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Risk Assessment Method for Fresh Fruit and Vegetable Cold Chain Logistics based on Improved Mutation Level Model with AHP Analysis

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Abstract

This paper aims to improve the quality and safety risk assessment method of fresh fruits and vegetables cold chain logistics, firstly, design the wireless sensor network combined with RFID and WSN, establish the information collection module based on the Internet of Things (IoT), and adopt the maximum and minimum value method of normalization for the collected data, and at the same time, put forward the safety warning indicator system of the whole process of fresh fruit and vegetable production - sales. At the same time, a cold chain logistics safety warning indicator system for the whole process of "production - sales" of fresh fruits and vegetables is proposed, and the indicators affecting the quality and safety of fresh fruits and vegetables are analyzed through the AHP hierarchical analysis method to obtain the order of importance of the warning indicators of the safety of the cold chain logistics of fresh fruits and vegetables at all levels, and a risk assessment model based on the AHP analysis with the improvement of the number of mutations is constructed accordingly to carry out a risk assessment on the safety of the cold chain of fresh fruits and vegetables. Accordingly, a risk assessment model based on AHP analysis is constructed to improve the mutation level, and the risk assessment of fresh fruit and vegetable cold chain quality and safety is conducted.

Keywords

Cold Chain Logistics Safety Monitoring Index System; Maximum-minimum Value Method; AHP Hierarchical Analysis; Improvement of Mutation Level.

1. Introduction

Cold chain logistics in foreign countries started early and developed fast, and has become mature, and the research on this issue has also shifted from the theoretical level to the updating of technology and risk control and other fine points. China's cold chain logistics started late, and a large number of scholars have conducted researches on optimizing the location of cold chain logistics centers and distribution routes, cold chain technological innovation, cold chain logistics risk management, etc. However, there are still many problems in the areas of whole process supervision of cold chain logistics, packaging standards for fresh products, and standards for freezing and refrigerated transportation services and management of commodities.

In the optimization of agricultural cold chain logistics system research, Wang Xuhui et al [1] constructed the framework of fresh agricultural products cold chain logistics system, and pointed out that the degree of perfection of fresh agricultural products cold chain Internet of things, cold chain Internet of things standard system and the degree of information sharing between the nodes of the cold chain is the three determinants of the system's operational efficiency, etc.; in the study of cold chain logistics of agricultural products based on big data, Zhang Xicai[2] utilized the "urban big data

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technology" to improve the quality of the cold chain logistics system. Zhang Xicai[2] utilized big data technology to link the "urban big warehouse" with the "personal micro warehouse" to establish a whole-chain, traceable modern agricultural cold chain logistics development model,etc.; in the development and application of blockchain technology in the field of logistics research, Chen Fei et al[3] (2020) proposed the design of food traceability system, which can increase the function of food recall and complaint, and Mei BaoLin[4] believed that in the development of cold chain logistics of China's agricultural products, the integration of blockchain technology with GPS, intelligent temperature control, and the Internet of Things (IoT) technology, which can decipher the development of cold chain logistics from the origin, processing, storage and transportation, sales to the customer in the process of the "broken chain" problem.

In terms of logistics risk identification and assessment, Li Hohua et al[5] used entropy weight method and social network analysis to derive the important risk factors of fresh food cold chain logistics in the post epidemic era, and Li Sicong[6] used the combination of hierarchical analysis and entropy weight method to determine the index weights, and established a multi-indicator comprehensive risk assessment model, and Yao Xie[7] used the B2C model to study the logistics model of export e-commerce enterprises. export e-commerce enterprise logistics model as the research object, using the hierarchical analysis method to assess the logistics risk of export e-commerce, Skapinyecz et al[8] used the hierarchical analysis method to quantify the operational risk factors, and assessed the safety of the logistics of recyclables, Ji-Feng Ding et al[9] used the BWM assessment method to assess the key risk factors in the cold-chain logistics operations of the container carrier to assess and thus improve the risk management level of cold chain safety and performance, Yuyan Shen et al [10] designed a comprehensive index weighting method combining AHP method and entropy weighting method to quantitatively evaluate the main risks in the process of cold chain logistics of food products, and so on.

