The 6th International Conference on Economic Management and Green Development (ICEMGD 2022)
DOI: 10.54254/2754-1169/4/2022985

Food Supply Chain Risk Of Community Group Buying In The Post-Epidemic Era

Liu Yujing[1,a,*]

[1]*Business School,Beijing Wuzi University, Beijing 101149, China*
a. 3164592351@qq.com
**corresponding author*

Abstract: Due to the outbreak of COVID-19 at the beginning of 2020, community group buying is booming again, but at the same time, it will bring new risks. Combining with the characteristics of food quality and community group purchase management, from food procurement, supply, distribution, sales link of food supply chain risk is analyzed, by using analytic hierarchy process (AHP) and fuzzy comprehensive evaluation method in the food supply chain risk factors, the result shows that in the community group to the importance of the food supply chain risk for commodity procurement risk > External environmental risk > Logistics distribution risk > Information Technology Risk >Mission risk, By analyzing these five risks, preventive measures are provided for food supply chain risk management in community group buying.

Keywords: community group purchase, food supply chain, supply chain risk, AHP, fuzzy comprehensive evaluation method.

1. Introduction

With the development of community group buying, the risk of food supply chain has gradually become an increasingly noticeable topic, which has been widely concerned by countries all over the world. Scholars from all over the world have conducted in-depth research on this hot topic. Food supply chain risk refers to the possibility of food supply chain collapse, operational obstacles, reputation and economic loss and customer loss caused by various uncertain factors within the system in the process of operation of enterprises at each node of the food supply chain [1]. It is of great significance to analyze the development of food supply chain of community group buying. It is very important to find a suitable method to prevent supply chain risk. By establishing risk indicators and comparing the weight of risk indicators, this paper obtains the scores of risk indicators, and then puts forward corresponding suggestions for the risk degree of each stage. Some scholars believe that the study of food supply chain risk is of great significance for establishing food safety risk early warning. For example, from the perspective of supply chain, the food quality and safety risk evaluation index system is established, and a safety warning model is established to provide reference for food quality and safety warning [2]. In addition, the study of food supply chain risks is helpful for the industry to improve product quality and provide reference for the management of relevant departments [3]. Food supply chain risk research is also conducive to the establishment of food circulation database. For example, comprehensive recording of information in all links of the supply chain is conducive to the establishment of food circulation database, thus contributing to food safety and quality control and

DOI: 10.54254/2754-1169/4/2022985

national macro-control [4]. Although some methods have been proposed to assess the risk of the food supply chain, there are still some limitations, which lead to the inaccuracy of the risk assessment at each stage of the food supply chain. Therefore, it is very important to use limited resources to establish appropriate models to accurately assess the risk degree of each stage of the food supply chain.

At present, the research on food supply chain risk focuses on risk identification, assessment and management. In the source analysis of food supply chain risks, Liu Yongsheng [5] believes that the main sources of food supply chain risks are both exogenous and endogenous factors. In the food supply chain risk, the research Angle of food supply chain risk is different due to different research subjects. Zhang Qin et al. [6] identified four influencing factors from the three stages of raw material collection, processing and manufacturing and graded sales in the supply chain. Liu Yongsheng et al. [7] divided online food safety risks into risks in the supply stage and risks in the demand stage based on the perspective of supply chain. Jingxue Zhang[8] divided the risks in the supply chain of fresh electricity suppliers into external risks and internal risks. Compared with internal and external risks, Santeramo Fabio Gaetano et al. [9] divided risks in the food supply chain into objective risks and subjective risks for analysis. But pure food supply chain risk can be divided into two parts, easy to lose detail in specific research, therefore, zhang li [10] according to the characteristics of the two aspects of supply chain risk and food supply chain, according to the different perspective of the supply chain, the risk is divided into raw material commodity procurement, processing production risk, circulation sales link risk. Most of the above analyses classify risks from the overall food supply chain. Bouzembrak Yamine et al. [11] used The European dairy supply chain as an application case to identify chemical food safety risks related to abnormalities in Dutch milk by Using Bayesian networks, indicating that food safety problems may occur at the beginning of the supply chain. Using specific examples to analyze and identify risks helps to solve specific risks. Kalantari Fateme et al. [12] proposed a sustainable global food supply chain model considering the risk, considering that food is prone to deterioration without proper transportation and maintenance after production. Nurul Eiman Md Saad et al. [13] analyzed the impact of Novel Coronavirus on food safety and food supply chain, discussed and identified risks from the aspects of hygiene of food operators, complete vaccination requirements, kitchen hygiene and strict standard operating specifications, etc. In the above stages, food safety can be ensured. Preventing food safety risks from creeping up the supply chain.

