Research on Risk Evaluation of Community Group Buying Supply Chain

Weigang Zhang* and Min Huang

Liaoning Technical University, College of Business Administration，Huludao, Liaoning 125105, China

*532712474@qq.com

Abstract. The community group buying model, characterized by its "online pre-sale + offline pickup" approach, has sparked a new trend, utilizing bulk purchasing to reduce costs and enhance supply chain efficiency. However, the unique aspects of community group buying introduce multiple risks to its supply chain model. This study aims to construct a risk assessment indicator system for the community group buying supply chain that includes six primary indicators and twenty-four secondary indicators. Using the Analytic Hierarchy Process (AHP) to determine the weights of these indicators and combining it with the Fuzzy Comprehensive Evaluation method to rank the risk levels of the primary indicators, this research seeks to strengthen the control over risks within the community group buying supply chain. The findings reveal significant risks across various segments of the supply chain. Consequently, this paper proposes targeted measures and suggestions for each segment to effectively mitigate these risks and improve supply chain performance.

Keywords: Community Group Buying, Supply Chain; Risk Evaluation, Analytic Hierarchy Process, Fuzzy Comprehensive Evaluation.

1 INTRODUCTION

Community group buying has seen significant growth since 2018, accelerated by the COVID-19 pandemic in 2020 due to its low barriers to entry and promising market potential, attracting substantial capital investment. The "14th Five-Year Plan for Modern Logistics Development," released in December 2022, emphasized the development of innovative cold chain logistics, such as "fresh e-commerce + direct shipment from origin," further boosting community group buying. In 2022, the transaction volume reached 210 billion RMB, a 74.25% increase from the previous year, with projections for China's community e-commerce to hit 1.2 trillion RMB by 2025. The focus of community group buying is on perishable goods like fruits, vegetables, seafood, and prepared foods, which are characterized by short shelf lives, high turnover, and strong seasonality, presenting supply chain risks that can impact operational efficiency.

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The swift growth of community group buying has garnered academic attention towards its supply chain risks, with extensive research conducted on the challenges and optimization strategies within this domain. Xue JingMei and Wang Ang[1] simulated supply chain risks in community e-commerce for fresh products, analyzing processing, logistics, procurement, and after-sales services. They offered risk management advice based on their system dynamics study.Zhang Kexin[2] created a supply chain evaluation system for fresh agri-products in community group buying, targeting areas like procurement, warehousing, distribution, and group leader services. The study identified peak risks in warehousing/distribution and external factors, leading to proposed risk mitigation strategies. Zhao Jiahao and Wang Puqing[3]optimized and suggested improvements for the community group buying supply chain of fresh agri-products in Wuhan, focusing on production, warehousing, logistics, and sales stages. Shen Minxia[4]et al. examined risks in the community e-commerce supply chain operation, noting challenges in maintaining group leader service levels and standardizing product quality. Chen Yuelin and Li Yufeng[5]applied system dynamics to analyze and simulate the supply chain of fresh agri-products in community group buying, creating a four-level model. Their analysis of various scenarios' effects on inventory sharing and profit led to strategic advice for the growth of this sector. Hamed Aboutorab et al[6]. utilized the integration of two fundamental artificial intelligence methods, natural language processing and reinforcement learning, to assist supply chain risk managers in timely identifying supply chain disruption events. Petratos Pythagoras N and Faccia Alessio[7] found that information risk has significantly affected supply chains, causing disruptions. They studied blockchain's use in supply chains and concluded that it can improve risk management.

This study uses AHP and Fuzzy Comprehensive Evaluation to deeply analyze community group buying supply chain risks, aiming to identify and assess these risks. It provides strategies for risk prevention and supply chain enhancement, with specific recommendations for practical risk management and optimization on these platforms.

2 THEORETICAL ANALYSIS OF COMMUNITY GROUP BUYING SUPPLY CHAIN RISKS

Community group buying uses group leaders, typically store managers, as local distribution points and organizes residents via WeChat groups to buy goods through a mini-program within their community.[8]. The platform buys and delivers goods to group leader service points, who then inform residents to either receive doorstep delivery or pick up their items at the leader's location.[9].Community group buying, known for its innovation in online retail, draws consumers with cost-effectiveness, product diversity, and efficient service, rapidly building brand recognition. It outperforms traditional supply chains with quicker logistics, like next-day delivery. Yet, the model's reliance on fresh goods heightens supply chain complexity and risks due to stricter timeliness demands.

