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The Mechanism of Distribution Effectiveness of Territory Emergency Public Storage Materials

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Abstract: The effective distribution of public storage materials is the key to realizing rapid and accurate rescue of territories, which could truly solve the "last kilometer" problem of emergency rescue. At present, it is relatively rare to study the rapid and accurate distribution of emergency supplies by taking demand forecasts, emergency reserves, and distribution models as an organic whole. In view of the bottleneck of rapid and accurate rescue in the complex disaster environment, this paper selects various means such as field research, literature retrieval, and previous case analysis and uses the system analysis method. Next, this paper explains that the three main factors that affect the distribution of public storage materials are the demand of "black box", the scarcity of materials, and the blindness of distribution and constructs an effective analysis framework of demand predictability, material availability, and distribution accuracy. Finally, this paper puts forward the triangle structure framework of demand forecasting, virtual public storage, and comprehensive distribution and further explains the triangle structure relationship, operation mechanism, and operation strategy of effective distribution of public storage materials.

Keywords: territory emergency; public storage materials; distribution; effectiveness mechanism; last kilometer

1. Introduction

In recent years, the frequency of natural disasters in China has been significantly higher than usual, and the scale has been wider. These natural disasters have caused great loss to the country. After the disaster, emergency rescue faces the harsh environment of a demanding "black box", scarce resources [1], and damaged transportation roads, forming a "vacuum" state of on-site rescue. The research shows that the death toll increases rapidly within 24 h after the disaster, reaching the maximum within 8 to 16 h [2]. This means that emergency rescue must fill the vacuum of rescue as quickly as possible, quickly deliver materials to the disaster area [3], and save lives to the greatest extent possible. It has been proposed that the requirements of the scientificity, rapidity, and precision of the emergency rescue should be set higher in a severe disaster environment. The disaster relief "last kilometer" problem and implementation of fast and accurate rescuing become the key issues that have to be resolved. In order to solve the problem, the national general emergency plan for public emergencies have proposed that territorial management should be the main way to respond and resolve issues quickly. The United States Federal Emergency Management Agency has proposed an on-site emergency command system that does not rely on rear rescue, which can achieve early rapid response and implement on-site emergency disposal [4,5]. Most scholars study emergency material allocation based on demand forecasting. Xu [6] used a BackPropagation neural network to

predict emergency material demand and then established an emergency material allocation model. Pang [7] first used a BackPropagation neural network to predict the demand for emergency materials and established an emergency material distribution model consisting of emergency material supply points, transit points, and disaster points. Mohammadi [8] used the method of system engineering to predict the emergency material demand after an earthquake disaster and established a scientific and effective model and method of emergency material distribution. A few scholars have studied emergency material allocation based on reserve location. Ma [9] explored the selection of multiple temporary rescue centers near the disaster area and analyzed the optimization of emergency material allocation. Ge [10] and Paul [11] studied the location-allocation model of pre-disaster emergency material reserve.

In summary, in the past practice of emergency area, China has made some achievements in rapid and accurate rescue but, at present, it is relatively rare to study the rapid and accurate distribution of emergency supplies by taking demand forecasts, emergency reserves, and distribution models as an organic whole. This paper does not rely on external terrestrial emergency rescue modes to solve the bottleneck problem of fast and accurate emergency rescue on-site in complex environments [12]. This paper analyzes the factors that affect the effectiveness of emergency delivery in territories, constructs an effective analysis frame and a triangular structure frame, and provides a theoretical basis for solving the "last kilometer" problem of rapid and accurate rescue.

2. Connotations of Public Storage Materials Distribution

The distribution of public storage materials refers to the process of public reserve allocation. After an emergency, before the rear emergency materials are delivered to the disaster area, the emergency materials stored in a decentralized way will be distributed to the disaster affected areas in the shortest time.

Compared with general emergency material distribution, public storage material distribution has the following characteristics:

(1) Quick Response

Explained from three aspects: First, from the perspective of distance, public storage materials are stored in the disaster area and the nearest location; second, from the perspective of deployment process, after the disaster, the commanders in the disaster area can directly transfer materials from the public storage sites to the disaster sites according to the reserve agreement, which reduces the transfer process; third, from the information platform point of view, usually the public storage materials use the information platform to achieve unified management and information sharing. After the disaster, we can immediately use the information platform to quickly select the public storage sites that meet the needs of the disaster area for material distribution.

(2) Single Distribution Subject

The main body of national emergency material distribution includes civil administration, water conservancy, sanitation, transportation and other national and provincial emergency management departments, and non-governmental organizations such as the Red Cross, the Charity Federation, and other popular organizations. The only management body of the emergency command platform at all levels is the emergency coordination command center. After the disaster, the local emergency coordination command center predicts the demand for emergency materials, allocates the surrounding public storage materials according to the demand, and feeds back the disaster situation and demand to the upper level emergency coordination command center in time, and the upper level center allocates the rear emergency materials and transports them to the disaster area as quickly as possible.