Food safety risk assessment runs through the whole supply chain, and relevant research is extremely important, which is also an essential link in formulating food safety policies and measures. Zhang Min [14] took into account the complexity of the food supply chain network and the mutual transmission of risk factors among different enterprises, applied the analytic hierarchy process (AHP) to evaluate risks, and finally concluded that quality risk and logistics risk accounted for a large proportion in the evaluation of the food supply chain. Yao Qi [15] divided food supply chain risks into three categories according to the three layers of Internet of Things, namely, perception layer, network layer and application layer, and adopted OWA operator method to conduct modeling analysis on risk factors. Cui Shiying [16] used the improved interpretation structure model and hidden Markov model based on grey correlation analysis to conduct modeling to realize the risk assessment of food safety, and obtained the grading results of risk assessment. It can be seen from the above research of experts and scholars that the majority of studies on risk assessment in the food supply chain use the combination of qualitative and quantitative methods.

DOI: 10.54254/2754-1169/4/2022985

2. The model was established based on analytic hierarchy process

2.1. Set up process

2.1.1. Establish food supply chain risk indicators

Through the analysis of all links of the food supply chain under community group purchase, five first-level indicators and fifteen second-level indicators are determined[17], as shown in Table 1.

Table 1: Food supply chain risk index system under community group purchase.

Total indicator	Level indicators	The secondary indicators
Risk of food supply chain under community group purchase U	Commodity procurement risk U1	The food is not up to standard U11
		Improper supplier U12
		Off-time delivery U13
	Logistics distribution risk U2	Logistics node conversion is slow U21
		Sorting efficiency is low U22
		Come across an emergency U23
	Mission risk U3	Operating capacity is not high U31
		Low service quality U32
		Improper after-sales treatment U33
	Information technology risk U4	Information asymmetry U41
		Food is not traceable U42
		Distrust between buyer and seller U43
	External environmental risk U5	The natural environment U51
		Policies and regulations U52
		Fierce competition among peers U53

2.1.2. Construct the judgment matrix

The 1-9 scale method was used to compare the indicators, so as to determine the weight of each indicator, as shown in Table 2.

DOI: 10.54254/2754-1169/4/2022985

Table 2: 1-9 Scale table.

scale	meaning
1	Factor i is equally important than factor j
3	Factor i is slightly more important than factor j
5	Factor i is significantly more important than factor j
7	Factor i is more important than factor j
9	Factor i is more important than factor j
2，4，6，8	Take the median of two adjacent judgments
The bottom	Contrary to the above meaning,and $a_{ij}=1/a_{ji}$

The judgment matrix is constructed as follows:

$$A = A(a_{ij}) = \begin{pmatrix} a_{11} & \cdots & a_{1i} \\ \vdots & \ddots & \vdots \\ a_{i1} & \cdots & aij \end{pmatrix} \tag{1}$$

2.1.3. Test the consistency of the judgment matrix

Firstly, the consistency index CI was calculated according to the maximum eigenvalue λ_{max} of the judgment matrix and the number of dimensions of the judgment matrix, and then CR was calculated according to the RI sample mean of the 1-10 order matrix in Table 3.

$$CI = \frac{\lambda_{max} - n}{n-1} \tag{2}$$

$$CR = \frac{CI}{RI} \tag{3}$$

Table 3: RI sample means of the 1-10 order matrix.

Order number	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.50

DOI: 10.54254/2754-1169/4/2022985

2.1.4. Comprehensive Analysis

Table 4: Judgment matrix of first-level indicators.

