Original Research Article

Fuzzy comprehensive evaluation of fresh food supply chain quality based on AHP

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Abstract: With the continuous improvement of consumers' requirements for the quality and safety of fresh food, the quality of its supply chain is attracting increasing attention. This paper takes the fuzzy comprehensive evaluation of fresh food supply chain quality based on analytic hierarchy process (AHP) as the starting point. First of all, deeply analyze the characteristics of the fresh food supply chain and the quality influencing factors, and clarify the key indicators such as logistics links, suppliers, external environment, personnel quality, and after-sales service that affect supply quality. Then, the AHP method is introduced to construct a quality evaluation index system and determine the weight of each index, so as to systematize and hierarchize the complex quality evaluation problem. Then, fuzzy comprehensive evaluation is used to quantitatively evaluate the quality of the fresh food supply chain, transforming the fuzzy quality concept into specific numerical indicators, providing relatively scientific and accurate quality evaluation basis for enterprise managers and relevant departments. This research aims to provide effective methods and decision support for the quality control of the fresh food supply chain, so as to improve the overall quality level of the fresh food supply chain and protect the rights and interests of consumers..

Keywords: Analytic hierarchy process; Supply chain quality; Fuzzy comprehensive evaluation

1. The necessity of quality assessment of fresh food supply chain.

Recently, fresh food is occupying an increasingly important position in people's daily lives. With the continuous improvement of consumers' requirements for food freshness, quality and safety, the efficient operation of the fresh food supply chain has become crucial[1]. However, there are many factors that affect the quality of the fresh food supply chain. These factors may not only affect the quality and safety of food, but also cause serious damage to the economic benefits and social reputation of enterprises.

First of all, fresh food has characteristics such as perishability and timeliness, and has extremely high requirements for environmental conditions such as temperature and humidity. In each link of the supply chain, such as production, transportation, storage, and sales, a little carelessness may lead to food spoilage and thus trigger food safety issues. Therefore, conducting quality assessment on the fresh food supply chain can timely discover potential risk factors and take effective measures to ensure the quality and safety of food.

Secondly, the fresh cold chain food supply chain involves multiple links and many participants, including producers, suppliers, transporters, retailers, etc[2]. Coordination and cooperation between various links are crucial. Once problems occur, it may trigger a chain reaction and affect the normal operation of the entire supply chain. Through quality assessment, weak links and potential risk in the supply chain can be identified, communication and collaboration among various participants can be strengthened, and the stability and reliability of the supply chain can be improved.

Finally, with the increasingly fierce market competition, conducting quality assessment on the fresh

food supply chain can help enterprises better understand market dynamics and customer demand, optimize supply chain management, reduce operating costs, improve customer satisfaction, and thus enhance the core competitiveness of enterprises.

This paper takes a certain fresh food supply chain as the research object, combines the analytic hierarchy process method to analyze the factors affecting the quality of the fresh supply chain, provides decision-making references for improving the overall supply quality of fresh food, and also has reference significance for the selection and evaluation of other product supply models.

2. Design of quality evaluation indicators for fresh food supply chain

Fresh food has characteristics such as perishability, timeliness, and sensitivity to environmental conditions. Different kinds of fresh food have different spoilage rates and suitable storage temperatures. For example, the respiration of fruits and vegetables generates heat and requires specific ventilation conditions; meat and seafood have stricter requirements for temperature, and slight temperature fluctuations may lead to spoilage. When evaluating, these characteristics should be fully considered to determine appropriate storage, transportation, and sales conditions to reduce the risks brought by product characteristics. Although the supply chain of fresh food has received increasing attention, there are still many problems in comprehensive quality. The continuous changes in the fresh food market make the problem of fresh food supply more and more prominent. The factors affecting quality are multifaceted. Through distributing questionnaires online and in Shijiazhuang area, this paper determines several factors that should be considered in the quality evaluation of the fresh food supply chain, mainly including: logistics links, suppliers, external environment, personnel quality, after-sales service, etc., thus constructing a quality evaluation index system for the fresh food supply chain. The problem of low quality level in the fresh food supply chain can be addressed through evaluation using a set of indicators mentioned above.

