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Analyzing the Effect of Cold Chain Logistics Service Risks on Quality Performance for Fresh Agricultural Products in China

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Abstract. This study analyzed the impact of service quality risks in cold chain logistics for fresh produce on enterprise quality performance in China. Questionnaire surveys were conducted with 516 employees from agricultural enterprises. SEM analysis showed service risks in transportation and warehousing negatively affect quality performance. Moderation analysis revealed supply chain risk management strategies mitigate this impact. The study provides insights to help agricultural enterprises in China mitigate quality risks and enhance performance through effective cold chain logistics service management.

Keywords: cold chain logistics services quality risks, supply chain risk management, quality performance

1. Introduction

As the daily dietary necessities of the residents, the total consumption of fresh agricultural products is rising year by year, and the demand for high quality is increasing. As the total consumption of fresh agricultural products is increasing year by year and the demand for high quality is increasing, the issue of preservation of freshness and quality is getting more and more attention from the government, enterprises and consumers. The cold chain plays an important role in solving this key problem. The quality risk of logistics services in the cold chain of fresh agricultural products not only affects the health and safety of consumers, but also has an important impact on safeguarding the quality performance of associated enterprises in the supply chain.

At the present stage, the service quality level of China's fresh agricultural products cold chain logistics providers is not uniform, especially the whole fresh agricultural products cold chain has a high risk of logistics service quality. For fresh agricultural products enterprises with high competitive pressure and high operating costs, it is of great significance to develop supply chain logistics service quality risk management to improve the quality performance of enterprises. For fresh agricultural products enterprises with high competitive pressure and high operation cost, it is of great significance to develop supply chain logistics service quality risk management to improve the quality performance of enterprises. Cold chain transportation and warehousing, as important links in cold chain logistics, directly affect the quality performance of fresh produce cold chain logistics enterprises.

This paper aims to study the relationship between the quality risks of cold chain logistics warehousing and transportation services, supply chain risk management strategies, and business performance in the context of fresh agricultural product cold chain logistics. It seeks to explore how effective risk management strategies can enhance business performance. By comprehensively analyzing the optimization of cold chain logistics, supply chain risk management strategies, and evaluation indicators of business performance, this paper aims to provide valuable insights and recommendations for fresh agricultural product companies to achieve supply chain optimization and improve business performance.

2. Literature Review

In the research of supply chain service quality risk, Ren, Fang, Yang, and Han (2022) analyzed the control strategy of e-commerce logistics outsourcing quality risk based on principal-agent theory. Chen, Qian, Yang, and Wu (2022) identified the service quality risk of senior care service supply chain based on service life cycle theory. According to Liu, Li, and Qi (2019), food cold chain is a supply chain that chills and freezes food from the entire process of supply, transportation, sales, and distribution to ensure the safety, quality, and shelf life of the food purchased by consumers, and is essential to reduce food waste and ensure food safety. Oliveira, Jin, Lima, Kobza, and Montevechi (2019) developed an intelligent risk management system for the actual operation of the food cold chain logistics, which is based on risk identification, risk detection, response behavior judgment and risk management functions as guidelines, where risk management functions are independent from other rules but dynamically linked to them for handling risks at runtime.

Regarding the research on the quality risks of warehousing and transportation services in fresh agricultural product cold chain logistics, many scholars in the field of cold chain research have focused more on related technical standards, optimization algorithms for cold storage configuration, and decision-making issues (Qian, Yu, Jiang, Yang, & Wu, 2022).

At the current stage, empirical research on the impact of supply chain risks on performance has made significant progress. Shojaei and Haeri (2019) found that supply chain risks and performance are interrelated, forming the basis of supply chain risk management. Wang, Yu, and Wang (2019) argued that corporate risk, as a measure of company information and operational environmental risks, is a potential key determinant of corporate performance. Gao et al. (2020) suggested that supply chain risks

have a negative impact on the performance of logistics operations. Esmizadeh and Mellat Parast (2021) found that supply chain risks have a negative impact on corporate performance. Kraude, Narayanan, and Talluri (2022) proposed that supply chain risks enhance corporate agility performance through supply chain integration, acting as a mediator in the relationship between supply chain risks and agility performance. Rehman, Jajja, and Farooq (2022) used structural equation modeling to analyze the impact of cross-border e-commerce supply chain risks on supply chain performance.

