Research on Formation Mechanism and Intervention Mechanism of Food Cold Chain Logistics Chain Destruction

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ABSTRACT

The economic and social background formed by our food cold chain logistics has been discussed first and the inevitability of chain destruction happening has been elaborated; chain destruction and composition of economic interests of each subject have been studied by taking economic interest as the mainline and the reason for the formation of chain destruction phenomenon of each subject has been analyzed; at the same time, market supervision and related policy system about our food safety have been studied; finally on the basis of food cold chain logistics chain destruction model, vicious circle phenomenon of chain destruction has been analyzed through analyzing the interaction between chain destruction and each influencing factor. Early warning mechanism before food cold chain destruction and control mechanism in food cold chain logistics circulation process will explain from control technologies such as HACCP system and application of internet of things; remedy mechanism after happening of food cold chain destruction, such as collaborative replenishment strategy and cold chain logistics rescue model etc. have been studied accordingly.

Keywords: Formation Mechanism, food cold chain logistics, intervention Mechanism, food safety;

1. INTRODUCTION

The difference between food cold chain logistics and traditional logistics lies in that food cold chain logistics is with very distinctive 3T characteristics, that is the final quality of logistics is determined by the storage temperature, circulation time of cold chain and storability of product itself. But these characteristics have very high requirement for the requested time of transportation as well as temperature requested for storage. But the influencing factors for the happening of chain destruction phenomenon of “cold chain is not cold” and “two ends cold and middle hot” needs to be analyzed comprehensively; the formation mechanism for cold chain destruction needs to be clarified, only in this way the cold chain destruction phenomenon can be governed from the source and achieves long-term control. In view of this, it is necessary to analyze the phenomenon of food cold chain destruction in a comprehensive and systematic way, analyze the reason for cold chain generation deeply, study the formation mechanism of food cold chain destruction systematically and provide theoretical support and basis for establishing long-term management of cold chain destruction based on related researches at home and abroad (Deng, 2012). Firstly, this paper applies ISM method to study the formation mechanism of food cold chain destruction and studies the intervention mechanism of chain destruction, which is not only helpful to re-examine the structure of food cold chain logistics system and each module, find out food cold chain logistics system for weakening and getting over chain destruction risk of food cold chain logistics, decreasing expected cost of chain destruction in supply chain and
constructing efficient and rapid food cold chain logistics system, but also enrich the theoretical content of our logistics management and food safety management to promote the development of our logistics science especially the development of cold chain logistics science (Hoang et al., 2012).

2. MATERIALS AND METHODS

It can be seen from the composition of food cold chain node that the whole cold chain must integrate these nodes seamlessly, because the cumulative exposure situation of products in cold chain for heat determines the speed of its decay. If a bit of defect in cold chain causes the decay of products or make the product fail to enter normal sales, and then other processes in the cold chain can’t make up or change the damages it produced. It is a long supply chain from the gaining of raw material to the final products on the tables of consumers, while cold chain requires that the whole process must be controlled with low temperature; under current development situation in China, cold chain market is still in a chaotic state and chain destruction phenomenon usually happened in food cold chain logistics. Starting from each chain node of the cold chain, this paper adopts fishbone analysis method to analyze and study the phenomenon of cold chain destruction.

![Figure 1. Food cold chain node chain destruction influencing factors](image)

Fishbone analysis method can be called as cause and effect analysis, which is firstly proposed by Japanese management master Mr. Shi and is also called as diagram. This is a method commonly used by consultants, which can be widely applied in product quality analysis, key factor analysis and enterprise strategy analysis etc (Li, 2016). It is simple, practical and relatively intuitive. The specific steps of fishbone analysis method are:

(1) Confirm the practical problems that need to make cause and effect analysis: reasons causing chain destruction of each chain node in food cold chain.

(2) Make deep investigation and diagnosis focusing on practical problems, summarize past research material, analyze and discuss with people of cold chain enterprises, summarize the
following influencing factors affecting each chain node destruction of cold chain: lacking of unified cold chain supervision and implementation standards as well as laws and regulations, minimizing cost to maximize own interests, illegal operation under malicious competition, low technical level for refrigeration and freezing, lacking of equipment and facilities, lacking of third party logistics enterprises (Li and Nien, 2012). Small-sized and scattered cold chain enterprises, weak cold chain consciousness and less attention to management details etc.

![Figure 2](image-url)  
**Figure 2.** Different strategies payment Matrix game

(3) Draw fishbone diagram (as shown in Figure 1), taking practical problems need to be solved as fish heads, taking main aspects related to problems as the backbones of fishbone, taking main factors related to problems as big fish bones and taking specific factors related to problems as small fish bones.

(4) Make cause and effect analysis, summarize problems, discuss internal cause and effect relationship and confirm main reasons for problems according to fish bone diagram.

