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Research on the Early Warning Mechanism of Cold Chain Logistics Risk of Fresh Agricultural Products

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ABSTRACT

In recent years, fresh agricultural product safety incidents have emerged one after another, and the quality risk of fresh agricultural products has become a pain in the cold chain. This research first summarizes the status quo of cold chain logistics of fresh agricultural products and the research results of related literature, proposes the direction and purpose of this research, and then establishes a risk warning system for the cold chain logistics risks of fresh agricultural products; conducts relevant through expert interviews, questionnaires, etc. Data collection, combined with the characteristics of the cold chain logistics of fresh agricultural products, sorted out a first-level risk indicator system based on processing risk, packaging risk, transportation risk, inventory risk, management risk, and information risk; finally, SPSS 21.0 was used for data analysis and established The linear equation constructs a cold chain logistics risk early warning model for fresh agricultural products, which provides quantifiable results for fresh agricultural products enterprises, verifies the feasibility of the model through empirical analysis, and further enriches the research on fresh agricultural products, which has certain reality Meaning and academic value.

KEYWORDS: *fresh agricultural products; cold chain logistics; risk early warning system; factor analysis*

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INTRODUCTION

In recent years, the quality of fresh agricultural products has received more and more attention. Fresh agricultural products are different from other products. Fresh agricultural products have the characteristics of perishable and corrosive. In addition to the regional and seasonal characteristics of production, the cold chain logistics of fresh agricultural products is particularly important.

Compared with the cold chain logistics of agricultural products in developed countries (see Table 1), whether it is in the picking of fresh agricultural products, pre-cooling insurance, and refrigerated transportation, there is still a big gap between China and other countries, and more attention should be paid to fresh products. The issue of agricultural cold chain risks.

Table 1 Comparison of cold chain logistics of agricultural products in developed countries and China

-	other	china
Loss rate after picking vegetables	5%	25%-30%
Pre-cooling preservation rate	80%-100%	about30%
Refrigerated transportation rate	USA：80%-90% Japan：98%以上	Total transportation rate：10%-20%

According to statistics, the output of quick-frozen products in China has increased at a rate of about 35% in recent years, which is much higher than the global average. Among quick-frozen products, only meat, aquatic products, a small amount of milk and vegetables have entered the cold chain system. There is a lot of waste, and the cold chain has become an important risk at present. According to the China Cold Chain Logistics Development Report, the damage rate of China's quick-frozen products reached 20%-30% in 2017, far exceeding other developed countries. The corruption of fresh products reached hundreds of millions of tons each year, and the direct losses caused were as high as Billions of dollars.

Nowadays, consumers are increasingly inclined to buy fresh and natural fresh agricultural products, and the demand is increasing. China's fresh agricultural product supply chain cannot fully meet the needs of consumers. There are many risks in the fresh agricultural product supply chain, whether it is between all the participants in the fresh agricultural product supply chain, the connection and cooperation in the supply chain, or the external environment of the fresh agricultural product supply chain. Due to the numerous circulation links of fresh agricultural products and the complex supply chain network, it is necessary to pass the risks in the supply chain of fresh agricultural products for graduate students, and on the premise of a clear understanding of the risks, propose relevant countermeasures to solve the risks to improve fresh agricultural products. The operational efficiency of the supply chain can provide better services to consumers.

1. Literature review

The study summarized the relevant research results from 2013 to 2019, and summarized it through two parts: fresh agricultural product supply chain risk and fresh agricultural product supply chain risk evaluation.

1.1. Fresh agricultural products cold chain logistics risk

The concept of cold chain was first proposed by Albert in the 1880s, when refrigerants, refrigerators and various frozen foods began to enter the market. C.M Palmer (1996), through a study of the British meat industry, proposed that the cold chain logistics process should maintain integrity and smooth information communication, and pointed out the necessity of upstream and downstream cooperation in cold chain logistics.