In summary, the empirical research on the impact of cold chain logistics transportation and warehouse service quality risks in the fresh agricultural product supply chain on quality performance is scarce. However, some scholars have focused on supply chain risks as antecedent variables to quality performance. S. Zhang, Chen, She, and Li (2021) argued that unclear information about product quality risks among upstream and downstream supply chain members could lead to product safety crises. B. Zhang (2022) Xu, Zhou, Zhang, Zhai, and Zhang (2023) found that supply chain risks reduce the extent of quality-related performance measures such as product quality, reliable delivery, and flexibility in their research.

From the above research, it is evident that there is limited research on the impact of quality risks in fresh agricultural product cold chain logistics storage and transportation services on quality performance, as well as the identification of key risk factors influencing quality performance from the perspective of quality performance. Additionally, among the limited literature on quality risks in fresh agricultural product cold chain, more attention has been given to product quality risks in the supply chain, while there is a lack of exploration on service quality risks in the supply chain. Therefore, this study aims to explore the impact of quality risks in fresh agricultural product cold chain logistics storage and transportation services on quality performance from the perspective of fresh food enterprises. It aims to identify key risk factors influencing quality performance and consider the moderating effect of supply chain risk management strategies. The study provides theoretical support and strategic references for enterprises in managing quality risks in fresh agricultural product cold chain logistics storage and transportation services and enhancing quality performance.

3. Theoretical Framework and Hypotheses

Cold chain transport service quality risk is due to the cold chain transport process, cold chain transport personnel, equipment, environment and management and other reasons brought to the fresh agricultural products cold chain logistics service quality risk (Chandran, Hasanuzzaman, Arıcı, & Kumar, 2022). Cold chain storage service quality risk is the logistics service quality risk brought by cold chain storage personnel, equipment, environment and management to the fresh agricultural products cold chain (X. Zhang, Sun, & Sun, 2022). Quality performance is an important topic of interest in supply chain research, and this paper defines it from both quality and performance perspectives at the organizational level (Teng, Tsinopoulos, & Tse, 2022; Yingfei et al., 2022). From a quality perspective, due to the broad and evolving nature of quality, quality performance can be understood as an organization's performance regarding external quality, internal quality, product quality and process quality (Mondal & Samaddar, 2023). This paper studies the impact of cold chain logistics storage and transportation service quality risks on performance is fundamental to enterprise risk management. Numerous research findings have demonstrated a significant negative correlation between cold chain storage, transportation service quality risks, and performance. Li, Li, and Wu (2022) study by A found that cold chain storage and transportation service quality risks have a negative impact on product quality, delivery reliability, and flexibility, which are performance indicators related to quality. However, the extent to which different types of cold chain transportation service quality risks affect performance may vary. Therefore, the current focus of research is to identify key risk factors that affect performance and to explore in depth the relationship between cold chain storage, transportation service quality risks, and performance in the context of fresh agricultural products (X. Zhang et al., 2022).

Based on this, the following hypotheses are proposed in this paper:

H1: Cold chain logistics warehouse service quality risk significantly affects quality performance in fresh agricultural products.

H2: Cold chain logistics transportation service quality risk significantly affects quality performance in fresh agricultural products.

