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Fresh Agricultural Products Online Retailer's Emergency Logistics Capability Framework During the Pandemic*

Miao SU [1], Yanfeng LIU[2], Keun-sik PARK[3]

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Abstract

Purpose: During the pandemic, a large number of orders forced online retailers of fresh produce to quickly change their emergency logistics capabilities to meet the needs of ordinary consumers during the pandemic. Our research aims to help online retailers establish an emergency physical distribution framework for fresh produce during disasters to meet consumer needs. **Research design and methodology:** 160 effective responses were collected from the online response team in Wuhan, China, and exploratory factor analysis was used to determine the emergency logistics capability framework. Twelve experts were invited online to collect their scoring opinions and use the entropy method to determine the importance of emergency logistics capabilities. **Results:** Our results have identified a total of 17 emergency logistics factors for online retailers, and we found that Transportation route planning and reconstruction capabilities, Emergency plan planning ability, and Supply chain real-time information sharing capability are the most important in the overall framework. **Conclusions:** This research completely established the physical distribution framework of fresh agricultural products online retailer in emergency situations. It enriches academic resources in the field of emergency distribution and provides a scientific basis for corporate managers to improve their physical distribution capabilities in emergency situations.

Keywords : E-commerce, Emergency Logistics, Logistics Capability, Fresh Products, Entropy Method

JEL Classification Code: L81, Q13, M11, R41

1. Introduction

Since the outbreak of the COVID-19 epidemic, the Chinese government has adopted a model of restricting population movement and closure management. The Wuhan Epidemic Prevention and Control Headquarters issued an emergency lockdown and closure of Wuhan's airports, railway stations, bus stations, and other exits. The most effective way to prevent epidemics is to strictly isolate and treat infected people, but strict isolation measures make buying fresh produce a problem for the Chinese people. People can't live without Fresh agricultural products, Therefore, in the critical period of COVID-19, buying fresh agricultural products through e-commerce platforms has become a common choice for many citizens.

According to China's iiMedia Report, the period of the COVID-19 outbreak in mainland China was from January 22 to February 6, 2020. The average daily number of new users of the e-commerce platforms for fresh products exceeds 40,000.

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1 First Author, PhD student, Department of International Trade and Logistics, Chung-Ang University, Korea.
Email: marksu@cau.ac.kr
2 Co-First Author, PhD student, Department of International Trade and Logistics, Chung-Ang University, Korea.
Email: liuyanfeng1379@cau.ac.kr
3 Corresponding Author, Assistant Professor, Department of International Trade and Logistics, Chung-Ang University, Korea.
Email: pksik0371@cau.ac.kr

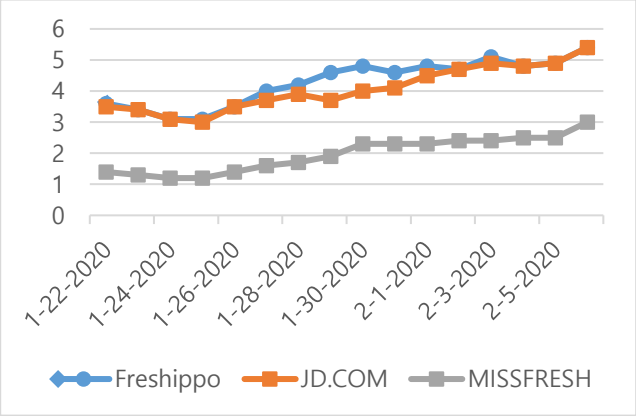

Figure 1: The average daily number of new users (in 10,000)

The sudden order demand far exceeds the immediate response capability of online retailers. Online retailers are facing the hard-to-satisfy demand for cold chain consumers. On the one hand, it is affected by the lack of labor, road restrictions, and other related factors during the pandemic. Moreover, the logistics efficiency of e-commerce enterprises for fresh agricultural products is extremely low, and the agricultural product supply chain faces more complex difficulties. Many local suppliers of agricultural products faced sales problems, and many regions have difficulty buying vegetables, which are priced highly in varying degrees. Consequently, citizens' demand for fresh agricultural products cannot be met, and farmers' product sales channels cannot be opened. These two problems have become major issues for citizens' livelihood security during the epidemic.