Many scholars at home and abroad have carried out a lot of research on the development status and countermeasures of agricultural cold chain logistics, including the development and operation of agricultural cold chain logistics, technology application and informationization management, etc. The research methods of scholars at home and abroad in risk identification and assessment mainly include hierarchical analysis method and entropy power method, etc. In this paper, we combine the hierarchical analysis method with the mutation hierarchical method, and design the improved AHP-based mutation hierarchy method to carry out risk assessment of the quality and safety of fresh fruit and vegetable cold chain logistics based on the indicators of quality and safety, and verify the method's applicability and simplicity through examples. This paper combines the hierarchical analysis method with the mutation level method, and on the basis of analyzing the indicators affecting the quality and safety of fruit and vegetable cold chain logistics, designs the improved mutation level method based on AHP to carry out the risk assessment of the quality and safety of fresh fruit and vegetable cold chain logistics, and verifies the applicability and simplicity of the method through the examples. The method can decompose the complex problem into multiple levels and factors, evaluate the mutation phenomenon in the system in a more systematic way, reveal the hierarchical relationship and mutual influence among factors, and also respond to different evaluation scenarios and needs in a more flexible way, so as to provide a new idea for the identification and evaluation of the risk of quality and safety of fresh fruit and vegetable cold chain logistics.

2. Fresh Fruit and Vegetable Cold Chain Logistics Information Collection based on Internet of Things

The information collection of fresh fruits and vegetables, such as articles and environment, is transmitted and stored to the cloud platform through convergence and communication network, and written into the data table corresponding to the EPC code of the articles. The public information platform and the sub-management system of each link call the information, calculation and data mining capability of the cloud platform through the unified interface with the cloud platform, so as to meet the information demand of real-time and dynamic visualized tracking monitoring, early warning and traceability of the information of the articles and environment of the articles and environment of the different users under the corresponding privileges. Dynamic visualization of tracking and monitoring, early warning and traceability, etc. The information collection module includes the whole cold chain information collection network of IoT item recognition technology and environment sensing technology, as shown in Figure 1, which is the key to real-time monitoring of the whole cold chain items, environment and other information to ensure the quality of fresh fruits and vegetables, and is the focus of constructing the whole cold chain logistics system of fresh fruits and vegetables based on cloud computing.

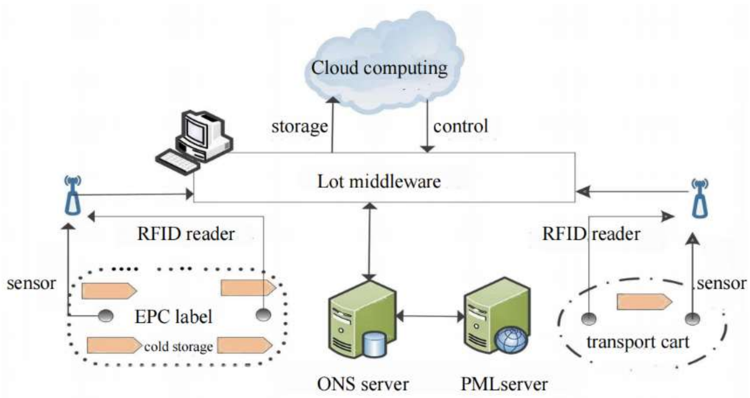

Figure 1. Full cold chain information collection network

In EPC IoT, consider the study of intelligent wireless sensor network based on the combination of RFID and WSN.WSN (Wireless Sensor Network), Chinese name is wireless sensor network, is a wireless network composed of a large number of distributed sensor nodes, through the nodes to sense the environment information and transmit it to the base station for processing.RFID (Radio Frequency Identification (RFID), Chinese name for radio frequency identification, is a non-contact identification technology using radio waves, which realizes the identification of items through the wireless communication between readers and tags. Here RFID is combined with WSN, the RFID reader, as a WSN intelligent sensing node, and sensor technology integrated into the RFID module, so that the WSN not only collects fresh fruits and vegetables throughout the cold chain of products, environment and other data information, but also RFID system data transmission, and through the wireless convergence network access to the wide-area communication transmission network, and ultimately to realize the collected Relevant data information is efficiently and accurately transported and stored to the IoT cloud platform designed by us, using geographic information GIS system for real-time display and monitoring of transportation information, and global positioning GPS system for positioning and tracking of transportation carriers.