2.1 Community Group Buying Supply Chain Structure

The study examines the community group buying supply chain with key players like suppliers, distribution centers, platforms, group leader pick-up points, and consumers. It traces the goods from suppliers, through storage and logistics, to the pick-up points, and finally to consumers, creating a network that integrates logistics, cash, and information flows.

2.2 Identification of Risk Links and Risk Factors

The community group buying supply chain involves goods moving from suppliers, through the platform, to consumers, with three main entities: suppliers, the platform, and community leaders. It includes six essential processes: procurement and supply, warehousing and distribution, cooperative relationship building, information technology application, head service provision, and external environment adaptation., each carrying potential risks from participant decisions and external factors.

3 COMMUNITY GROUP BUYING SUPPLY CHAIN RISK ASSESSMENT

3.1 Building a Risk Evaluation Indicator System for Community Group Buying Supply Chains

The community group-buying supply chain risk assessment index system was initially built after extensive literature review and research to categorize risk factors at each supply chain link. It includes 6 primary and 24 secondary indexes, as detailed in Table 1.

Table 1. Risk evaluation indicator system

aggregate target	Level 1 indicators	Secondary indicators	Level 1 indicators	Secondary indicators
community group purchasing (CPG) Chain risk A	Procurement supply risk A1	Inadequate vendor selection A11	Information technology risk A4	Information asymmetry A41
		Product quality A12		Accuracy and timeliness of information transmission A42
		Delivered on time A13		Relevant technology lags behind A43
	Warehousing and distribution risk A2	Transportation efficiency A21	Head of Mission Service Risk A5	Head of Mission Operational Capability A51
		Refrigeration technology A22		Moral hazard A52
		Package A23		Custodial storage of goods A53
		Sorting efficiency A24		Backlog of commodities not available for
		Critical Incident		

		Management A25		timely delivery A54 Mishandling of A55 after sale
	Partnership risk A3	Moral hazard A31 Mutual distrust among enterprises A32 Balanced distribution of benefits A33 Inter-enterprise cultural differences A34	External environment risk A6	Natural environmental factors A61 Relevant Policies and Regulations A62 Fluctuations in economic markets A63 Peer competition A64

3.2 Weight Determination for Community Group Buying Supply Chain Risk Indexes using AHP

Professionals in community group purchasing are invited to rank the importance of indicators at various levels. Using hierarchical analysis, the weights for first-level and second-level indicators in the supply chain are calculated based on these rankings, followed by a consistency check. Table 2 provides the judgment matrix for the first-level indicators.

Table 2. Judgment matrix for level 1 indicators

	A1	A2	A3	A4	A5	A6	weights W	λ_{max}	CI	RI	CR
A1	1	1/3	1	6	2	3	0.185				
A2	3	1	3	6	3	5	0.372				
A3	1	1/3	1	5	1/3	4	0.149				
A4	1/6	1/6	1/5	1	1/4	1/5	0.035	6.621	0.124	1.260	0.099
A5	1/2	1/3	3	4	1	4	0.184				
A6	1/3	1/5	1/4	5	1/4	1	0.075				

In the AHP hierarchical analysis method for calculating the weights of the first-level indicators of the community group-buying supply chain, the consistency of the judgment matrix is verified by using CR (calculated by the formula CR=CI/RI), which is lower than 0.1 to indicate a good consistency, and if the CR value is more than 0.1, the indicators need to be recalculated. The CI of the given indicator is 0.124, CR is 0.099 and RI is 1.260, which meets the consistency criteria. Therefore, the calculation of the

weights of the indicators at all levels is reliable. The calculation of the weights of the second-level indicators passed the consistency test, and the final results are shown in the table below.

Table 3. Summary of weights of indicators at various levels

Level 1 indicators	weights	Secondary level indicators	weights
Procurement supply risk A1	0.185	Inadequate vendor selection A11	0.619
		Product quality A12	0.284
		Delivered on time A13	0.097
Warehousing and distribution risk A2	0.372	Transportation efficiency A21	0.227
		Refrigeration technology A22	0.046
		Package A23	0.084
		Sorting efficiency A24	0.352
		Critical Incident Management A25	0.291
Partnership risk A3	0.149	Moral hazard A31	0.425
		Mutual distrust among enterprises A32	0.142
		Balanced distribution of benefits A33	0.342
		Inter-enterprise cultural differences A34	0.091
Information technology risk A4	0.035	Information asymmetry A41	0.608
		Accuracy and timeliness of information transmission A42	0.272
		Relevant technology lags behind A43	0.120
Head of Mission Service Risk A5	0.184	Head of Mission Operational Capability A51	0.132
		Moral hazard A52	0.048
		Custodial storage of goods A53	0.149
		Backlog of commodities not available for timely delivery A54	0.390
		Mishandling of A55 after sale	0.281
External environment risk A6	0.075	Natural environmental factors A61	0.168
		Relevant Policies and Regulations A62	0.069
		Fluctuations in economic markets A63	0.280
		Peer competition A64	0.483