In severe public health emergencies, the unblocked emergency logistics of fresh agricultural products has played a key decisive role. A good supply of fresh agricultural products not only relates to the daily life and emotional stability of ordinary people but also provides food and material security for medical staff struggling on the front line. Fresh agricultural products, such as fresh vegetables, meat, eggs, and fruits, are delivered to consumers' homes via e-commerce and logistics companies. In extraordinary times, logistics vehicles and human resources are particularly scarce. The emergency logistics capabilities of e-commerce enterprises for fresh products determine its supply efficiency.

Therefore, it is essential to actively respond to various major public health events that human society may face in the future to ensure the safety and stability of human life during major epidemics. This research conjectures the necessity to improve the emergency logistics capabilities of fresh food e-commerce companies, establish an emergency logistics management system, and carry out evaluation research on their emergency logistics capabilities.

2. Literature Review

2.1. Optimization of Emergency Logistics Plan

Özdamar et al. (2004) used the Lagrangian relaxation method to solve the multi-commodity network circulation problems in emergency logistics and vehicle routing optimization problems in the occurrence of natural disasters. Meanwhile, Caunhye et al. (2012) utilized content analysis technology to review the optimization model used in emergency logistics. The facility locations and pre-arrangement are believed to be the main elements before the disaster, whereas the delivery of relief supplies and transportation of the wounded are classified as post-disaster actions. According to these operations, the work in the literature is divided into three parts: facility location, relief delivery and transportation of casualties, and other operational optimization studies. Sheu (2007) proposed a hybrid fuzzy clustering optimization method for the operation of emergency logistics collaborative delivery. This is mainly manifested in the optimization of the disaster-stricken area grouping and joint optimization of delivery problems. Meanwhile, Tovia (2007) established an emergency response model (ERM) in the paper, which can be used by the Emergency Preparedness Office to evaluate emergency logistics capabilities and challenges during the occurrence of natural disasters. Moreover, he made assumptions about the threat of weather interference systems and its analysis to help the effective management and operation of the emergency logistics system. Pettit & Beresford (2005) proposed an improved rescue response model of emergency logistics in emergency situations, which considered the existing military and non-military response models.

2.2. Research on evaluation of Logistics Capability

Gong et al. (2012) built an operation model for emergency logistics system and its evaluation index based on the characteristics of suddenness and time uncertainty. The information entropy method combining subjective judgment and objective evaluation is used to determine the index weight coefficient. Then, fuzzy clustering and information entropy are used to determine the weights in the evaluation process of emergency logistics system's reliability. Meanwhile, Zhang & Fu (2012) established the evaluation index system of emergency logistics, integrated the advantages of analytic hierarchy process (AHP) and data envelopment analysis (DEA), and combined the DEA algorithm with the AHP to improve the performance level of the emergency logistics system. Ju et al. (2012) proposed a hybrid fuzzy method composed of a fuzzy AHP and binary fuzzy language method to evaluate emergency

response capability. Tong-tong (2011) utilized the fuzzy clustering analysis method to classify emergency logistics capability evaluation indicators, eliminate unreasonable indicators, determine the key elements of emergency logistics center evaluation capabilities, and finally build an appropriate evaluation index system. Xu & Gong (2016) established an emergency logistics support capability evaluation index system and evaluation model based on triangular fuzzy entropy and Choquet integral.

2.3. Emergency Logistics Capability

Ou et al. (2004) elaborated on the background, definition, research content, theoretical value, and application potential of emergency logistics. Moreover, he discussed the mechanisms of the application of government coordination, mass mobilization, legal guarantee, and emergency channel in emergency logistics. The realization of emergency logistics through the establishment of an emergency response organization is proposed. Meanwhile, Xiaoqun et al. (2007) clarified the characteristics of emergency logistics capabilities from the aspects of time validity, flexibility, particularity, scalability, and completeness. The system composition and framework structure of emergency logistics capabilities are constructed from the perspectives of logistics activity, logistics systems, and logistics capabilities attributes. Xie & Qiu (2005) discussed the origin, concept, and characteristics of emergency logistics, and they constructed the basic framework of the emergency logistics operation. To ensure the successful operation of emergency logistics, the role of governments at all levels and the construction of information systems and transportation infrastructure must be strengthened.