According to the characteristics of the public storage materials and the requirements of emergency rescue after the disaster, the distribution of public storage materials should follow the following main principles:

(1) Non Dependence

After the disaster, a large number of relief supplies in the rear are not able to reach the disaster area immediately [13]. It is necessary to make full use of the public storage materials distributed and stored in the disaster area and the surrounding area to carry out early disposal to meet the needs of the disaster area [14]. Therefore, the principle of non-dependence should be followed in the management of the distribution of goods and materials.

(2) Rapidity

Rapidity is one of the main principles of public storage material distribution. Under normal circumstances, the public storage materials need to achieve unified management and information resource sharing through the information platform and establish a rapid emergency response mechanism. According to the predicted demand after the disaster, the emergency materials of the public storage sites are directly distributed to the disaster sites with the goal of minimizing time, while taking into consideration factors such as transportation means, road conditions, and outbound capacity. It is beneficial to reduce the intermediate links, shorten the transportation distance and time, and carry out early rescue in a timely manner.

(3) Accuracy

Accuracy refers to the accuracy of emergency material demand in the disaster area. The early stage of disaster relief is usually based on the demand forecast of the disaster area, which can avoid the waste of a large amount of relief materials and maximize the value of public storage materials. Therefore, it is necessary to obtain disaster information in a timely manner, perform demand forecasting based on the information, and provide a basis for the distribution of public supplies. At the same time, various factors affecting the delivery of emergency supplies must be considered to ensure the feasibility of the distribution plan and provide a guarantee for accurate rescue.

3. Triangle Structure of Public Storage Material Distribution

Public storage materials are a kind of civil society material, which are scattered and stored in the hands of different social owners such as various enterprises, e-commerce platforms, voluntary organizations, families [15], and individuals in the disaster area and the surrounding areas. Public storage materials use computers, communication networks, and other technologies to establish a wide range of social emergency material reserves through physical storage, enterprise storage [16–18], contracted storage, production capacity storage, and other storage methods [19,20]. That is the virtual emergency material reserve [21]. It does not appear after natural disasters but is a public reserve of materials that combines the needs of ordinary and emergency supplies [22,23]. In normal conditions, it is used as production management material, circulation material, family reserves, and consumer materials; in an emergency, it is used as emergency rescue material. By integrating the emergency supplies of different storage entities across the country, a large enough virtual warehouse can be established in the country to provide personalized emergency supplies for each disaster-stricken person.

The distribution of public storage materials is the key point for rapid and accurate rescue of the territory. By analyzing the main factors affecting the distribution of materials, an analysis framework for the effectiveness of distribution is proposed, and the triangular structure framework for distribution is further analyzed.

3.1. Main Factors Affecting the Distribution of Public Storage Materials

After the occurrence of a natural disaster, it is very difficult to organize the distribution of public storage materials in a series of links, such as material collection, packaging, ex-warehouse, and transportation, under the extremely harsh environment of some territories.

3.1.1. Demand for Black Box

Due to the suddenness and unpredictability of disasters, once a disaster occurs, road disruption and communication network paralysis cause the entire disaster area to lose contact with the outside world, and the needs of the disaster area are completely in a "black box" state. The emergency coordination command center cannot immediately accurately obtain the disaster area's disaster scope, damage degree, disaster situation change, or the number of victims. It is difficult to determine the type and quantity of emergency materials needed for rescue in the disaster area, resulting in a "black box", and they are unable to start rapid and accurate rescue. Therefore, quickly solving the black box problem of demand in the disaster area after the disaster and shortening the time of the black box of demand as much as possible are the prerequisites for the implementation of the effectiveness of public storage material allocation [24].

3.1.2. Material Scarcity

At present, China's emergency supplies reserve still has problems, such as unbalanced distribution, shortage of materials, and long distances from the disaster area, which makes it difficult to immediately meet the needs of the disaster area [25]. In the 2003 Kashgar earthquake in Xinjiang, due to the lack of emergency tent reserve points around the disaster area, it was only possible to transfer 6000 tents from Wuhan National Emergency Material Reserve Point to Xinjiang for five days. After the Wenchuan earthquake, all emergency tents in the state reserve were emptied within 48 h. After the Ministry of Civil Affairs raised funds through various channels, the entire requirement gap was as high as 800,000. The emergency rescue services neglected the emergency supplies stored in the public reserves of different owners. These materials lacked network and platform management, and they did not play the role of early emergency rescue after the disaster.