Wu Zhihua (2006) conducted a preliminary discussion on the characteristics of the agricultural supply chain, and believed that the following properties must be considered. The first is biochemical properties, which is its most important attribute; the second is periodicity, because agricultural products have a growth cycle, so the acquisition of agricultural products has time constraints; the third is edibility, the final product in the agricultural supply chain is to be eaten of. Clarifying the above characteristics of the agricultural product supply chain is conducive to scientific research on agricultural product supply chain risks. Smith (2015) believes that the main purpose of the traceability system of the US food industry is to improve the management level of food suppliers, facilitate the traceability of food quality, provide supervision and consumers with important or unrecognizable important information, and ensure food safety. Xiong Feng and Peng Jian (2015) believe that the particularity of self-employed production and the growth environment of fresh agricultural products makes the production of fresh agricultural products decentralized, which requires accurate and timely delivery of logistics and information between supply chains, otherwise Will bring losses to producers and consumers. Gan Yanyan and Zheng Yaqin (2017) summarized through a literature review that the current agricultural product supply chain risks are mainly concentrated in the risks brought by the participants in the supply chain, the links in the supply chain are linked to the risks brought by cooperation, and the external environment of the fresh agricultural product supply chain. The resulting risk. Xie Sixin (2018) elaborated on the possible risks in the three links of storage, sorting and transportation by dividing the process of fresh agricultural products, but did not form a clear system, and did not give specific standards and Measurement methods. Ni Jianbo (2018) conducted research on fresh food e-commerce, and believed that the current problems restricting the further development of fresh food e-commerce include internal and external risks in the cold chain. The internal risks include procurement and supply risks, technical risks, and organizational risks; external risks are divided into market demand risks, environmental risks and economic policy risks. The researchers only gave the relevant specific risks, but did not establish a fresh agricultural product cold chain risk system on this basis, and did not quantify the qualitative problems.

Jia Jiangming and Cui Zhijun (2018) identified the risk factors of the fresh agricultural product supply chain, formed a risk network, analyzed the characteristics of the risk network through social network analysis (SNA) technology, and explored the internal mechanism of risk formation. Finally, adjust, optimize and control the risks of the fresh agricultural product supply chain. Wang Kemeng (2018) analyzed the influencing factors of the fresh agricultural product supply chain development through the critical success factor method, including management level, agricultural technology, market competition, and personnel quality. At the same time, he constructed a factor structure model and deeply analyzed each factor. The degree of influence between the two countries has put forward countermeasures such as innovative supply chain management, improving the quality of employees, building a friendly market and promoting agricultural technology. Wang Shu (2018) elaborated on the factors affecting the development of the fresh agricultural product supply chain from three aspects: production, distribution, and sales. The production process includes planting factors and warehousing factors; the distribution process mainly includes loading and transportation. , Temperature control, delivery and unloading four sub-links; sales link includes three aspects of market, consumer and marketing. Through the critical success factor method, each element is analyzed and corresponding countermeasures are given. Zhang Shijun (2018) believes that there are risks in the supply, demand, information, cooperation, logistics, environment and other aspects of the agricultural product supply chain. He established an evaluation system for agricultural product supply chain risks and constructed a comprehensive evaluation of agricultural product supply chain risks based on intuitionistic fuzzy theory method.

1.2. Cold chain risk assessment of fresh agricultural products

Deng Junmiao (2008) applied the HALLIKAS risk assessment method to the risk assessment of farmers in the agricultural product supply chain, and quantitatively evaluated the risks of farmers from the perspective of the probability and outcome of risk events. Liu Mei et al. (2011) put forward seven factors that affect the risk of the food supply chain. On this basis, through a questionnaire, the vensim simulation software is used to determine the mutual causality between these factors, and the system dynamics theory is used to establish a dynamic evaluation. The model obtains a ranking of the weight values of dynamic risk factors, thereby making up for the lack of static assessment. Zhang Li and Liu Jiandong (2014) established three first-level indicators of internal risk, inter-node risk, and external environmental risk at each node based on the analytic hierarchy process; agricultural products with 10 secondary indicators including raw material supply, information risk, and government policy-oriented risk The supply chain risk indicator system finally believes that the risks of each node in the supply chain are greater. Zhang Yan (2017) established the seven link names of processing and packaging, inventory, loading and unloading, and transportation from the perspective of cost constraints, and established a risk warning system for fresh agricultural products through SPSS21.0, but the model did not proceed. The empirical analysis also did not give specific critical values. Chen Weizheng and Fan Wen (2019) used Bayesian theory to consider the successive transmission of risks, and used GENIE software to establish a DBN risk assessment system based on processing, refrigeration, transportation, and sales. The probability of occurrence of the risk is the highest, so recommendations are given for transportation risks. For fresh agricultural products, the risks that may occur to different companies are also different. The study did not give a reference direction for the occurrence of other risks. This is also one of our future research directions. Xue Linlin (2018) concluded that the cold chain risks of agricultural products are mainly concentrated in the aspects of outbound inspection, loading, transportation, unloading, and information processing through the operation process of the cold chain logistics of fresh agricultural products for graduate students. corresponding strategy.