By implementing supply chain risk management strategies, companies can achieve closer alignment between supplier goals and company goals. According to (Hermoso-Orzáez & Garzón-Moreno, 2022; Wicaksana, Ho, Talluri, & Dolgui, 2022), supply chain risk management strategies primarily include risk avoidance strategies, risk sharing strategies, and risk mitigation strategies. Risk avoidance strategy is the action taken by an organization to avoid risk and choose to move away from the source of risk, focusing on reducing the likelihood of risk occurrence (Ganesh & Kalpana, 2022). Risk sharing strategy refers to the transfer of part of the risk from the organization to other organizations through economic contracts, and the use of contractual provisions of legal responsibility for supply chain partners to share part of the risk (Rinaldi, Murino, Gebennini, Morea, & Bottani, 2022). Risk handling strategy refers to the remedial actions taken after the occurrence of risk, focusing on reducing the uncertainty of risk loss (Ali, Golgeci, & Arslan, 2023). Prior to the occurrence of risks, adopting risk avoidance strategies is an effective method for risk prevention . These strategies aim to interrupt the transmission of risks by assessing cold chain logistics service providers and sharing information in real time, thereby mitigating the negative impact of quality risks in cold chain logistics services for fresh agricultural products on quality performance When risks are present, losses caused by unreliable suppliers can be reduced through risk-sharing mechanisms such as price incentives. (Wicaksana et al., 2022). Fresh produce companies can mitigate risks by signing service guarantee agreements with cold chain logistics providers, jointly developing service plans, and implementing supplier integration strategies. According to stakeholder theory, risk-sharing encourages cold chain logistics service providers to invest more resources, improve their conditions, overcome existing technological and capacity limitations, and reduce the probability of service quality risks to pursue greater returns and development. After a risk occurs, risk management strategies focus more on emergency management and post-incident handling. Efficient risk management strategies can compensate for the quality-related performance of the company. Therefore, by implementing supply chain risk management strategies, the impact of quality risks in fresh produce cold chain logistics services on the company's quality performance is gradually reduced (Shen & Liao, 2022).

H3a: Risk avoidance strategies significantly moderate the relationship between quality risks in fresh produce cold chain logistics warehousing services and company performance.

H3b: Risk avoidance strategies significantly moderate the relationship between quality risks in fresh produce cold chain logistics transportation services and company performance.

H4a: Risk sharing strategies significantly moderate the relationship between quality risks in fresh produce cold chain logistics warehousing services and company performance.

H4b: Risk sharing strategies significantly moderate the relationship between quality risks in fresh produce cold chain logistics transportation services and company performance.

H5a: Risk handling strategies significantly moderate the relationship between quality risks in fresh produce cold chain logistics warehousing services and company performance.

H5b: Risk handling strategies significantly moderate the relationship between quality risks in fresh produce cold chain logistics transportation services and company performance.

The conceptual framework of this paper is illustrated in Figure 1.

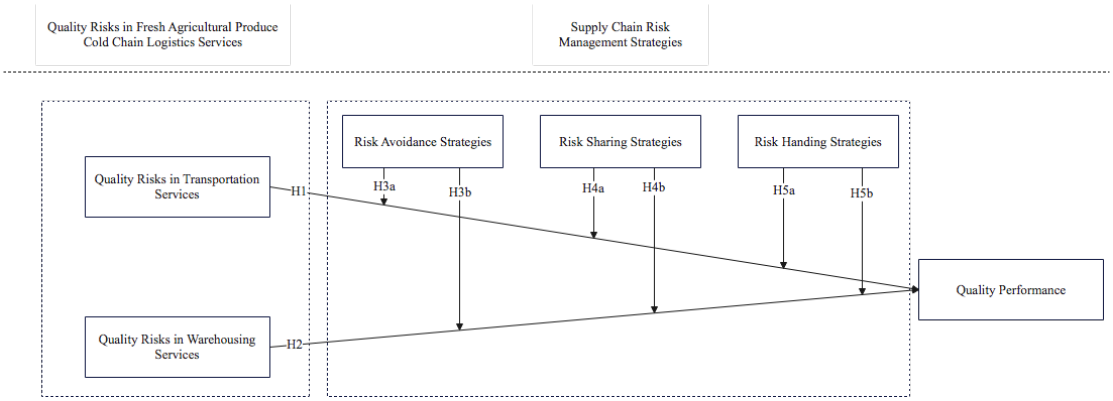

Fig. 1: Conceptual Framework

4. Research Design and Data Analysis

4.1.Questionnaire Design

This study employed a questionnaire survey to test the research hypotheses. To control common method bias, the following measures were taken in scale development:

