



Research on the Construction and Design of Emergency Material Mobilization Chain

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Abstract

To address the practical challenge of severe supply-demand imbalances for emergency supplies in highly uncertain emergencies, this paper systematically explores the construction and design of emergency supplies mobilization chains based on the extraordinary supply theory. First, it analyzes the dissipative structural properties of the emergency supplies support system as a complex system, pointing out that its core objective is to achieve dynamic supply-demand balance throughout its lifetime through the transition between normal and extraordinary supply. Second, it clarifies the concept and connotation of the emergency supplies mobilization chain, revealing its chain structure composed of the emergency supplies management chain and the emergency supplies supply chain through a two-layer flexible connection: the management chain is responsible for overall coordination and decision-making, while the supply chain undertakes the specific provision of emergency supplies tasks, and their interaction is the key to achieving stable extraordinary supply. Furthermore, it designs a “peacetime-emergency integration,

task-oriented” organizational architecture for the emergency supplies mobilization chain, proposing a multi-source redundant supply chain layout and a matrix collaborative management chain model, along with mechanisms for entity selection and dynamic adjustment. This research provides a new theoretical perspective and operational construction paradigm for improving the agility and reliability of emergency supplies support systems.

Keywords: extraordinary supply, emergency supplies supply chain, emergency supplies management chain, emergency supplies mobilization chain.

1 Introduction

In recent years, various emergencies have occurred frequently around the world, causing significant impacts within the region and even globally. For example, the freezing events in southern China in 2008 and the Wenchuan earthquake on May 12th; the 2010 Haiti earthquake and the aftermath of the aftershocks, the Chilean earthquake and tsunami; the global outbreak of COVID-19 in early 2020, etc. The range of impact and the speed of spread caused by various emergencies are far greater than ever before, and the traditional emergency supplies support system has become difficult to effectively cope with the surging and fluctuating demand for emergency supplies. Therefore, how to build an emergency supplies support system that suits China's national conditions is an important issue for improving



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China's emergency management level and ensuring the completion of emergency tasks.

The emergency supplies support system is an open and dynamic system involving multiple entities, and countries around the world have established corresponding emergency supplies support systems based on their national conditions. Fan [1] believed that emergency management is a complex, open, and large-scale systems engineering project. Cheng [2] optimized the "layered" emergency supplies support system in the direction of an "organism" characterized by efficiency, coordination, proactiveness and adaptability. Van Wassenhove [3] expounded on the importance of the market in the process of emergency supplies support. Kapucu [4] analyzed the structure of the U.S. emergency supplies management system, identified key factors for emergency supplies support, and emphasized the importance of collaboration in the process of emergency supplies management.

Research related to emergency supplies supply chains. The emergency supply chain is an essential component of emergency supplies support, and its efficiency directly affects the actual effect of emergency supplies support. Fiedrich et al. [5] explored that under the premise of limited resources, the effective utilization of emergency supplies can achieve better benefits. Xu et al. [6] constructed a BCM emergency supply chain system consisting of three parts: operational continuity planning, business continuity planning, and data acquisition and analysis system. Kovács and Spens [7] and Kunz and Gold [8] analyzed the composition of the emergency supplies supply chain. Mehrotra et al. [9] proposed a ventilator supply chain based on stochastic optimization model allocation and sharing. Singh et al. [10] established a PDS network simulation model to study disruptions and resilience in the food supply chain under three scenarios. Shu [11] used the "context-response" emergency decision-making model to study resource allocation services and optimal scheduling decisions in emergency supplies supply chains. Manopiniwes and Irohara [12] proposed a multi-objective stochastic optimization model for comprehensive decision-making before and after disasters, considering facility, inventory location and rescue vehicle planning in emergency logistics. Caunhye et al. [13] analyzed the binding characteristics of emergency supplies support and established and explained the whole-process model of emergency supplies supply. Özdamar et al. [14] established an objective function for minimizing the supply and demand deviation of emergency

supplies and studied the problem of minimizing transportation time. Jotshi et al. [15] attempted to establish a "robust" scheduling model and route by analyzing and simulating the relevant resources in the disaster area after the earthquake. Chen [16] designed a collaborative management framework for emergency supplies at the strategic, tactical and technical levels based on the characteristics of the demand for emergency supplies, and studied the collaborative mechanism of the emergency supplies supply chain from the perspectives of organization, process and information. Gong [17] used the NSGA-II algorithm to solve the multi-objective model of emergency supplies for multiple suppliers and manufacturers, and emphasized the importance of emergency production support. At present, scholars generally form a consensus that the emergency supply chain is an important component of emergency supplies support, and its efficiency directly affects the actual effect of emergency management, and attempt to construct the emergency supplies supply chain from a multi-objective perspective.