2.1. Analysis of factors affecting supply quality

2.1.1. Logistics section

Different transportation modes have their own advantages and disadvantages. Road transportation is flexible and convenient, but it is greatly affected by traffic conditions; railway transportation has a relatively low cost, but the route is fixed; air transportation is fast, but the cost is high; Similarly, water transportation is suitable for large-volume cargo transportation, but a long time is needed. An appropriate transportation mode needs to be selected according to the characteristics and needs of fresh food, When it is evaluated. In the entire logistics process, maintaining an appropriate temperature is the key to ensuring the quality of fresh food. Appropriate packaging materials can protect fresh food from physical damage, reduce moisture loss and prevent pollution; in addition, cargo damage in the distribution link is also the most important part of evaluating supply chain quality. Therefore, the logistics link includes: transportation mode, temperature control, packaging materials and distribution link.

2.1.2. Supplier

The reputation of suppliers is directly related to the quality and supply stability of fresh food. Suppliers with low credibility tend to provide less quality, Factors such as the production capacity, inventory level, and delivery timeliness of suppliers will also affect the smooth operation of the fresh food supply chain. When evaluating, it is necessary to ensure that suppliers can meet the needs of enterprises and avoid risks caused by insufficient supply or delay. Whether suppliers have established a sound quality management system is also crucial to the quality

of fresh food. Choosing suppliers with a strict quality management system can reduce quality risks. In addition, the fresh food supply chain is easily affected by emergencies such as natural disasters and public health events. Suppliers should have the ability to respond quickly and deal with emergencies. In the event of a crisis, they must be able to ensure timely supply. Therefore, supplier evaluation includes: supplier reputation, supply capacity, quality management system, and emergency response ability[3-4].

2.1.3. External environment

Natural disasters such as earthquakes, floods, typhoons, rainstorms, and blizzards may damage the supply chain's infrastructure and affect the transportation of goods. The increase in extreme weather events may affect the production and storage of fresh food and increase the risk of the supply chain. The government may introduce new laws and regulations to regulate all links of the supply chain. Compliance operations should be ensured to ensure that supply is not affected. Inflation, exchange rate fluctuations, and economic recessions will all have an impact on supply chain quality. Timely and accurate demand forecasting is crucial. At the same time, animal epidemics such as bird flu will cause disruptions in livestock farming and then affect the supply side of the supply chain. Therefore, the external environment mainly includes: natural environment risks, changes in laws and regulations, economic environment, and animal epidemics[5].

2.1.4. Personnel qualities

Every link of the fresh food supply chain requires operation and management by professional personnel, including production workers, transportation drivers, warehouse managers, sales personnel, etc. They should have corresponding professional skills、knowledge and be familiar with the characteristics and processing methods of fresh food. All personnel involved in the supply chain should have a high awareness of quality and quality standards, Strengthen the training and education of employees, improve their quality awareness and responsibility, and ensure food quality and safety,which is also a major point to consider. Specific aspects include professional skills, quality awareness, service attitude and sense of responsibility[6].

2.1.5. After-sales service

After-sales service is a potential way to attract customers. It can provide customers with convenient return and exchange channels, such as online applications and handling at offline stores, thereby ensuring that customers can easily put forward return and exchange requests and get them processed in a timely manner. Once a return and exchange application from a customer is received, the enterprise should respond quickly and arrange personnel to handle it in a timely manner. Establish multiple complaint channels and form a professional complaint handling team to facilitate customers to file complaints at any time, ensure that the complaint channels are unimpeded, and customers' complaints can be received and processed in a timely manner. Conduct regular customer follow-ups and provide timely feedback on results to understand customers' satisfaction with products and services and collect customers' opinions and suggestions. Through follow-ups, enterprises can discover problems in time, improve products and services, and improve customer satisfaction. Membership system, customized services, and community services are also important aspects of after-sales service. Therefore, after-sales service mainly includes: service efficiency, complaint handling, client review, and value-added services.