- Multi-item measurement scales were used. Mature and widely used multi-item scales from the literature were adopted to measure the variables in this study, with adjustments made according to the research purposes.
- "Back-translation" of the English scales was conducted. The translation process focused on the clarity of wording and underwent repeated revisions to ensure simplicity and comprehensibility.
- The questionnaire items were improved based on pilot testing. Interviews and pilot testing were conducted, and revisions were made based on the feedback received.
- Anonymity of respondents was ensured. It was stated that there were no right or wrong answers, aiming to increase respondents' willingness to provide candid responses.
- The research objectives were clearly stated, ensuring that the results were solely used for academic research purposes.

4.2.Sample and Data Collection

Based on the main research focus of this paper, 516 staff members from 15 large-scale, well-known, and representative fresh produce cold chain logistics transportation enterprises in Zhengzhou City were selected as research participants. An anonymous questionnaire survey was conducted from March 2023 to May 2023. The survey questionnaire primarily used a Likert five-point scale. The expected levels of agreement included "strongly disagree," "disagree," "neutral," "agree," and "strongly agree," assigned values of 1, 2, 3, 4, and 5, respectively.

Considering the diversity, accessibility, and convenience of the survey data, a portion of the surveyed companies distributed the questionnaires through online platforms such as WeChat, QQ, and email. The online surveys included an introductory statement clarifying the research objectives to ensure the validity of the online data. Another portion of the surveyed companies entrusted relevant managers to distribute the questionnaires offline, with the number of distributed questionnaires controlled to be below 15% of the total number of employees in each company. Statistically, a total of 550 questionnaires were distributed in this survey, and 520 questionnaires were collected, resulting in a response rate of 94.45%. After excluding invalid questionnaires, a total of 516 valid questionnaires were obtained, yielding an effective response rate of 99.23%. These figures meet the basic requirements for further analysis of the sample data. Based on the 516 valid questionnaires collected, empirical analysis was conducted using SPSS 26.0 software.

This study selected four control variables: respondent age, department, position, and years of work experience. The percentage of each category under these variables reflects the diversity of the respondents. Regarding age, the survey mainly targeted the age group of 20-35, which accounted for 79.07% of the total sample, aligning with the survey background. In terms of departments, the survey covered various departments including procurement, logistics, quality control, supplier management, marketing, administration, finance, and others. The logistics, supplier management, and quality control departments were the main focus, accounting for 58.52% of the total sample. Regarding positions, the survey mainly targeted frontline managers and regular employees who are familiar with the quality risks of fresh produce cold chain logistics services, accounting for 50.97% and 25.00% of the total sample, respectively. In terms of work experience, the main focus was on employees with 5-10 years of experience, accounting for 51.94% of the total sample. Therefore, the sample data exhibits good representativeness and meets the requirements for research analysis. The background information of the sample is shown in Table 1.

Table 1: Sample Demographic Characteristics

Title	Options	Frequency	Percentage (%)	Cumulative Percentage (%)
Age.:	Below 20 years old	37	7.17	7.17
	20-35 years old	408	79.07	86.24
	35-50 years old	57	11.05	97.29
	Above 50 years old	14	2.71	100.00
Department:	Procurement Department	69	13.37	13.37
	Logistics Department	174	33.72	47.09
	Quality Control Department	51	9.88	56.98
	Supplier Management Department	77	14.92	71.90
	Marketing Department	49	9.50	81.40
	Office Department	34	6.59	87.98
	Finance Department	26	5.04	93.02
	Other Departments	36	6.98	100.00
Position	Senior executive	46	8.91	8.91
	Middle-level manager	263	50.97	59.88
	Regular employee	129	25.00	84.88
	Researcher	78	15.12	100.00
Years of work experience	Less than 5 years	156	30.23	30.23
	5-10 years	268	51.94	82.17
	10-15 years	66	12.79	94.96
	15 years or more	26	5.04	100.00
Total		516	100	100