	U_1	U_2	U_3	U_4	U_5	W	AW
U_1	1	1/3	2	5	3	0.247	1.355
U_2	3	1	3	4	3	0.404	2.247
U_3	1/2	1/3	1	4	3	0.185	0.990
U_4	1/5	1/4	1/4	1	1/3	0.056	0.289
U_5	1/3	1/3	1/3	3	1	0.108	0.554

2.1.5. Determination of the weight of first-level indicators

The maximum eigenroots of the matrix can be calculated from the above table:

$$\lambda_{max}=5.340.$$

$$CI=\frac{\lambda_{max}-n}{n-1}=0.085$$

Look-up table is $RI=1.120$,so $CR=\frac{CI}{RI}=0.076<0.10$,meet the consistency test.

2.1.6. Determination of the weight of secondary indicators

The judgment matrix, weight value and consistency test of the second-level indicators are shown in the following table.

Table 5: Judgment matrix and weight of commodity procurement risk U1.

	U_{11}	U_{12}	U_{13}	W	AW	λ_{max}	CI	RI	CR
U_{11}	1	4	6	0.685	2.131	3.059	0.030	0.580	0.051<0.10
U_{12}	1/4	1	3	0.221	0.673				
U_{13}	1/6	1/3	1	0.093	0.281				

Table 6: Judgment matrix and weight of of logistics distribution risk U2.

	U_{21}	U_{22}	U_{23}	W	AW	λ_{max}	CI	RI	CR
U_{21}	1	1/2	2	0.312	0.952	3.053	0.027	0.580	0.046<0.10
U_{22}	2	1	2	0.490	1.510				
U_{23}	1/2	1/2	1	0.198	0.599				

DOI: 10.54254/2754-1169/4/2022985

2.1.7. Summary of weights of indicators at all levels

It can be seen that the judgments of the first-level and second-level indicators meet the consistency test. According to the weight of each risk, the weights of evaluation indicators at all levels are summarized, and the weight vectors of the first-level and second-level indicators are determined as follows:

W=（0.247,0.404,0.185,0.056,0.108）;
W1=（0.685,0.221,0.093）;
W2=（0.312,0.490,0.198）;
W3=（0.539,0.164,0.297）;
W4=（0.123,0.320,0.557）;
W5=（0.106,0.633,0.260）.

Table 7: Judgment matrix and weight of of principal service risk U3.

	U_{31}	U_{32}	U_{33}	W	AW	λ_{max}	CI	RI	CR
U_{31}	1	3	2	0.539	1.625	3.008	0.004	0.580	0.007<0.10
U_{32}	1/3	1	1/2	0.164	0.492				
U_{33}	1/2	2	1	0.297	0.894				

Table 8: Judgment matrix and weight of information technology risk U4.

	U_{41}	U_{42}	U_{43}	W	AW	λ_{max}	CI	RI	CR
U_{41}	1	1/3	1/4	0.123	0.369	3.018	0.009	0.580	0.016<0.10
U_{42}	3	1	1/2	0.320	0.967				
U_{43}	4	2	1	0.557	1.688				

Table 9: Judgment matrix and weight of external environmental risk U5.

	U_{41}	U_{42}	U_{43}	W	AW	λ_{max}	CI	RI	CR
U_{41}	1	1/5	1/3	0.106	0.320	3.039	0.019	0.580	0.033<0.10
U_{42}	5	1	3	0.633	1.946				
U_{43}	3	1/3	1	0.260	0.790				

DOI: 10.54254/2754-1169/4/2022985

3. The construction of fuzzy comprehensive evaluation model

3.1. Analysis Process

3.1.1. Construct the evaluation factor set

Factor set U={U_1, U_2, U_3, U_4, U_5}, where U1 is commodity procurement risk, U_2 is logistics distribution risk, U_3 is leader service risk, U_4 is information technology risk, and U_5 is external environment risk. Set factor set U_1={U_{11}, U_{12}, U_{13}}, where U_{11} is unqualified food quality, U_{12} is unsuitable supplier, and U_{13} is not punctual delivery; Set factor U_2={U_{21}, U_{22}, U_{23}}, where U_{21} is slow transformation of logistics nodes, U_{22} is low sorting efficiency, and U_{23} is accidental emergencies. Set factors U_3={U_{31}, U_{32}, U_{33}}, where U_{31} is low operation capacity, U_{32} is low service quality, and U_{33} is improper after-sales treatment; Set factors U_4={U_{41}, U_{42}, U_{43}}, where U_{41} is information asymmetry, U_{42} is food not traceable, and U_{43} is distrust of buyers and sellers; Set factor concentration U_5={U_{51}, U_{52}, U_{53}}, where U_{51} is natural environment, U_{52} is policies and regulations, and U_{53} is fierce competition.