3. RESULTS AND DISCUSSIONS

3.1 Analysis of Market Supervision Level

(1) Concept assumption

This paper analyzes the problems of government supervision and illegal operation in food cold chain with adoption of principle agent theory. Firstly make assumption for the game between food cold chain and government supervision:

Participant assumption: participant is the main body for decision making in one game, in this paper, it mainly refers to food cold chain supplier and government supervision department. Its objective function is to maximize its payment level through selecting activities or strategies. In addition, the decision-making between them is independent (Liang, 2011).

The main work of government supervision department is to supervise the supplier of food cold chain. Foods suppliers usually maximize own interests through saving cost.
Food cold chain suppliers have only two kinds of strategies: illegal operation and legal operation.

The supervision method of government can be predicted by food cold chain supplier.

In the game, various costs and earnings can be attained in the future between cold chain supplier and government supervision department can be estimated, which is a kind of public information, in addition, their know the behaviors of each other. If food cold chain supplier breaks the law, it can be checked by supervision department (Liu and Zhao, 2013).

(2) Construction of game model

Assume the probability of illegal operation of food cold chain supplier is \( p \), the probability of non-illegal operation is \( 1-p \); the supervision probability of government supervision department is \( q \) and the non-supervision probability is \( 1-q \). Under normal situation, the earnings of food cold chain supplier is \( R \) and cost is \( C \), while if the expected earnings of illegal operation is \( R_1 \), \( R_1 > R \). The cost of government supervision is \( M \), the punishment for illegal operation of food cold chain supplier is \( Q \) and \( R_1 - C - Q > R - C \). As shown in Figure 2, it is the payment matrix of supervision model under different strategies. The probabilities of following four situations are \( pq, p(1-q), q(1-p), (1-q)(1-p) \) respectively and then solve the nash equilibrium for mixed strategy.

Assume the expected earnings of food cold chain supplier is \( U_1 \), then

\[
U_1 = (R_1 - C - Q)pq + (R_1 - C)p(1-q) + (R - C)(1-q)q + (R - C)(1-p)(1-q)
\]

(1)

\[
p = \begin{cases} 
0 \left( q < \frac{R_1 - R}{Q} \right) \\
(0,1) \left( q = \frac{R_1 - R}{Q} \right) \\
1 \left( q > \frac{R_1 - R}{Q} \right)
\end{cases}
\]

(2)

\[
p = \begin{cases} 
0 \left( p < \frac{2M}{Q} \right) \\
(0,1) \left( p = \frac{2M}{Q} \right) \\
1 \left( p > \frac{2M}{Q} \right)
\end{cases}
\]

(3)
3.2 Consciousness level analysis

(1) Weak cold chain awareness

Cold chain market develops rapidly, but the fatigue state of market can be found through deep exploration, the main reason lies in the fact that the market lacks a strong motivation power—not realizing the important of cold chain to fresh food. Cold chain system in Europe and United States is quite perfect and in R there is no saying about “food without pre-cooling is not welcomed”. However, many suppliers, sellers, consumers in China have no concept for food cold chain logistics and they are with weak cold chain awareness. The destruction of cold chain awareness causes the destruction of practical cold chain, which worsens the development of food cold chain logistics in China.

(2) Greedy awareness

Greedy is common mentality of illegal tendency of profit. After attaining profit by performing cold chain operations by many times, the violators attain psychological pleasure and successful experience and the greedy desire strengthens gradually, causing vicious circle.

(3) Speculation awareness

Motivated by greedy awareness and speculation awareness, food cold chain illegal violators forget the laws and regulations and desperate to make illegal operations to attain the maximum profit of enterprises (Liang, 2011).

(4) Conformity awareness

Drift with the current in the big environment, short-sighted, pleased with one-time profit, which cause rampantly vicious competition and illegal operation.
3.3 Analysis for formation mechanism

The frequent happenings of food cold chain destruction phenomenon make the cold chain market become chaotic and form vicious market competition focusing on price competition. To attain more profit, cold chain awareness is slack. Take illegal operation of decreasing cost as the main competition method and then cause bad chain reactions of deconstruction and food safety accidents etc.

![Diagram of food cold chain logistics information network system](image)

**Figure 4.** Food cold chain logistics information network system

It can be seen from above analysis that there are various reasons for the generation of food cold chain logistics destruction, which include not only the reasons of origin of logistics enterprises, but also reasons of market, policy, system and laws etc; at the same time, there are also reasons of overall environment of our social and economic development (Li, 2016). It is almost impossible for us to differentiate the influencing degree of each influencing factor quantitatively from the process of food cold chain destruction, but if there is one factor exists, it may possibly cause the destruction of food cold chain logistics.

The formation mechanism of food cold chain destruction is as shown in Figure 3.

