Quest Journals
Journal of Research in Business and Management
Volume 13 ~ Issue 5 (May 2025) pp: 08-15
ISSN(Online):2347-3002
www.questjournals.org

Research Paper

Risk Assessment on Quality Safety of Pre-prepared Dishes from a Perspective of Supply Chain

Yuyu Huang, Lihua Wu
(School of Management Science and Engineering, Beijing Information Science and Technology University)
Corresponding Author: Lihua Wu

ABSTRACT: *In the paper, a risk evaluation index system on the quality safety of pre-prepared dishes is developed from a supply chain perspective. The system integrates all key stages from raw material procurement to distribution and sales, taking into account various categories of risk factors. Based on the quality safety management practices of pre-prepared dishes enterprises, relevant governmental and industry regulatory standards, as well as insights from practitioners, the study selects Company A as the research subject. A combined methodology involving expert scoring, analytic hierarchy process (AHP), and fuzzy comprehensive evaluation (FCE) is adopted. Expert assessments are first used to construct the judgment matrix, followed by the calculation of index weights through AHP. And finally, FCE is applied to generate an overall risk evaluation score. The results indicate that the proposed model can effectively identify and quantify potential risk factors. For Company A, storage and transportation are identified as the critical risk control node, while raw material quality emerges as a relatively weak link. The conclusions provide decision-making support for supply chain managers, pinpoint the key risk control points across different stages, and propose strategies for enhancing the quality safety management of pre-prepared dishes.*

KEYWORDS: *Pre-prepared Dishes, Quality Safety, Risk Assessment, Supply Chain, Analytic Hierarchy Process, Fuzzy Comprehensive Evaluation*

R*eceived 01 May., 2025;* ***R****evised 06 May., 2025;* ***A****ccepted 08 May., 2025*

I. INTRODUCTION

Pre-prepared dishes refer to pre-packaged meals made from one or more edible agricultural products and their derivatives, which are industrially pre-processed and require heating or cooking before consumption. The pre-prepared dish industry features a long and complex supply chain, encompassing raw material sourcing, processing and production, storage and transportation, and final retail. Each of these stages presents potential quality safety risks. For instance, raw materials may pose hazards due to pesticide residues, while the production process may involve non-compliant use of food additives or issues related to hygienic conditions.

Currently, the identification and screening of risks in pre-prepared dish safety focus mainly on the safety of raw materials, as well as the development of advanced and innovative processing and sterilization technologies. These efforts aim to ensure food safety and prevent nutrient loss during processing. For example, Smith J et al. analysed the ready-to-eat food supply chain in Japanese convenience stores and identified risks such as cold chain interruptions and cross-contamination [1]. The European Food Safety Authority (EFSA) has conducted full-chain assessments of microbiological (e.g., Listeria monocytogenes) and chemical risks (e.g., phthalate migration) in pre-packaged refrigerated foods and proposed graded control strategies [2]. Zhu Yi pointed out that the main safety risks in pre-prepared dishes include the freshness of raw ingredients, regulated use of food additives during processing, seamless cold chain logistics, and packaging integrity [3]. The China National Food Industry Association has emphasized the need of systematically identifies quality safety risks across production, logistics, and sales stages and proposed collaborative full-chain governance strategies [4].

Compared with the traditional food safety assessment, research on the evaluation of quality safety risk in pre-prepared dishes is still limited. This paper aims to extract and evaluate the risk factors across the supply chain of pre-prepared dishes by using classical methods such as AHP and FCE. The remainder of the paper is structured as follows: Section 2 constructs the risk evaluation index system for pre-prepared dish quality safety.

Section 3 describes the evaluation process and presents a case study on Company A. Section 4 analyses the evaluation results, and Section 5 concludes the study and discusses future research directions.

II. CONSTRUCTION OF THE EVALUATION INDEX SYSTEM

2.1 Quality Safety Risk in the Supply Chain of Pre-prepared Dishes

As shown in Figure 1, the supply chain of pre-prepared dishes includes four main stages: raw material supply, production and processing, logistics and transportation, as well as distribution and sales.