1.3. Literature review

In terms of the risk of cold chain logistics of fresh agricultural products, the main direction of cold chain research is still concentrated on the demand forecast and route optimization of cold chain logistics of agricultural products. There are relatively few studies on the risk of cold chain of fresh agricultural products. Because of the special nature of fresh agricultural products, the cold chain is an important part of the supply chain, and cold chain logistics is also one of the focus and difficulty of current research. Scholars have studied the agricultural product supply chain from different perspectives, and the risk factors are also different. Some scholars have studied the source of fresh agricultural products, and some scholars have studied the problems in the cold chain transportation process, but In the cold chain logistics system of fresh agricultural products, picking and pre-cooling fresh agricultural products-processing-transportation-sales-consumers are a long process. There are various risks in each link, as long as there is a node If it is not cold, it will affect the quality of fresh produce. Therefore, according to the whole process of the cold chain logistics system, this research divides the cold chain links of fresh agricultural products into processing, packaging, inventory, transportation, management, and information risk to carry out cold chain research on fresh agricultural products, and divides the cold chain of fresh agricultural products. As a first-level indicator, the chain process is used to determine the entire cold chain risk indicator system for fresh agricultural products through research and data collection.

In the cold chain evaluation of fresh agricultural products, research is mainly conducted on a certain sector. The existing cold chain of fresh produce mainly focuses on countermeasures and improving the efficiency of the supply chain, and there is little research on current risk early warning. The research methods most commonly used by researchers include analytic hierarchy process, critical control point of hazard analysis, fuzzy comprehensive evaluation, structural equation model, Bayesian network method and neural network model, etc. This research plan combines qualitative and quantitative methods to pass SPSS21. 0 Use factor analysis to study the inherent links between data, build a fresh agricultural product risk early warning system, and establish a fresh agricultural product risk early warning model by analyzing critical control points, which can not only predict the risk of the entire fresh agricultural product cold chain logistics, but also Predict the risk of the cold chain of fresh agricultural products between each node.

2. Construction of a risk index system for cold chain logistics of fresh agricultural products

2.1. Initial establishment of evaluation indicators

This research first analyzes the cold chain logistics system as shown in Figure 1. The cold chain logistics system for fresh agricultural products is divided into five links, which are raw material origin, product processing, warehouse storage, stores and consumers, capital flow, logistics, and business. Flow and information flow run through the entire system, and we use this perspective to study the influencing factors of cold chain logistics risks. Through online research on three large agricultural product bases, we understand the basic status of cold chain logistics of fresh agricultural products, and conducted interviews with managers and consumers, and used this as the basis for the initial establishment of a fresh agricultural product supply chain risk indicator system.

This research was conducted in the form of a combination of survey questionnaires and semi-structured interviews. Before conducting on-site investigations, this study drafted a questionnaire after several discussions, and revised the questionnaire after expert comments, and finally formed a formal questionnaire.