3.1.3. Distribution Blindness

After a natural disaster, roads are disrupted and communication networks paralyzed. Little data on the actual disaster situation are reported to the emergency coordination command center. During the rescue, only the experience of the rescue commander can be used to make material distribution decisions, and it is impossible to know the type and quantity of materials needed in the affected area. The distribution decision made by the decision maker based on his own experience and judgment can cause uneven distribution of materials. In some cases, a lot of unnecessary emergency supplies were sent, but those needed were not delivered and accurate relief could not be achieved, which reflects the blindness of distribution. In one case, due to the lack of overall considerations, after the formulation of the material distribution plan, the emergency materials could not be delivered in time and the road paralysis could not be prevented. This all reflects the blindness of emergency material distribution.

To sum up, in order to eliminate the influence of three major factors (the demand of black box, material scarcity, and distribution blindness) in the shortest time, solve the problem of rapid and accurate material distribution in the territory, and ensure the efficiency of emergency rescue, this paper proposes an analysis framework of the effectiveness of the distribution of local public storage materials.

3.2. An Analysis Framework for the Effectiveness of Public Storage Material Distribution

After a natural disaster occurs, the demand in the disaster area is often in a "black box" state, and the types and quantities of emergency supplies needed in the disaster area cannot be accurately obtained immediately. It is necessary to rely on new rapid disaster acquisition technology to ensure the predictability of the disaster area's demand [26]. After determining the quantity and type of emergency materials required at the disaster site, it is necessary to overcome the scarcity of emergency materials in the territory as soon as possible and search and find out whether there are emergency materials needed in the territory, where these emergency materials are stored, and whether they can be obtained quickly. Only when the spatial location of emergency materials is quickly obtained can blind material

distribution be avoided and the accuracy of material distribution at multiple disaster sites be achieved. For this reason, an analysis framework for the effectiveness of public storage material distribution is proposed, which includes demand predictability, material availability, and distribution accuracy, as shown in Figure 1.

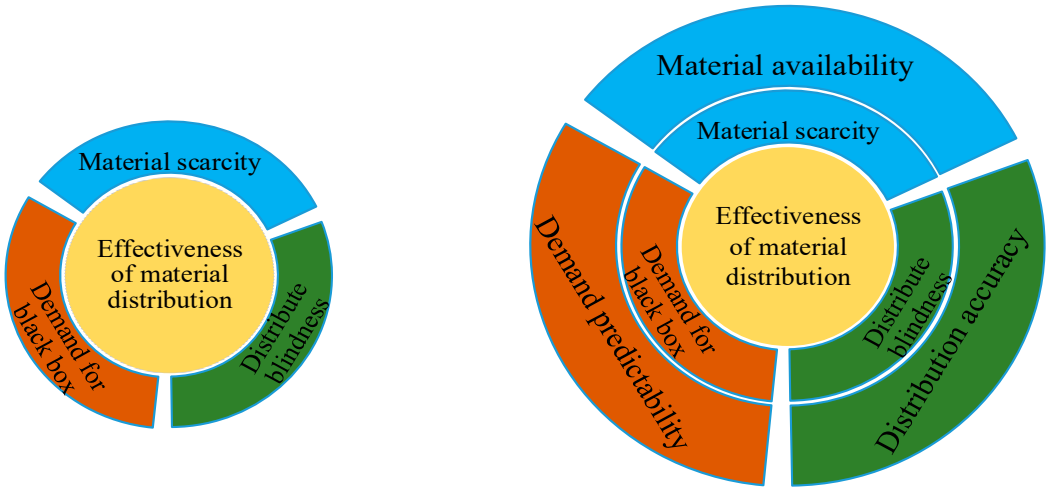


Figure 1. An analysis framework for the effectiveness of public storage material distribution.

3.2.1. Demand Predictability

After a disaster, time becomes the most precious factor in disaster relief. In the case of network paralysis and communication interruption, it is vital to quickly and accurately obtain the demand forecast information of the disaster area and then, according to the demand information, carry out the rescue as soon as possible to maximize the survival rate. It is the premise of rapid rescue to ensure that the demand can be predicted and to define the type and quantity of material demand.

3.2.2. Material Availability

The imbalance of the national emergency material reserve and the single type of reserve cause the phenomenon that no materials or emergency materials are emptied within a short time after disasters. Emergency material reserves are the guarantee of rapid rescue. Before disasters occur, it is necessary to make regular reserves of various emergency supplies. After the disaster, obtaining information on emergency material reserves as soon as possible is the key to fundamentally solving the problem of insufficient types and quantities of materials.

3.2.3. Distribution Accuracy

The information of major natural disasters is complex and changeable, and it is necessary to comprehensively consider various factors under the limited rescue time. To meet the emergency needs of the disaster area, a scientific and optimized distribution plan must be formed so as to achieve the accuracy of the distribution plan. After the implementation of the distribution plan, scientific rescue, accurate rescue, and accurate distribution of materials were achieved.