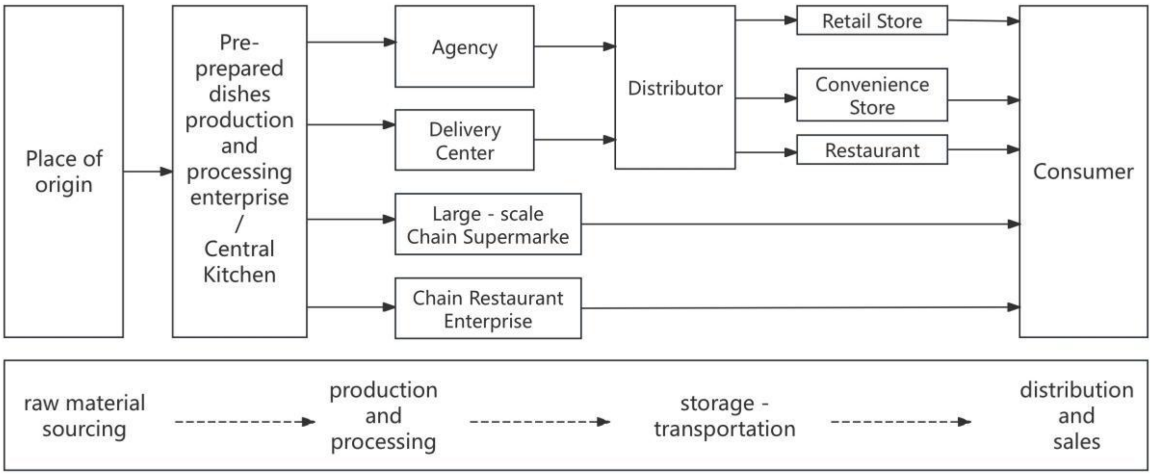

Figure 1: Supply chain of pre-prepared dishes

The potential risks in each stage are summarized as follows:

(1) Raw material risks: risks may arise during the supply of raw materials, including pesticide and veterinary drug residues testing, raw material quality, raw material selection, supply stabilities of raw material, and the material's nutritional values.

(2) Production risks: including risks occurring in the manufacturing process, such as the production license, R&D validation, hygiene standards in the production environment, temperature control, health of employees, product additives, and packaging method and material of products.

(3) Enterprise supervision risks: referring to the risks arising from whether the production enterprise has implemented quality control measures, include inadequate supervision procedures, negligence of the regulatory departments, lack of transparency in the supervision process, and insufficient enforcement of internal penalties.

(4) Logistics risks: the risks during the logistics phase include storage and transportation conditions, packaging for cold chain logistics, transportation and delivery timeliness, product damage or loss during transit.

(5) Distribution and sales risks: risks during the distribution and retail process, such as sales license, ethical risks of operators, unfair market competition, usage or cooking methods informed, and false advertising.

2.2 Construction of the Evaluation Index System

Based on the above analysis and incorporating some commonly used indicators from the risk evaluation of quality safety in the traditional food industries [5-9], this study establishes a hierarchical evaluation index system consisting of five primary dimensions: raw material risks, production process risks, enterprise supervision risks, logistics risks, and distribution and sales risks. These five primary indicators are further refined into 25 secondary sub-indicators. The complete evaluation index system is presented in Table 1.

Table 1: Evaluation index system

Target Layer A	Criterion Layer B	Sub - index Layer
Risk assessment of quality safety	Raw material risks (B1)	Pesticide and veterinary drug residue testing, raw material quality, supply stability of raw material, raw material selection, and nutritional content testing.
	Production process risks (B2)	Production license, R&D validation, hygiene of the production environment, temperature control, health conditions of employees, compliance in the use of food additives, and packaging methods and materials for finished products.
	Enterprise supervision risks (B3)	Soundness of internal supervision procedures, responsibility of enterprise supervision departments, transparency of the supervision process, and adequacy of enforcement and penalties.
	Logistics risks	Compliance with storage and transportation conditions, adequacy of logistics packaging, timeliness

	(B4)	of transportation and distribution, and risk of product loss.
	Distribution and sales risks (B5)	Sales operation licensing, moral integrity of operators, risks of unfair market competition, clarity of consumption instructions, and false advertising.