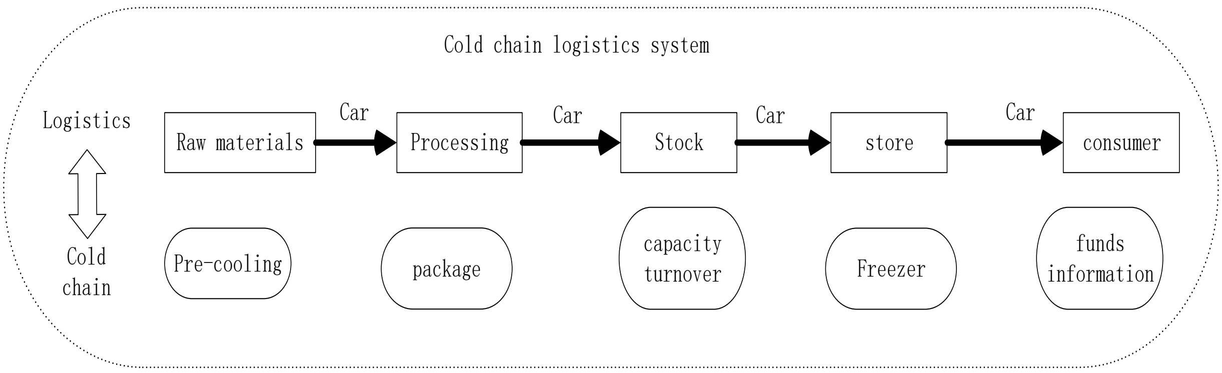

Figure 1 Cold chain logistics system

2.2. Selection of Evaluation Index

2.2.1. Screening of evaluation indicators

The indicator system initially established in this study is based on research, expert consultation, literature review, and factors affecting the cold chain logistics of fresh agricultural products. Therefore, the 24 indicators summarized contain relatively large subjective components. Moreover, when establishing evaluation indicators, the coverage should be as wide as possible, and it is inevitable that there will be duplication and indicator interference, which requires further optimization.

At present, there is relatively little attention in the cold chain logistics of fresh agricultural products. This research plan follows the entire link of the fresh agricultural product supply chain to build a fresh agricultural product cold chain risk warning system. The initial investigation may have redundant and unreasonable indicators, so experts are used The interview deletes and selects indicators.

The study selected consumers, on-campus experts, and off-campus business experts as consulting objects to screen the indicators. This study divided the selection process into two parts. First, an expert questionnaire consultation was conducted, a round of indicators was selected, and then the second One-time feedback is used for data collection, and indicators with lower importance are deleted to obtain a new set of evaluation indicators. Feedback the new evaluation index set to the experts, and consult each expert whether to conduct further screening.

Through the online survey of three fresh produce stores, a preliminary cold chain logistics risk index system for fresh produce is obtained, and the final evaluation indicators are obtained through the final selection of experts, as shown in Table 2-1.

Table 2-1 Cold chain logistics risk early warning indicator system for fresh agricultural products

First level indicator	Secondary indicators
Processing risk X_1	Product processing speed X_{11}
	Pre-cooling control technology X_{12}
Packaging risk X_2	Packaging cost ratio X_{21}
	Packaging damage ratio X_{22}
	The correct rate of packaging use X_{23}
Inventory risk X_3	Cold storage capacity X_{31}
	Cargo loss rate X_{32}
	Inventory turnover X_{33}
Transport risk X_4	Loading and unloading flexibility X_{41}
	Reasonable operation process X_{42}
	Refrigerator truck operating rate X_{43}
	Cold car temperature stability X_{44}
Manage risk X_5	Customer satisfaction X_{51}
	Standard implementation level X_{52}
	Process Management X_{53}
Information risk X_6	Information sharing rate X_{61}
	Information accuracy rate X_{62}