Research on disruptions in emergency supplies supply chains. Feng et al. [18] argue that the various stages of the supply chain disruption risk management process consist of four parts: disruption risk identification, assessment, implementation, and monitoring, and study strategies for mitigating supply chain disruption risks. Tang [19] believes that disruption risk is the disruption of emergency supplies caused by various unexpected events, which can be divided into major supply chain disruptions and minor supply chain disruptions. These disruptions may cause changes in supply chain parameters, including changes in start-up costs, changes in inventory holding costs, changes in productivity, changes in production costs, and changes in demand rates, etc. Ivanov [20] based on an analysis of supply shortages and costs, used discrete event simulation models to study supply chain exit strategies during the COVID-19 pandemic. Xanthopoulos et al. [21] constructed single-period inventory models under different service level constraints to describe decision-making strategies when there is a risk of disruption in the dual-source procurement supply chain network. Atasoy et al. [22] studied supply chain disruptions from an emergency management perspective, considering the inventory problem of manufacturers (or retailers) at non-stationary random supply service levels. Sawik [23] considered a customer-driven three-stage supply chain and addressed supply chain disruption

risk through a stochastic mixed integer programming approach. Fujimoto and Park [24] proposed that supplier fragility would cause supply chain disruptions and identified it from four dimensions: supplier concentration, risk, transferability, and substitutability. Schmitt and Snyder [25] designed multiple backup supplier supply chain models with individual supplier disruptions, random lead times, and additional stage state-related uncertainties. Tang and Tomlin [26] designed a single-cycle inventory model for short life-cycle products and explored ways such as supplier diversification, emergency procurement, and demand management to mitigate the risk of supplier disruption. Haijun et al. [27] proposed the concept of supply chain resilience and antecedent latent variables, and constructed a dynamic relationship model of supply chain resilience, dynamic capability, and competitiveness. Through literature review, it can be found that most of the existing supply chain disruption problems are based on the enterprise supply chain under normal conditions, and there are relatively few studies on the disruption of the emergency supplies supply chain under crisis conditions.

The emergency supplies supply chain is the foundation of emergency supplies support, a point on which academic consensus has been reached. Research in this area has gradually evolved from single-objective to multi-objective, from single-stage to whole-process, and from simple algorithms to complex algorithms. However, two core shortcomings remain in the existing literature. First, studies on supply chain disruptions have predominantly focused on risk prevention and control in routine commercial supply chains, overlooking the characteristics of the emergency supplies supply chain under the extreme conditions of various emergencies, such as sudden shifts in supply and demand, forced disruptions, and emergency restarts. Second, existing research has severed the linkage between the material-flow supply chain and the emergency management system. Most studies optimize emergency supply chain scheduling, inventory, and risk control models in isolation, and few have established the linkage logic between the management side and the supply side. This is the core motivation for proposing the concept of the emergency supplies mobilization chain in this paper.

The main contributions of this paper can be summarized as follows :

First, building on an analysis of the basic theory of

the emergency supplies support system, this paper systematically investigates the concept, connotation, and characteristics of the theory of extraordinary supply of emergency supplies, and constructs a theoretical framework for the extraordinary supply of emergency supplies. To a certain extent, this helps to distinguish the state of material supply under normal conditions from that under crisis conditions, thereby avoiding the confusion between market product supply behavior in normal times and emergency material supply behavior in times of crisis.

Second, this paper clarifies that the emergency supplies support system is composed of the emergency supplies supply chain and the emergency management chain flexibly linked together. It analyzes the different interactive modes of collaboration and dynamic adjustment between the emergency supplies supply chain and the emergency supplies management chain, and designs the emergency supplies mobilization chain by applying integrated and systematic thinking.

2 Basic Theory

Emergency supplies are important resources for responding to emergencies. The emergency supplies studied in this paper refer to all types of resources necessary in the process of pre-event preparation, in-event response and post-event recovery in order to effectively deal with all kinds of emergencies. The demand for emergency supplies has the following characteristics: uncertainty, that is, the time and place of the demand are difficult to predict, and the types and quantities vary depending on the type and stage of the event; timeliness: supplies must be delivered within a reasonable time, which is directly related to the safety of life and property; weak economy, with social benefits as the primary goal, taking into account economy within time constraints; at different stages, demand shows a pattern of being low before the event, high during the event with sharp fluctuations, and gradually stabilizing after the event. Therefore, the supply of emergency supplies must follow these characteristics and be coordinated and rhythmic. The industrial age emphasizes certainty and predictability in the development of things, but with the development of theory and practice, more and more scholars have recognized that uncertainty and nonlinearity are important components of the complex and dynamically changing real world, and a sound emergency supplies support system is the key guarantee for achieving emergency supplies supply.

First of all, the purpose of the emergency supplies

system is to achieve a balance between supply and demand of emergency supplies. The fundamental purpose and value of the emergency supplies system is to ensure the safety of people's lives and property by achieving a balance between supply and demand of emergency supplies. In the entire life cycle of emergency response, in the pre-event stage, the daily supply of emergency supplies is used to predict, prevent and prepare for possible emergencies, and in the event stage, the extraordinary supply of emergency supplies is used to rebalance supply and demand in the face of huge deviations caused by emergencies. In the post-event stage, the supply and demand of emergency supplies are restored to equilibrium through the shift from extraordinary supply to normal supply.

Secondly, the emergency supply system is a complex integrated system. The emergency supplies support system maintains stability by controlling the state, functions, behaviors, and evolving trends of its components. As a complex system composed of multiple entities that perform emergency supplies support duties throughout the entire process of emergency management, the various factors within the system interact with each other and must evolve the organizational structure and operation from disorder to order through means such as information support and coordinated operation, especially in the event of an emergency. To ensure that all elements within the emergency supplies support system are coordinated and effectively complete the task of emergency supplies support.

Again, the emergency supplies support system has typical dissipative structure characteristics. The emergency supplies support system has typical dissipative structure characteristics [28]. When an emergency occurs, the original balance of supply and demand of emergency supplies is disrupted, the emergency supply system under normal conditions is far from equilibrium, and the emergency supply system changes from normal to dangerous, that is, from equilibrium to far from equilibrium; drastic changes in the external environment lead to adjustments or reconstructions within the emergency supplies system, achieving a rebalancing of supply and demand through emergency supplies. During the realization of emergency supplies, the supply and demand of emergency supplies gradually shift from an unbalanced state to a balanced state, reaching a new equilibrium state; with the completion of emergency response, the demand for emergency supplies gradually decreases, the supply of emergency

supplies exceeds the demand, and the system moves away from equilibrium again. The emergency supplies support system achieves the transition from equilibrium to equilibrium again by adjusting the supply of emergency supplies.