3. Establishment of a System of Safety Indicators Affecting the Cold Chain Logistics of Fresh Fruits and Vegetables

3.1 Construct a Cold Chain Logistics Safety Index System for the Whole Process of "Production - Sales".

Through the analysis of the factors and conditions involved in the safe operation of each circulation link of fresh fruit and vegetable cold chain logistics, the safety of fresh fruit and vegetable cold chain logistics involves multiple aspects of picking, processing, transportation, sales and other aspects of the impact of indicators, through the analysis of the safety factors affecting the safety of each link of the cold chain logistics of fresh fruits and vegetables as well as the relevant industry standards of the cold chain logistics of fresh fruits and vegetables, combined with the principle of constructing the indicator system, the impact of fresh fruits and vegetables By analyzing the safety influencing factors in each link of fresh fruit and vegetable cold chain logistics and the relevant industry standards of fresh fruit and vegetable cold chain logistics, combined with the construction principles of the index system, we categorize and screen the factors affecting the safety of fresh fruit and vegetable cold chain logistics, and construct the fresh fruit and vegetable early warning index system. The hierarchical analysis method is used to solve the relevant indicators and obtain the weights of the early warning indicators for the safety of fresh fruit and vegetable cold chain logistics at all levels.

On the basis of the logistics policies and regulations promulgated by the state and the related research results of cold chain logistics in Shaanxi Province, a cold chain logistics safety index system for the whole process of "production - sales" of fresh fruits and vegetables is proposed.

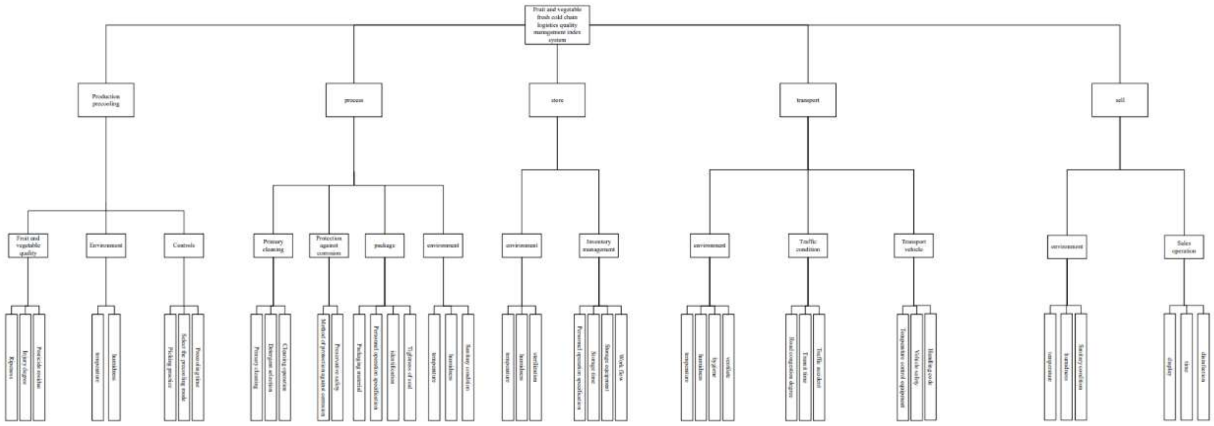

Figure 2. Fruit and vegetable fresh cold chain logistics safety index system

3.2 Maximum-minimum Method for Indicator Data Normalization

By reviewing the literature and investigating relevant enterprises and consulting with experts, the data that can be reasonably valued are directly used as raw data, and the indicator data that cannot be obtained are directly consulted with experts and graded by on-site investigations. Part of the data is mainly collected through the Internet of Things devices combined with sensors to collect a large amount of monitoring data, although there is no network in transit, but the device will store all the data into the ROM chip, once the automatic search for available wireless networks, or human initiative to configure the network connection, the device will automatically upload all the data to the cloud, and the cloud servers to complete the data analysis and storage. Reserve.