This indicator system comprehensively reflects the risks in the processing, packaging, inventory, transportation, management and information links of the cold chain logistics of fresh agricultural products. In the processing risk indicators, two indicators of commodity processing speed and pre-cooling control technology are selected. These indicators reflect the possible problems of fresh agricultural products at the source of the supply chain. The faster the commodity processing speed, the greater the freshness preservation of fresh agricultural products. Good; the better the front-end pre-cooling technology of the supply chain, the better the quality of agricultural products. The greater the value of these indicators, the better the operation effect of cold chain logistics; conversely, the greater the logistics risk. In the packaging risk indicators, three indicators are selected: packaging cost ratio, packaging damage ratio, and correct packaging use rate. The correct packaging use rate is a positive indicator, and the packaging cost ratio and packaging damage ratio are negative indicators. In the transportation of fresh agricultural products, packaging plays a vital role, and the use of appropriate packaging will reduce the risk of the cold chain process. In the inventory risk indicators, cold storage capacity, cargo loss rate and inventory turnover are selected. The larger the cold storage capacity, the smaller the possibility of fresh agricultural products accumulation outside the warehouse; the smaller the loss rate of goods, the higher the efficiency of the entire cold chain; the faster the inventory turnover, the faster the product circulation, which reduces the overall process output. Warehouse storage time. In the transportation risk indicators, four indicators are selected: loading and unloading flexibility, operation flow rationality, cold car operation rate, and cold car temperature stability. Among them, operation flow rationality and cold car temperature stability are the key to the entire transportation link. In the management risk indicators, three indicators are selected: customer satisfaction, standard implementation level, and process management. Customer satisfaction is the core, and customer satisfaction can effectively feedback the defects at the end of the entire cold chain. Two indicators, information sharing rate and information accuracy rate, are selected in the information risk. At present, we have entered the era of the Internet of Things. The accuracy of information can effectively improve operational efficiency, and timely discover the deviations of fresh agricultural products in the cold chain process. Make corrections.

3. Construction of cold chain logistics risk model for fresh agricultural products

3.1. Selection of methods for constructing evaluation index system

The construction methods of the evaluation index system can be divided into two categories: The first category is subjective methods, such as expert evaluation method and analytic hierarchy process. The advantage of the subjective method is that experts can reasonably determine the order of the indicators based on actual problems, and the calculation is simple, but the shortcomings are subjective and arbitrary. Different experts are selected and the weight coefficients obtained are different. The evaluation process The transparency and the difference in linearity. The second category is the objective weighting method that directly determines the index weight based on the dispersion degree of the index attribute value series of each evaluated object, such as factor analysis, coefficient of variation method, and maximum entropy weight technology method. The objective method is not subjective and arbitrary, the evaluation result has a strong mathematical theoretical basis, the determination is dependent on the actual problem domain, and the calculation is more complicated.

Many studies have used the principal component analysis method for evaluation, but to some extent, the factor analysis method is the expansion and extension of the principal component analysis method, and the research problems are more extensive and in-depth. Therefore, this research mainly introduces factor analysis, which is also the main research method of this research.
(1) Application scope of factor analysis method
① The variables are correlated and can be directly measured

Because factor analysis can extract common factors, if there is no correlation between variables, common factors cannot be extracted. The correlation between variables can be judged by Bartlett's spherical test. If the correlation matrix is a unit matrix, the variables are independent and factor analysis cannot be performed. In addition, the KMO test is an important step in factor analysis, which can examine the partial correlation between variables. This is also an important step to eliminate variables that researchers don't want to appear. Regarding whether the variables can be directly measured, this is not the key to the problem. Other methods can be used to quantify the qualitative index results.

② The common factor should have practical significance
Carrying out factor rotation on the basis of principal component analysis can make the significance of the common factor more obvious, but if it is difficult to define the actual meaning of the extracted common factor, the data and variables should be analyzed again.

(2) Analysis of the characteristics of factor analysis
The advantage of factor analysis is that several common factors can be obtained by comprehensive analysis from a large number of original variables through the method of dimensionality reduction, which can still represent most of the original variables. In addition, on the basis of principal component analysis, through factor rotation, common factor variables have higher interpretability. The disadvantage of factor analysis is that there are too many constraints. For cases where it is difficult to obtain a sufficient number of samples, this method is not particularly convenient to apply.

3.2. Effective processing of questionnaires

After the questionnaire was sorted out, the research conducted a credibility analysis of the questionnaire, and through SPSS21.0, the Cronbach's Alpha coefficient reliability test was performed on the sample data to determine the rationality of the survey results. When the value of the coefficient is greater than 0.8, it indicates that the sample data has a certain reference value; when the value of the coefficient is less than 0.6, it is recommended to perform the survey procedure again. The questionnaire in this study carried out a reliability analysis of 24 items as shown in Table 3-1. The Cronbach's Alpha coefficient value is 0.944, indicating that the reliability of the questionnaire is very high, and data analysis can be carried out through the questionnaire.