3 Methodology

3.1 The Concept and Connotation of Extraordinary Supply of Emergency Supplies

In terms of the supply and demand relationship in economics, there are usually two development models in the process of social development: "demand-driven" and "capacity-driven". The former emphasizes planning the direction and pattern of social development, with the premise of clarifying social demands; the latter emphasizes capacity building, that is, starting from the supply side, in the case of unclear demand, based on the construction of various resource supply capacity to achieve the purpose of meeting demand. With the development of theory and practice, more and more scholars have come to recognize that when the social state undergoes drastic changes, social demand is difficult to predict and efforts need to be made from the supply side by enhancing the level of effective supply to achieve a balance between supply and demand of various social resources, that is, through extraordinary supply to achieve a rebalancing of supply and demand of social resources during drastic changes in the social state.

Extraordinary supply refers to a supply modality that, in times of drastic social change, mobilizes national economic resources from the supply side—through administrative intervention and market mechanisms—to restore balance between supply and demand of critical resources.

First, the implementation of extraordinary supply occurs amid dramatic changes in social conditions. Extraordinary supply is triggered neither by ordinarily low nor ordinarily high supply-demand levels, but rather by dramatic, sudden fluctuations in the balance. It is provided to meet the fluctuating demands that arise when the state of society undergoes a drastic change. Whether the social demand is at a relatively low or relatively high level, when the social state is in a stable development state, there is no need for extraordinary supply to meet the demand generated by the changes in the social state, and it still mainly relies on the market mechanism for regulation. In times of emergency or war, when the state of society undergoes a drastic change in a short period of time, and causes

a drastic fluctuation in the balance of supply and demand for various resources, extraordinary supply activity takes place.

Second, the driving force of extraordinary supply is the imbalance between supply and demand. Extraordinary supply occurs when the supply under normal conditions fails to meet the demand for resources under crisis. When an emergency occurs, the demand for resources surges relatively, and it is difficult to achieve a balance between supply and demand of resources under normal conditions, which may cause serious social consequences such as great personal injury and property loss. In order to effectively avoid serious social harm, it is necessary to meet the drastic fluctuations in demand through extraordinary supply.

Again, the object of the extraordinary supply effect is the socio-economic system. The extraordinary supply capacity did not arise out of thin air; it requires a real physical system as a support, namely a socio-economic system. Unlike normal supply behavior, which is mainly regulated by market mechanisms, extraordinary supply is achieved through the combined action of administrative means and market mechanisms on the socio-economic system, which places greater emphasis on the role of administrative means in the process of resource supply.

Ultimately, the goal of extraordinary supply is to rebalance the supply and demand of resources. The theory of extraordinary supply aims to achieve a supply capacity that exceeds the normal state, but the goal of extraordinary supply is not simply to provide more resources, but to meet the demand efficiently, rhythmically, economically through effective means of work, with neither insufficient supply nor excessive supply, but to achieve a stable and dynamic balance of supply and demand. While ensuring a stable supply of resources, economic factors should also be taken into account.

3.2 Characteristics of Extraordinary Supply

The theory of extraordinary supply is based on the current economic and social development situation in China and the context of supply-side structural reform to address the imbalance between supply and demand of various resources in a crisis situation. Extraordinary supply, unlike regular market supply, has its own characteristics such as safety, government leadership and intervention, dynamics and stability. The specific features are as follows.

First, safety features. The primary purpose of extraordinary supply is to meet the demand for sharp fluctuations that arise in times of crisis and to ensure the economic, social, cultural, ecological and other security levels of a country or region. Whether it is an emergency or a battle, the priority should be to ensure the safety of the public and the loss of property. If the demand for resources in a crisis cannot be met in a timely manner, it will cause great damage to the health of the people, the safety of property and the social environment. Extraordinary supply has the characteristic of a weak economy, that is, while ensuring extraordinary supply, economy also needs to be taken into account.

Second, characteristics of government dominance and intervention. The extraordinary supply activity differs from ordinary supply activities in that it is a supply activity regulated and interfered with by the government. In times of crisis, the demand for emergency resources surges, and it is difficult to meet the demand for extraordinary supplies by relying solely on market forces. At such times, the government needs to achieve extraordinary supply through administrative intervention, market regulation and other means, depending on the nature of the task and the characteristics of the demand. Some of the supply activities for resource demand during the 2008 Wenchuan earthquake and the outbreak of COVID-19 outbreak in early 2020 were led by the government.

Third, dynamic features. Extraordinary supply is a dynamic process. The realization of extraordinary supply is extremely dynamic and is mainly influenced by both external and internal environments. First, the external influences are mainly in two directions. One is that the demand for emergency supplies is constantly generated and changing due to the characteristics of the occurrence and evolution of various emergencies themselves; the demand for emergency supplies is regularly generated and changed; both scenarios require the extraordinary supply system to dynamically adjust to the changes in resource demand caused by the external environment due to the disruption of some supply capacity caused by an emergency. Second, the internal environmental effects are mainly due to the dynamic changes within the extraordinary supply system caused by factors such as its response life cycle, task allocation, and conflict coordination.