3. Research Methods and Materials

3.1. Definition

Liu & Ke (2012) defined fresh agricultural products as fresh vegetables, fruits, aquatic products, poultry, and meat products. Wang & Yip (2018) state that the whole process of cold chain logistics for fresh agricultural products includes harvest (slaughtering or fishing) of meat, poultry, aquatic products, vegetables, fruits, eggs, and others. These products should be kept in a low-temperature environment to ensure safety and quality when received by customers. Accordingly, this article conjectures that the emergency logistics of fresh agricultural product e-commerce enterprises mainly pertains to cold chain transportation, cold storage, loading and unloading transportation, and insulation packaging. The circulation processing, cold chain delivery, and e-commerce information processing are a special logistics activity that guarantees the demand for fresh agricultural products in emergency situations. The emergency logistics capability of fresh agricultural product e-commerce enterprises is a comprehensive reflection of any link in the emergency logistics operation process of agricultural products.

3.2. Evaluation index

Xiaoqun *et al*. (2007) constructed the micro-level system structure and framework of emergency logistics capability from three levels: the nature of logistics activities, the abstract characteristics of the logistics system, and the constituent elements of logistics capabilities. Meanwhile, Zhang & Fu (2012) made a detailed indicator system classification for the emergency logistics system and evaluated the emergency logistics performance from eight aspects: emergency information, emergency category, disaster area location, transportation, government management, rescue personnel, government coordination mechanism, and the aftermath. Gong *et al.* (2012) analyzed the reliability of the emergency logistics system from four aspects of emergency logistics, namely, information system, transportation and delivery, command and cooperation system, and financing system.

Table 1: Evaluation indexes for emergency logistics capability

Constructs	
Overall responsiveness X_1	Delivery route optimization capability X_{10}
Emergency planning ability X_2	Fresh agricultural products storage X_{11}
Ability to collaborate with governmentX_3	Ability to match the demand in the disaster area X_{12}
Vehicle manpower dispatching ability X_4	Processing and packaging emergency capability X_{13}
Ability to collaborate with other organizations X_5	Cold chain transportation equipment coordination capability X_{14}
Timeliness of Fresh Agricultural Products Delivery X_6	Supply chain information collection capabilities X_{15}
Safety capability during delivery X_7	Emergency service promotion capabilities X_{16}
Transportation route planning and reconstruction X_8	Real-time information sharing capability X_{17}
Rate of goods integrity X_9	Emergency warning capability X_{18}

We adopted the recommendations of emergency logistics performance system developed by Zhang & Fu

(2012) and the emergency logistics system developed by Gong *et al.* (2012). Besides, based on the characteristics of major public health events such as the new COVID-19 pandemic in 2020, combined with expert recommendations, 18 evaluation indicators for the emergency logistics capabilities of fresh agricultural products were initially selected from the operation level of the e-commerce enterprises (Table 1). In addition, we have coded each indicator and will continue to use these codes.

3.3. Questionnaire design and survey

This article uses a questionnaire survey to collect the importance of indicator information in Wuhan, China. Then, the SPSS software is used to analyze the questionnaire data through reliability, validity, and factor analyses.

Table 2: Specific sample information of the survey

Questionnaire content		Frequency	Proportion
Age	Under 35	82	52.25%
	36–40 years old	58	36.25%
	41–45 years old	15	9.38%
	Above 45	5	3.13%
Working years	5 years or less	78	48.75%
	6–10 years	25	15.63%
	11–20 years	55	34.38%
	More than 20 years	2	1.25%
Business category	Fresh Products E-commerce Enterprise	72	45%
	Agricultural product distributors, farmers	24	15%
	Logistic company	28	17.5%
	Agricultural products processing and storage enterprises	36	22.5%
	other	0	0
Education	High school	28	17.5%
	College	108	67.5%
	Master student	24	15%
	PhD	0	0
Position	Senior management	8	5%
	Middle management	68	42.5%
	General staff	84	52.5%
Fresh products e-commerce customers	YES	160	100%
	NO	0	0
Notes: N=160			

By consulting a large number of documents, we combine the actual situation and characteristics of emergency logistics of fresh agricultural products. The basic structure of the questionnaire design consists of two parts. The first half of the questionnaire is to understand the basic information of the surveyed person, such as age, working experience, education level, and position. The second half is for the 18 variables that affect the emergency logistics capability evaluation system. A 5-point Likert scale is used (1 = extremely unimportant, 2 = less important, 3 = average,4 = more important, and 5 = very important). The greater is the score, the greater is the degree of importance. A total of 160 valid questionnaires were recovered. The specific sample information of the survey is presented in Table 2.