3.1.2. Determine the theory domain of evaluation grade

The evaluation set V={V_1, V_2, V_3, V_4, V_5}, where V_1 has the lowest risk, V_2 has a low risk, V_3 has a medium risk, V_4 has a higher risk and V_5 has a high risk. The relationship between evaluation level and evaluation score is shown in Table 10 below.

Table 10 : Evaluation grade and evaluation score.

Rating	V_1	V_2	V_3	V_4	V_5
Risk level	The minimum	Low	Medium	Higher	High
Score	0~20	20~40	40~60	60~80	80~100

3.1.3. Establish fuzzy relation matrix

The factors in the evaluation factor set constructed above are evaluated to determine the membership degree of the evaluation thing to the evaluation set V, and the fuzzy relation matrix is obtained, as shown in the figure below.

$$R = \begin{pmatrix} r_{11} & \cdots & r_{1n} \\ \vdots & \ddots & \vdots \\ r_{m1} & \cdots & r_{mn} \end{pmatrix} \tag{4}$$

Where r_{mn} represents the membership degree of the MTH index to the NTH evaluation grade.

3.1.4. Fuzzy comprehensive analysis

The membership vector of index pair comment set can be obtained by the following formula:

$$B = W \cdot R = (b_1, b_2, \cdots, b_m) \tag{5}$$

DOI: 10.54254/2754-1169/4/2022985

Where is the weight vector of indicators at all levels $W=(W_1,W_2,\cdots,W_n)$; b_m represents the membership degree of factor U to comment V_m.

3.1.5. Quantitative evaluation results

The comments set is divided into five grades and assigned, as shown in Table 10. The assignment matrix can be obtained as F, and $F=(f_i)_{5\times1}$, so the quantified value of food supply chain risk under community group purchase is:

$$L=B\cdot F \tag{6}$$

Where is B fuzzy comprehensive evaluation vector; F is the assignment matrix.

3.2. Evaluation Results

Questionnaires were issued to 10 experts and related personnel on food supply chain risk under community group purchase to obtain relevant data. According to the obtained data, fuzzy evaluation results of first-level indicators can be obtained, as shown in Table 11:

Table 12: Fuzzy evaluation of first-level indicators.

Level indic-ators	B1	B2	B3	B4	B5	Score
Commodity procu-reme-nt risk U_1	0	0.27 19	0.33 11	0.30 54	0.09 06	64.23
Logistics distribution risk U_2	0.01 98	0.27 92	0.29 36	0.35 84	0.04 90	62.75
Mission risk U_3	0.07 89	0.24 92	0.42 11	0.22 11	0.02 97	57.47
Information technology risk U_4	0.01 23	0.28 77	0.44 43	0.15 57	0.10 00	60.87
External environmental risk U_5	0.08 45	0.12 11	0.39 96	0.30 45	0.08 93	63.80

4. Result analysis

From the above analysis of food supply chain risks under community group buying, it can be seen that in the risk of commodity purchase, the weight of unqualified food quality is 0.685, the weight of unsuitable supplier is 0.221, and the weight of unpunctual delivery is 0.093. In logistics distribution risk, the weight of low sorting efficiency is 0.490, the weight of slow transformation of logistics nodes is 0.312, and the weight of accidental emergencies is 0.198. In the risk of chief service, the weight of low operation capacity is 0.539, improper after-sales treatment is 0.297, and low service quality is 0.164. In the information technology risk, the weight of buyer and seller distrust, food traceability accounted for 0.320, information asymmetry accounted for 0.123; In the external environment risk, the weight of policies and regulations is 0.633, the weight of peer competition is 0.260, and the weight of natural environment is 0.106. It shows that in the five first-level risks, food quality is not qualified, sorting efficiency is low, operation capacity is not high, buyers and sellers do not trust, policy and regulation risks account for a high weight, we should pay special attention to these links, and try to avoid or reduce the possibility of their risk.