Fourth, stability characteristics. In order to respond

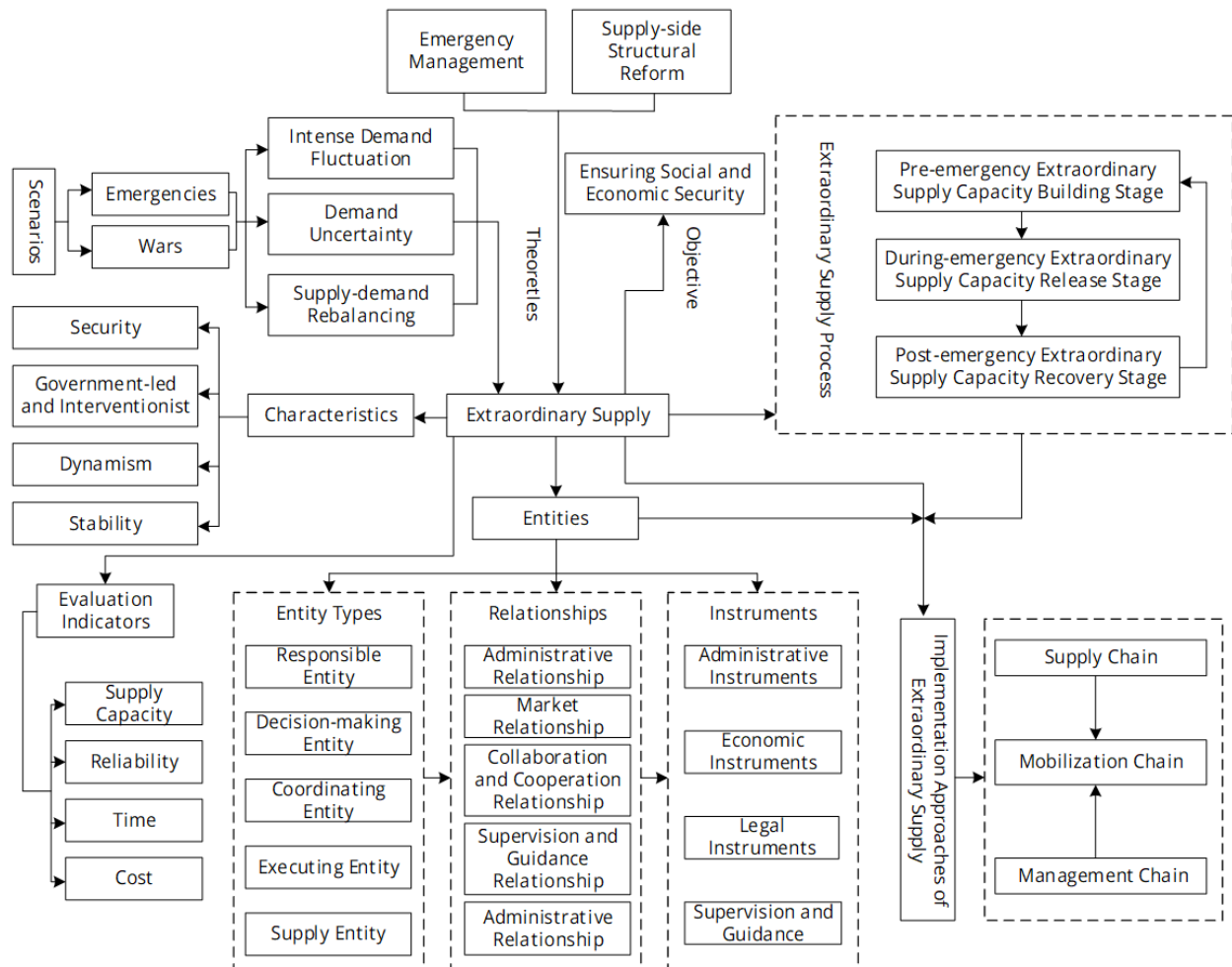


Figure 1. Framework diagram of the theory of extraordinary supply.

to drastic changes in demand caused by unexpected events, a stable resource supply system is necessary, referring to the stability of the overall structure and performance of the extraordinary supply system, rather than the stability of the final quantity of resource supply. Emphasize that during extraordinary supply activities, all levels of the system can operate stably, meet extraordinary demands with quality and quantity guaranteed, and complete emergency supplies supply tasks in a timely and efficient manner in critical situations.

By defining the concept, connotation, and characteristics of extraordinary supply, the framework of the extraordinary supply theory system is constructed (Figure 1).

4 Emergency Supplies Mobilization Chain

4.1 Conceptual Implications of the Emergency Supplies Mobilization Chain

To meet the demand for emergency supplies, a special supply chain is needed to achieve extraordinary supply

of emergency supplies, namely the emergency supplies mobilization chain.

At present, scholars at home and abroad have conducted extensive research on emergency supply chains, which are generally defined as dynamic supply chains controlled by the government with the aim of meeting the demand for emergency supplies in various emergencies and maximizing social and economic benefits [29, 30]. In addition, relevant scholars have systematically defined the concept of the mobilization chain and formed the view that the national economic mobilization chain is a chain composed of the management chain and the supply chain with the goal of completing the national economic mobilization task [31–34]. In this paper, the emergency supplies mobilization chain refers to a chain system composed of the management chain and the supply chain, with multiple participants jointly forming a stable and extraordinary supply capacity to meet the unpredictable and highly fluctuating emergency supplies demand tasks (Figure 2).

