

# Research on Emergency Supply Chain Collaborative Management During the COVID-19 Pandemic

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**Keywords:** Supply Chain Management, Emergency Supply Chain, Collaborative Management.

**Abstract:** In order to improve the capacity of the national emergency supply chain in the context of COVID-19, this paper will analyze the current situation of the emergency supply chain, proposes horizontal and vertical coordination of collaborative management, analyze the causes of the shortage of emergency medical supplies and put forward corresponding policy suggestions. These reasons include insufficient capacity on the supply side of the supplies, imbalance in the situation on the demand side of the supplies, numerous obstacles in the transportation of the supplies, poor professionalism in the storage points of the supplies, and poor collaboration in the supply chain as a whole, etc. In response to these problems, it is proposed to exchange information between the supply side and the demand side of the supply chain through horizontal collaborative management to reduce the bullwhip effect as well as reduce logistics and transportation time. It also proposes to improve the ability of the material raising end through vertical collaborative management, and at the same time borrow emerging logistics enterprises to improve logistics efficiency. Based on the supply chain theory, this study elaborates the operation process from the perspective of the overall management of the emergency material security system in the context of public health emergencies, identifies the causes of the poor operation of the emergency medical material supply chain, and puts forward targeted policy recommendations to improve the management of emergency medical materials in public health emergencies in China, so as to provide reference for the establishment of a sound public health system in China.

## 1. Introduction

### 1.1 Background

Since the COVID-19 outbreak in 2019, the capacity of emergency supply chains in countries around the world has been significantly tested across industries. When emergencies occur, how to produce emergency supplies quickly and efficiently to reach the groups in need and minimize losses is a question that every country needs to think about [1]. And after a major disaster, the government's active implementation of mobilization policies can greatly increase the production capacity of emergency goods [2]. To address the current crisis, the solutions chosen by many countries to deal with this outbreak are lockdown strategies, regional quarantine, and household isolation, which ensure the normal functioning of the health system during epidemic prevention and significantly reduce the incidence of COVID-19 [3]. This method is effective but leads to shortages of medical supplies and basic necessities in hard-hit areas. Since the ability to dispatch supplies has a decisive impact on emergency relief during an emergency [4], active national regulation is required to ensure the supply of basic necessities and medical supplies in the areas where the epidemic occurs. However, the mobilization of national supplies to support the epidemic area at the fastest speed, due to the large sudden demand, the imperfect emergency logistics management system, and the emergency supply chain is faced with uncertain events, as manifested in the time and place of the event, the type of event, the scale of impact, etc. are not known in advance, may result in a large fluctuation in the match between supply and demand differences [5], leading to the lack of supplies such as masks and disinfectant, occurred not only in the epidemic area but also throughout the

country. If supplies are needed from abroad one needs to consider the significant risk of re-importation of the virus from overseas, Leung K (2020) et al. used an infectious disease model to estimate the potential impact of deregulation to predict a possible second wave of infection and the results showed that interventions cannot be relaxed and surveillance has to be strengthened to achieve an optimal balance between health and economic protection [6]. Thus many industries that have long relied on imports are experiencing supply barriers at particular times. These barriers constantly affect the development of the supply chain and may have a butterfly effect in the case of unexpected public health events.

### **1.2 Current status of research**

Since Stren Glud Johansen and Anders Thorstenson (1998) proposed a warehouse model for emergency supply chains and contingency supply chains [7]. In the context of the SARS epidemic, Amy Z. Zeng (2004) developed a supply chain supply risk decision model to reduce supply uncertainty by using a decision tree approach [8]. Wilson (2006) used a system dynamics approach to analyze the advantages of the VMI model in coping with uncertainty risk in order to improve the efficiency of the supply chain during emergencies. This literature explains the ability of emergency supply chains to cope with uncertainty [9].

Gong Ying (2009) analyzed the characteristics of the relief emergency supply chain in the face of natural disasters and proposed a phased strategy [10]. Fan Bo et al. (2019) argued that emergency intelligence systems should draw on corporate supply chain theory for the relief and disposal of disaster events [11]. Li Ning (2020) used collaborative management theory to eliminate supply chain disjointedness using planning, information logistics and standardization [12]. These studies focus more on introducing theories to analyze various aspects of the emergency supply chain to solve emergency supply chain management problems.