2.2. Index design for supply quality evaluation

In the research, the specific influencing factors in each element are obtained by distributing questionnaires both online and offline. The first-level indicators mentioned is divided into the following second-level indicators. For each second-level indicator, pairwise scoring is conducted to form a complete set of indicator systems.

Based on the content above, a supply chain quality evaluation indicator system including 5 first-level indicators and 20 second-level indicators is established, as shown in Table 1.

Table 1. Evaluation index system for supply quality.

First-level indicators	Second-level indicators
Logistics section U1	Transportation mode U_{11}
	Temperature control U_{12}
	Packaging material U_{13}
	Delivery U_{14}
Supplier U2	Supplier reputation U_{21}
	Supply capacity U_{22}
	Quality management system U_{23}
	Emergency response capability U_{24}
External environment U3	Environment risk U_{31}
	Changes in laws and regulations U_{32}
	Economic environment U_{33}
	Animal epidemics U_{34}
Personnel quality U4	Professional skills U_{41}
	Quality awareness U_{42}
	Service attitude U_{43}
	Responsibility U_{44}
After-sales service U5	Service efficiency U_{51}
	Complaints U_{52}
	Client review U_{53}
	Value-added services U_{54}

A hierarchical structure diagram was summarized and drawn based on the evaluation indicators of supply chain quality in Table 1, as shown in the following Figure 1.

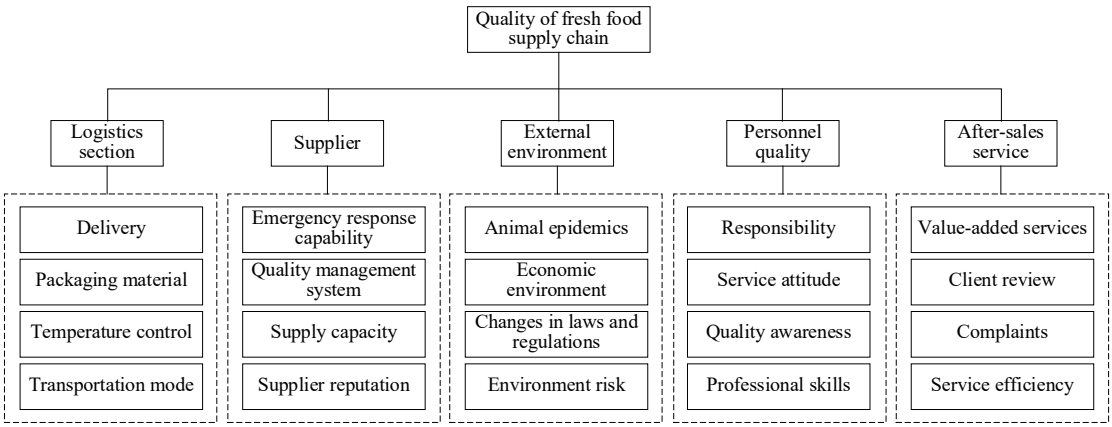

Figure 1

3. Construction of comprehensive evaluation model for supply chain

3.1. Determination of influencing factor set

Ui which is subjected to the set U={ U_1,U_2,…,U_m} is the evaluation factor of the evaluated object, the m represents the number of evaluation factors, which is determined by the specific indicator system. For the convenience of weight distribution and evaluation, evaluation factors can be divided into several categories. Each

category is regarded as a single evaluation factor. As shown in the hierarchical structure diagram, the factor set U can be set as follows:

U={U1,U2,U3,U4,U5}, U_1={U_{11},U_{12},$U1_3$,U_{14}},U_2={U_{21},U_{22},U_{23},U_{24}},U_3={U_{31},U_{32},U_{33},U_{34}},U_4={U_{41},U_{42},U_{43}, U_{44}},

U_5={U_{51},U_{52},U_{53},U_{54}}

3.2. Establishment of evaluation set

The construction of the model requires the establishment of an evaluation set to evaluate the final result. Set V = {V_1, V_2,..., Vn} as a set of comment grades composed of various overall evaluation results that evaluators may make on the evaluated object. Where V_j represents the jth evaluation result. According to the known situation of the fresh supply chain as above, the evaluation set V = {V_1, V_2, V_3, V_4, V_5} = {“extremely good”, “very good”, “good”, “fair”, “poor”} is established.