3.3.1. Reliability analysis

This article uses SPSS 26.0 to analyze the reliability of the statistical data and content of the questionnaire. Reliability analysis is the basis of other analyses. In this study, the Cronbach α coefficient is 0.888, indicating the credibility of the questionnaire.

3.3.2. Factor analysis

In this paper, the factor analysis is used to test the degree of interpretation of the evaluation indicators of emergency logistics capability of fresh agricultural product e-commerce enterprises under major public health incidents. This paper uses two methods, KMO and Butler sphere test, to analyze the correlation of the data. In this study, the KMO value is 0.846, and the Sig value of Bartlett's Test of Sphericity test is 0.000<0.001, indicating the suitability of the questionnaire data for the factor analysis.

Table 3: KMO and Bartlett's Test

KMO and Bartlett's Test	
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.	0.846
Bartlett's Test of Sphericity	1275.362
df	153
Sig.	0

Next, using the maximum variance method for orthogonal rotation, this paper conducts exploratory factor analysis on the questionnaire data. Moreover, the results of the calculation show a total of 4 eigenvalues greater than 1, which can be intercepted using the standard interception factor with a characteristic root greater than 1. The cumulative variance reaches 64.248%.

The loading matrix of the factors is orthogonally rotated, and the results are presented in Table 4. The rate of goods integrity X_9 qualitatively changes after orthogonal rotation; thus, this index is removed because the factor variable load value is lower than 0.6. The remaining factor variable load values can be clearly seen.

Through the exploratory factor analysis, there are four principal component factors. We adopted the research recommendations of Zhang & Fu (2012) and Gong et al. (2012). Our research determined an evaluation index system for the emergency logistics capabilities of fresh agricultural product e-commerce enterprises in major public health incidents. According to the relevant theories and the advice of consulting experts, factors 1, 2, 3, and 4 are set as management coordination ability, operation, and delivery ability, storage processing capability, and supply chain information management capability, respectively. Finally, a preliminary establishment of an evaluation index system of emergency logistics capacity includes 1 first-level indicator, 4 second-level indicators, and 17 third-level indicators, as shown in Table 5.

Table 4: Principal component analysis

	Component 1	Component 2	Component 3	Component 4
X_1	**0.757**	-	-	-
X_2	**0.761**	-	-	-
X_3	**0.758**	-	-	-
X_4	**0.735**	-	-	-
X_5	**0.805**	-	-	-
X_6	-	**0.781**	-	-
X_7	-	**0.707**	-	-
X_8	-	**0.772**	-	-
X_9	-	-	-	-
X_{10}	-	**0.794**	-	-
X_{11}	-	-	-	**0.811**
X_{12}	-	-	-	**0.707**
X_{13}	-	-	-	**0.782**
X_{14}	-	-	-	**0.686**
X_{15}	-	-	**0.834**	-
X_{16}	-	-	**0.734**	-
X_{17}	-	-	**0.764**	-
X_{18}	-	-	**0.734**	-
The extraction and rotation methods used are principal component analysis and varimax with Kaiser normalization, respectively.				
a. Rotation converged in six iterations.				