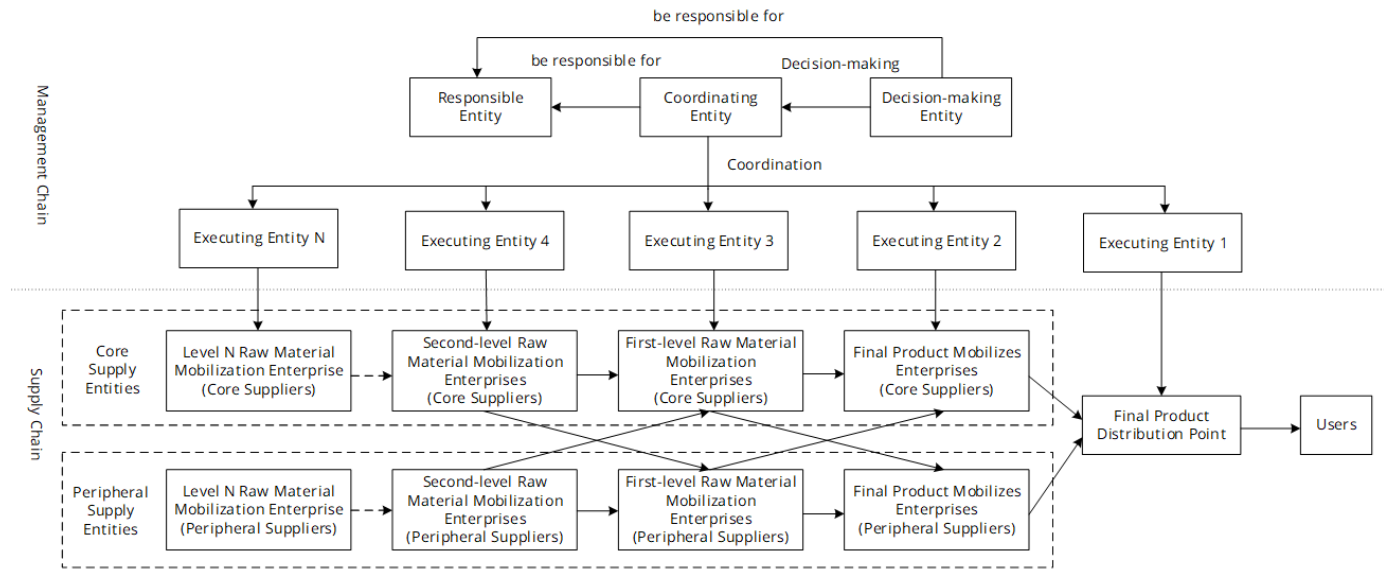


Figure 2. Schematic diagram of the emergency supplies mobilization chain.

4.2 Composition of the Emergency Supplies Mobilization Chain

The emergency supplies mobilization chain is transformed from the macro industrial chain or the meso-micro supply chain, presenting a chain or network structure, relying on the emergency supplies supply chain and emphasizing the construction and operation of the emergency supplies management chain. Unlike the general supply chain, the emergency supplies mobilization chain is formed only in the event of a disaster and is a realistic carrier to meet the demand for emergency supplies and achieve the rebalancing of emergency supplies in a critical situation. The emergency supplies mobilization chain is composed of management entities with emergency supplies management functions and supply entities that actually supply emergency supplies, which are interrelated and collaborative. That is, it is composed of the emergency supplies management chain and the emergency supplies supply chain. The emergency supplies supply chain is coordinated and controlled by the emergency supplies management chain and achieves a stable and extraordinary supply of emergency supplies through the interaction of the "two chains".

(1) Supply chain of emergency supplies

An emergency supplies supply chain refers to a supply chain composed of numerous suppliers to achieve an extraordinary supply of emergency supplies after an emergency occurs. The emergency supplies supply chain runs through the flow of emergency supplies from raw material suppliers at the beginning to demand points at the end, and includes information

flow and capital flow, etc. Although the supply chain of emergency supplies is transformed from the normal supply chain, there are significant differences between the two. First of all, the supply chain under normal conditions is mainly regulated by market mechanisms, while the supply chain of emergency supplies is dealing with the special behavior of emergency supplies support activities in a crisis situation, which is mainly regulated by government administrative intervention and supplemented by market mechanism regulation. The operation mode of the two is extremely different. Secondly, the demand faced by the supply chain under normal conditions is volatile but generally predictable, and the insufficiency of supply chain capacity under normal conditions often does not cause serious social consequences, while the changes in resources demand faced by the supply chain of emergency supplies are characterized by drastic and unpredictable changes, and the imbalance between supply and demand of emergency supplies can easily cause serious social consequences. Again, the supply of emergency supplies is less constrained by economic rules in a crisis situation, and at this time, the supply of emergency supplies aims to maximize the overall interests of society. These different characteristics also determine that the emergency supplies supply chain needs to achieve extraordinary supply of emergency supplies through the emergency supplies management chain.