3.3. Triangle Structure Framework of Public Storage Material Distribution

Defining the type and quantity of materials through demand forecasting can effectively solve the black box problem of post-disaster demand. After determining the needs of the disaster area, it is important to search for emergency materials that can meet the needs of the disaster area to achieve the availability of materials after the disaster. It is necessary to establish a virtual public storage of territory emergency materials, use the comprehensive information platform [27], form a rapid response mode, and achieve rapid material acquisition. On the basis of demand determination and virtual public

storage point selection, a comprehensive scientific and optimized public storage material distribution model is established. This model considers all kinds of influencing factors of public storage material distribution, which can ensure that emergency materials can be delivered according to demand and realize material exhaustion and accurate distribution, as shown in Figure 2.

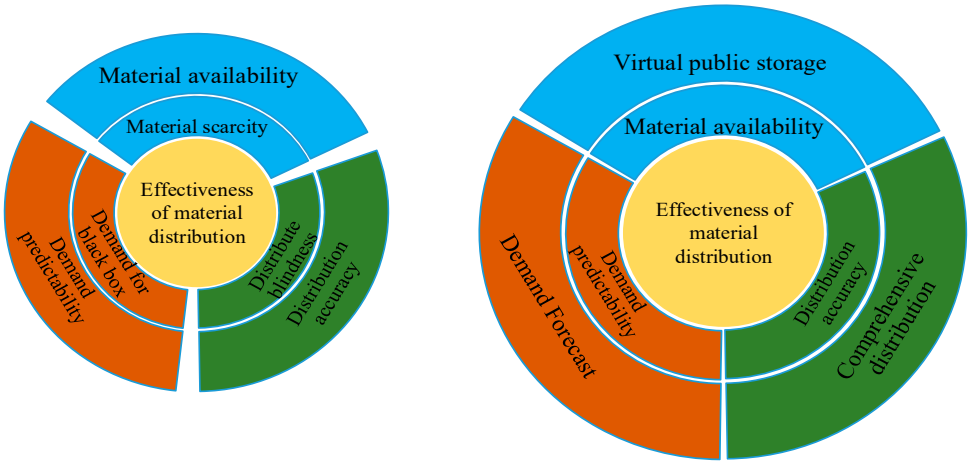


Figure 2. Triangle structure framework.

Defining the types of materials needed through demand forecasting is a prerequisite for the effectiveness of territorial emergency distribution. The rapid acquisition of materials through the virtual public reserve is the guarantee of effectiveness of emergency distribution of territories. Accurate distribution of supplies through comprehensive distribution is a fundamental way to achieve the effectiveness of emergency distribution of territories. These three constitute a triangular structure, as shown in Figure 3.

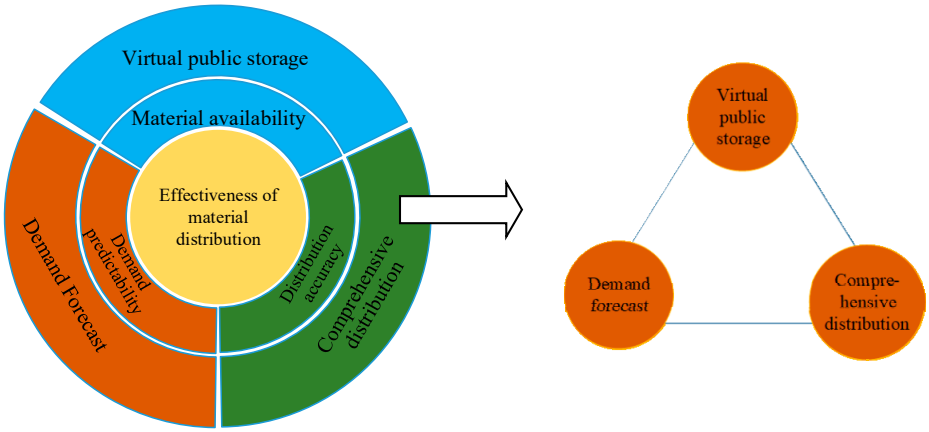


Figure 3. Triangle structure.

3.3.1. Demand Forecast

Demand forecasting is the fundamental premise for achieving rapid and accurate rescue, and it is the basis for rescue, disposal, and handling of all emergencies. Only by determining the needs of the disaster area in a timely and accurate manner can we really shorten the demand acquisition time, realize the predictability of demand, and provide data support for the selection of public storage sites and the distribution of comprehensive materials.

3.3.2. Virtual Public Storage

Virtual public storage is mainly intended to solve the problem of the rapid acquisition of materials. [28]. It makes full use of the emergency supplies of social public storage and forms a rapid response model by integrating information platforms through diversified and socialized storage methods. In a normal state, it realizes the unified management and dispatch of the territories of emergency supplies for emergency storage. In the emergency, it quickly searches for virtual emergency storage points that can meet the needs of rescue to ensure the availability of emergency supplies. This model can achieve the rapid acquisition of emergency supplies after a disaster and gain time for rapid rescue.