Table 5: Evaluation index system for the emergency logistics capabilities

Level 2	Level 3	Index content explanation
Management and coordination ability	Overall responsiveness (X_1)	Overall quick response capability of e-commerce enterprises through the emergency logistics system
	Emergency plan planning ability (X_2)	Planning ability for emergency logistics operation for fresh agricultural products
	Ability to collaborate with government (X_3)	E-commerce companies and the government's joint ability to implement emergency logistics of fresh agricultural products
	Vehicle manpower dispatching ability (X_4)	Cold chain logistics vehicles and logistics personnel dispatching ability in emergencies
	Ability to collaborate with other organizations (X_5)	The ability to cooperate with other social organizations to ensure smooth flow of goods
Operational delivery capabilities	Timeliness of Fresh Agricultural Products Delivery (X_6)	The ability to deliver emergency fresh agricultural products to customers at a designated time
	Safety capability during delivery (X_7)	Logistics practitioners and commodity safety assurance capabilities in emergencies
	Transportation route planning and reconstruction (X_8)	Ability to re-plan and repair the damaged logistics transportation network
	Delivery route optimization capability (X_{10})	Capabilities to optimize delivery network under certain logistics resources
Storage processing capacity	Fresh agricultural products storage (X_{11})	Refrigeration, freezing, and low-temperature storage facilities and area
	Ability to match the demand in the disaster area (X_{12})	E-commerce company's ability to store and supply fresh agricultural products
	Processing and packaging emergency capability (X_{13})	Emergency response capabilities for special packaging and processing of fresh agricultural products
	Cold chain transportation equipment coordination capability (X_{14})	Coordination ability of cold chain vehicles and other equipment
Supply chain information management capabilities	Supply chain information collection capabilities (X_{15})	Ability to collect information on unsalable fresh agricultural products supply chain
	Emergency service promotion capabilities (X_{16})	The ability to promote emergency logistics services in all links of the fresh produce supply chain
	Real-time information sharing capability (X_{17})	Ability to share information on emergencies in all links of the supply chain
	Emergency warning capability (X_{18})	Warning capabilities for challenges and problems faced after emergencies

3.4. Design of Index Evaluation Standard

Based on literature and expert suggestions, this paper sets the evaluation criteria of the percentile system to construct the evaluation index system and uses the three classification methods to evaluate the level of emergency logistics capability of fresh produce e-commerce enterprises: level I is the excellent standard with a comprehensive score of 80–100 points; level II is good evaluation standard with the weighted comprehensive score of 60–80 points for each evaluation index; level III is poor with the comprehensive score of 0–60 points.

3.5. Entropy method

After comparing the advantages and disadvantages of various comprehensive evaluation methods, this paper finally chooses the entropy method to solve the evaluation index weight of the e-commerce enterprises' emergency logistics ability under major public health events. In information theory, entropy is a measure of uncertainty. The greater the amount of information, the smaller the uncertainty, and thus, the smaller the entropy, and vice versa.

The randomness and disorder degree of an event and the degree of index dispersion can be determined by calculating the entropy value. The greater the degree of dispersion of the index, the greater is its influence on the comprehensive evaluation. Moreover, the larger the (weight), the smaller the entropy value. After determining the weight solution method, this article verifies data using MatlabR2020a for statistical analysis, as suggested by experts.

Before calculating the comprehensive index, the collected data must be standardized; that is, the absolute value of the index is converted into a relative value,

and $x_{ij} = |x_{ij}|$, to solve the homogeneity problem. Moreover, the scoring values of each indicator expert in this article are all positive indicators; hence, we use positive indicator data to standardize the high and low indicators. The specific method is as follows:

$$x_{ij}^{'} = \frac{x_{ij} - \min\{x_{ij}, \cdots, x_{nj}\}}{\max\{x_{ij}, \cdots, x_{nj}\} - \min\{x_{1j}, \cdots, x_{nj}\}}$$

For convenience, the normalized data are still recorded as x_{ij}; then, x_{ij} is still the normalized score of the expert i (i = 1, 2 …, n) on the indicator j (j = 1, 2 …, m).

Then, the following values are calculated:

(1) Percentage of the index scored by the i expert under the j index:

$$p_{ij} = \frac{x_{ij}}{\sum_{i=1}^{n} X_{ij}}, i = 1, \cdots n, j = 1, \cdots, m$$