III. CONSTRUCTION OF THE EVALUATION MODEL

3.1 Evaluation Methods and Implementation Process

（1）Analytic Hierarchy Process

AHP is a multi-criteria decision-making method designed to decompose a complex decision problem into multiple levels, typically including a goal level, criteria level (also known as the standards or indicators level), and alternatives level. Through expert judgment, it establishes the relative importance among criteria, thereby determining the weights of various factors and ultimately synthesizing the decision outcome.

（2）Fuzzy Comprehensive Evaluation

FCE is a method widely applied in the assessment of systems with high uncertainty. It is particularly suitable for evaluating complex systems or those with multiple levels and factors, enabling quantitative analysis of the combined effects of various factors. The core idea involves constructing a fuzzy evaluation matrix to transform qualitative assessments into quantitative indicators, and then using fuzzy operations to evaluate the overall impact of different factors on the objective.

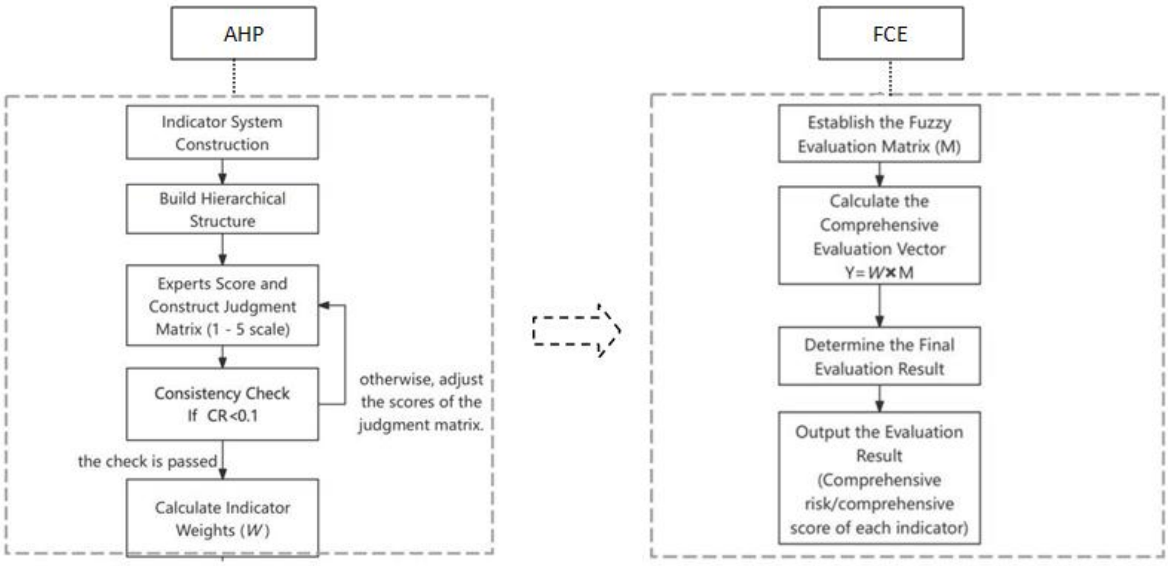

Figure 2: Evaluation methods and procedures

3.2 Data Collection

The study takes Company A as the empirical research subject. Company A is a highly influential and well‑known prefabricated food enterprise in China. It operates six integrated production bases and has built a nationwide marketing network centered on East China, comprising 18 external marketing offices, 6 branch companies, 13 liaison offices, 8 independent workstations, and over 1,000 primary distributors.