There are many ways to normalize the raw data, generally there are two: the maximum-minimum value method and the mean-variance method. In this paper, the maximum-minimum value method is used to normalize the quantitative evaluation indexes.

Positive indicator: the size of the data changes in the same direction as the evaluation objective, i.e., the larger the actual value of the indicator, the higher the evaluation value, which is normalized by the following formula.

$$p_{ij} = \frac{x_{ij} - \min\limits_{1 \le i \le n}\{x_{ij}\}}{\max\limits_{1 \le i \le n}\{x_{ij}\} - \min\limits_{1 \le i \le n}\{x_{ij}\}} \tag{1}$$

Negative indicator: the size of the data changes in the same direction as the evaluation objective, i.e., the larger the actual value of the indicator, the lower the evaluation value, which is normalized by the following formula.

$$p_{ij} = \frac{\max_{1 \le i \le n}\{x_{ij}\} - x_{ij}}{\max_{1 \le i \le n}\{x_{ij}\} - \min_{1 \le i \le n}\{x_{ij}\}} \tag{2}$$

Interval Indicators: Notation of Intermediate Indicators as $Mid = \frac{\max_{1 \le i \le n}\{x_{ij}\} - \min_{1 \le i \le n}\{x_{ij}\}}{2}$.

When $Mid \le x_{ij} \le \max_{1 \le i \le n}\{x_{ij}\}$,

$$p_{ij} = \frac{\max_{1 \le i \le n}\{x_{ij}\} - x_{ij}}{\max_{1 \le i \le n}\{x_{ij}\} - \min_{1 \le i \le n}\{x_{ij}\}} \tag{3}$$

When $\min_{1 \le i \le n}\{x_{ij}\} \le x_{ij}\ Mid$,

$$p_{ij} = \frac{x_{ij} - \min_{1 \le i \le n}\{x_{ij}\}}{\max_{1 \le i \le n}\{x_{ij}\} - \min_{1 \le i \le n}\{x_{ij}\}} \tag{4}$$

4. A Risk Assessment Method based on AHP Analysis with Improved Mutation Level Modeling

4.1 Basic Steps to improve the Mutation Level Method

Catastrophe (Catastrophe) refers to the process in which things suddenly jump from one form of state to another with the change of some control variables, and the change of this process is discontinuous. Catastrophe level method is based on catastrophe theory and fuzzy mathematics, it is a comprehensive evaluation method to decompose the evaluation target for multi-level contradiction, and then use catastrophe theory and fuzzy mathematics to combine to produce catastrophe fuzzy affiliation function, and then carry out comprehensive quantitative operation by the normalization formula, and then finally normalize it to a parameter, that is, to seek out the total affiliation function, so as to sort and analyze the evaluation target.

The basic steps for improving the mutation level method are as follows:

1) According to the purpose of the evaluation, the total evaluation indicators are decomposed at multiple levels and arranged into an inverted tree-like hierarchy of objectives. The raw data only need to know the data of the lowest level sub-indicators.

2) Determine the type of mutation system of the mutation evaluation index system and construct an improved mutation system model. According to the needs of the actual problem, determine the selected model, the contradiction between the goal and the conditions of the problem is resolved.

3) Determine the order of importance of indicators according to AHP. According to the hierarchical analysis method to determine the degree of importance of the indicators, calculate the comprehensive degree of importance of the indicators, according to the degree of importance of the size of the mutation system to get the correct ordering of the control variables within the mutation system.

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4) Derive the normalization formula from the bifurcation equation of the mutation system. The derivation process of the normalization formula of the mutation model involves the potential function and divergence equation of the system. By analyzing this potential function, the divergence set equation can be derived so that when |x| = 1, the range of values of the state variable x and the control variable can be determined when evaluating the decision. The normalization formula is essentially a multidimensional fuzzy affiliation function, which is used to normalize variables of different dimensions to the same scale for easy comparison and analysis.

5) Comprehensive evaluation using the normalization formula and the evaluation principles of the mutation level method. According to the determined importance ranking of indicators and the evaluation principle of mutation level method, the normalization formula is used to calculate the mutation affiliation value of indicators at all levels, and the total mutation affiliation value is calculated upward step by step.