(2) Entropy value of the j index:

$$e_j = -k \sum_{i=1}^{n} p_{ij} \ln(p_{ij})$$

$$(k = 1/\ln(n) > 0,\ e_j > 0)$$

(3) Information entropy redundancy:

$$d_j = 1 - e_j$$

(4) Weight of each indicator:

$$w_j = \frac{d_j}{\sum_{j=1}^{n} d_j}$$

(5) Comprehensive score of each expert on the evaluation enterprise:

$$s_i = \sum_{j=1}^{n} w_j p_{ij}$$

(6) The actual score of emergency logistics capability of fresh agricultural product e-commerce enterprises:

$$z_i = \sum_{j=1}^{n} w_j x_{ij}$$

4. Results

4.1. Data analysis

This article selected a fresh agricultural product e-commerce company in Wuhan with a relatively mature business during the Covid-19 outbreak as the evaluation object. The survey interviewed 12 logistics managers (a-l) from a fresh agricultural product e-commerce company and university logistics experts in Wuhan, China. According to the emergency logistics evaluation indicators of the fresh produce e-commerce company that we determined, 12 experts and scholars scored the actual situation of the company. We put the score data of the experts and scholars in the appendix at the end of the article and x_{ij} is the score value of the index j by the expert i (i = 1, 2 …, n ; j = 1, 2, …, m).

The entropy value and weight of each index obtained from the software analysis and calculation are presented in Table 6.

Table 6: Index weight table

Index	Entropy	Weights	Weight ranking
X_8	0.9893	0.0788	1
X_2	0.9903	0.0718	2
X_{17}	0.9904	0.0710	3
X_3	0.9909	0.0675	4
X_{10}	0.9910	0.0666	5
X_{13}	0.9912	0.0648	6
X_{14}	0.9912	0.0647	7
X_6	0.9915	0.0629	8
X_{18}	0.9917	0.0611	9
X_7	0.9925	0.0557	10
X_{12}	0.9926	0.0549	11
X_{11}	0.9928	0.0534	12
X_4	0.9929	0.0527	13
X_{15}	0.9930	0.0518	14
X_5	0.9931	0.0513	15
X_{16}	0.9951	0.0365	16
X_1	0.9953	0.0346	17

4.2. Interpretation of result

4.2.1. Management and coordination ability

The results of data analysis revealed that in terms of management and coordination capabilities, among the fresh agricultural products emergency logistics indicators, the

emergency planning capacity indicators accounted for more than 7%, its weight ranking second, which implies the importance of emergency logistics plan construction for fresh agricultural products. Under emergency conditions, the weight of the coordination capacity between the emergency logistics of fresh agricultural products and government agencies accounted for about 6.75%, which is enough to show that coordination with government agencies plays an important role in emergencies. Meanwhile, the vehicle manpower dispatching ability and overall emergency logistics response-ability indicators account for 5.3% and 5.1% of the total indicator weights, respectively. From an overall point of view, the emergency logistics management and coordination capabilities of fresh food e-commerce enterprises occupy the highest position. Fresh e-commerce companies need to pay more attention to the development and construction of emergency logistics plan capabilities.

4.2.2. Operational delivery capabilities

Results reveal that operational and delivery capabilities account for more than 27%, of which emergency transportation route planning and reconstruction capabilities account for about 8% of the overall index system. This weight ranks first in the emergency logistics capability index system. The emergency logistics environment is very different from the general logistics environment, wherein logistics facilities will be greatly restricted. With limited logistics resources, the planning and reconstruction of logistics transportation routes are particularly important. Meanwhile, the weight of the delivery route optimization capability index also accounts for more than 6.6%. The delivery route optimization capability improves delivery efficiency in special emergencies and is of great significance in ensuring the safety of delivery personnel. Among the indicators, the weight of processing and packaging emergency capabilities accounted for about 6.5% of the total, accounting for a considerable proportion. This is because, in emergencies, the usual processing methods cannot meet the emergency requirements for logistics. For example, in the COVID-19 outbreak, fresh agricultural products e-commerce companies in Wuhan sell fresh agricultural products in bulk package, canceling the sale of individual products, thereby meeting the needs of many consumers in special periods and saving manpower, material resources, and financial resources.

4.2.3. Storage processing capacity

The weight of the coordinated operation capability index of cold chain transportation equipment also occupies about 6.5%, which is mainly restricted by the characteristics of fresh agricultural products. This indicator guarantees the freshness of commodities upon customer receipt. Meanwhile, fresh produce warehouse storage capacity index and the demand matching capacity index of the disaster area account for about 5.3% and 5.5% of the total weights, respectively. This shows that the cold chain storage area and infrastructure also account for a large proportion of the emergency logistics capacity evaluation.