3.3. Determination of weights for each indicator

The AHP was applied to determine weights in the research, meanwhile, combining qualitative and quantitative methods was used to compare and judge the relative importance of each indicator pairwise. Based on the above analysis, a judgment matrix was established, and then the weights are solved and perform consistency checks can be conducted. After consulting relevant materials and soliciting opinions from experts of the field, pairwise comparisons were made between indicators at the same level, the specific judgment scale is represented by the scaling method as follows:

Table 2. Judgment scale.

Definition	Explanation	Judgment scale B_{ij}
Equally important	B_i and B_j are equally important.	1
Slightly important	B_i is slightly more important than B_j.	3
Obviously important	B_i is obviously more important than B_j.	5
Strongly important	B_i is strongly more important than B_j.	7
Extremely important.	B_i is extremely more important than B_j.	9
Intermediate value of adjacent assessment.	Intermediate value between the above two adjacent judgment scales.	2、4、6、8

After scoring pairwise, W_i and λ_{max} were determined, and hen the consistency testing on the weights can be conducted. And the consistency can be determined by referring to the judgment criteria in Table 3 below. The specific formula is as follows:

$$W\,i = \frac{1}{n}\sum_{i=1}^{n} \left(dij \sum_{k=1}^{n} dkj\right)$$

$$\lambda\,max = \frac{1}{n}\sum_{j=1}^{n} \left(d\,ij \cdot wj/wi\right)$$

$$CI=(\lambda max - n)/(n-1)$$

$$CR=CI/RI$$

W_i-the weight of indicators

λ-the maximum eigenvalue of the matrix

CI and CR represent the consistency testing parameters

Table 3. Average random consistency index.

维数	1	2	3	4	5	6	7	8	9
RI	0.0.0	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45

3.4. Constructing a fuzzy evaluation matrix

Based on the conditions of the evaluated supply chain, a single factor analysis was conducted on the second layer of the evaluation index system to obtain a single factor fuzzy evaluation matrix. Specifically, the fuzzy evaluation matrix R can be calculated using the following formula,

$Bi=W_iR_i$

$$R=\begin{bmatrix} B11 & B12 & B13 & B14 & B15 \\ B21 & B22 & B23 & B24 & B25 \\ B31 & B32 & B33 & B34 & B35 \\ B41 & B42 & B43 & B44 & B45 \\ B51 & B52 & B53 & B54 & B55 \end{bmatrix}$$

3.5. Conducting fuzzy comprehensive evaluation

The fuzzy comprehensive evaluation model can be established by a fuzzy synthesis transformation on the weights of evaluation factors and the evaluation matrices of various influencing factors, specifically, as follows:

$$B=W\cdot R=(W1,W2,W3,W4,W5)\begin{bmatrix} B11 & B12 & B13 & B14 & B15 \\ B21 & B22 & B23 & B24 & B25 \\ B31 & B32 & B33 & B34 & B35 \\ B41 & B42 & B43 & B44 & B45 \\ B51 & B52 & B53 & B54 & B55 \end{bmatrix}$$

4. Case study

A medium-sized fresh food company which is located in Shijiazhuang China had considerable profits at the initial stage of operation, however, a series of problems such as customer complaints and a decline in profit margin occurred in the following operation process. According to the analysis above, AHP was applied to establish a model to evaluate the quality of this supply chain. And a survey with 200 questionnaires was conducted on customers, 160 valid questionnaires were obtained. The final scoring results are as follows:

4.1. Construct a judgment matrix

The details are presented below:

$$A=\begin{bmatrix} 1 & 7 & 3 & 2 & 5 \\ 1/7 & 1 & 2 & 1/2 & 1/3 \\ 1/3 & 1/2 & 1 & 1/2 & 1/2 \\ 1/2 & 2 & 2 & 1 & 3 \\ 1/5 & 3 & 2 & 1/3 & 1 \end{bmatrix} \quad B1=\begin{bmatrix} 1 & 5 & 3 & 7 \\ 1/5 & 1 & 1/5 & 2 \\ 1/3 & 5 & 1 & 3 \\ 1/7 & 1/2 & 1/3 & 1 \end{bmatrix} \quad B2=\begin{bmatrix} 1 & 2 & 3 & 2 \\ 1/2 & 1 & 2 & 1/2 \\ 1/3 & 1/2 & 1 & 1/2 \\ 1/2 & 2 & 2 & 1 \end{bmatrix}$$

$$B3=\begin{bmatrix} 1 & 1/2 & 2 & 2 \\ 2 & 1 & 5 & 7 \\ 1/2 & 1/5 & 1 & 4 \\ 1/2 & 1/7 & 1/4 & 1 \end{bmatrix} \quad B4=\begin{bmatrix} 1 & 1/2 & 3 & 2 \\ 2 & 1 & 5 & 7 \\ 1/3 & 1/5 & 1 & 4 \\ 1/2 & 1/7 & 1/4 & 1 \end{bmatrix} \quad B5=\begin{bmatrix} 1 & 1/7 & 1/2 & 5 \\ 7 & 1 & 1/6 & 1/3 \\ 2 & 6 & 1 & 1/2 \\ 1/5 & 3 & 2 & 1 \end{bmatrix}$$

Based on AHP and the following formulas, the weights corresponding to each factor are determined in the table as shown in Tables 3 and Table 4:

$W_i = \frac{1}{n}\sum_{i=1}^{n}$ （dij $\sum_{k=1}^{n}$ dkj ）

$\lambda_{max} = \frac{1}{n}\sum_{j=1}^{n}$ （d ij · wj/wi）

CI:CI=$\frac{\lambda max - n}{n-1}$, CR=$\frac{CI}{RI}$

W_i-the weight of indicators

λ-the maximum eigenvalue of the matrix

CI and CR represent the consistency testing parameters

Table 4

A	B_1	B_2	B_3	B_4	B_5	W_i	W_i^0	λ
B_1	1	7	3	2	5	2.914	0.466	5.263
B_2	1/7	1	2	1/2	1/3	0.544	0.087	5.538
B_3	1/3	1/2	1	1/2	1/2	0.530	0.085	5.484
B_4	1/2	2	2	1	3	1.431	0.229	5.264
B_5	1/5	3	2	1/3	1	0.833	0.133	5.505

Table 5

B_1	B_{11}	B_{12}	B_{13}	B_{14}	W_i	W_i^0	λ
B_{11}	1	5	3	7	3.201	0.569	4.091
B_{12}	1/5	1	1/5	2	0.532	0.095	4.243
B_{13}	1/3	5	1	3	1.495	0.266	4.280
B_{14}	1/7	1/2	1/3	1	0.393	0.070	4.110

The following parameters can be obtained from Table 4:

W= (2.914,0.544,0.530,1.431,0.833) ,

W^0= (0.466,0.087,0.085,0.229,0.133) ,

λ= (5.263,5.538,5.484,5.264,5.505) ,

CI=0.103, CR=0.09

According to the table 3, the consistency can be verified.

Based on the Table 5, it can be obtained as follows:

W_1= (3.201,0.532,1.495,0.393) ,

W_1^0= (0.569,0.095,0.266,0.070) ,

λ= (4.091,4.243,4.280,4.110) ,

CI=0.06,CR=0.067,

Similar to the mentioned above, consistency has also been tested. And similarly, the following is also the same.