To thoroughly assess the quality safety risks of Company A's prefabricated dishes from the company's own perspective and to ensure the evaluation's authority, this paper assembled an expert evaluation panel of ten managers drawn from within Company A. Panel members hold diverse positions, ensuring problems are identified from multiple angles. Each member has over three years of tenure at Company A, guaranteeing a deep understanding of both the prefabricated foods sector and the company's current situation.

3.3 Ranking of Evaluation Indicator Weights

By aggregating the experts' scores and applying the weight‑calculation formulas, judgment matrices for both first‑level and second‑level indicators were constructed, and a corresponding weight‑distribution table was produced. The final overall ranking weights are presented in Table 2.

Table 2: Ranking of evaluation indicator weights

Target Layer A	Criterion Layer B	Weights	Sub - index Layer	Weights	ranking
Quality Safety Risk Assessment of Pre-prepared Dishes	Raw Material Risks (B1)	15.38%	Pesticide and veterinary drug residue testing （C1）	3.14%	13
			raw material quality (C2)	1.67%	21
			stability of raw material supply (C3)	4.81%	7
			raw material selection (C4)	4.81%	8
			nutritional content testing (C5)	0.95%	25
	Production Process Risks (B2)	30.77%	Production license (C6)	7.92%	2
			R&D validation (C7)	1.84%	18
			hygiene of the production environment (C8)	3.92%	10
			temperature control during the production process (C9)	1.84%	19
			health conditions of processing personnel (C10)	2.56%	14
			compliance in the use of food additives (C11)	6.35%	5
			packaging methods and materials (C12)	6.35%	6
	Enterprise Supervision Risks (B3)	15.38%	Soundness of internal supervision procedures (C13)	1.97%	17
			responsibility of enterprise supervision departments (C14)	3.94%	9
			transparency of the supervision process (C15)	7.34%	4
			adequacy of enforcement and penalties (C16)	2.13%	15
	Logistics Risks (B4)	30.77%	Compliance with storage and transportation conditions (C17)	15.81%	1
			adequacy of logistics packaging (C18)	7.90%	3
			timeliness of transportation and distribution (C19)	3.44%	12
			risk of finished product loss (C20)	3.62%	11
	Distribution and Sales Risks (B5)	7.69%	Sales operation licensing (C21)	0.99%	24
			moral integrity of operators (C22)	1.47%	22
			risks of unfair market competition (C23)	1.37%	13
			clarity of consumption instructions (C24)	2.07%	16
			false advertising (C25)	1.79%	20

3.4 Constructing the Membership Degree Matrix

(1) Establishing the evaluation set for FCE levels

The evaluation set denotes as {Good, Fairly Good, Average, Fairly Poor, Poor}, with the corresponding score values shown in Table 3.

Table 3: Score table for comment sets

Number	Levels	Score Value
1	Good	100
2	Fairly Good	80
3	Average	60
4	Fairly Poor	40
5	Poor	20

In the study, data were collected through an online questionnaire. Respondents were required to select one option from the following five levels when expressing their opinions on each item: Good, Fairly Good, Average, Fairly Poor, and Poor. These levels correspond to scores of 100, 80, 60, 40, and 20, respectively. A total of 381 questionnaires were collected, of which 363 were deemed valid.

(2) Statistical weight table for single-factor Indicators

Based on the collected questionnaire data, the weight of each evaluation level for a specific indicator (e.g., "Good" for pesticide and veterinary drug testing, denoted as C1) is calculated by dividing the frequency of that level by the total number of valid questionnaires. This process is repeated for each level and indicator to derive the statistical weight RRR for each quality safety risk factor of Company A's prefabricated dishes. The results are presented in Table 4.