4.3.Reliability and Validity Analysis of the Data

To test the reliability and validity of the scales used in this study, SPSS 26.0 was employed to conduct reliability and validity tests. As shown in Table 2, the α and composite reliability (CR) values for each construct are all above the recommended threshold of 0.700, indicating high reliability of the scales. Moreover, the average variance extracted (AVE) values for each construct are all above the

recommended threshold of 0.500, indicating good convergent validity of the scales. As shown in Table 3, the square root of AVE for each construct is higher than the correlation coefficients between the constructs, indicating good discriminant validity among the constructs. These results suggest that the data can be further analyzed using structural equation modeling.

Table 2: Reliability and Convergent Validity Testing of the Scales

Latent Variables	Measurement Items	CR	AVE	α
Quality risk of fresh agricultural products cold chain logistics transportation service TR	TR1: Improper temperature control during cold chain transportation TR2: Inappropriate transportation methods during cold chain transportation TR3: Poor packaging quality during cold chain transportation TR4: Information leakage or tampering during cold chain transportation TR5: Poor service attitude of cold chain transportation service personnel TR6: Frequent occurrence of unexpected events during cold chain transportation TR7: Lack of rationality in cold chain transportation vehicle configuration TR8: Inadequate handling of complaints by cold chain transportation service providers in case of cargo loss	0.993	0.999	0.953
Quality risks in fresh agricultural products cold chain logistics transportation services SR	SR1: Inability to maintain the required temperature range in cold storage. SR2: Lack of proper operation and maintenance of cold chain equipment. SR3: Insufficient regular cleaning and disinfection of cold chain equipment. SR4: Inadequate safety measures in cold storage, such as fire and theft prevention. SR5: Inability to timely deliver goods from cold storage. SR6: Inadequate management of inventory in cold storage. SR7: Unfavorable service attitude of cold storage personnel. SR8: Delivery of goods that do not meet the requirements of the order.	0.997	1	0.965
Risk avoidance strategies RAS	RAS1：Enterprise conducts evaluation and management of cold chain service providers. RAS2：Enterprise will allocate profits reasonably with cold chain logistics providers. RAS3：The enterprise will share information with cold chain logistics providers.	0.962	0.987	0.765
Risk sharing strategy RSS	RSS1：Enterprises sign service guarantee agreements with cold chain logistics providers. RSS2：Enterprises integrate cold chain service providers to jointly share risks. RSS3：Enterprises and cold chain logistics providers jointly develop service plans.	0.954	0.984	0.763
Risk handling strategies RRS	RRS1：The company has a sound risk emergency mechanism. RRS2：The company will use logistics delay strategies.	0.787	0.917	0.777

	RRS3：The company has multiple similar cold chain logistics service providers.			
quality performance QP	QP1：Compared to competitors, the company always achieves fast delivery.	0.96	0.993	0.942
	QP2：Compared to competitors, the company always completes deliveries on time.			
	QP3：Compared to competitors, the company is always flexible in changing its product portfolio.			
	QP4：Compared to competitors, the company can provide safer fresh products.			
	QP5：Compared to competitors, the company has a lower rate of fresh agricultural product loss.			
	QP6：Compared to competitors, the company can provide superior product quality.			

Table 3: Discriminant Validity Test of Constructs

Variables	TR	SR	RAS	RSS	RRS	QP
TR	0.996					
SR	0.705	0.998				
RAS	0.178	0.206	0.981			
RSS	-0.228	-0.198	0.304	0.977		
RRS	0.175	0.242	0.578	0.279	0.887	
QP	-0.252	-0.265	-0.338	-0.371	-0.149	0.98

Note: The blue numbers on the diagonal represent the square root of AVE (Average Variance Extracted), while the other numbers represent the corresponding correlation coefficients.

