

The Literature Review of Food Supply Chain Risk Assessment

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Abstract

In recent years, China's food safety problems emerge in endlessly, from the "sanlu milk powder contains melamine", "Shuanghui contains clenbuterol", to wal-mart false green pork, the occurrence of these events, makes the "safe" on the tip of the tongue is more and more attention. Food supply chain's each link is closely related to food safety, strengthen the risk management in the process of food supply chain operation is to avoid the urgent requirements of food safety and quality accident. The implementation of accurate, comprehensive and rapid analysis of supply chain risk assessment is a key link in the process of risk management. This article mainly Analysis of the research literature related food supply chain risk assessment ,so that we can better evaluate the domestic and foreign's research progress of food supply chain risk assessment.

Key words: The food supply chain; Risk assessment; Food safety

1. The introduction

In recent years, with the rapid development of our economy, people's living level continuously improve, our country's food industry has achieved rapid development, at the same time people has higher requirement for food. However, in recent years, food safety problems emerge in endlessly, Sudan red, cooking oil, poison capsule appalling events occur frequently, such as all kinds of food safety "door" testing the endurance of consumers, the open of the series "door", let consumers have a concern on food safety, people can not help send out such a question, "how many" door "to open in the future?"

In recent years, research on supply chain risk management and risk assessment is gradually heating up. Especially the food industry which with a long supply chain and the increasing uncertainty of the supply and demand, the research of the food supply chain risk management and risk assessment is more urgent and important.

2. The current research status of food supply chain risk

The food supply chain point to each link from primary production to consumption and operation order, includes that food and its accessories production, distribution, storage and processing (including in food production, the production of animal feed on, and the material may contact with food and raw materials production). The current studies of food supply chain mainly stay in from the Angle of the qualitative to analysis the risk factors, and puts forward some countermeasures to prevent or solve the risk. Such as Xiaolin Chen, Junwen Feng(2007) shows that the food supply chain and the general industry supply chain is different, they think the food supply chain risk mainly includes the technology risk, information risk, coordination, quality safety risk. Liang Xing, Yanhong Zeng (2006) analyze Shenzhen has taken some measures, in order to strengthen the management of production source, to ensure the quality and safety of agricultural products (food), mainly from the following five aspects: accelerate the process of agricultural standardization; implementation the whole process supervision of inputs, establish a product traceability system, and establish agricultural production operator self-discipline mechanism, establish a sound system of agricultural product quality safety risk assessment (food).

Weibin Zhang, Zhenyu Gu (2007) through the analysis of the food safety problems in the process of food supply chain, put forward that based on the EAN UCC system, through electronic food supply chain management, and applies the RFID technology in the food safety traceability.

Fucai Xu, Shaodong Meng (2010) by based on the cause of food supply chain risk, from food quality and safety risk, risk of logistics, food information risk, system risk four aspects carries on the analysis, gives a method of food supply chain risk assessment, finally proposed the corresponding risk prevention measures. Tongli Liu, Yaoqi Wang (2011) by analyzing the existing situation and problems of food supply chain in our country, put forward including dredging and improving the entire supply chain, scale of operation, national supervision, and set up professional logistics companies and logistics system which is the main way to solve food quality safety issues currently facing. Yu Zhang , Shouyang Wang (2010) proposed a model framework of quality and safety management, mainly including the traceability, transparency, detection, timeliness, and trust the five elements. Among them, the retrospective is defined by a series of process management, making the information related to all aspects of the product area associated, from raw materials to semi-finished products and finished products, by querying the information of products, products can be traced back to the last link of related information; Transparency refers to the various departments involved in the supply chain system can realize information transparency; while detectability and timeliness requires the logistics construction can be adapted to demand, trust is the basis for cooperation between the upstream and downstream enterprises in the supply chain. Hennessy (2001) discussed in the supply of safe food, the food industry play a leadership role. Neilvass, m.d., (2006) put forward that in the process of cold chain logistics through the adoption of HACCP theory analysis we can find out key hazard point in the cold chain logistics, and using technology to solve cold chain temperature monitoring logistics which lead to food safety issues.