3.3.3. Comprehensive Distribution

Due to the uncertainty of disasters and the complexity of rescue, we need to consider the road conditions, the storage of emergency supplies, the capacity of the warehouse, the scheduling of transportation vehicles, the forecast of the demand, and the restrictions on road traffic and time in the disaster area. By constructing a virtual public storage emergency materials distribution model, an optimized distribution plan for emergency materials can be generated to solve the blind distribution problem, ensure the accuracy of emergency material distribution programs, and truly achieve precise rescue.

4. Triangular Structure Relationship and Operation Mechanism

4.1. Triangle Structure Relationship

There are three key factors involved: demand forecast, virtual public storage, and comprehensive distribution. The three elements are complementary and mutually restricting. Once there is a lack of any element in the whole, or any element fails to achieve its own goal, the other two elements will be restricted, and neither of them can achieve the goal of territorial rapid and accurate rescue. Even if the demand forecast obtains the demand of the disaster area, comprehensive distribution can guarantee the delivery of materials, but in the absence of virtual public storage, it cannot achieve the goal of territorial emergency rapid rescue.

The relationship between the three key factors is dynamic and changes according to different types of disaster, different locations, and different degrees of disaster. Therefore, the relationships and goals between the three factors are not exactly the same, but are dynamic; therefore, the relationship between the three factors should be managed in a dynamic way.

The three key factors are the optimal trade-off relationship. The worst or best overall does not depend on which factor reaches the lowest or highest state. Only when all factors give full play to their unique core functions in the territorial emergency can the overall optimum be achieved. A change of one of the factors will inevitably affect the change of the other two factors. In order to achieve the goal of rapid and accurate rescue of the territorial emergency, the three key factors need to be in a balanced state.

The triangle structure formed by the three key factors of demand forecasting, virtual public storage, and comprehensive distribution is an interconnected, mutually constrained, interactive, and indivisible whole. Only when the relationship between the three elements reaches the optimal state can the ultimate goal of territorial emergency be achieved.

4.2. Operation Process of Triangle System

The operation process of the triangle system is composed of three key factors: demand forecast, virtual public storage, and comprehensive distribution, as shown in Figure 4.

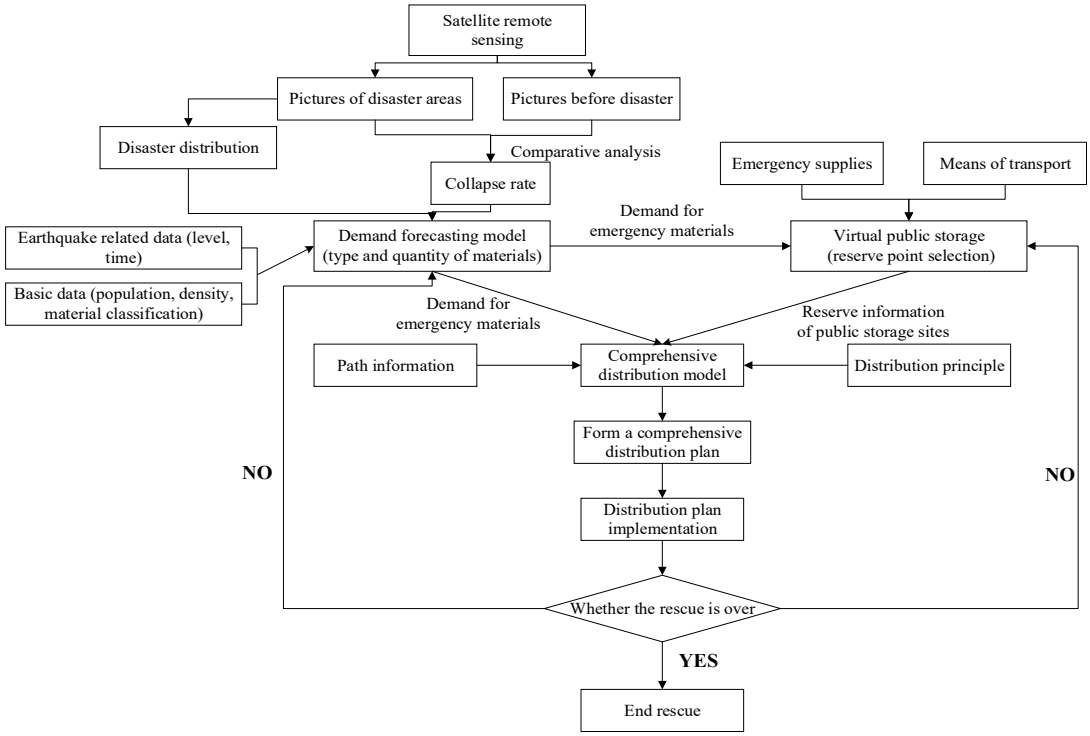


Figure 4. Operation process of triangle system.