4.4.Model Fit and Common Method Bias Test

In this study, the standardized path analysis of the structural model was conducted using AMOS 21.0 software. The model fit indices are presented in Table 4. Based on the model fit indicators, the model's $x^2/df = 1.596 < 3$. Additionally, the RMSEA and RMR values are 0.038 and 0.027, respectively, both below 0.1. The GFI, CFI, NFI, and NNFI values are all above 0.9, indicating that the model's fit indices are within the acceptable range, suggesting a good model fit.

Table 4: Model Fit Indices

Fit index	$\chi 2/df$	GFI	RMSEA	RMR	CFI	NFI	NNFI
Evaluation Criteria	<3	>0.9	<0.10	<0.05	>0.9	>0.9	>0.9
Value	1.596	0.91	0.038	0.027	0.994	0.984	0.993

In Table 5, it is shown that transportation service quality risks have a significant negative impact on quality performance. The negative impact of transportation service quality risks on quality performance implies that there may be issues during transportation such as delivery delays, damaged or lost goods, which can lead to a decline in quality performance. The significant negative impact of

transportation service quality risks on quality performance reveals the actual problems that need to be addressed in the supply chain, such as delivery delays, damaged goods, non-compliance with quality standards, and decreased customer satisfaction. These findings confirm the hypotheses H1 to H2 proposed in this study.

To mitigate the impact of common method bias, this study took measures in questionnaire design, including ensuring semantic distinctiveness of measurement indicators and requesting anonymous responses based on actual operational experiences without right or wrong answers. Additionally, Harman's single-factor test was used to conduct a variance analysis on the entire scale. The results revealed that the first principal component explained 18.727% of the total variance, which is below the threshold of 40%. This indicates that common method bias is not fundamentally affecting this study and satisfies the requirements for further data analysis.

Table 5: Path Coefficients and Statistical Test Values of the Initial Structural Equation Model

X	→	Y	Unstandardized Path Coefficients	SE	z (CR Value)	p	Standardized Path Coefficients	Test Results
TR	→	QP	-0.184	0.093	-1.983	0.047	-0.129	Passed
SR	→	QP	-0.351	0.111	-3.149	0.002	-0.227	Passed

4.5.Moderation Analysis

In this study, the SPSS 26.0 software was used to establish multiple regression models to test the moderating effects of risk avoidance strategies, risk sharing strategies, and risk management strategies.

- Testing the Moderating effect of risk avoidance strategies.

i. Detection of the moderating effect of risk avoidance strategies on the relationship between cold chain transportation service quality risks and quality performance

The results of the moderating effect of risk avoidance strategies on the relationship between cold chain transportation service quality risks and quality performance are shown in Table 6.

Table 6: Moderating Effect of Risk Avoidance Strategies on the Relationship between Cold Chain Transportation Service Quality Risks and Quality Performance

	Model 1		Model 2		Model 3	
	β	p	β	p	β	p
TR	-0.287	0.000**	-0.214	0.001**	-0.269	0.000**
RAS			-0.433	0.000**	-0.431	0.000**
TR*RAS					-0.113	0.013*
R^2	0.361		0.474		0.487	
F	F (5,410)=5.293,p=0.000		F (6,409)=14.406,p=0.000		F (7,408)=13.397,p=0.000	

Dependent variable: QP

* p<0.05 ** p<0.01

The regression coefficient results indicate that the interaction coefficient between cold chain transportation service quality risk and risk avoidance strategy is -0.013 (p<0.05). This supports the hypothesis H3a, which states that the risk avoidance strategy has a negative moderating effect on the relationship between cold chain transportation service quality risk and quality performance.

ii. Moderation Effect of Risk Avoidance Strategy on the Relationship between Cold Chain Warehousing Service Quality Risk and Quality Performance

The moderation effect of risk avoidance strategy on the relationship between cold chain warehousing service quality risk and quality performance is presented in Table 7.