3. The research summary of supply chain risk evaluation indicators

Supply chain risk management is an important part of supply chain management. Scholars in the research of supply chain risk assessment both at home and abroad, mainly reflected in the construction of supply chain and supply chain risk evaluation index system of risk evaluation method two aspects.

There are two more classic research in foreign research for supply chain risk assessment index system, the first example is a European telecoms giant put forward , who proposed the processing method of financial information can be used to handle risk information; The second example comes from a semiconductor manufacturers in the United States, the enterprise in order to solve the problem of supply chain risk in the early phase of raw materials life cycle, proposed eight important factors of the risk assessment . European telecoms giant in the supply chain risk assessment process, first of all, held a meeting by the collaborators of risk assessment process and the product manager, a semi-annual meeting, second of all products related to evaluate the effects of the risk, followed by an assessment of all the risks associated with the impact caused by the product, and each quarterly reporting to the risk assessment decisions collaborators. Evaluation and measurement process in 13 areas to consider, as shown in Table 1.

Table 1: Risk assessment of 13 areas (Europe,for example)

NO.	Risk assessment
1	The additional transportation costs because of lack of advance planning
2	The additional costs because of the lack of pre-planned that action was canceled
3	The additional costs caused by old expired raw materials
4	The unexpected raw material prices rise because of the allocation problem
5	The unexpected raw material prices rise due to production problems
6	The unexpected raw material prices rise because of the specification change
7	The loss caused by delay in delivery
8	The loss caused by supplier product quality defects
9	Loss of vendors due to unreliable reputation
10	The contract risks
11	The unexpected raw material prices rise because of the companies are on the rise,expand the scale stage, single source of raw materials
12	Investment in supplier for its improvement
13	The current risk

Semiconductor companies in the United States subdivided the 10 steps in the risk assessment process. Risk assessment factor has 8 elements, these factors is very important for a reliable prediction of the rich raw material and service supply system.

These factors include: design, quality, cost, delivery efficiency, manufacturability, suppliers, laws and regulations, as well as environmental, health and safety factors. The definition of the eight factors are shown in table 2. The product manager will be combined with the actual situation analysis of these factors, and divide risk level of each factor.

Table 2 risk attribute definition (U.S.companies, for example)

Risk measure	assessment	definition
design		Refers to according to production target design, test design, and the ability to create a product, it is package which including the design of the company and suppliers, involved in the outsourcing supplier service
quality		Direct and indirect materials, services and products continue to meet the specifications and requirements, and support the system in place to ensure the controllability
cost		Budget costs from consumers, the industry benchmark, the standard cost model and determine the appropriate trading decisions plan
Validity of supply		The estimate for the material fee which are not mention but conform to the requirement and is suitable
manufacturability		When raw materials conform to the specifications and the risk associated with manufacturing production capacity. Also before the material acceptance we should consider the potential problems, such as material conform to the specifications but can't meet the production target
supplier		Evaluating and selecting good suppliers that have a healthy financial position, and where the region's political stable, less natural disasters. Also to be considered when the company will be too dependent on the supplier industry business
Laws and regulations		Raw materials, products and services related to the substantive legal issues, such as import and export restrictions, taxes risks associated with the closing terms. Additional risk factors include raw materials, products and services related to mandatory legal restrictions
Environmental, health and safety		Company and its suppliers use and handle hazardous materials, and compliance with environmental laws and other governmental policies and regulations

4. Summary of supply chain risk assessment methods

The research of supply chain risk assessment methods was started earlier at abroad, and has made some achievements. In the early risk assessment, primarily based on past experience and control of the entire supply chain to judge, with advances in technology and the generation of some new techniques and methods, in particular the development of computer technologies, scholars often use quantitative methods to study Supply chain risks, but these quantitative evaluation methods often have subjective color; at present the most used is a combination of quantitative and qualitative methods, this method can make more accurate assessment of supply chain risks. Domestic scholars' representative research results in this area are:

Yan Jia (2001) etc., who proposed an assessment method for supply chain risks based on genetic algorithm, used genetic algorithm to solve supply chain risk model; Weidong Ding (2003) used fuzzy factor analysis method to solve supply chain risk assessment model; Yu FU(2005) adopted artificial intelligence reasoning method to solve the supply chain risk assessment model; Jun Wu(2004) etc., who used Conditional Value at Risk (Conditional Value at Risk, CVAR) to solve the supply chain risk assessment model; Xinli Wang(2010)^[41] built BP neural network expert system for supply chain risk assessment, the study shows that this method is able to make more accurate assessment of supply chain risks.

As the supply chain risk assessment is uncertain, therefore scholars use subjective methods under normal circumstances, of course, some scholars have adopted objective methods. Subjective methods mainly are AHP, fuzzy evaluation method and gray evaluation method; objective methods mainly are entropy method etc. The overall risks of supply chain are composed of multiple risk fitting. Most scholars at home and abroad believe that there is a linear relationship between these different risks, the easiest way is to first determine the degree of importance that each risk weights, then use the weighted average of the individual to synthesize an overall risk.

Xiaogan Jiang, Fenglin Chen and Feng Wang^[11] proposed a risk assessment system of supply chain from the perspective of supply chain operation structure, they believe that in the supply chain the risk most likely to occur between the upstream and downstream enterprises are the logistics risk and organization risk, logistics has a general impact, organization basically has a small impact on the supply chain, although the possibility of information risk is higher, it has little impact on the supply chain.

Among various risks occurred in enterprises, the probability of cooperation risk is low, but once it happens, the impact is particularly destructive; most likely is profit risk, profit volatility followed by its general destructive power. Among external risks of the supply chain, the most destructive one is natural environment, sufficient to cause paralysis of the supply chain, but the possibility of its occurrence is moderate; the risk brought about by the domestic economic environment is the most vulnerable, but its destructive ability is general; legal environmental risk has a moderate occurrence probability, and its destructive power is in general. They believe that these aforementioned three levels, from small to large, from the point to line, face, should be expanded layer by layer. For each process, evaluation factors should be selected, the impact extent and occurrence possibility of assessment factors should be determined, also the evaluation results should be calculated, and finally by linear superposition the whole supply chain risk is got.

Here are a few of the most common supply chain risk assessment methods:

(1) Analytical Hierarchy Process (AHP)

AHP is a combination of qualitative and quantitative analysis proposed by operational research experts Saaty at the University of Pittsburgh in the mid-1970s. The basic principle of AHP is to divide the target into several levels through the relationship between its various indicators, the same level indicators have the same degree, and different levels have a certain affiliation. AHP calculation is relatively simple, the finally obtained results are the relative weight of each indicator of the target layer.

The advantage of AHP is the combination of the qualitative analysis and quantitative calculation, which can not only reflect the advantage of qualitative analysis, and has the advantage of quantitative analysis; while using the perspective of system, analyze from an overall view, so that it can grasp the overall situation, with a very broad application space. The disadvantage of AHP is also evident, mainly in the weight index of judgment matrix, affected by experts' subjective relatively largely, and sometimes the judgment matrix does not meet the consistency.

(2) Fuzzy Comprehensive Evaluation Method

Fuzzy comprehensive evaluation method is also a commonly used supply chain risk assessment methods. In 1965, cybernetics expert at the University of California, LA Zadeh in the paper of Fuzzy Sets, for the first time, used mathematical methods to express the "fuzzy" concept. Served as a bridge between classical mathematics and the real world which is full of ambiguity, thus it declared the birth^[42] of fuzzy math. Fuzzy Comprehensive Evaluation is based on fuzzy math theory and linear transformation principle, in full consideration of the actual situation of each evaluation factor, make a reasonable pros and cons assessment or rating evaluation.