### **1.3 Objectives and significance of research**

According to the relevant definition given by the United Nations (UNJLC, 2008), the emergency supply chain includes: moving people, raising, storing and moving large volumes of suitable materials, coordination and sharing of limited transportation capacity, and specific delivery of materials from outside the affected area [13]. In the critical moment of the COVID-19 outbreak in 2020, the lack of a perfect emergency logistics management system and the failure to quickly establish a unified dispatch and coordination mechanism for emergency logistics and supply chain led to a broken chain in the supply chain and a shortage of emergency supplies, which put tremendous pressure on health care workers and made it difficult to effectively control the epidemic. With the development of human society, the damage brought by emergencies to human society far exceeds that of the war years [14]. Therefore, this paper takes the new crown epidemic as the background, based on the discussion of the meaning of emergency logistics and then analyzes the management of the emergency supply chain, in order to improve the emergency response capability, improve the emergency management system and provide reference for resuming work and production in the post-epidemic era.

### **1.4 Structure of this paper**

The first part of mainly introduces the current situation of the research on emergency logistics at home and abroad and the research significance of the article. The second part mainly introduces the main contents and methods of the study. The third part elaborates the current situation of emergency logistics management in the context of the COVID-19 and analyzes the emerged problems. The fourth part summarizes the whole article.

## **2. Method**

In order to study the emergency supply chain, this paper adopts scientific research methods, including literature analysis methods, and quantitative analysis method. At the same time, based on

these research methods, this paper designs a research technical route based on the emergency supply chain, as follows:

## 2.1 Research Method

### 2.1.1 Literature analysis method

This method takes emergency logistics and supply chain management as the guidance, and summarizes the research on relevant theories in emergency response at home and abroad, so as to prove the current research status of emergency supply chain.

### 2.1.2 Quantitative analysis method

This method uses trend analysis and comparative analysis of the data of the poor emergency supplies, and compares and describes the changing characteristics and interrelationships of the emergency supplies in terms of quantity.

## 2.2 Emergency supply chain evaluation index

The evaluation indicators of the emergency supply chain should have the following aspects. The first is the degree of impact on emergencies, the second is the performance of the emergency supply chain itself, the third is the security of the emergency organization, the fourth is the completeness of the emergency information system, the fifth is the reliability of the emergency supply chain operation process, and the sixth is the agility of the emergency supply chain. Evaluate the emergency supply chain based on these six aspects [15].

## 2.3 Research flow Chart

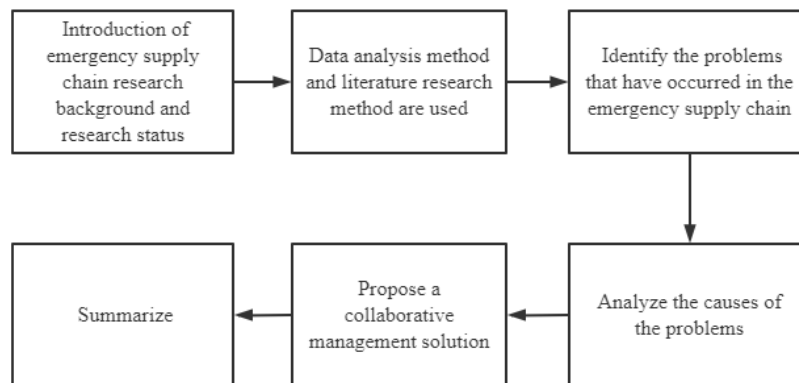


Figure 1. Research flow chart

As shown in Figure 1, the first step is to introduce the research background and current status of the research, through reading literature and experience to understand the background of the epidemic situation, and analyze domestic and international literature to understand the current status of research on emergency logistics. Secondly, the data analysis method and literature research method are used to analyze and understand the data and cases. The third presents the supply chain problems found during the epidemic. Fourthly, the causes of the problems are analyzed. The fifth proposes to solve the problem through collaborative management theory. Sixth conclude the whole paper.