So the vector of level 1 weighting indicators is:

$$W = (0.185,0.372,0.149,0.035,0.184,0.075)$$

The vector of secondary indicator weights is:

$$W_1 = (0.619,0.287,0.094)\ , W_2 = (0.227,0.046,0.084,0.352,0.291)$$

$$W_3 = (0.425,0.142,0.342,0.091)\ , W_4 = (0.608,0.272,0.120)$$

$$W_5 = (0.132,0.048,0.149,0.390,0.281)\ ,$$

$$W_6 = (0.168,0.069,0.280,0.483)$$

3.3 Fuzzy Comprehensive Evaluation of Supply Chain Risk under Community Group Buying

Supply Chain Risk Evaluation Level Matrix. The risk levels of the community group buying supply chain are defined as a fuzzy set V, encompassing five tiers: V=(lowest, low, medium, high, highest), each quantified with corresponding values V=(20, 40, 60, 80, 100). Subsequently, a survey was administered to experts, who evaluated the risks of the community group buying supply chain based on the various risk factors encountered by the fresh e-commerce supply chain. After compiling and organizing these ratings, a ranking matrix for the supply chain risk assessment was established, with the detailed outcomes displayed in Table 4.

Table 4. Community Group Buying Supply Chain Risk Evaluation Rating Matrix

Level 1 indicators	Secondary indicators	rating				
		V1	V2	V3	V4	V5
Procurement supply risk A1	Inadequate vendor selection A11	0.08	0.20	0.23	0.34	0.14
	Product quality A12	0.15	0.25	0.18	0.22	0.20
	Delivered on time A13	0.10	0.24	0.26	0.31	0.09
Warehousing and distribution risk A2	Transportation efficiency A21	0.08	0.22	0.34	0.24	0.08
	Refrigeration technology A22	0.09	0.17	0.31	0.32	0.11
	Package A23	0.08	0.24	0.31	0.33	0.04
	Sorting efficiency A24	0.04	0.18	0.295	0.385	0.10
	Critical Incident Management A25	0.12	0.22	0.22	0.32	0.12
Partnership risk A3	Moral hazard A31	0.10	0.14	0.29	0.34	0.13
	Mutual distrust among enterprises A32	0.47	0.20	0.13	0.13	0.07
	Balanced distribution of benefits A33	0.15	0.27	0.30	0.20	0.08
	Inter-enterprise cultural differences A34	0.40	0.25	0.15	0.15	0.05
Information technology risk A4	Information asymmetry A41	0.40	0.30	0.18	0.12	0
	Accuracy and timeliness of information transmission A42	0.41	0.21	0.19	0.13	0.06
	Relevant technology lags behind A43	0.06	0.21	0.28	0.29	0.16
Head of Mission Service Risk A5	Head of Mission Operational Capability A51	0.24	0.05	0.32	0.29	0.10
		0.09	0.23	0.24	0.33	0.11

	Moral hazard A52	0.16	0.20	0.15	0.44	0.05
	Custodial storage of goods A53	0.21	0.12	0.39	0.29	0.05
	Backlog of commodities not available for timely delivery A54	0.38	0.21	0.19	0.16	0.06
	Mishandling of after saleA55					
	Natural environmental factors A61	0.34	0.30	0.16	0.15	0.05
		0.09	0.15	0.25	0.38	0.13
External environment risk A6	Relevant Policies and Regulations A62	0.18	0.19	0.24	0.32	0.07
	Fluctuations in economic markets A63	0.03	0.13	0.21	0.44	0.19
	Peer competition A64					

Fuzzy Integrated Evaluation of First-Level Indicators. Above, the six risks in the supply chain chain link of community group purchasing are evaluated in a one-level fuzzy synthesis, and the judgment matrix can be obtained by organizing the data of 5 $R1$, $R2$, $R3$, $R4$, $R5$, $R6$:

$$R1 = \begin{bmatrix} 0.08 & 0.20 & 0.23 & 0.34 & 0.14 \\ 0.15 & 0.25 & 0.18 & 0.22 & 0.20 \\ 0.10 & 0.24 & 0.26 & 0.31 & 0.09 \end{bmatrix}$$