Table 3-1 Reliability statistics

Cronbach's Alpha	Number of items
.944	24

In this survey, a total of 100 questionnaires were distributed as shown in Table 3-2, and 83 copies of complete opinions were returned. The validity rate of the questionnaire was 83%. The evaluation opinions were processed for statistical analysis.

Table 3-2 Summary of case handling

		N	%
Case	Effective	83	100.00
	Excluded[a]	0	0
	Sum	83	100.0
a. In this program, delete based on the list of all variables.			

3.3. factor analysis

3.3.1. Applicability of factor analysis

First consider whether there is a certain linear relationship between the evaluation indicators, and whether it is suitable to use factor analysis to extract common factors. Through the correlation coefficient matrix of each index, the calculation results of the Bartley sphericity test and the KMO test method are reflected for analysis. It can be seen from the correlation coefficient matrix that most of the correlation coefficients are relatively high, and there is a strong linear relationship between the evaluation indicators, and common factors can be extracted from them, which is suitable for factor analysis.

Through Bartlett's sphere test, we can see that the observed value of the statistic is 593.096, and the corresponding probability p is close to 0. Since the probability p is less than the significance level a, the 0 hypothesis should be rejected, and the correlation coefficient matrix is considered to have a significant relationship with the identity matrix. At the same time, the KMO value is 0.773. According to the KMO measurement value standard given by Kaiser, the evaluation index is suitable for factor analysis.

Table 3-3 KMO and Bartlett's test

The Kaiser-Meyer-Olkin measure of sample adequacy.		.773
Bartlett's sphericity test	Approximate chi-square	593.096
	df	146
	Sig.	.000

3.3.2. Extract common factors

From the extraction column of common factor variance in Table 3-4, it can be seen that all evaluation indicators have a high degree of commonality, and the information loss of each variable is less. Therefore, the overall effect of this factor extraction is ideal.

Table 3-4 Common factor variance

Label	Initial	Extract	Label	Initial	Extract
X11	1.000	.819	X42	1.000	.768
X12	1.000	.895	X43	1.000	.938
X21	1.000	.884	X44	1.000	.814
X22	1.000	.903	X51	1.000	.891
X23	1.000	.910	X52	1.000	.900
X31	1.000	.855	X53	1.000	.781
X32	1.000	.908	X61	1.000	.872
X33	1.000	.890	X62	1.000	.869
X41	1.000	.928	-	-	-
Extraction method: principal component analysis					

According to the correlation coefficient matrix of the original index, the principal component analysis method is used to extract the common factors and the characteristic roots with characteristic roots greater than 1 are selected, and the analysis results are shown in Table 3-5.

Table 3-5 Total variance explained

N	Initial eigenvalue			Extract the sum of squares and load			Rotate the sum of squares loading		
	Total	variance	accumulation	Total	variance	accumulation	Total	variance	accumulation
1	7.328	43.105	43.105	7.328	43.105	43.105	2.742	16.132	16.132
2	2.563	15.079	58.183	2.563	15.079	58.183	2.701	15.890	32.022
3	1.845	10.852	69.035	1.845	10.852	69.035	2.691	15.829	47.851
4	1.159	6.821	75.856	1.159	6.821	75.856	2.576	15.154	63.005
5	1.040	6.118	81.974	1.040	6.118	81.974	2.134	12.553	75.558
6	.889	5.231	87.205	.889	5.231	87.205	1.980	11.647	87.205
Extraction method: principal component analysis									

It can be seen from Table 3-5 that the number of common factors with a characteristic root greater than 1 is 5. In the SPSS statistical software for gravel maps, the slope of the component number axis 1-6 is much greater than 7-24. Component 7 gradually showed a trend in addition to being flat. Therefore, the study believes that it is reasonable to select six common factors, which are 7.328, 2.563, 1.845, 1.159, 1.040, and 0.889. Their cumulative variance contribution rate is 87.205%. In general, the original The evaluation index information is less lost, and the effect of factor analysis is better. This can be seen from the value of KMO. In Table 3-5, the first common factor has the largest value, so its contribution to the whole is also the largest, and the other five distances are relatively small. It can be seen from the result of factor rotation that the cumulative variance contribution rate has not changed, that is to say, it does not affect the common degree of the evaluation indicators, but the original variance of each indicator is redistributed, and the variance contribution rate is changed. , Making the common factor easier to interpret.