## 2.4 Data and Cases

### 2.4.1 Data

In order to conduct this study, this paper needs to obtain relevant data for analysis. Figure 1 shows the data of medical mask production value obtained through Xinhua.com and Figure 2 shows the data of medical mask price obtained through Fortune.com.

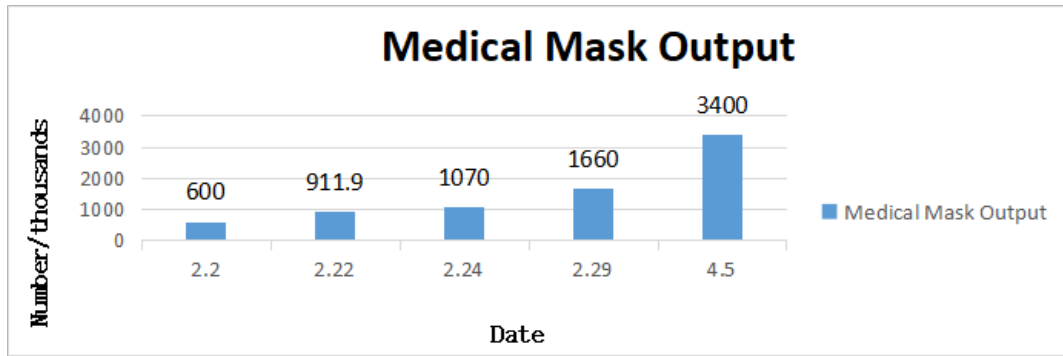


Figure 2. Medical Mask Output Graph

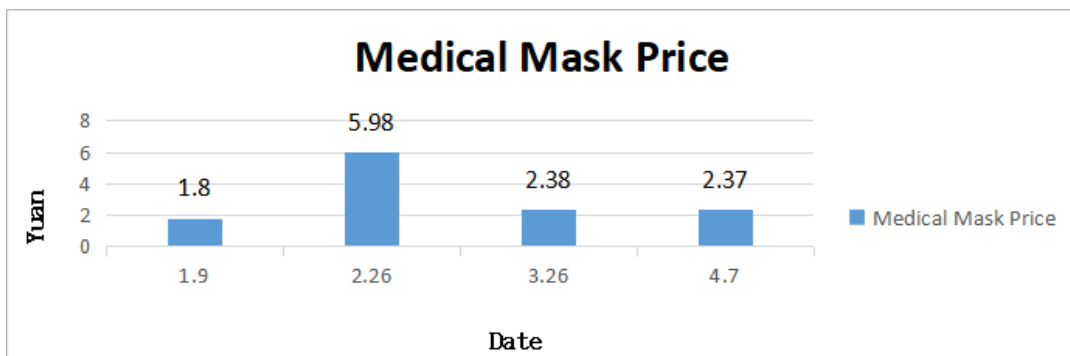


Figure 3. Medical Mask Price Graph

#### 2.4.2 Cases

According to the report of truck driver's home: many truck drivers went to Wuhan, Hubei during the epidemic, and the drivers suffered unfair treatment. According to a driver's disclosure, they were told that they needed to be quarantined before they could transport the materials again during the process of transporting emergency supplies many times, while many checkpoint interrogated the drivers many times.

### 3. Results and Discussion

#### 3.1 Phenomenon

According to the medical mask production graph in Figure 2, we can learn that: in January or so the new crown epidemic began to break out, in February 2 the basic production of medical masks was 600,000 per day, while in 4.5 medical mask production only reached 3.4 million per day. It took 2 months for manufacturers to increase production to basically meet the demand for epidemic prevention, and there would be many more problems.

According to the medical mask price chart in Figure 3, the price of medical masks was 1.8 yuan per mask before the outbreak began, while the price of masks rose to 5.98 yuan after China issued an epidemic notification on February 20, seriously destroying the market balance, while the average price of each mask sold for 0.9 yuan in March 2020 was even lower than the cost price.

According to the report of the Case, there are many unreasonable behaviors in the process of transporting emergency supplies, which seriously affect the efficiency of transportation.