4.2.4. Supply chain information management capabilities

For the supply chain information management capabilities, real-time information sharing capabilities account for the highest proportion, which is 7.1%. This shows that enterprises, university experts, and scholars believe in the importance of real-time information sharing in the unified supply chain during the occurrence of public health incidents, which will help enterprises with the management of inventory and shortcomings. Next, the proportion of emergency early warning capability indicators also accounted for 6.11%, implying the enterprises' responsibility and obligation to carry out an emergency early warning to all nodes of the supply chain according to the established emergency logistics plan. This will also ensure full preparedness of emergency logistics operations of fresh agricultural products. At the same time, the indicators of supply chain information collection and operation service promotion capabilities also accounted for 5.18% and 3.65%, respectively. Supply chain information is always essential to e-commerce companies for fresh agricultural products.

5. Discussion

5.1. Improvement plan

The company scoring range is obtained from the weight of each indicator calculated by the entropy method and the scores given by 12 e-commerce managers and logistics experts for fresh agricultural products in Wuhan, China. According to calculations, the actual scores of the emergency logistics capacity of this e-commerce enterprise in Wuhan range from 63.15 to 71.86, implying a relatively low and good level. This article conjectures the necessity to propose an emergency logistics improvement plan for fresh agricultural products to improve the logistics capabilities of Chinese enterprises for fresh agricultural products during emergency.

5.1.1. Emergency logistics plan for fresh agricultural products

E-commerce companies need to establish emergency logistics work plans based on past public health emergencies and respond to various future public health events. Moreover, these companies should draft operation plan for logistics under the jurisdiction of each department, such as the

transportation, delivery, warehousing, purchasing, and e-commerce operation departments. During the occurrence of public health emergencies, emergency logistics operations should be implemented step by step.

5.1.2. Linkage mechanism

E-commerce enterprises for fresh agricultural products can quickly control the spread of epidemics only by maintaining close cooperation with the government and sharing intelligence resources with government agencies. For instance, during the COVID-19 outbreak Wuhan, China, the government took strict measures to close all exits from Wuhan. Moreover, fresh food e-commerce companies utilized the "green channels" opened by local government agencies to ensure a continuous supply of fresh agricultural products in the fight against the pandemic. This enables local citizens to effectively implement home isolation, cut off the source of infection, and successfully control the epidemic within a certain period. Therefore, strengthening the cooperation and linkage between fresh food e-commerce enterprises and government agencies for the emergency logistics operation can enhance enterprises' competitiveness.

5.1.3. Intelligent logistics technology

Improving the level of smart logistics technology can effectively improve the emergency logistics capabilities of fresh agricultural products e-commerce. Avoiding direct contact with people can effectively cut off the route of virus transmission. For the last mile delivery of fresh agricultural products, intelligent logistics technology is used to reduce the direct contact between logistics courier and customers, which can not only accomplish the delivery task in an emergency environment but also effectively protect the lives of people. Intelligent logistics equipment represented by unmanned automatic delivery vehicles and drone automatic sorting has highlighted its advantages in improving logistics efficiency and reducing personnel cross-infection. This is of great significance for improving emergency logistics support capabilities in public health emergency cases and major natural disasters. Moreover, it has a profound impact on improving the overall quality and efficiency of the logistics industry.

5.1.4. Emergency logistics education

At present, personnel training for emergency logistics has not yet entered the right track. E-commerce companies for fresh agricultural products need to develop such training based on the characteristics of fresh agricultural products and various emergencies. The training can ensure smooth implementation of emergency logistics in all aspects. Well-trained personnel is not only capable of handling the general logistics business for agri-products but also possess scientific knowledge to implement emergency logistics response. E-commerce companies can effectively carry out targeted training and cooperation, offer emergency logistics courses, increase scientific research input, and improve the level of scientific research on emergency logistics for agricultural products.