6) Evaluate the risk level of the evaluation target according to the total affiliation function results. According to the correspondence of the evaluation index system, the total mutation affiliation value is calculated, and then Table 1 determines the safety risk evaluation level of fruit and vegetable fresh cold chain logistics.

Table 1. Criteria for risk level assessment

Scope of evaluation findings	[0~0.2]	(0.2~0.3]	(0.3~0.4]	(0.4~0.5]	(0.5~1]
Police situation	Class I	Class II	Class III	Class IV	Class V

4.2 Mutation Modeling

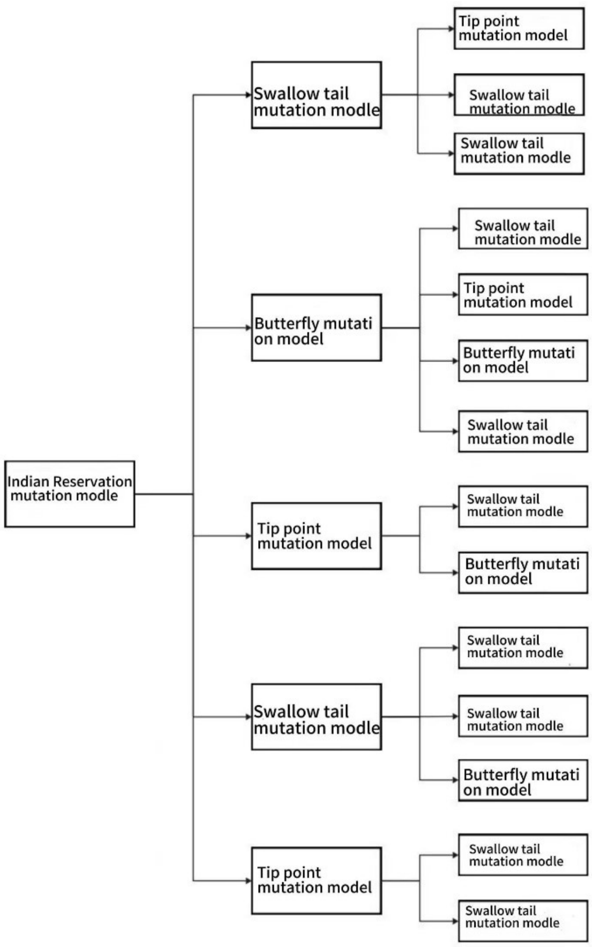

Figure 3. Improved mutation model

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The mutation systems established in this problem include the cusp mutation system, the swallowtail mutation system, the butterfly mutation system and the Indian hut mutation system (also known as the hut mutation system), and each of the mutation systems contains a state variable x as well as the coefficients of the state variable x, such as u, v, w, etc., which represent the control variables of the state variable. If an indicator is only decomposed into two sub-indicators, the system can be regarded as a cusp mutation system; if an indicator can be decomposed into three sub-indicators, the system can be regarded as a swallow-tail mutation system; if an indicator can be decomposed into four sub-indicators, the system can be regarded as a butterfly mutation system; if an indicator can be decomposed into five sub-indicators, the system can be regarded as an Indian hut mutation system. According to the safety index system of cold chain logistics in the whole process of "production - sale" of fresh fruits and vegetables established above, we can establish the following mutation model:

4.3 Improved Mutation Level Model Construction based on AHP

Key Steps in AHP Decision Making.

(1) Analyzing the problem

Determine the overall goal of the system through a deep understanding of the system, figure out the scope involved in the planning decision, the measure programs and policies to be adopted, the guidelines, strategies and various constraints to achieve the goal, etc., and collect information extensively.

(2) Establishment of a hierarchical model

Establish a multi-level hierarchical structure to classify the system into several hierarchical levels according to the different objectives and differences in realized functions.

(3) Construct judgment matrix

Determine the degree of correlation between neighboring level elements in the above hierarchical structure. By constructing a two-by-two comparison judgment matrix A, the relative weights of the elements related to an element in the current level are determined in terms of the importance of the element in the previous level. The comparison values are usually used as shown below.