All the above examples have confirmed that there are many problems in the management of the emergency supply chain in the epidemic situation.

#### 3.2 Causes analysis

##### 3.2.1 Mismatch between supply side and demand side

The contradiction in the emergency supply chain first appears in the mismatch between supply side and demand side, where the materials produced on the supply side are not enough to meet the

demand side. The lack of capacity on the supply side is the primary problem in the emergency supply chain. At the beginning of the outbreak, it was winter and productivity was low, and it was dangerous for labor-intensive enterprises to start work during the outbreak and after the end of the outbreak. The simultaneous rise in prices of raw materials required for the production of emergency medical supplies, influenced by rising demand, can also lead to untimely output on the supply side.

Since many regions did not have enough experience before the epidemic started, many regions basically had no contingency plans, resulting in insufficient stocks of existing medical supplies, which made localities suffer great losses during the epidemic.

#### 3.2.2 The Problems at the logistics part

With the surge at the beginning of the supply chain corresponding to the pressure coming to the middle end of the supply chain which is the logistics segment, how to transfer supplies to the epidemic area in a short time and how to make the logistics system take on such a huge transfer of supplies in a short time became an urgent problem to solve.

There are two key points in the handling of emergency supplies, which are:

(1) Storage nodes. The problem of warehouses in emergency logistics is becoming more and more obvious. Many places lacked perfect storage areas when emergency supplies were received in the middle of the epidemic, leading to insufficient warehouses in hospitals and other medical locations to cope with the large amount of emergency supplies. The picking of emergency supplies that have arrived is also a big problem. The picking is basically done by untrained volunteers when the supplies arrive, resulting in low picking efficiency and poor accuracy.

(2) Transportation section. The first problem that appears in the transportation section is the transportation personnel. During the epidemic many public facilities stop working, while at the same time a large amount of supplies are transported by land, and the closure of some road transportation service rest areas will cause the transportation vehicles to be unable to refuel in time, leading to problems in the transportation of emergency supplies. Secondly, the choice of transportation nodes was also problematic in the process of transportation. In the pursuit of speedy short-haul transportation, distribution centers were responsible for centralizing and distributing supplies, but the lack of experience in emergency management resulted in many goods not being deployed to the desired locations in a timely manner. Finally in many places there is a confusion in the management of passes, and in times of severe epidemics many areas restrict the access of the population and will be checked in the transport of emergency supplies resulting in slow and inefficient transport.

#### 3.2.3 The problem of demand side

The problem of demand side is that the price of masks skyrocketed at the beginning of the epidemic and people got information about the epidemic leading to the masses getting into a 'purchasing frenzy', resulting in an increase in unreasonable demand. The people's eager demand for emergency supplies led to the increasing severity of the bullwhip effect. Limited by the unpredictability of public health emergencies and the degree of medical technology development, the demand side of the supplies often could not submit accurate demand in the first place, thus affecting the estimation and judgment of the real demand at the command point and the supply side, resulting in the demand for emergency medical supplies not being met in time. Secondly, the imperfect information system in many areas can cause untimely information exchange in many areas, resulting in the inability to obtain timely warnings of epidemics, which can make it impossible to get supplies in time when a disaster occurs.

### 3.3 Solution method

#### 3.3.1 Collaborate management concept

When encountering public health emergencies, the state has the most important responsibility, and it is of great benefit to provide solutions to problems from the national perspective. The concept of collaborate management can be adopted to control public health emergencies. The idea of collaborate management is to dispatch the forces of all parties and give full play to the effect of  $1+1>2$ . When applied to the emergency supply chain, it is a collaborate management form that

combines the forces of various parts in the supply chain, allocates them together from the overall situation.

#### 3.3.1.1 Overall collaboration (Vertical collaboration)

The supply side and demand side of the supply chain cooperate to improve the problems faced at present. It is an important step to improve the pressure at the production end by reducing the bullwhip effect. The transparency of data on the demand side can control the idea that illegal enterprises intend to make big money in times of crisis. Transparency of data can effectively reduce the price increase of raw materials and the price increase on the supply side from the root, and improve the enthusiasm of the supply side for production and provide the required emergency materials faster.