Table 4: Statistical weight table for single-factor indicators

Indicator	Code	Good	Fairly Good	Average	Fairly Poor	Poor
Pesticide and veterinary drug residue testing	C1	0.496	0.322	0.165	0.008	0.008
raw material quality	C2	0.413	0.388	0.190	0.008	- .0
stability of raw material supply	C3	0.455	0.331	0.198	0.017	- .0
raw material selection	C4	0.397	0.347	0.174	0.066	0.017
nutritional content testing	C5	0.339	0.339	0.240	0.083	- .0
Production license	C6	0.405	0.388	0.140	0.041	0.025
R&D validation	C7	0.471	0.331	0.182	0.017	- .0
hygiene of the production environment	C8	0.496	0.281	0.207	0.017	- .0
temperature control during the production process	C9	0.529	0.306	0.140	0.025	- .0
health conditions of processing personnel	C10	0.421	0.372	0.182	0.025	- .0
compliance in the use of food additives	C11	0.496	0.322	0.149	0.033	- .0
packaging methods and materials	C12	0.397	0.372	0.215	0.017	- .0
Soundness of internal supervision procedures	C13	0.397	0.322	0.256	0.008	0.017
responsibility of enterprise supervision departments	C14	0.289	0.388	0.306	0.017	- .0
transparency of the supervision process	C15	0.455	0.372	0.157	0.017	- .0
adequacy of enforcement and penalties	C16	0.521	0.306	0.165	0.008	- .0
Compliance with storage and transportation conditions	C17	0.529	0.306	0.149	0.017	- .0
adequacy of logistics packaging	C18	0.455	0.331	0.198	0.017	- .0
timeliness of transportation and distribution	C19	0.455	0.364	0.182	- .0	- .0
risk of finished product loss	C20	0.463	0.322	0.174	0.041	- .0
Sales operation licensing	C21	0.479	0.322	0.182	0.017	- .0
moral integrity of operators	C22	0.504	0.306	0.157	0.017	0.017
risks of unfair market competition	C23	0.479	0.322	0.157	0.033	0.008
clarity of consumption instructions	C24	0.504	0.306	0.174	0.017	- .0
false advertising	C25	0.388	0.405	0.182	0.025	- .0

(3) Construction of the Membership Degree Matrix

Based on the statistical weights presented in Table 4 and employing the membership degree calculation formulas, the membership degree matrix for assessing the quality safety risks of Company A's prefabricated dishes has been established, as shown in Table 5.

Table 5: Membership degree matrix

Results	Membership Degree
Good	0.449
Fairly Good	0.339
Average	0.185
Fairly Poor	0.023
Poor	0.004

3.5 Results of the Fuzzy Comprehensive Overall Evaluation

(1) Comprehensive score of the quality safety risks of Company A's prefabricated dishes

The comprehensive score of the quality safety risks of Company A's prefabricated dishes calculated based on the membership degree matrix is shown in Table 6.

Table 6: Score of the quality safety risks of Company A

Good	Fairly Good	Average	Fairly Poor	Poor	Total Score
0.449	0.339	0.185	0.023	0.004	84.13

(2) Quality safety risk scores for each stage of Company A's prefabricated dishes

Utilizing the previously established membership degrees and questionnaire statistics, and incorporating the hierarchical analysis weights derived from expert evaluations, comprehensive scores for the quality safety risks at each stage of Company A's prefabricated dishes were calculated. These results are presented in Table 7.

Table 7: Sorting of the overall scores

Indicator	Score Value	AHP Weights	Comprehensive Score	Rank
Compliance with storage and transportation conditions	86.94	15.81%	13.75	1
adequacy of logistics packaging	84.46	7.90%	6.67	2
Production license	82.15	7.92%	6.51	3
transparency of the supervision process	85.29	7.34%	6.26	4
compliance in the use of food additives	85.62	6.35%	5.44	5
packaging methods and materials	82.98	6.35%	5.27	6
stability of raw material supply	84.46	4.81%	4.06	7
raw material selection	80.83	4.81%	3.89	8
hygiene of the production environment	85.12	3.92%	3.34	9
responsibility of enterprise supervision departments	79.01	3.94%	3.11	10
risk of finished product loss	84.13	3.62%	3.05	11
timeliness of transportation and distribution	85.45	3.44%	2.94	12
Pesticide and veterinary drug residue testing	85.79	3.14%	2.69	13
health conditions of processing personnel	83.8	2.56%	2.15	14
clarity of consumption instructions	85.95	2.07%	1.78	15
adequacy of enforcement and penalties	86.78	2.13%	1.85	16
Soundness of internal supervision procedures	81.49	1.97%	1.61	17
temperature control during the production process	86.78	1.84%	1.60	18
R&D validation	85.12	1.84%	1.57	19
false advertising	83.14	1.79%	1.49	20
raw material quality	84.13	1.67%	1.40	21
moral integrity of operators	85.29	1.47%	1.25	22
risks of unfair market competition	84.63	1.37%	1.16	23
Sales operation licensing	85.29	0.99%	0.84	24
nutritional content testing	78.68	0.95%	0.75	25