Table 2. Definition of judgment matrix scales

Scale	Connotation
1 3 5 7 9	Equal importance of the two elements compared to each other The former is slightly more important than the latter The former is significantly more important than the latter The former is more strongly important than the latter The former is more important than the latter.
2,4,6,8	Intermediate values of the above adjacent judgments
Inverse	The two elements are compared, with the latter having a higher importance scale than the former

(4) Consistency test

(a) Calculation of consistency indicators

$$C.I. = \frac{\lambda \max - n}{n-1} \tag{5}$$

$$\lambda_{\max} \approx \frac{1}{n}\sum_{n-1}^{n}\frac{(AW)_i}{W_i} = \frac{1}{n}\sum_{i-1}^{n}\frac{\sum_{j-1}^{n} a_{ij} w_j}{Wi} \tag{6}$$

where $(AW)_i$ denotes the ith component of AW.

(b) Finds the corresponding average random consistency index.

The table gives the average random consistency indicator obtained by calculating the 1st to 12th order reciprocal matrix 1000 times. Then the average consistency indicator R.I. values are given in Table 3.

Table 3. Randomized consistency indicator RI values

N	1	2	3	4	5	6	7	8	9	10	11	12
R.I.	0	0	0.52	0.89	1.12	1.26	1.36	1.41	1.46	1.49	1.52	1.54

R.I. is the average value of the consistency index of the same order random judgment matrix, and its introduction can overcome to some extent the disadvantage that the consistency judgment index increases significantly with n.

$$C.R. = \frac{C.I.}{R.I.} < 0.1 \tag{7}$$

When the C.R. calculated by each computation matrix satisfies Equation (7), the results of hierarchical single sorting are considered to have satisfactory consistency, otherwise it is necessary to adjust the value of the elements taken by the judgment matrix.

The results of AHP analysis are shown in the table below.

Table 4. Results of consistency test

Consistency test for Level I indicators			Consistency test for Level III indicators		
Level I indicators	CR=0.089764<0.1	Passed	Operational specification	CR=0.03703<0.1	Passed
Consistency test for Level II indicators			Freshness and preservation	NULL	
Production pre-cooling session	CR=0.03703<0.1	Passed	Packaging	CR=0.022673<0.1	Passed
Processing sector	CR=0.043814<0.1,	Passed	Processing environment	CR=0.017591<0.1	Passed
Storage sector	NULL	Passed	Storage environment	CR=0.0035525<0.1	Passed
Transport sector	CR=0.03703<0.1	Passed	Inventory management	CR=0.043814<0.1	Passed
Sales segment	NULL		Transportation environment	CR=0.029507<0.1	Passed
Consistency test for Level III indicators			Traffic condition	CR=0.017591<0.1	Passed
Fruit and vegetable quality	CR=0.082468<0.1	Passed	Transportation vehicles	CR=0.03703<0.1	Passed
Clean Primary	CR=0.017591<0.1	Passed	Sales environment	CR=0.03703<0.1	Passed
Production pre-cooling environment	NULL		Sales Operations	CR=0.023649<0.1	Passed

The order of importance of the indicators affecting the quality and safety of fresh fruit and vegetable cold chain logistics is shown in Table 5.

