology to deal with the barriers.

3 Analysis of information sharing among members of food industry green supply chain management mode

On the basis of the above theoretical description, the author uses game theory to analyze the necessity of using information sharing mechanism among members of food industry green supply chain management mode. For convenience, we make the following hypothesis. Hypothesis one: the discussed food industry green supply chain has two main bodies-suppliers and producers. Producers decide the price of the final product B, however, the suppliers decide the price of the medium product A. The producers' final product B needs a unit of medium product A, that is, products sold by producers and suppliers are completely the same. To the producers and suppliers, they own the corresponding private information. Hypothesis two: the demand function of green supply chain management mode is linear function, $P_2(p)=a-bq$, in the function, P_2 is the price of the final product of producers, q is the consumption quantity of consumers, $a>0, b>0$. the unit circulation cost of producers and suppliers is C_i, $i=1, 2$ constantly ($i=1$ represents suppliers, $i=2$ represents producers) decreases along with the increase of available technology information-x_i. We suppose here $C_i=C_{0i}-x_i, C_2=C_{02}+P_1-x_2, C_1=C_{01}-x_1$, among them $x_i=x_{0i}+\Delta x_j, x_{0i}$ is the owned technology information of enterprise-I, $\Delta x_j(0<\Delta x_j<1)$is the technology information achieved by behavioral main body-i from behavioral main body-j, $j=1,2$ and $i\neq$j.

On the basis of the above hypothesis, we discuss the profit levels of information sharing and without information sharing.

3.1 Without information sharing When behavioral main bodies don't make information sharing, the game is supposed to be as follows:

The first stage: the retailers decide the marketing price and corresponding output of final products. The second stage: the suppliers decide the price and corresponding output of medium products. To the retailers, the goal is seeking for maximum profit, that is $\max_{q,P_2}(\pi_2)$. In it, $\pi_2=P_2q-C_2$. In order to realize the goal, the following function must be satisfied $-d\pi_2/dq=0$. After solving, we can get the optimal value q^*, P_2^*:

$$q_{1N}^*=\frac{a+x_{02}-C_{02}-P_1}{2b}, P_{2N}^*=\frac{a+C_{02}+P_1-x_{02}}{2}$$

In the second stage, it is decided by the suppliers. To the suppliers, the goal is to seek for maximum profit, that is $\max_{P_1}(\pi_1)$. In order to realize the goal, the following function must be satisfied $-d\pi_1/dP_1=0$. We can get the optimal price of medium product $-P_{1N}^*$:

$$P_{1N}^{*}=\frac{a+x_{02}+C_{01}-C_{02}-x_{01}}{2}$$

Using the above solving results, we can get the profit level of retailers and suppliers $-\pi_{1N}^{1*}$ and π_{2N}^{1*}.

$$\pi_{1N}^{*}=\frac{(a-C_{01}-C_{02}+x_{01}+x_{02})^{2}}{8b},$$

$$\pi_{2N}^{*}=\frac{(a-C_{01}-C_{02}+x_{01}+x_{02})^{2}}{16b}.$$

3.2 With information sharing When two behavioral main bodies are having information sharing, it is supposed that, through agreement, every main body gives the other the same information, that is, $\Delta x_i=\Delta x_j=\Delta x, \Delta x\ni[0,\min(x_i,x_j)]$. From the above solving process, we can get $P_{1Y}^{*},P_{2Y}^{*},q_{Y}^{*}$ under the condition of information sharing:

$$q_{Y}^{*}=\frac{a-(C_{02}-x_{02}+P_{1}-\Delta x)}{2b},$$

$$P_{1Y}^{*}=\frac{a+x_{02}+C_{01}-x_{01}}{2},$$

$$P_{2Y}^{*}=\frac{a+(C_{02}-x_{02}+P_{1}-\Delta x)}{2}.$$

On the above basis, it can be further get the profit level $-\pi_{1Y}^{*}$ and π_{2Y}^{*} of suppliers and retailers when they are having information sharing:

$$\pi_{1Y}^{*}=\frac{(a-C_{01}-C_{02}+x_{01}+x_{02}+2\Delta x)^{2}}{8b},$$

$$\pi_{2Y}^{*}=\frac{(a-C_{01}-C_{02}+x_{01}+x_{02}+2\Delta x)}{16b}.$$

And the differences of the profit level of retailers and suppliers before and after information sharing $\Delta\pi_1$ and $\Delta\pi_2$ are:

$$\Delta\pi_{1}=\pi_{1Y}^{*}-\pi_{1N}^{*}=\frac{\Delta x^{2}}{2b},$$

$$\Delta\pi_{2}=\pi_{2Y}^{*}-\pi_{2N}^{*}=\frac{\Delta x^{2}}{4b}.$$

We can get from the above that, information sharing between producers and suppliers can improve the profit level of producers and suppliers. That means information sharing can improve the profit of members attending the information sharing. But if we want to realize effective information sharing in green supply chain management mode, we should pay attention to three points: Firstly, the members of information sharing should include not only members in the green supply chain management but also consumers. Due to the limitations, cost of leaning and limited use of time, the consumers can't have the knowledge and ability of their consumed food. This provides possibilities for the products of traditional food industrial mode to replace the products of higher green degree and occupy the market. Therefore, consumers should become the important members of information sharing in the green supply chain management mode. Secondly, the content of information sharing should contain not only stock information but also other knowledge and information, particularly contains relevant information sharing related to green technology and functions information of green product. Thirdly, the measures of information sharing should include not only formal communication but also informal communication.

4 Conclusions

Along with the penetration of low-carbon and environment protection idea, green supply chain management is the inevitable choice of the development of food industry. However, realizing information sharing is the key of green supply chain management. From the practical conditions, the information sharing among the members of supply chain faces various barriers, such as the information technology of enterprises is not enough and so on, some enterprises even intentionally set up barriers for they don't want to share information with others. For this reason, the enterprises of supply chain should change their inherent idea from the base, open to others, strengthen communications with other member enterprises and establish information platform to realize information sharing.

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