DOI: 10.54254/2754-1169/4/2022985

The score of commodity procurement risk in the first-level index is 64.23. Logistic distribution risk score is 62.75; The risk score of mission service was 57.47. The information technology risk score was 60.87; The score for external environmental risk was 63.80. We can see commodity procurement, logistics, information technology risk and the risk of external environment risk evaluation scores were more than 60, indicates that under the current community group in the food supply chain risk, in the commodity procurement, logistics, information technology and the external environment that several parts there are bigger problems, it is necessary to strengthen the management. Link to pay more attention, especially in the commodity purchase for food source must tighten the control at first, strictly put an end to unqualified food quality problems, in addition to the supplier of choice should also be strictly selected, verify the food suppliers from various perspectives, emphasizes the suppliers' delivery will be carried out in accordance with the stipulated time, in order to avoid unnecessary loss.

5. Revelation

5.1. Risk prevention measures for commodity procurement

Good quality control, improve food quality. In the selection of procurement of raw materials, procurement personnel to the field review, strictly control the quality of food, to eliminate source pollution; When choosing suppliers, we should pay attention to whether the suppliers have fixed supply channels, high-quality products and good after-sales service;Sign the contract with the supplier, make clear the delivery time and the action in case of abnormal delivery, etc [17]. To improve the supplier management system, the platform should select high-quality product suppliers for long-term cooperation due to the wide variety of food and uneven suppliers in community group buying.

5.2. Logistics distribution risk prevention measures

Advanced logistics equipment and technology [18]. In the future, goods conversion efficiency of each logistics node should be strengthened, periodic training of relevant personnel should be conducted, and standardized management should be improved. For fresh food, increase cold chain infrastructure to ensure that all aspects of food delivery to consumers are intact. In view of emergencies, on the one hand, we should strengthen the resilience of relevant personnel to deal with risks, and on the other hand, we should check logistics equipment regularly. In addition, enterprises can also cooperate with universities to cultivate talents of relevant majors, so as to achieve a win-win situation.

5.3. Information technology risk prevention measures

Establish information sharing system [19], realize two-way information transfer between "shared storehouse - central storehouse - grid storehouse", avoid bullwhip effect, resulting in information distortion. Establish food traceability management system, once food safety problems occur, suppliers can be quickly traced, the cause can be found and solved efficiently, so as to avoid further expanding risks.

5.4. Preventive measures against external environmental risks

Actively cooperate with relevant national policies, strictly observe and implement the "nine-no-no" policy during the epidemic period, and do not disturb the market order. At the same time, community group-buying platforms should strengthen their core competitiveness. When exposing food safety incidents, the government should guarantee the rights and interests of consumers, and consumers should also choose platforms with public trust [20]. In the special period, the platform should adjust

DOI: 10.54254/2754-1169/4/2022985

personnel, formulate coping strategies, reduce or transfer risks, and look for new development opportunities. In the event of natural environmental risks, expert advice should be sought while monitoring the environment in real time, and alternative transportation routes should be selected to ensure that food supplies are not interrupted, thus reducing losses to the platform.

5.5. Risk prevention measures for leader's service

First of all, the leader, as the core figure of the community group buying, should cultivate the leader's sense of belonging to the platform. Only when the leader highly identifies with the brand values and concepts of the platform, can the business be done well. Secondly, the community group buying platform should train leaders regularly to improve their business ability, including how to operate community group buying mini program, how to operate the community, after-sales service and so on, so as to better maintain existing customers and develop potential customers. Finally, an incentive system should be established to link the income of the leader with the turnover to enhance the stickiness between the leader and the platform. Conduct regular performance assessment on the leader, optimize the whole team through survival of the fittest, and ensure long-term and stable development of the community group-buying platform.

6. Conclusion

In this paper, the risk assessment technology of community group-buying food supply chain combining analytic hierarchy process (AHP) and fuzzy comprehensive evaluation method is adopted to establish risk indicators and assign values. Because the food throughout the supply chain has complexity and ambiguity, so it is also using the fuzzy comprehensive evaluation method on the risk rating, make evaluation result more credible, and the risk of each stage is ranked, finally it is concluded that commodity procurement risk > External environmental risk > Logistics distribution risk > Information Technology Risk >Mission risk. To provide a basis for reducing the probability of food supply chain risk. Since the development of community group buying is not yet fully mature, the risk factors of food supply chain under it are also quite changeable. In the future, with the development of community group buying, the risk indicators of food supply chain can be gradually enriched, so as to make the risk evaluation results more reliable.

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