3.4 Early warning mechanism of food cold chain logistics destruction

Firstly, our country should continue to improve food cold chain logistics information website, establish food cold chain logistics information center by taking this website as platform, based on integrating existing resource and with adoption of database management system to classify and select food borne diseases of frozen food and fresh food, real-time supervision of hazards and temperature, danger evaluation of destruction etc and make comprehensive analysis and supervision; make evaluation and early warning for food cold chain logistics situation (Liu, 2014), open to the public regularly through early warning publishing platform of food cold chain logistics information to make related departments and consumers attain various information about food cold chain logistics timely and conveniently, ensure the right to know of the public and encourage the public to participate in safety supervision of food cold chain logistics quality, as shown in Figure 4.

At the same time, information communication platform-food cold chain logistics destruction analysis early warning information delivery system, among departments should be constructed as soon as possible; realize information resource sharing of food cold chain logistics, improve emergency report system continuously, set up open, timely and smooth information network system, minimize sudden and potential food cold chain destruction risk.
and achieve early discovery, early prevention, early treatment and early settlement for food cold chain logistics destruction problem.

Improve the existing food safety early warning mechanism, set up special early warning organization framework construction for food cold chain safety, strengthen organization framework support system charged by government, intermediaries, enterprises and continuously by taking laws as assurance on existing basis; equip professional workers, who is in charge of propaganda of food cold chain safety and staffs training on one hand; on the other hand, make good supervision and early warning of cold chain destruction (Li and Nien, 2012).

(1) Make reasonable planning and division of labor

![Food chain logistics chain scission warming organizational framework for the construction](image)

**Figure 5.** Food chain logistics chain scission warming organizational framework for the construction

Food safety is in close relationship with the life of people, different from other emergent events, it relates to the confidence of people to nation and happiness of people to life. Therefore, the government plays an absolutely dominant role in the early warning of food cold chain destruction, compared with other early warning subjects; it is with more authority and implementation effect. Through setting up food cold chain supervision
mechanism, the government strengthens the system and coordination of laws and regulations of food cold chain, avoids unclear division of labor and crossing management situation in law enforcement process, makes re-division of labor for crossing and repeating parts, makes integrated planning and distribution for blind area of management, makes full use of existing early warning temperature control technology to make responsible, fair and effective supervision of food cold chain in a genuine way.

(2) Build up communication mechanism of government, enterprise, intermediaries and media

The management of food cold chain early warning mechanism should not neglect the promotion function of enterprise, media, intermediary and consumer. The supervision of government is only external constraint; the process operation and self-inspection of food cold chain supplier, logistics provider and vendor specifications are the internal decisive factors, as is shown in Figure 5.

![Figure 6. Food cold chain logistics alliance mode](image)

First, it is the source effect of food cold chain supplier, because they are the first line of defense of food cold chain. The happening of food cold chain destruction can only be prevented effectively only through the rigid constraints and requirements of food cold chain supplier to logistics provider. Therefore, it needs to put emphasis on the food cold chain supplier in early warning mechanism to encourage them to make early warning management actively. Second, media and intermediary play a key role in information communication and publishing. The media can spread the early warning information and early warning countermeasures of government timely, intermediary organization can contact consumers with the shortest distance, who also play an important role in supervision of cold chain market and promotion of cold chain technology.

Last, as the last process of food cold chain, if the consumers want to maintain their rights, they should not purchase the decayed and smelly goods, offer feedbacks to vendors timely and establish good cold chain market order. Meanwhile, the government should guide a correct consumption concept among consumers for frozen food and fast frozen food and
establish early warning mechanism for food cold chain in a genuine way, as is shown in Figure 6.

4. CONCLUSION

Starting from chain node composition of food cold chain logistics and destruction reason of each chain node destruction, this paper analyzes the formation mechanism of our food cold chain logistics destruction and establishes intervention mechanism for early warning, process control and post restoration with adoption of information economics, system engineering and other theories from six layers of economic and social environment, economic profit motivation, technology, market supervision, laws and regulations and awareness.

(1) It can be learnt from research on destruction formation mechanism that the focus of early warning mechanism of food cold chain logistics destruction is to improve the basic database of food cold chain logistics information, set up information early warning and publish platform for food cold chain logistics destruction and construct early warning system for food cold chain logistics information. Based on this, establish early warning organization framework and strengthen the construction of early warning laws and regulation system and improve construction of cold chain logistics.

(2) The focus of control mechanism of food cold chain logistics destruction is to establish HACCP control mechanism, effective supervision mechanism, cold chain alliance mechanism and information sharing mechanism, during which time; it can't be separated from the adoption of various cold chain logistics information technologies. Only through improving cold chain logistics information technology can real-time tracking and tracing as well as making control and management of the whole process be realized effectively.

(3) The remedy mechanism of food cold chain logistics destruction mainly takes remedial measures for transportation, distribution, sales and consumption processes and improves the construction of the whole cold chain.

5. REFERENCES