Table 7: Moderation effect of risk avoidance strategy on the relationship between cold chain warehousing service quality risk and quality performance.

	Model 1		Model 2		Model 3	
	β	p	β	p	β	p
SR	-0.366	0.000***	-0.231	-0.263	0.000**	-0.361	0.000**
RAS				-0.422	0.000**	-0.416	0.000**
SR*RAS						-0.149	0.005**
R 2	0.371			0.478		0.493	
F	F (5,410)=6.299,p=0.000			F (6,409)=14.746,p=0.000		F (7,408)=13.984,p=0.000	

Dependent variable：QP

* p<0.05 ** p<0.01

The regression coefficient results indicate that the interaction coefficient between the risk avoidance strategy and the quality performance of cold chain transportation services is -0.149. This supports the hypothesis H5b, suggesting that the risk avoidance strategy has a negative moderating effect on the relationship between the quality risk of cold chain warehousing services and quality performance.

- Testing the Moderating Effect of Risk Sharing Strategy

i. Moderation Effect Test of Risk Sharing Strategy on the Relationship between Risk Exposure and Quality Performance in Cold Chain Transportation Services

The results of testing the moderation effect of the risk sharing strategy on the relationship between risk exposure and quality performance in cold chain transportation services are presented in Table 8.

Table 8: Moderation Effect of Risk Sharing Strategy on the Relationship between Risk Exposure and Quality Performance in Cold Chain Transportation Services

	Model 1		Model 2		Model 3	
	β	p	β	p	β	p
TR	-0.287	0.000**	-0.379	0.000**	-0.31	0.000**
RSS			-0.451	0.000**	-0.429	0.000**
TR*RSS					-0.134	0.001**
R 2	0.361		0.348		0.569	
F	F (5,410)=5.293,p=0.000		F (6,409)=22.448,p=0.000		F (7,408)=21.419,p=0.000	

Dependent variable：QP

* p<0.05 ** p<0.01

The regression coefficient results show that the interaction term between risk sharing strategy and risk exposure in cold chain transportation services is -0.191. Hypothesis H4a is supported, indicating that the risk sharing strategy has a negative moderating effect on the relationship between risk exposure and quality performance in cold chain transportation services.

ii. The moderation effect of risk sharing strategy on the relationship between quality risk in cold chain warehousing services and quality performance

The results of the moderation effect of risk sharing strategy on the relationship between quality risk in cold chain warehousing services and quality performance are shown in Table 9.

Table 9: Moderation Effect of Risk Sharing Strategy on the Relationship between Quality Risk in Cold Chain Warehousing Services and Quality Performance

	Model 1		Model 2		Model 3	
	β	p	β	p	β	p
SR	-0.366	0.000**	-0.5	0.000**	-0.377	0.000**
RSS			-0.469	0.000**	-0.439	0.000**
SR*RSS					-0.148	0.004**
R 2	0.371		0.571		0.586	
F	F (5,410)=6.299,p=0.000		F (6,409)=25.372,p=0.000		F (7,408)=23.349,p=0.000	

Dependent variable：QP

* p<0.05 ** p<0.01

The regression coefficient results show that the interaction coefficient between risk sharing strategy and quality risk in cold chain warehousing services is -0.148. The hypothesis H4b is supported, indicating that risk sharing strategy has a negative moderating effect on the relationship between quality risk in cold chain warehousing services and quality performance.

- Testing the Moderating Effect of Risk Handling Strategy

i. Moderating Effect of Risk Handling Strategy on the Relationship between Cold Chain Transportation Service Quality Risk and Quality Performance

The moderating effect of risk handling strategy on the relationship between cold chain transportation service quality risk and quality performance is presented in Table 10.

Table 10: Moderating Effect of Risk Handling Strategy on the Relationship between Cold Chain Transportation Service Quality Risk and Quality Performance.