4.2.1. Demand Forecast

After the disaster, satellite-remote-sensing, unmanned aerial vehicles, and individual equipment are used to collect disaster information through the establishment of an integrated space-earth information monitoring system. Combined with the basic data integrated before the disaster and fully considering the influencing factors of the post-disaster material demand, we have established a forecast model for emergency material demand. At present, there is a lot of research relating to the demand forecasting model. Taking into consideration the characteristics of prediction data, such as accessibility, real-time performance, rapidity, and quasi-determination, a comparative analysis is made on the existing scholars' research on the forecasting model. This paper selects the following models for the comparative analysis of the existing scholars' prediction models:

$$log_{10}^{RD} = 9.0RB^{0.1} - 10.07 \quad (1)$$

$$ND = f_p * f_t * RD * \mathrm{M} \quad (2)$$

RD refers to the death rate of people; RB refers to the collapse rate of houses (the ratio of the number of collapsed rooms to the total number of rooms or the ratio of the area of collapsed buildings to the total building area in a region); *ND* refers to the estimated death rate of people in a city or region; f_p refers to the population density correction factor for this area; f_t refers to the correction factor for the time of the earthquake; M is the total number of people in the city or region, and the number of people injured is generally 3–5 times the number of deaths. The information input to the prediction model includes basic data, post-disaster information collection, collapse rate, and distribution of the

disaster points. The prediction model of emergency material demand based on the classification of casualties [29,30] and emergency materials can be obtained as follows:

$$D_{\mathrm{jk}} = \begin{cases} Q_{\mathrm{km}} * \mathrm{SS}, \text{ Primary demand materials for life} \\ \mathrm{QV}_{\mathrm{km}} * \mathrm{SS} * T, \text{ Life cycle demand materials} \\ Q_{\mathrm{kh}} * (\mathrm{ZS\text{-}SW}), \text{ Primary demand materials for living} \\ \mathrm{QV}_{\mathrm{hk}} * (\mathrm{ZS\text{-}SW}) * T, \text{ Life Cycle Materials} \end{cases} \quad (3)$$

D_{jk} refers to the demand for the k-th material at the j-th disaster site; Q_{km} refers to the unit demand for primary life materials for a single injured population; QV_{km} refers to the unit demand for the life cycle materials of a single injured population; Q_{kh} refers to the unit demand for the primary living materials of a single living population; QV_{kh} refers to the unit demand of the living cycle materials for a single living population; T refers to the time of emergency material demand; SS refers to the number of injured people in the disaster area; ZS refers to the total number of people in the disaster area; and SW refers to the death toll in disaster area [31].

This model provides the basis and reference for the subsequent distribution of public storage materials, so as to launch rapid and accurate rescue.

4.2.2. Virtual Public Storage

After a disaster, the usually established virtual crowd storage platform is used to obtain the post-disaster crowd storage information as quickly as possible, and the information is aggregated on the emergency command platform to determine the situation of emergency supplies [32]. According to the needs of the disaster-stricken area, the public storage sites are selected, and the selected emergency storage sites are used for the emergency supplies. In this way, it can provide a basis for the optimized distribution of storage materials, improve the feasibility of the distribution of materials, and ensure that the storage materials can be delivered accurately and in a timely manner, truly achieving the goal of rapid rescue in terms of emergency materials.

4.2.3. Comprehensive Consideration of Material Distribution

Based on the basic principles of the allocation of public storage materials, the allocation of public storage materials should comprehensively consider the supply of materials, the type of transportation means, the limited time for receiving emergency materials at the disaster site, the minimum satisfaction rate of emergency materials, road interruptions, maximum road traffic, etc.

4.2.4. Formulation of Distribution Plan

According to the principle of distribution of mass storage materials, the construction of a comprehensive distribution model of territory emergency virtual public storage materials requires the combination of emergency big data and disaster forecasting emergency material demand information, public storage point selection information, and information on road assessment in the disaster areas. In accordance with the basic requirements of a national emergency, it is necessary to select a suitable model algorithm and make a practical emergency material distribution plan. This paper selects the following models:

$$\begin{aligned} \min \mathrm{TT} &= \sum_{i=1}^{m} \sum_{j=1}^{n} \sum_{k=1}^{z} \left(t_{\mathrm{ij}} + \mathrm{MT_{ik}} X_{\mathrm{ijk}} + \mathrm{HT_0} X_{\mathrm{ijk}}\right) \\ &= \sum_{i=1}^{m} \sum_{j=1}^{n} \sum_{k=1}^{z} \sum_{h=1}^{l} \left(\frac{\mathrm{Dis_{ijh}} R_{\mathrm{ij}}}{V_h Q_h} + MT_{\mathrm{ik}} X_{\mathrm{ijk}} + \mathrm{HT_0} X_{\mathrm{ijk}}\right) \end{aligned} \quad (4)$$