5.1.5. The last one mile

When the epidemic broke out in Wuhan, local e-commerce enterprises of agricultural products and social organizations extensively cooperated, which promoted the rapid elimination of the epidemic in Wuhan. Therefore, the promotion of non-governmental cooperation should also be included in the scope of emergency logistics. Moreover, the participation of non-governmental organizations with a logistics professional background must be increased and complement with official resources. Furthermore, their respective strengths must be acknowledged, and they should better adapt to the urgency and diversity of emergency logistics needs. Also, it is necessary to strengthen cooperation with private professional logistics companies and effectively utilize social logistics resources and promotional material delivery and optimize the delivery network. In order to improve the ability of private professional organizations in dealing with emergencies, the usual targeted training and drills must be strengthened.

5.1.6. Emergence service

E-commerce companies face the huge risk of supply chain logistics rupture from suppliers during emergency public health incidents. The rupture of logistics means that fresh agricultural products from source companies will be unsalable. Not only will companies run out of inventory, but also customers in the disaster area will not be guaranteed fresh farm products. As a solution, companies must open emergency logistics services online via the Internet or the emergency logistics system. This method ensures the smooth flow of emergency supplies in all links. E-commerce companies for fresh agricultural products can also take this opportunity to provide emergency logistics, Internet sales, processing and warehousing, and emergency delivery services to other agricultural source companies in the society.

5.2. Practical implications and Limitations

Our research has enriched the research in the field of emergency physical distribution under disaster conditions in the fresh produce supply chain. In order to prevent the interruption of the agricultural product supply chain in an emergency situation, we have made contributions to the construction of the flexibility and regeneration capacity of supply chain logistics. Our research has established a framework for emergency logistics capabilities under emergency disasters (such as the covid-19 pandemic). In

order to cope with various emergencies in the future, online retail supply chain managers can build enterprise emergency logistics capabilities based on our research results.

Although this article established a framework for emergency logistics capabilities for online retailers of fresh produce, the research area of this article is mainly concentrated in Wuhan, the most severely affected area in China. The regional and cultural differences are not ruled out. In the future, we will stand from the perspective of the global supply chain to study the logistics capacity building of the global fresh agricultural product supply chain in emergencies such as the pandemic (COVID-19) and discuss how to maintain a flexible global supply chain emergency physical distribution capacity.

6. Conclusion

After collecting and sorting out a large number of logistics cases related to fresh agricultural product e-commerce enterprise in Wuhan during the COVID-19 pandemic and related supply chain papers, this study established an evaluation index system of the logistics capability of e-commerce enterprise for fresh agricultural products. First, we searched and established a research database using questionnaires, combined exploratory factor analysis and entropy methods for an evaluation model of e-commerce agri-enterprises' emergency logistics capabilities, and calculated the weights of emergency logistics evaluation indicators. The research results are more objective than other research methods. This paper makes a detailed analysis of the results and proposes an improvement plan for the emergency logistics for e-commerce agri-enterprises based on the case. Moreover, this study provides methods and theoretical basis for e-commerce business managers to improve their emergency logistics capabilities. Under major public health incidents, e-commerce business managers can make full use of their corporate advantages to fight the epidemic with government agencies and protect human life. The system evaluation model also provides a reference for system evaluation research and decision analysis in other fields.

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Appendixes

Appendix 1: Expert evaluation score

	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}	X_{16}	X_{17}	X_{18}
a	68	50	59	64	48	76	52	45	68	80	87	66	70	54	74	60	66
b	76	44	76	88	65	77	66	52	74	46	78	66	42	43	31	76	50
c	66	80	43	66	54	56	74	60	51	59	53	86	68	72	84	59	72
d	73	57	83	60	53	51	68	81	61	61	72	64	50	54	71	51	58
e	61	40	67	75	46	56	44	78	58	83	66	73	60	67	83	62	68
f	62	75	56	68	81	64	85	39	59	80	45	73	64	84	67	52	62
g	58	80	68	88	72	78	61	37	73	65	82	89	44	54	81	43	70
h	75	82	61	83	37	67	81	61	53	72	60	87	66	60	81	42	68
i	31	69	41	49	71	70	63	79	67	37	62	81	59	72	81	78	53
j	64	51	85	66	69	65	74	52	73	69	81	59	54	63	82	68	58
k	81	69	54	81	65	47	75	89	68	84	67	81	68	57	82	74	72