Table 5. Ranking of the importance of indicators

Level I indicators	Secondary indicators	Tertiary indicators	Combined level of importance	Level I indicators	Secondary indicators	Tertiary indicators	Combined level of importance
A1	B1	C2	0.1973	A5	B13	C39	0.0079
A3	B8	C21	0.1155	A3	B9	C27	0.0078
A1	B2	C4	0.0958	A4	B10	C31	0.0062
A1	B1	C1	0.0881	A2	B5	C12	0.0056
A3	B8	C22	0.0614	A1	B3	C8	0.0054
A4	B10	C28	0.0502	A2	B7	C19	0.0053
A3	B9	C24	0.0374	A5	B14	C42	0.0052
A1	B3	C6	0.033	A2	B4	C10	0.0049
A1	B2	C5	0.0319	A4	B12	C36	0.0038
A1	B1	C3	0.0295	A3	B9	C26	0.0037
A4	B10	C29	0.023	A4	B11	C32	0.0035
A4	B12	C35	0.023	A5	B13	C40	0.0032
A2	B4	C9	0.0222	A2	B7	C20	0.002
A3	B8	C23	0.0217	A4	B11	C34	0.002
A5	B13	C38	0.0194	A2	B5	C13	0.0019
A3	B9	C25	0.0174	A2	B6	C14	0.0018
A1	B3	C7	0.0134	A5	B14	C41	0.0015
A4	B10	C30	0.0098	A2	B6	C15	0.0011
A4	B12	C37	0.0093	A5	B14	C43	0.0009
A2	B7	C18	0.0092	A2	B6	C16	0.0004
A4	B11	C33	0.0092	A2	B6	C17	0.0002
A2	B4	C11	0.0085	add up the total			1

4.4 Normalization Formula and Evaluation Principles

The calculation process of the improved mutation level method is mainly to normalize the collected data, bring the processed data into the normalization formula for comprehensive quantitative calculation, from the bottom to the first level, to find out the total value of the mutation affiliation function of the evaluation system. When using the normalization formula for multi-objective evaluation decision-making, the corresponding values calculated for each control variable (i.e. indicator) of the same object should adopt the principle of "taking the smallest out of the large", but for the existence of complementary indicators, the average is usually used as a substitute. In the final comparison of objects, the principle of "taking the smallest with the largest" should be adopted, i.e., the evaluation objects should be ranked according to the size of the scores of the total evaluation indicators.

When using the mutation level method for comprehensive evaluation, two principles need to be taken into account: the "complementary" principle and the "non-complementary" principle, and only by following such a principle can we meet the requirements of the divergence equation in the mutation

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theory. The principle of complementarity refers to the fact that when the control variables within the mutation system have interconnected relationships with each other, the average value of the mutation level of each control variable is chosen as the value of the mutation level of the whole system when calculating the mutation value of the state variables of the system with the normalization formula. This principle is also known as the mean value principle; the non-complementary principle means that when the control variables within the mutation system are independent of each other and have no obvious connection, the smallest value of the mutation level of each control variable is chosen as the value of the mutation level of the whole system when the mutation value of the state variables of the system is calculated. This principle is also known as the principle of taking the smallest among the large. Therefore, according to the above two principles, different mutation systems follow different principles, the calculation of the normalization formula is different, the following gives several common mutation systems of the normalization formula, as shown in Table 6.

Table 6. Normalization calculation formula

System of mutations	Evaluation principles	Evaluation formula
Spike mutation system	The principle of complementarity	$x=\frac{1}{2}(x_u+x_v)=\frac{1}{2}(\sqrt{u}+\sqrt[3]{v})$
	The principle of non-complementarity	$x=\min(x_u,x_v)$=$\min(\sqrt{u},\sqrt[3]{v})$
Swallowtail mutant system	The principle of complementarity	$x=\frac{1}{3}(x_u+x_v+x_w)=\frac{1}{3}(\sqrt{u}+\sqrt[3]{v}+\sqrt[4]{w})$
	The principle of non-complementarity	$x=\min(x_u,x_v,x_w)$=$\min(\sqrt{u},\sqrt[3]{v},\sqrt[4]{w})$
Butterfly mutation system	The principle of complementarity	$x=\frac{1}{4}(x_u+x_v+x_w+x_t)=\frac{1}{4}(\sqrt{u}+\sqrt[3]{v}+\sqrt[4]{w}+\sqrt[5]{t})$
	The principle of non-complementarity	$x=\min(x_u,x_v,x_w,x_t)$=$\min(\sqrt{u},\sqrt[3]{v},\sqrt[4]{w},\sqrt[5]{t})$
Indian Cottage Mutation System	The principle of complementarity	$x=\frac{1}{5}(x_u+x_v+x_w+x_t+x_s)=\frac{1}{5}(\sqrt{u}+\sqrt[3]{v}+\sqrt[4]{w}+\sqrt[5]{t}+\sqrt[6]{s})$
	The principle of non-complementarity	$x=\min(x_u,x_v,x_w,x_{t,,})$=$\min(\sqrt{u},\sqrt[3]{v},\sqrt[4]{w},\sqrt[5]{t},\sqrt[6]{s})$