W_2= (1.861,0.841,0.537,1.189) , W_2^0= (0.420, 0.190,0.121,0.269) ;

W_3= (1.189,2.893,0.795,0.366) , W_3^0= (0.227,0.552,0.152,0.070) ;

W_4= (0.841,2.817,1.278,0.330) , W_4^0= (0.160,0.535,0.243,0.063) ;

W_5= (0.904,1.414,0.289,2.711) , W_5^0= (0.170,0.266,0.054,0.510)

4.2. Establish an evaluation matrix

Twenty supply chain experts were invited to evaluate and score the secondary indicators of the factors

affecting the quality of the supply chain, and the following evaluation matrix was obtained:

$$R1=\begin{bmatrix} 0 & 0.15 & 0.35 & 0.25 & 0.25 \\ 0 & 0.15 & 0.3 & 0.4 & 0.15 \\ 0.15 & 0.15 & 0.3 & 0.3 & 0.1 \\ 0.15 & 0.35 & 0.2 & 0.2 & 0.1 \end{bmatrix}$$

$$R2=\begin{bmatrix} 0.2 & 0.35 & 0.2 & 0.2 & 0.05 \\ 0.05 & 0.15 & 0.5 & 0.25 & 0.05 \\ 0.2 & 0.25 & 0.4 & 0.1 & 0.05 \\ 0.25 & 0.4 & 0.1 & 0.2 & 0.05 \end{bmatrix}$$

$$R3=\begin{bmatrix} 0.2 & 0.45 & 0.1 & 0.25 & 0 \\ 0.05 & 0.05 & 0.3 & 0.5 & 0.1 \\ 0.2 & 0.25 & 0.5 & 0 & 0.05 \\ 0 & 0.15 & 0.4 & 0.35 & 0.1 \end{bmatrix}$$

$$R4=\begin{bmatrix} 0 & 0.2 & 0.4 & 0.3 & 0.1 \\ 0.05 & 0.15 & 0.2 & 0.6 & 0 \\ 0.15 & 0.45 & 0.2 & 0.05 & 0.15 \\ 0.2 & 0.05 & 0.3 & 0.4 & 0.05 \end{bmatrix}$$

$$R5=\begin{bmatrix} 0.05 & 0.05 & 0.3 & 0.4 & 0.2 \\ 0.15 & 0.05 & 0.3 & 0.25 & 0.25 \\ 0.25 & 0.15 & 0.2 & 0 & 0.4 \\ 0.15 & 0 & 0.3 & 0.25 & 0.3 \end{bmatrix}$$

By performing fuzzy matrix multiplication using the formula $B_i=W_i^0 \square R_i$, B_i can be obtained separately as follows:

$$B_1=W_1{}^0 \cdot R_1=(0.569,0.095,0.266,0.070) \cdot \begin{bmatrix} 0 & 0.15 & 0.35 & 0.25 & 0.25 \\ 0 & 0.15 & 0.3 & 0.4 & 0.15 \\ 0.15 & 0.15 & 0.3 & 0.3 & 0.1 \\ 0.15 & 0.35 & 0.2 & 0.2 & 0.1 \end{bmatrix}$$

$$=(0.15，0.15，0.35，0.266，0.25)$$

$$B_2=W_2{}^0 \cdot R_2=(0.420,0.190,0.121,0.269) \cdot \begin{bmatrix} 0.2 & 0.35 & 0.2 & 0.2 & 0.05 \\ 0.05 & 0.15 & 0.5 & 0.25 & 0.05 \\ 0.2 & 0.25 & 0.4 & 0.1 & 0.05 \\ 0.25 & 0.4 & 0.1 & 0.2 & 0.05 \end{bmatrix}$$

$$=(0.25，0.35，0.2，0.2，0.05)$$

Similarly, B_3 B_4 and B_5 can be concluded .