IV. RESULTS ANALYSIS

4.1 Overall Safety Risk Evaluation Result for Company A

Based on Table 6, by summing the membership degree matrix of Company A's quality safety risks of prefabricated dishes with the corresponding score values from the evaluation set, a comprehensive score of 84.13 was obtained. According to the value ranges defined in Table 8, this score falls within the "Excellent" category.

Table 8: Results of comprehensive evaluation

The value range of F	Levels
[80，100]	Excellent
[60，80）	Good
[40，60）	Average
[20，40）	Poor
[0，20）	Critical

This result is significant, indicating that internal personnel of Company A highly recognize the effectiveness of the company's efforts in controlling the overall quality safety risks of its prefabricated dishes. As a prominent and well-known enterprise in the prefabricated food market, the evaluation result reflects its robust advancements in various areas, including the establishment of a quality management system, control over production processes, and staff training. Moreover, it demonstrates the company's advanced concepts and efficient execution capabilities in managing quality safety risks within the prefabricated food industry. This sets a commendable example for other enterprises and positively contributes to the healthy development of the entire prefabricated food sector.

4.2 Single Factor Risk Evaluation Results for Company A

Based on the comprehensive scores presented in Table 6 and considering the AHP weights, the evaluation across various stages reveals the following insights:

(1) Top 5 indicators with the highest scores are compliance with storage and transportation conditions, adequacy of logistics packaging, production license, transparency of the supervision process and compliance in the use of food additives. The five high-scoring indicators suggest that Company A excels in controlling risks associated with the regulatory compliance and technical execution. The company's strong performance in areas such as production licensing, cold chain logistics, and standardized additive usage reflects its robust quality management systems and effective implementation of technical standards.

(2) Bottom 5 Indicators with the lowest scores include raw material quality, moral integrity of operators, risks of unfair market competition, sales operation licensing and nutritional content testing. The bottom five factors indicate the potential risk controlling weaknesses in Company A, particularly concerning upstream and downstream supply chain management and soft power aspects. Factors such as supplier quality, ethical practices of operators, and market competition dynamics may not be fully under the company's direct control. Additionally, the lower weights assigned to these indicators in the AHP analysis contribute to their reduced overall scores, suggesting they are not considered core production processes within the company. Nevertheless, these areas highlight opportunities for Company A to strengthen its management practices and enhance risk mitigation strategies across the entire supply chain.

4.3 Suggestions for Improving Risk Control for Company A

Based on the analysis of high--scoring and low-scoring indicators, Company A exhibits a typical characteristic of emphasizing fundamental technical compliance while under emphasizing upstream and downstream management. The lower-scoring areas are primarily concentrated in raw material procurement and distribution sales. To address these weaknesses, the following improvement measures are proposed:

(1) For raw material quality risks, Company A can establish an "ABCD" four-tier dynamic supplier classification and evaluation system, updated quarterly, and implement a block chain traceability platform to log raw material origins, pesticide residue test data, and other critical information. Simultaneously, the company should strengthen raw material admission standards and enforce mandatory testing for high-risk categories to ensure compliance and product safety.