The six components Y1-Y6 obtained in the factor analysis are the six links of processing, packaging, transportation, inventory, management, and information in the cold chain process of fresh agricultural products.

3.4. Model construction

In the rotating component matrix in Table 3-6, the principal components 1-6 represent the six major links in the cold chain logistics of fresh agricultural products. From the principal components of the rotation component matrix, the larger the value, the larger the information explained.

Table 3-6 Rotation component matrix

序号 Label	Ingredients						Label	Ingredients					
	1	2	3	4	5	6		1	2	3	4	5	6
X11	.013	.387	.435	.577	.270	.273	X42	.306	.299	.018	.312	.698	.023
X12	.057	.564	.175	.734	.054	-.032	X43	.254	-.233	.302	.737	.373	.213
X21	.743	.064	.221	.127	.252	.448	X44	.411	.143	.758	.032	-.128	.181
X22	.083	.239	.801	.367	.238	.075	X51	.865	.099	.223	.032	.274	-.089
X23	.275	.131	.823	.303	.206	.079	X52	.530	-.020	.324	.648	-.004	.305
X31	.155	.847	.153	.209	.082	.200	X53	.681	.019	.188	.520	-.099	-.038
X32	-.050	.870	.242	-.139	.084	.254	X61	.217	.587	-.066	.150	-.175	.650
X33	-.023	.273	.202	.109	.061	.871	X62	.448	.297	.278	.166	-.501	.474
X41	.100	-.001	.213	.059	.932	.000	-	-	-	-	-	-	-

Extraction method: principal component analysis
Rotation method: Orthogonal rotation method with Kaiser standardization.
a. The rotation converges after 10 iterations.

Table 3-7 Component Matrix

Label	Ingredients						Label	Ingredients					
	1	2	3	4	5	6		1	2	3	4	5	6
X11	.798	.043	.299	-.270	.111	.073	X42	.568	-.308	.446	.324	.199	-.085
X12	.682	.121	.244	-.324	.357	-.350	X43	.682	-.512	-.017	-.214	.313	.258
X21	.743	-.135	-.267	.461	-.012	.175	X44	.676	.029	-.300	-.105	-.505	-.006
X22	.785	-.142	.190	-.354	-.323	.013	X51	.592	-.372	-.236	.492	-.155	-.286
X23	.807	-.230	.015	-.247	-.381	.015	X52	.812	-.193	-.354	-.112	.245	.074
X31	.658	.483	.306	.106	.049	-.287	X53	.630	-.264	-.440	.006	.206	-.279
X32	.469	.637	.423	.140	-.242	-.160	X61	.547	.674	-.069	.220	.234	.106
X33	.555	.484	.058	.069	.050	.580	X62	.594	.474	-.539	-.004	-.029	.002
X41	.377	-.548	.594	.288	-.110	.191	-	-	-	-	-	-	-

Extraction method: principal component analysis
a. Six components have been extracted.

According to the component matrix in Table 3-7, the linear expressions of six principal components (represented by L) on the cold chain logistics risk of fresh agricultural products can be obtained:

$$Y_1=0.798X_{11}+0.682X_{12}+0.743X_{21}+0.785X_{22}+0.807X_{23}+0.658X_{31}+0.469X_{32}+0.555X_{33}+0.377X_{41}+0.568X_{42}+0.682X_{43}+0.676X_{44}+0.592X_{51}+0.812X_{52}+0.630X_{53}+0.547X_{61}+0.594X_{62}$$