(2) Emergency supplies management chain

The emergency supplies management chain is a chain-like organizational structure composed of management entities such as government functional

departments based on their rights and responsibilities to ensure extraordinary supply of the emergency supplies supply chain, including responsible entities, decision-making entities, coordinating entities and implementing entities. The emergency supplies management chain is responsible for the overall decision-making, coordination and guidance of emergency supplies support activities, and is composed of all levels of government and various functional departments involved in emergency supplies support tasks. Among them, the emergency supplies management chain does not include specific logistics, but only information flows among different entities at all levels and of all types and various reactions based on such information flows. The emergency supplies management chain is based on the transformation of the government's daily administrative management organizational system, but it has distinct dynamic characteristics. First of all, the emergency supplies management chain has two operating states: normal and abnormal, that is, whether an emergency occurs determines whether the two states switch. Secondly, in an abnormal situation, the emergency supplies management chain dynamically adjusts the composition and structure of its members based on changes in the quantity and type, timeliness and rhythm of the extraordinary supply and demand of emergency supplies.

for the specific supply of emergency supplies. The emergency supplies supply chain is the foundation of the emergency supplies support system and is responsible for the specific supply and service work of emergency supplies support activities; The emergency supplies management chain achieves a stable and extraordinary supply of emergency supplies by managing the emergency supplies supply chain, and the two interact through a double-layer flexible connection mode (Figure 3).

5 Design of Emergency supplies Mobilization chain

5.1 Organizational structure of the emergency supplies mobilization chain

Based on the theory of extraordinary supply, this paper constructs the framework of the emergency supplies support system with the emergency supplies mobilization chain as the specific form (Figure 4).

Functional characteristics of the emergency supplies mobilization chain. Emergency supplies mobilization chains are built to ensure emergency supplies. Under normal circumstances, the daily supply of emergency supplies is regulated by the market mechanism. The management layer composed of various government functional departments plays a guiding and supervisory role, but mainly relies on the market supply and demand mechanism to achieve the guarantee of emergency supplies under normal circumstances. In times of crisis, the market behavior of the supply layer alone is difficult to meet the sudden and volatile demand for emergency supplies. It is necessary to achieve extraordinary supply of emergency supplies through the interaction process between the management and the supply layer under the intervention of administrative means of the management. Therefore, the management subjects of the emergency supplies mobilization chain mainly come from the government administrative system and have a stronger government background and regulatory ability, which is also the main difference between the emergency supplies mobilization chain and the ordinary industrial supply chain.

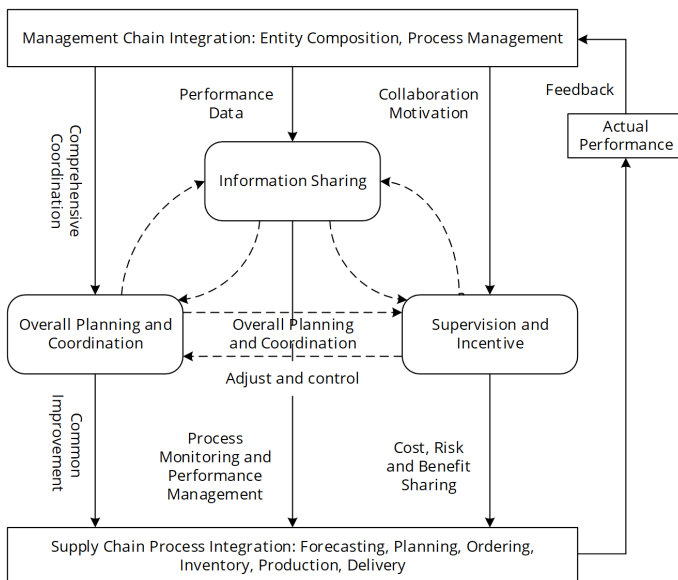


Figure 3. Diagram of interaction between the management chain and the supply chain.

The emergency supplies mobilization chain consists of the emergency supplies management chain, which is responsible for overall coordination, and the emergency supplies supply chain, which is responsible

The realization characteristics of the emergency supplies mobilization chain. The emergency supplies mobilization chain ensures emergency supplies by achieving a stable and extraordinary supply of emergency supplies. The emergency mobilization chain is constructed based on the characteristics of emergency supplies demand and the entire economic