$$R2 = \begin{bmatrix} 0.08 & 0.22 & 0.34 & 0.24 & 0.08 \\ 0.09 & 0.17 & 0.31 & 0.32 & 0.11 \\ 0.08 & 0.24 & 0.31 & 0.33 & 0.04 \\ 0.04 & 0.18 & 0.29 & 0.39 & 0.10 \\ 0.12 & 0.22 & 0.22 & 0.32 & 0.12 \end{bmatrix}$$

$$R3 = \begin{bmatrix} 0.10 & 0.14 & 0.29 & 0.34 & 0.13 \\ 0.47 & 0.20 & 0.13 & 0.13 & 0.07 \\ 0.15 & 0.27 & 0.30 & 0.20 & 0.08 \\ 0.40 & 0.25 & 0.15 & 0.15 & 0.05 \end{bmatrix}$$

$$R4 = \begin{bmatrix} 0.40 & 0.30 & 0.18 & 0.12 & 0 \\ 0.41 & 0.21 & 0.19 & 0.13 & 0.06 \\ 0.06 & 0.21 & 0.28 & 0.29 & 0.16 \end{bmatrix}$$

$$R5=\begin{bmatrix}0.24 & 0.05 & 0.32 & 0.29 & 0.10\\ 0.09 & 0.23 & 0.24 & 0.33 & 0.11\\ 0.16 & 0.20 & 0.15 & 0.44 & 0.05\\ 0.21 & 0.12 & 0.39 & 0.29 & 0.05\\ 0.38 & 0.21 & 0.19 & 0.16 & 0.06\end{bmatrix}$$

$$R6=\begin{bmatrix}0.34 & 0.30 & 0.16 & 0.15 & 0.05\\ 0.09 & 0.15 & 0.25 & 0.38 & 0.13\\ 0.18 & 0.19 & 0.24 & 0.32 & 0.07\\ 0.03 & 0.13 & 0.21 & 0.44 & 0.19\end{bmatrix}$$

This results in a fuzzy composite evaluation set for each of the risk indicators $Bi(i=1\sim 6)$ and a score for each risk indicator $S_{\mathrm{vi}}(i=1\sim 6)$:

$$B1=W1*R1=(0.619,0.287,0.094)\begin{bmatrix}0.08 & 0.20 & 0.23 & 0.34 & 0.14\\ 0.15 & 0.25 & 0.18 & 0.22 & 0.20\\ 0.10 & 0.24 & 0.26 & 0.31 & 0.09\end{bmatrix}$$

$$=(0.1151,0.2181,0.2185,0.3027,0.1525)$$

$$S_{v1}=(0.1151,0.2181,0.2185,0.3027,0.1525)\begin{bmatrix}20\\ 40\\ 60\\ 80\\ 100\end{bmatrix}=63.602$$

The same reasoning can be used to obtain:

$B2=(0.0780,0.2053,0.2853,0.3256,0.0967)$, $S_{V2}=62.608$

$B3=(0.2729,0.2505,0.2865,0.2735,0.1066)$, $S_{V3}=62.207$

$B4=(0.3619,0.2647,0.1947,0.1431,0.0355)$, $S_{V4}=44.512$

$B5=(0.1951,0.1532,0.3350,0.2777,0.0623)$, $S_{V5}=58.580$

$B6=(0.1282,0.1765,0.2123,0.3527,0.1284)$, $S_{V6}=63.412$

Based on the above results, the evaluation matrix of the community group purchasing supply chain risk can be derived as: $B_{总}=\begin{bmatrix} B1 \\ B2 \\ B3 \\ B4 \\ B5 \\ B6 \end{bmatrix}$, and The result of the comprehensive evaluation of supply chain risk is C, $C=W*B_{总}=(0.1492,0.2047,0.2741,0.2811,0.1061)$, which leads to an overall score of Community Group Buying Supply Chain Risk: $S_{总}=60.709$.

The First-Level Fuzzy Comprehensive Evaluation Results. Through the above calculations can be obtained the results of the first-level fuzzy comprehensive evaluation of community group purchasing shown in Table 5.