$$\begin{cases} \sum_{j=1}^{n} X_{\mathrm{ijk}} \le P_i S_{\mathrm{ik}} \\ \sum_{i=1}^{m} X_{\mathrm{ijk}} \le D_{\mathrm{jk}} \\ \sum_{k=1}^{z} X_{\mathrm{ijk}} \le U_{\mathrm{ij}} \\ \sum_{i=1}^{m} X_{\mathrm{ijk}} \ge e_k D_{\mathrm{jk}} \end{cases} \quad (5)$$

X_{ijk} refers to the number of "i", emergency supply points, allocated to category "k", emergency supplies in "j", the disaster areas; TT refers to the total time allocated for emergency supplies; $\mathrm{Dis}_{\mathrm{ijh}}$ refers to the distance between "i", the emergency supply point, and "h", type of transport at the "j" disaster point; HT_0 refers to the total time required for unit emergency supplies to be loaded and unloaded at supply point "i" and demand point "j"; $\mathrm{MT}_{\mathrm{ik}}$ refers to "i", the emergency supply point, and "k", emergency supplies out of storage capacity; R_{ij} refers to the road traffic between "i", the emergency supply point, and "j", the disaster point. V_h refers to the transport speed of the mode of transport, "h"; Q_h refers to whether the "h" mode of transport can be selected, and the choice of mode of transport shall be determined according to the type of natural disaster and the traffic conditions in the place where the disaster occurs; P_i refers to Whether emergency supplies can be normally supplied at "i", the emergency supply point; S_{ik} refers to the number of "k" types of emergency supplies available for distribution at "i", the emergency supply point; U_{ij} refers to maximum flow allowed from "i", the emergency supply point to "j", the disaster point, at the same time; D_{jk} refers to the demand for the *k*-th material at the *j*-th disaster site; e_{k} refers to the satisfaction rate of the "k" material.

4.2.5. Implementation of Distribution Plan

After the public storage materials distribution plan is determined, it enters the emergency implementation phase. This stage requires coordination and cooperation from multiple parties. In order to ensure the efficiency of the warehouse's materials delivery, we need to make full use of warehouse personnel, volunteers, and warehouse delivery equipment. When the public storage materials leave the warehouse, the delivery vehicles need to arrive at the designated place according to the prescribed time. The transportation of emergency materials requires the coordination of various departments such as meteorology, transportation, and the army. The emergency coordination and command center in the disaster area is the core to ensuring that the emergency materials are delivered to the disaster area in accordance with requirements.

After a completed emergency distribution process, the next stage of emergency material distribution is entered according to the latest information from the disaster relief feedback, and so on until the emergency rescue is over.

4.3. Triangular Validity Operation Strategy

In order to ensure the normal operation of the triangular structure, the strategies to ensure the effective operation of the triangular distribution of material reserves include:

4.3.1. Combination of Peacetime and Emergency

The combination of peacetime and emergency mainly refers to peacetime reserve and wartime (emergency) operation [13], as shown in Figure 5.

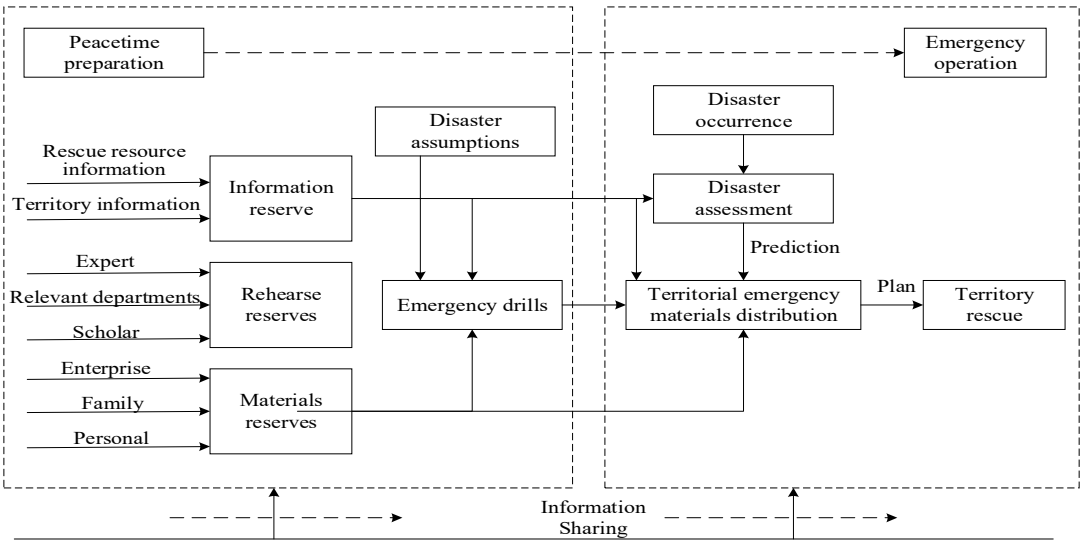


Figure 5. Combination of peacetime and emergency.