$$Y_2=0.043X_{11}+0.121X_{12}-0.135X_{21}-0.142X_{22}-0.230X_{23}+0.483X_{31}+0.637X_{32}+0.484X_{33}-0.548X_{41}+0.568X_{42}+0.682X_{43}+0.676X_{44}+0.592X_{51}+0.812X_{52}+0.630X_{53}+0.547X_{61}+0.594X_{62}$$

$$Y_3=0.299X_{11}+0.244X_{12}-0.267X_{21}+0.190X_{22}+0.015X_{23}+0.306X_{31}+0.423X_{32}+0.058X_{33}+0.594X_{41}-0.308X_{42}-0.512X_{43}+0.029X_{44}-0.372X_{51}-0.193X_{52}-0.264X_{53}+0.674X_{61}+0.474X_{62}$$

$$Y_4=-0.270X_{11}-0.324X_{12}+0.461X_{21}-0.354X_{22}-0.247X_{23}+0.106X_{31}+0.140X_{32}+0.069X_{33}+0.288X_{41}+0.324X_{42}-0.214X_{43}-0.105X_{44}+0.492X_{51}-0.112X_{52}+0.006X_{53}+0.220X_{61}-0.004X_{62}$$

$$Y_5=0.11X_{11}+0.357X_{12}-0.012X_{21}-0.323X_{22}-0.381X_{23}+0.049X_{31}-0.242X_{32}+0.050X_{33}-0.110X_{41}+0.199X_{42}+0.313X_{43}-0.505X_{44}-0.155X_{51}+0.245X_{52}+0.206X_{53}+0.234X_{61}-0.029X_{62}$$

$$Y_6=0.073X_{11}-0.350X_{12}+0.175X_{21}+0.013X_{22}+0.015X_{23}-0.287X_{31}-0.160X_{32}+0.580X_{33}+0.191X_{41}-0.085X_{42}+0.258X_{43}-0.006X_{44}-0.286X_{51}+0.074X_{52}-0.279X_{53}+0.106X_{61}+0.002X_{62}$$

In the above-mentioned expression, X11 to X62 are the variables after the original index is standardized with a mean value of 0 and a standard deviation of 1.

According to the contribution rate of the principal component factors after the rotation in the previous table, the formula for the early warning of cold chain logistics risks of fresh agricultural products can be obtained:

$$F=0.16132Y_1+0.1589Y_2+0.15199Y_3+0.15829Y_4+0.12533Y_5+0.11647Y_6$$

Among them, Y1 to Y6 represent the factors explained in the previous study.

4. Empirical analysis

The research can calculate the comprehensive evaluation value F of the cold chain logistics of fresh agricultural products according to the early warning index value of the cold chain logistics of fresh agricultural products. In order to more intuitively predict the risk value of the cold chain logistics of fresh agricultural products, the research has determined the risk measurement value through field investigation and expert scores. The research determined that Y1=1.774, Y2=1.523, Y3=1.647, Y4=1.145, Y5=1.334, Y6=1.413, F=1.312, (Y1-Y6 represents the risk value of each component in the factor analysis, F is the whole fresh agricultural product Cold chain logistics risk value). When part of the Y value reaches the target value and the indicator reaches the risk warning value, it is considered that there is a greater risk in this link and should be corrected or modified in time; when the fresh agricultural product cold chain logistics risk value Y reaches the target value, the model considers that The cold chain logistics risk of fresh agricultural products is relatively high, and corresponding measures should be actively taken to reduce the cold chain logistics risk.

5. Summary

In order to make the fresh agricultural product cold chain logistics risk early warning model more effective, more sample data can be collected. Since this study uses questionnaires and semi-structured interviews with experts, the data obtained is subjective. The cold chain risk early warning model of fresh agricultural products constructed in this study can be adjusted appropriately when studying the cold chain risks of fresh agricultural products in different regions. In follow-up research, the objective data of cold chain logistics of fresh agricultural products can be used to make predictions. Research is more convincing. If conditions permit, the scope and spatiality of the investigation can be increased, and similar areas can be investigated separately, such as the risk of cold chain logistics of fresh agricultural products in China and the United States, making the model more practical and meaningful. The theoretical basis of the rich cold chain logistics of fresh agricultural products.

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