In order to strengthen management, emergency logistics centers can be set up in key areas to implement unified collection, storage, scheduling and distribution of medical materials; Under the concept of collaborate management, it can effectively reduce residents' panic and provide residents with matching emergency materials, which can not only reduce market chaos, but also reduce the pressure on the supply chain, and contribute to supporting areas with severe epidemic situation.

Under the basic transportation system, staffs of transportation often have to go through repeated safety inspections many times, which may result in a lot of time consumption. Collaborate management is also great for the promotion of logistics system. Under the concept of collaborate management, the time spent by staff of transportation in inspection and queuing can be greatly reduced by controlling the starting point, mid-end node and destination. Staff of transportation only need to go through one nucleic acid test to start driving and transportation. Due to the control of collaborate management, staff of transportation would not contact COVID-19 patients, so that they can reach their destinations safely and avoid repeated tests. Moreover, under the concept of collaborate management, there is a clear understanding of the number of vehicles to be arrived, and the number of unloading areas can be increased or decreased in real time at the destination, so as to achieve the purpose of zero waiting and zero queuing for transport vehicles.

#### 3.3.1.2 Individual collaboration (Horizontal Collaboration)

Nowadays, all kinds of public crises in the world, whether inducing factors or manifestations, have shown a trend of diversification and complexity, which gradually exceeds the scope of government's ability. When a crisis occurs, the joint action of the government and society would give full play to the leading role of the government and the strength of the people, and apply the advanced technology and relevant experience of social enterprises, which may greatly improve the level of emergency management.

In response to the crisis of COVID-19, with the help of private enterprises, the ability of emergency supply chain is greatly improved. In the stage of logistics transportation, integrating e-commerce or logistics distribution enterprises with supply chain-related service capabilities can greatly improve the material distribution capacity and the material transportation efficiency. In key links such as trunk transportation, terminal distribution and warehousing business of materials, qualified and intelligent third-party logistics companies can undertake and use their existing resources and existing service capabilities to help the distribution of materials.

It can also provide great assistance in times of crisis by establishing a fund-raising channel for emergency materials on the supply side, and making extensive use of the strength of the public to jointly raise materials. During the epidemic, many overseas Chinese actively contributed their strength. Consulates of various countries are actively preparing materials and making great contributions to epidemic prevention.

#### 3.3.2 Application of emerging technologies

Material distribution during the epidemic period pushed unmanned logistics to a new height. The "White Paper on Standardization Requirements of Autopilot Logistics Vehicles" issued in March 2020 puts forward the standard system of Autopilot Logistics Vehicles and the suggestion of formulating a road map. At present, Wuhan Optics Valley Zhilian Co., Ltd. has built an automatic driving platform with a total length of 13.4m and tested intelligent networked vehicles. Based on the continuous progress of lidar technology, the support of many national departments and the efforts of

a large number of researchers, the automatic driving technology will usher in rapid development, and unmanned logistics will have a promising future.

The development of driverless technology makes people see the possibility of logistics industry in the future, and it is also huge for the promotion of emergency logistics. After the popularization of driverless technology, the risk of emergency supply chain will be greatly reduced, and the epidemic situation can be effectively prevented from being transmitted through the supply chain without people driving on vehicles.

#### 4. Conclusion

COVID-19 is a major public health emergency, and dealing with public health emergencies is a complex project. Ensuring the supply of relief materials is related to people's lives and a major issue in stabilizing social order. Emergency logistics is an important support to deal with public health emergencies, and adequate material reserve and supply is an important guarantee to successfully fight against the epidemic. It has important theoretical and practical value on exploring how to have a high-level emergency logistics system. Facing the threat of COVID-19, adopting the theory of collaborate management can effectively integrate the strength of the country. Horizontal coordination can increase the epidemic prevention force, while vertical integration can effectively improve the efficiency, and the combination of the two can greatly improve the ability to solve the epidemic situation. In the future, emergency logistics system can combine advanced technologies such as unmanned driving, artificial intelligence and 5G system to prepare for the next crisis.

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