Advantages of fuzzy comprehensive evaluation method is the use of membership functions and fuzzy statistical methods in the process of quantifying qualitative indicators index; while evaluating index weights, there is no absolute positive or negative, but with fuzzy evaluation method, so it solves the index ambiguity and uncertainty in real life. The disadvantage is that the indicators will be evaluated repeatedly, and the influence of subjective factors can not be eliminated.

(3) TOPSIS method

TOPSIS (Technique for Order Preference Similarity to Solution, the ideal solution Ideal by approximation) method is a relatively simple risk assessment methods. The basic principle is: to sort the possible optimal value and the worst value, and then calculate the distance between the evaluation object and the optimal value (the ideal solution) and the worst value (negative ideal solution) separately, obtain the relative closeness extent of the evaluation object and the optimal value (ideal solution), as a basis for the evaluation of the pros and cons^[43].

Advantages of TOPSIS evaluation method is that the distribution of data, the number of samples and targets are not limited, the calculation process is not very complicated, this method has an application range as wide as AHP. The disadvantage is that you need to determine the weight, with a certain degree of subjectivity and arbitrariness, while the determination of ideal solution and negative ideal solution is largely affected by evaluation conditions, besides this approach will also result in information duplication between the relationships of evaluation indicators.

(4) The principal component analysis

The theory of principal component analysis is mathematical transformation. Through a linear transformation it scatters a set of variables so that they no longer have relationships. Then sort them according to the relative variance in descending order, this arrangement will determine the merits of a variety of indicators.

The advantage of principal component analysis is the weight of each factor is determined by the size of the contribution rate to avoid the interference of human factors. The disadvantage is that the calculation process is cumbersome, and it requires a larger number of samples, it is not suitable for the risk evaluation system with a small number of indicators, in addition, this method is based on the sample index attribute to make a comprehensive evaluation, so the evaluation results are largely affected by the number of samples.

(5) Artificial Neural Network (ANN) analysis method

Artificial neural network analysis methods are developed in the late 1980s, it is an emerging discipline. This approach using simulated certain behaviors of the human brain, through learning and training with large amounts of data, identifies the internal relationships between the input and output, according to this relationship and realistic input values, solves the real output value^[44].

This method is applied to the supply chain risk assessment models, one can ensure the accuracy and objectivity of evaluation results. The disadvantage is that its internal calculations are opaque, totally depending on computer operation, once the relationship between input and output is determined, the evaluation result will be determined, so it ignores the link between the actual evaluation factors.

(6) Gray Comprehensive Evaluation Association (GRA)

Gray comprehensive evaluation association is also a common supply chain risk assessment method that uses the size of the correlation with the optimal solution to sort the evaluation factors. First find out the correlation coefficient matrix made up by the feasible solutions and the ideal solution, then get the correlation degree through the correlation coefficient matrix, and finally **sort according to the** size of the correlation to determine the weight of each factor^[45].

This calculation method is relatively simple, can be directly calculated with the original data, does not need to analyze a large number of sample data. Its disadvantage is that the results will be affected by the elements of the judgment matrix and appear the phenomenon of multiple solution. In addition, the correlation is always positive, reflecting the relationship between things is a positive correlation in the actual case, so that negative correlation between data will be lost.

In summary, there are a lot of methods for supply chain risk assessment. While solving the model, each method has different considering focus, so different evaluation methods may lead to different results of the evaluation.

5. Summary

Extensive literature has done studies on the source and prevention of food supply chain risk, proposed a variety of different preventive measures for each risk, but the number of the papers that established evaluation index system and did the risk assessment of food supply chain is relatively small, through the supply chain Risk evaluation index and assessment methods literature review, summarize main points of the establishment of supply chain evaluation index, and have played a reference for the establishment of the food supply chain risk assessment system. Finally, the existing supply chain evaluation methods are reviewed and compared, these advanced evaluation methods can be transformed into a suitable method for food supply chain risk assessment.

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