(2) For nutritional component testing, the company can collaborate with CNAS-accredited laboratories to establish a joint testing center, enabling real-time synchronization of nutritional data and ensuring timely monitoring and management of raw material composition.This approach leverages CNAS-certified expertise to maintain data accuracy and regulatory compliance, while integrating advanced systems for instant access to critical quality metrics.

(3) For operator ethical standards, the company can collaborate with upstream suppliers and downstream distributors to establish an ethical governance system. This system should explicitly prohibit eight categories of high-risk behaviors such as commercial bribery and false advertising, while incorporating detailed penalty provisions for violations into labor contracts. Simultaneously, ethical indicators should be integrated into supplier and distributor evaluations, allowing for immediate termination of cooperation in cases of major ethical violations.

(4) For unfair market competition, the company can establish an "Anti-Unfair Competition Emergency Plan" to address behaviors such as malicious low-price dumping and patent infringement, reserving the right to

pursue legal recourse. Additionally, the company should implement compliant pricing mechanisms by adopting a cost-plus pricing model, strictly controlling gross profit margins to avoid being drawn into price wars.

(5) For sales operation licensing，the company can establish a digital licensing management system to automatically track the validity periods of distributors' certifications such as SC licenses and ISO certifications, while conducting cross-departmental compliance audits every six months to ensure 100% coverage of operational licenses. To address regulatory differences for prepared dishes across provinces, Company A should commission third-party institutions (e.g., SGS) to conduct compliance assessments for market entry before expanding into new regions, thereby avoiding policy blind spots.

V. CONCLUSIONS

This study establishes a prefabricated dish quality and safety risk evaluation index system and assessment model from a supply chain perspective, employing expert scoring method, Analytic Hierarchy Process (AHP), and Fuzzy Comprehensive Evaluation (FCE). An empirical investigation was conducted on the risks of Company A's prefabricated dishes. The research results indicate that Company A demonstrates overall excellent control of prefabricated dish safety and quality risks. However, deficiencies were identified in five aspects: raw material quality, nutritional component testing, operator ethical standards, unhealthy market competition, and sales operation licensing. Corresponding improvement measures are proposed for these five vulnerable areas in Company A. Future research could explore dynamic risk assessment models on one hand, while on the other hand, collect more extensive enterprise data and employ advanced evaluation methods such as artificial intelligence algorithms to construct assessment models.

REFERENCES

[1]. Smith J, Tanaka K. Microbial Contamination Risks in Ready-to-Eat Meal Supply Chains: A Case Study of Japanese Convenience St ores[J]. Food Control, 2022, 135: 108702.

[2]. European Food Safety Authority. Risk Assessment of Pre-packaged Chilled Foods in EU Markets[R]. Parma: EFSA Journal, 2023: 1-89.

[3]. Zhao, L., & Wang, Y. Q. Series IV on Prefabricated Dishes Observation—Quality Issues of Prefabricated Dishes Remain to Be Sol ved. *China Food Industry*, 2023, (02): 18-21.

[4]. China National Food Industry Association. Analysis Report on Risk Management in the Prefabricated Dish Industry, 2024, China F ood Publishing House. Retrieved February 15, 2025, from https://www.cnfia.cn

[5]. Jia Yangyang, et al. Innovations and challenges in the production of prepared dishes based on central kitchen engineering: A review and future perspectives.[J].Innovative Food Science & Emerging Technologies,2023,103521.

[6]. Huang, Jinjin, Min Zhang, and Zhongxiang Fang. Perspectives on Novel Technologies of Processing and Monitoring the Safety and Quality of Prepared Food Products. [J].Foods, 2023, 12(16): 3052.

[7]. Zhao, J. G., & Yang, W. M. Research on high-quality development of prefabricated dishes in Zhongyuan Agricultural Valley under the background of food safety. Modern Food, 2023, 29(18): 78–80.

[8]. Duan, Q. H. Methods to improve the quality and safety of prefabricated dishes. Food Safety Journal, 2023, 20:160–162.

[9]. Wen, G. H. Thoughts on improving the quality of prefabricated dishes. China Quality Supervision, 2023, 5:66.