$B_3=W_3{}^0 \cdot R_3=(0.2, 0.227, 0.3, 0.5, 0.1)$;

$B_4=W_4{}^0 \cdot R_4= (0.15, 0.16, 0.2, 0.535, 0.15)$;

$B_5=W_5{}^0 \cdot R_5= (0.15, 0.054, 0.51, 0.25, 0.3)$

Based on the fuzzy vectors of various indicators, the fuzzy comprehensive evaluation moment R is constructed as follows:

$$R=\begin{bmatrix} 0.15 & 0.15 & 0.35 & 0.266 & 0.25 \\ 0.25 & 0.35 & 0.2 & 0.2 & 0.05 \\ 0.2 & 0.227 & 0.3 & 0.5 & 0.1 \\ 0.15 & 0.16 & 0.2 & 0.535 & 0.15 \\ 0.15 & 0.054 & 0.51 & 0.25 & 0.3 \end{bmatrix}$$

4.3. Fuzzy comprehensive evaluation

According to the synthesis operation of fuzzy matrix:

B=W • R

B can be concluded as follows:

$$B = (0.466, 0.087, 0.085, 0.229, 0.133) \cdot \begin{bmatrix} 0.15 & 0.15 & 0.35 & 0.266 & 0.25 \\ 0.25 & 0.35 & 0.2 & 0.2 & 0.05 \\ 0.2 & 0.227 & 0.3 & 0.5 & 0.1 \\ 0.15 & 0.16 & 0.2 & 0.535 & 0.15 \\ 0.15 & 0.054 & 0.51 & 0.25 & 0.3 \end{bmatrix}$$

$$= (0.15, 0.16, 0.35, 0.266, 0.25)$$

From the above judgment matrix, it can be concluded that all have passed the consistency test. The fuzzy vectors of each indicator can be obtained from the above evaluation matrix. Finally, a fuzzy comprehensive evaluation matrix is constructed for fuzzy comprehensive evaluation. The results show that the maximum value is located in the third position. According to the maximum membership principle, it can be concluded that the supply chain is at a good level.

5. Several suggestions for improving the quality of fresh food supply chain

The issue of fresh food supply quality is not only valued by supply enterprises but also attracts the attention of a large number of consumers. Based on the analyses mentioned above and in combination with reality, several suggestions for improving supply quality can be drawn as follows:

a) Strengthen source management: Strictly screen suppliers of fresh food products. Give priority to choosing suppliers with good reputations, sustainable production capabilities, and strict quality control for cooperation, and establish long-term and stable cooperative relationships. Jointly formulate strict production standards with suppliers and supervise and guide the production process of suppliers to ensure that they produce in accordance with standards.

b) Optimize the logistics link: Upgrade transportation equipment, detect the temperature inside the vehicle to ensure the freshness of fresh food products during transportation. Reasonably plan for transportation routes to reduce transportation time and costs. Improve transportation efficiency and service quality. Build modern fresh food storage facilities and implement scientific inventory management methods to deal with expired or deteriorated products in a timely manner.

c) Strengthen quality inspection: Establish a complete inspection system to ensure that products meet quality and safety standards. Cooperate with authoritative third-party inspection institutions to regularly inspect and evaluate fresh food products.

d) Improve the level of informatization : Establish a supply chain management system and implement a traceability system. Strengthen the professional skill training of personnel and cultivate quality awareness.

6. Conclusions

This paper provides effective methods and decision support for quality control of fresh food supply chains. In practical applications, Enterprises can conduct a comprehensive evaluation of their own fresh food supply chain according to the evaluation index system and methods constructed by the research, identify weak links, and make targeted improvements and optimizations. At the same time, relevant departments can also use the research results of this study to strengthen the supervision of fresh food supply chains and protect the rights and interests of consumers.

However, this paper also has certain limitations. For example, In the process of constructing the index system and determining the weight, there may be some subjectivity. In practical applications, the fresh food

supply chains of different regions and enterprises may have differences, and it needs to be further adjusted and improved according to the actual situation. Future research can be further expanded in the following aspects:

a) further optimize the evaluation index system to improve its universality and accuracy.

b) combine advanced technologies such as big data and artificial intelligence to realize real-time monitoring and dynamic evaluation of the quality of fresh food supply chains.

c) Strengthen the research of supply chain risk management and improve the anti-risk ability of fresh food supply chain.

In conclusion, improving the quality of fresh food supply chains is a long-term and complex process that requires the joint efforts of enterprises, the government, and all sectors of society. This research provides useful references and methodological support for the realization of this goal, and hopes to contribute to promoting the healthy development of the fresh food industry.

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