5. Example Implementation of an Improved Mutation Level Risk Assessment Methodology based on AHP Analysis

According to the analysis and research of the range of data indicators of fresh fruits and vegetables from production pre-cooling to sales, this paper uses a random number generator to generate random data, for example, the degree of cleaning and processing operation specification floating normal distribution, the expectation is set to 0.8, and the variance is set to 0.06; the humidity of the storage environment obeys a uniform distribution, ranging from 80%-98%, etc., and the actual data are collected by the information acquisition system based on the Internet of Things. The actual data were collected by an information collection system based on the Internet of Things (IoT). We use one of the data sets for risk assessment, and the assessment process and results are shown in the following table. According to the risk level assessment criteria in Table 7, the safety risk level of this cold chain logistics process is Grade 1.

Table 7. Combined total mutation affiliation values for each level of indicators

Risk indi-ces	Level I indica-tors	Mutation affiliation value	Contr-ol variable	Seconda-ry indicat-ors	Mutation affiliation value	Contr-ol variab-le	Tertia-ry indicat-ors	Mutation affiliation value	Norma-lized data
0.16	A1	0.80	0.65	B1	0.65	0.42	C1	0.91	0.75
							C2	0.62	0.38
							C3	0.42	0.03
				B2	0.73	0.39	C4	0.39	0.15
							C5	0.65	0.27
				B3	0.87	0.57	C6	0.57	0.32
							C7	0.89	0.71
							C8	0.87	0.56
	A2	0.00	0.00	B4	0.00	0.00	C9	0.28	0.08
							C10	0.00	0
							C11	0.00	0
				B5	0.91	0.68	C12	0.68	0.46
							C13	0.78	0.48
				B6	0.00	0.00	C14	0.00	0
							C15	0.88	0.67
							C16	0.65	0.18
							C17	0.92	0.65
				B7	0.92	0.77	C18	0.77	0.6
							C19	0.86	0.63
							C20	0.80	0.41
	A3	0.00	0.00	B8	0.74	0.55	C21	0.55	0.3
							C22	0.85	0.62
							C23	0.84	0.5
				B9	0.00	0.00	C24	0.00	0
							C25	0.85	0.61
							C26	0.73	0.21
							C27	0.75	0.31
	A4	0.00	0.00	B10	0.87	0.75	C28	0.75	0.56
							C29	0.93	0.8
							C30	0.87	0.57
							C31	0.83	0.4
				B11	0.97	0.90	C32	0.74	0.41
							C33	1.00	1
							C34	0.96	0.84
				B12	0.00	0.00	C35	0.76	0.58
							C36	0.88	0.61
							C37	0.00	0
	A5	0.00	0.00	B13	0.00	0.00	C38	0.00	0
							C39	0.73	0.39
							C40	0.84	0.5
				B14	0.00	0.00	C41	0.87	0.65
							C42	0.00	0
							C43	0.92	0.73

6. Conclusion

This paper proposes to establish a wireless sensor network combining RFID and WSN based on Internet of Things for cold chain logistics process information collection, constructs a safety index system for the whole process of fruit and vegetable fresh food cold chain logistics, adopts the maximum and minimum value method to standardize the data, and combines the hierarchical analysis method with the mutation level method to solve the problem of cold chain logistics quality and safety risk assessment. The maximum-minimum value method is used to standardize the data, and the hierarchical analysis method is combined with the mutation level method to solve the problem of quality and safety risk assessment of cold chain logistics, and the feasibility and simplicity of the method are verified by random cases, which provides a new solution and idea for the safety assessment of the fruit and vegetable fresh cold chain logistics, and in the future, it can be combined with the information management system to digitize the data information and risk level in the process of the fruit and vegetable fresh cold chain logistics through the APP and the app, and other ways. In the future, it can be combined with the information management system to digitally display the data information and risk level in the process of fruit and vegetable cold chain logistics through APP and small program, which can help enterprises to improve the level of safety management and also bring better service experience for users.

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