Table 5. Level 1 fuzzy integrated evaluation

Level 1 indicators	Evaluation results	score
Procurement supply risk A1	(0.1151,0.2181,0.2185,0.3027,0.1525)	63.602
Warehousing and distribution risk A2	(0.0780,0.2053,0.2853,0.3256,0.0967)	62.608
Partnership risk A3	(0.2729,0.2505,0.2865,0.2735,0.1066)	62.207
Information technology risk A4	(0.3619,0.2647,0.1947,0.1431,0.0355)	44.512
Head of Mission Service Risk A5	(0.1951,0.1532,0.3350,0.2777,0.0623)	58.580
External environment risk A6	(0.1282,0.1765,0.2123,0.3527,0.1284)	63.412
total score		60.709

Analysis of Evaluation Results. The table presents the scores of six level 1 indicators in the community group purchasing supply chain, quantifying the significance of each risk aspect.Procurement and Supply Risk (A1), with a score of 63.602, is located at a higher risk level, implying that there are significant risks in the procurement part of the supply chain, which may involve unstable supply, poor quality control, and other factors. Warehousing and Distribution Risk (A2), with a score of 62.608, also shows a relatively high level of risk, pointing to potential problems in logistics management and storage of goods. Partnership Risk (A3) scored 62.207, indicating that there may be trust and coordination problems between partners, affecting the efficiency of supply chain cooperation. Information Technology Risk (A4) scored 44.512, which is lower than the other risk indicators, indicating that the application of information technology

is relatively mature and less risky at this stage. Service Risk of Head of Mission (A5) scored 58.580, indicating that there may be certain risks at the head of mission level in terms of service quality and product handling. External Environment Risk (A6) scored 63.412, indicating that external policies, market changes and other factors have a greater impact on the supply chain. Overall, the total score of the entire supply chain is 60.709, reflecting that there are medium-high level risks in the community group-buying supply chain as a whole.

4 RISK CONTROL COUNTERMEASURES UNDER COMMUNITY GROUP BUYING

This study provides a detailed assessment of the risks in the community group-buying supply chain through hierarchical analysis and fuzzy comprehensive evaluation method, revealing the risk levels of six key links: procurement and supply, warehousing and distribution, cooperative relationship, information technology, group leader service and external environment. The findings show that the procurement and supply risk, warehousing and distribution risk, partnership risk, and external environment risk are more significant, while the information technology risk is relatively low, and the head service risk is at a medium level. Based on these findings, this study proposes a series of targeted risk control countermeasures.

To bolster the management of procurement and supply risks, it is imperative to implement stringent criteria for supplier selection and to refine management protocols. Companies should meticulously investigate and compare potential supplier partners, focusing on the stability of their supply channels, the excellence of product quality and after-sales service, and their capability to ensure direct product sourcing and supply in alignment with the geographical requirements of community group buying platforms. Additionally,it is necessary to establish a comprehensive supplier management system. The service level of suppliers should be evaluated based on multiple factors, such as product supply efficiency and the effective order completion rate, to facilitate the selection of higher-quality suppliers for long-term cooperation with the platform.

To manage warehousing and distribution risks, improving cold chain logistics and training managers is key. With a demand for perishables on group buying platforms, maintaining proper storage temperatures to avoid spoilage is vital, requiring cold chain logistics and refrigerated equipment. Regular training ensures warehouse managers are adept in inventory and operations management, efficiently handling warehouse functions from receipt to dispatch.

To mitigate partnership risks, establishing a dynamic monitoring mechanism and a fair profit-sharing system is key. A robust monitoring system allows community group buying platforms to detect and address any unethical behavior among partners promptly, ensuring partnerships are formed only with those exhibiting high levels of loyalty and integrity. A balanced profit-sharing system is also essential to prevent conflicts with strategic partners and to sustain long-term collaborative relationships.

For risks associated with the application of information technology, it is essential to establish a robust information sharing system. In the event of any issue within the

supply chain, enterprises can promptly trace the problem back to its source through this system, accurately identifying the responsible parties. A transparent information system helps foster positive inter-company collaboration and accelerates the rapid development of community group buying platforms.

In terms of head of mission service risks, it is essential to carefully select and provide regular training to group leaders. Ensuring that selected group leaders are committed to long-term collaboration and possess strong ethical standards and credibility is crucial for enhancing delivery efficiency and bolstering brand trust. Additionally, group leaders must receive ongoing training to develop their business acumen and service capabilities, particularly in community management, to keep pace with evolving industry demands.

Finally, in response to external changes, supply chains must remain flexible and promptly adapt to environmental and policy shifts. Companies should keep abreast of relevant developments to reduce risks and adjust strategies as needed. With the community group buying industry still evolving, local governments need to implement and enforce regulations for a regulated market. Companies must understand and quickly adapt to policies, tackle industry challenges, and preserve their competitiveness to manage risks effectively.

This study offers a systematic approach to assessing community group-buying supply chain risks and suggests actionable management strategies to mitigate these risks, enhancing supply chain efficiency and competitiveness. Further research could evaluate the impact of these strategies for deeper insights into supply chain management.

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