	Model 1		Model 2		Model 3	
	β	p	β	p	β	p
TR	-0.287	0.000**	-0.254	0.000**	-0.296	0.000**
RRS			-0.169	0.022*	-0.184	0.013*
TR*RRS					-0.108	0.041*
R 2	0.361		0.373		0.382	
F □	F (5,410)=5.293,p=0.000		F (6,409)=5.340,p=0.000		F (7,408)=5.215,p=0.000	

Dependent variable：QP

* p<0.05 ** p<0.01

The regression coefficient results show that the interaction coefficient between risk handling strategy and cold chain transportation service quality risk is -0.108. Hypothesis H5a is supported, indicating that risk handling strategy has a negative moderating effect on the relationship between cold chain transportation service quality risk and quality performance.

ii. The moderating effect of risk handling strategy on the relationship between cold chain warehousing service quality risk and quality performance

The moderating effect of risk handling strategy on the relationship between cold chain warehousing service quality risk and quality performance is presented in Table 11.

Table 11: Moderating Effect of Risk Handling Strategy on the Relationship between Cold Chain Warehousing Service Quality Risk and Quality Performance.

	Model 1		Model 2		Model 3	
	β	p	β	p	β	p
SR	-0.366	0.000**	-0.327	0.000**	-0.396	0.000**
RRS			-0.15	0.042*	-0.163	0.027*
SR*RRS					-0.127	0.036*
R 2	0.371		0.381		0.391	
F □	F (5,410)=6.299,p=0.000		F (6,409)=5.982,p=0.000		F (7,408)=5.802,p=0.000	

Dependent variable：QP

* p<0.05 ** p<0.01

The regression coefficient results show that the interaction coefficient between risk handling strategy and cold chain warehousing service quality risk is -0.127. Hypothesis H5b is supported, indicating that risk handling strategy has a negative moderating effect on the relationship between cold chain warehousing service quality risk and quality performance.

5. Research Conclusions and Discussion

In this section, the paper will delve into the key findings, linking them back to existing literature, outlining the theoretical and practical implications of these significant results, and suggesting future research directions to build upon this study.

First and foremost, the primary findings of this study reveal that service quality risks in the cold chain logistics of fresh agricultural products significantly impact enterprise quality performance. The quality risks associated with cold chain logistics transportation and warehousing can lead to quality damage, reduced product quality, diminished customer satisfaction, and adverse effects on the enterprise's reputation and market competitiveness.

These findings are consistent with some existing research that has explored the relationship between supply chain risks and performance. However, this study contributes by emphasizing the mitigating role of supply chain risk management strategies, providing specific implementation recommendations. This has significant practical implications for enterprises aiming to enhance their performance through effective service risk management.

From a theoretical standpoint, this study underscores the role of supply chain risk management in mitigating the impact of cold chain service quality risks on quality performance. This theoretical contribution aids in further expanding risk management theory, particularly within the realms of supply chain and cold chain logistics.

In practical terms, these research results offer guidance to enterprises on how to better manage service quality risks in cold chain logistics. Enterprises can take a series of measures, including the development of comprehensive risk assessments and emergency plans, improvement of information communication and coordination, maintenance of cold chain equipment and environmental conditions,

enhancement of product quality and transportation efficiency, and safeguarding of their reputation and market position.

In summary, this study provides valuable insights into the impact of service quality risks in cold chain logistics for fresh produce on enterprise quality performance in China. The findings demonstrate the mitigating role of supply chain risk management strategies, offering practical guidance for enterprises seeking to enhance their performance through effective service risk management. Further research conducted across various geographical locations and cold chain stages would strengthen and validate these conclusions.

6. The limitations

Future research directions may include expanding the study to various geographical locations and different stages of the cold chain to bolster the conclusions and gain a more comprehensive understanding of the subject. Additionally, employing mixed methods research approaches could provide a more holistic view of the impact of service quality risks in cold chain logistics on enterprise quality performance.

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