(1) Peacetime reserves

Before the disaster, the emergency storage work should be done from three aspects: material storage, information storage, and simulation exercise. In peacetime, it is necessary to sign emergency supply contracts with various enterprises, logistics parks, voluntary organizations, families, and individuals with reserve capacity, and to ensure a certain amount of emergency reserves under the premise of a normal circulation of enterprises. According to the principle of territorial management, it is necessary to make a pre-disaster reserve including basic information such as emergency personnel, vehicles, materials, population, area, and disaster relief capacity to ensure the accuracy and timeliness of disaster relief. Emergency drills are usually conducted in accordance with a predetermined rescue plan to form a rescue plan that is in line with the actual situation of disaster relief and can be successfully launched and implemented.

(2) Emergency operation

After the disaster, all the normal operating states will be terminated, and the emergency operating state will be immediately converted according to the emergency plan. In accordance with the emergency contract signed, the production enterprise will fully convert the existing production capacity into the production of supply emergency products to meet the needs of the rescue. All emergency transport personnel and transport vehicles will terminate their normal state, turn to emergency state according to the emergency requirements, and stand by.

4.3.2. Territory Rescue

Relevant national documents such as the "Emergency Response Law of the People's Republic of China" and other relevant documents clearly stipulate that China should establish a "territory-based" emergency management system. Based on the territories after the disaster, satellite images were obtained. Through comparative analysis with pre-disaster images [33], it is possible to obtain post-disaster dependency ratios and comprehensive data such as population density, time of earthquakes, and rescue capabilities in order to predict rescue needs in disaster areas and provide a basis for emergency rescue. According to the demand forecast information of the territories after the disaster, we can use the territories virtual public storage information platform to search for virtual public storage points that can meet needs and quickly obtain the storage information. Considering factors, a practical material distribution plan is formed to achieve rapid and accurate rescue in the territory.

4.3.3. Social Participation

It is necessary to make full use of social materials, make emergency preparations in advance, and realize the ability to transform the potential of social emergency before disasters into emergency response after disasters. A good social mobilization mechanism should be formed before the disaster occurs [34,35].

4.3.4. Comprehensive Optimization

The suddenness and complexity of disasters require comprehensive emergency rescue, which is mainly reflected in the following two aspects: First, the distribution of emergency supplies should consider the supply and demand of the disaster area. Second, after determining the supply, the integrated distribution model of virtual public storage materials should realize the precise distribution and rapid delivery of emergency materials.

4.4. Triangular Validity Operation Application

Based on the study of earthquakes in natural disasters, this paper proposes a triangle structure framework of public storage material distribution. The application of this framework can be directly applied to dependency emergency relief without relying on the rescue of rear emergency supplies, and the scope of application can be large or small, such as in villages, towns, counties, and cities. The theory of this structure can be extended to other natural disasters such as floods and typhoons, and it can even be applied to different types of emergencies, such as public health emergencies, accidents, and disasters. The premise of the application is that, according to different kinds of emergencies, the virtual crowd storage platform can be used to integrate the emergency supplies and transportation tools needed for rescue in peacetime. The principle is to obtain the data relating to the population in need of rescue, obtain the demand for emergency supplies, select the rescue point on the virtual public storage platform according to the demand, and form the distribution scheme by using the distribution model.

5. Conclusions

This paper studied the concept and characteristics of public emergency, public storage materials, and public storage material distribution. By analyzing the three main factors that affect the distribution of crowd sourced materials, namely the black box of demand, scarcity of materials, and blind distribution, this paper proposes an effective analysis framework of predictability of demand, availability of materials, and accuracy of distribution. This paper also constructs the triangle structure framework of public storage material distribution for demand forecasting, virtual public storage, and comprehensive distribution; expounds the relationship and operation process of the triangle structure; and describes the strategies of combining equalization and emergency, territorial rescue, social participation, and comprehensive optimization in the effective operation of the triangle.

In other emergencies, such as earthquake, flood, typhoon, or plague, the triangular structure can be applied to carry out rapid rescue by determining the number of people to be rescued, forecasting the demand for emergency supplies, selecting rescue points that meet the demand, and allocating supplies. In the future, we will focus on the comparative analysis of practical cases.

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