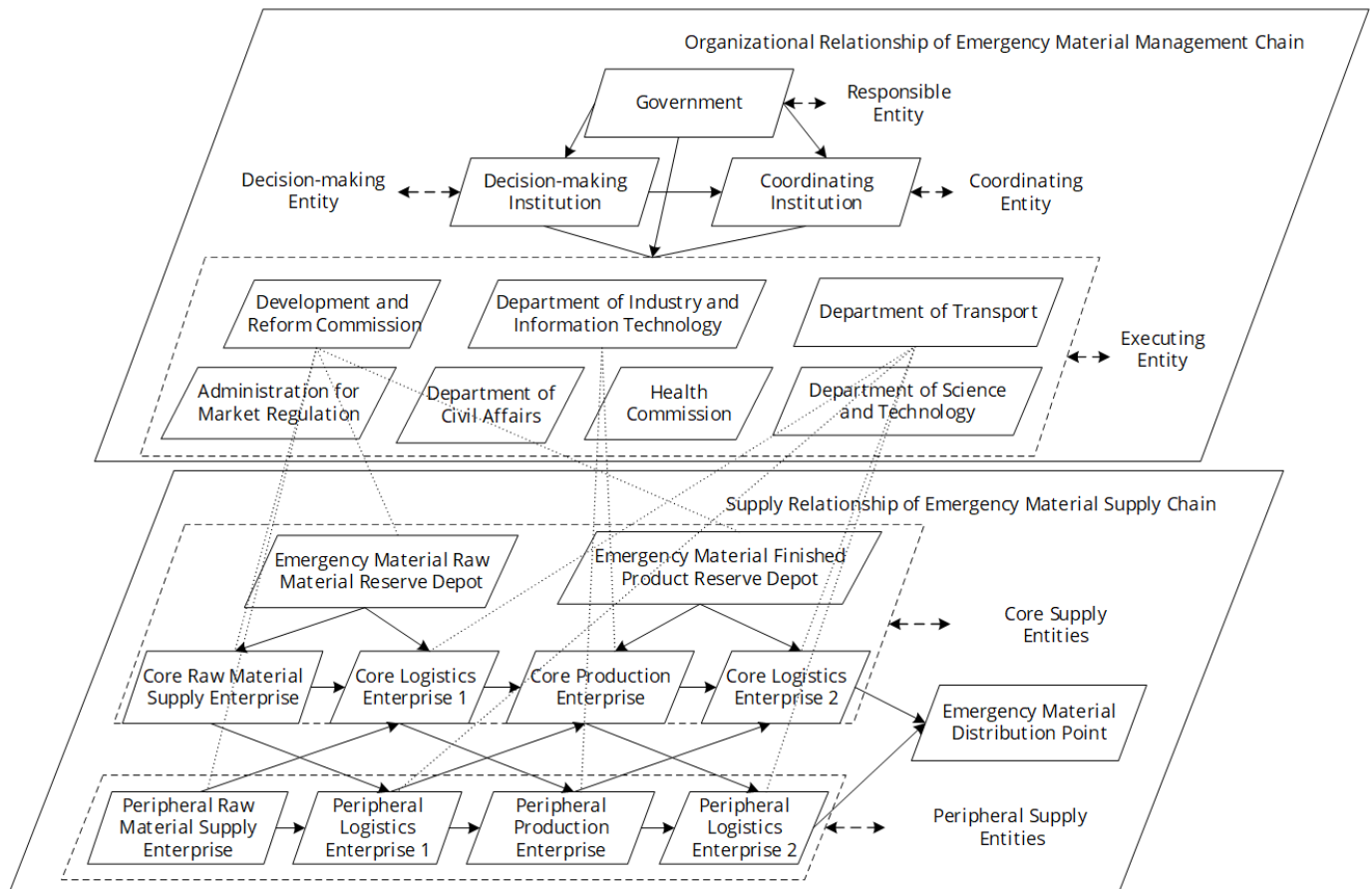


Figure 4. Schematic Diagram of the emergency supplies mobilization chain.

and social system. In the process of its formation, the primary task is to meet the demand for emergency supplies in critical situations and ensure the security of the entire economic and social system, while also taking into account the economic problems existing in the process of emergency supplies supply.

The composition characteristics of the emergency supplies mobilization chain. The emergency supplies mobilization chain is constructed by the management entities of the management level and the supply entities of the supply level through the main line of tasks, and consists of the task level, the entity level and the resource level. It is connected through the interactive feedback of the emergency supplies management chain and the emergency supplies supply chain, emphasizing the integration and construction of government functional departments at all levels, the military and enterprises and institutions based on the requirements of emergency supplies tasks (Figure 5). The constituent entities of the emergency supplies mobilization chain can be classified by nature into management entities and supply entities. The management entities can be further subdivided into responsible entities, decision-making entities,

coordinating entities and executive entities, and the supply entities can be divided into core supply entities and peripheral supply entities. Based on the degree of embeddedness, contract rigidity, and supplies criticality, emergency supply entities can be divided into core and peripheral ones. Core entities assume leading and backstop functions through statutory authorization, administrative directives, or long-term pre-reserve agreements, including government reserve depots, state-owned backbone logistics enterprises, and contracted manufacturers. They are characterized by triple rigidity—direct dispatchability, rapid response, and supplies continuity under institutional guarantees—concentrating on irreplaceable items such as life-sustaining supplies and operating under a public welfare logic. Peripheral entities participate through noninstitutionalized channels such as temporary procurement, donations, and civil mobilization, exhibiting high flexibility and strong volatility. Their sources are broad and fill supply gaps, yet their weak contracts easily lead to mismatches; nonetheless, they hold the potential to transform into normalized reserve forces. Selection criteria rest on criticality, response timeliness, and substitutability:

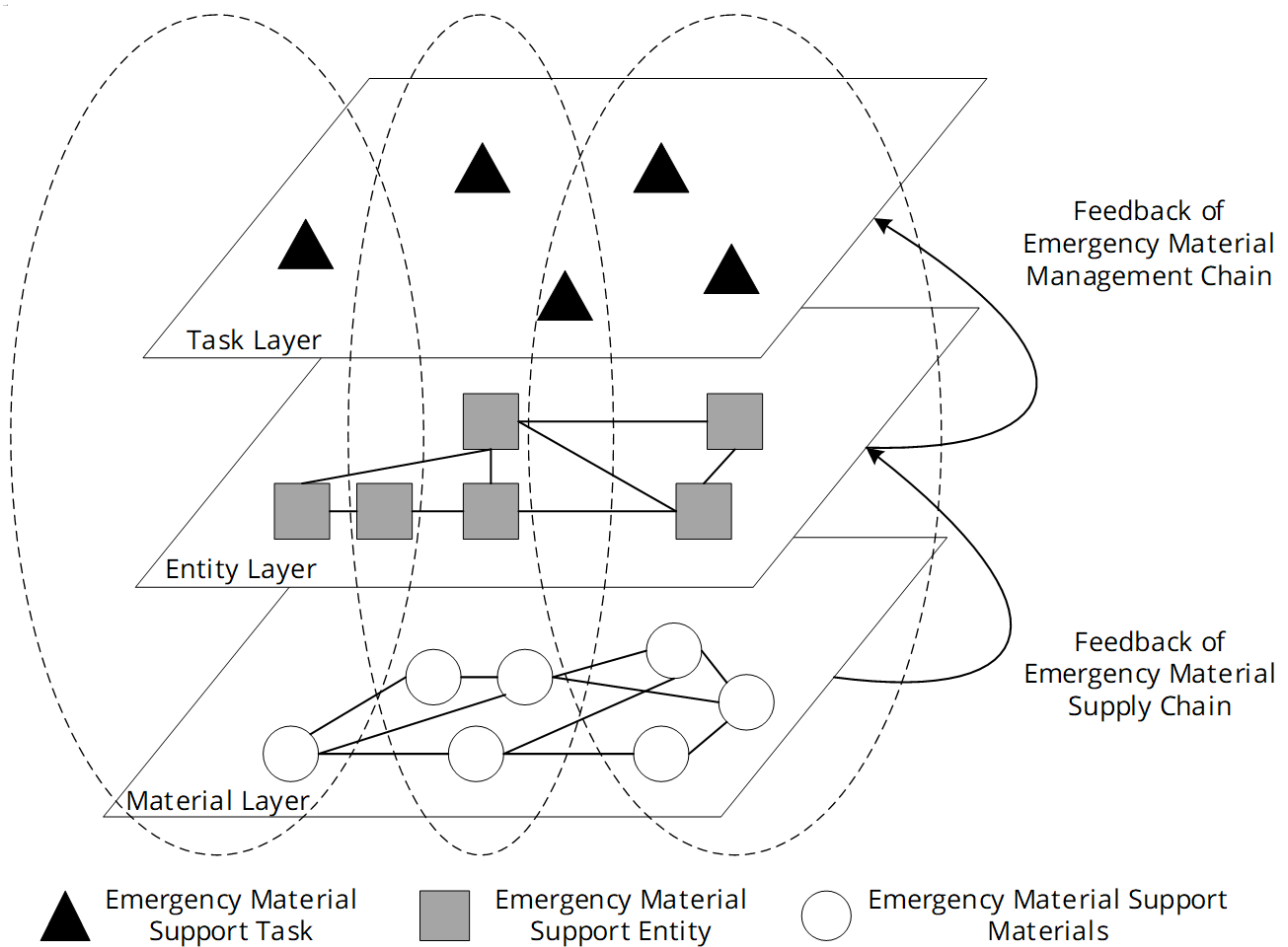


Figure 5. Diagram of the hierarchy of the emergency supplies mobilization chain.

for strategic materials, core entities are chosen, emphasizing inventory depth, production capacity, and information capability; for flexible materials, peripheral entities are selected, highlighting matching precision and digitalized logistics interfacing capacity. Concurrently, a compensatory substitution mechanism is established: when the core is incapacitated, peripheral entities with regional radiation and production conversion capabilities can temporarily switch roles, forming a nested core-periphery structure that enhances the robustness of emergency supplies assurance. Among them, various management entities constitute the management level of the emergency supplies mobilization chain, mainly responsible for coordinating, operating, coordinating and supervising the emergency supplies support work, etc., and generally do not provide specific emergency supplies; core suppliers and peripheral suppliers make up the supply layer of the emergency supplies mobilization chain, which is responsible for the actual supply of emergency supplies.

Dynamic characteristics of the emergency supplies mobilization chain. The emergency supplies

mobilization chain is a complementary dynamic organizational structure proposed to enhance the agility of the emergency supplies support system. On the one hand, unlike traditional static organizations with fixed organizational structures, the emergency supplies mobilization chain emphasizes dynamic changes in organizational structure, that is, based on the dynamic changes in emergency supplies demand, the emergency supplies mobilization chain achieves effective collaboration among the main bodies of the emergency supplies mobilization chain through dynamic adjustment and reconstruction of organizational composition, structure and scale, and achieves complementary advantages among the main bodies of emergency supplies support. To achieve the goal of enhancing the agility of the emergency supplies support system. On the other hand, the chain of emergency supplies mobilization itself has a certain life cycle, which changes with the life cycle. As the situation of various emergencies changes and the level of emergency response rises or falls, it causes changes in the scale and type of emergency supplies support requirements, resulting in changes in the emergency

organizational structure.

5.2 Selection of the main body of the emergency supplies mobilization chain

When selecting entities for the emergency supplies mobilization chain, relevant government departments join as management entities and relevant enterprises and public institutions join as supply entities. First, the risk identification agency under normal circumstances identifies and confirms the emergencies within the region and reports to the government as the responsible entity. The responsible entity determines the timing of the "transition from peacetime to emergency" and analyzes the demand for emergency supplies based on the "scenario - response" approach, clarifies the tasks of emergency supplies, and is responsible for the tasks of emergency supplies within the region. According to the requirements of the task, the responsible entity authorizes the decision-making and coordination entities to be responsible for the business access of various management functional entities and the organization and construction of emergency supplies support task management. Under the authorization of the responsible entity, the coordinating entity within the emergency supplies mobilization chain management level coordinates the executive entities within the administrative region. The coordinating body is not responsible for the specific supply details and returns to the coordinating function of the coordinating body, while the implementing body is responsible for mobilizing and coordinating the specific supply entities to complete the supply tasks. The chain structure formed by the responsible entity, decision-making entity, coordinating entity, and implementing entity—collectively constituting the emergency supplies management chain—ensures the supply of emergency supplies. Under normal circumstances, various entities at the management level do not directly supply emergency supplies. At such times, various supply entities at the supply level need to be connected. In order to achieve the actual supply of emergency supplies, the supply entities of the supply layer are connected under the regulation of the executive entities of the management level, and form an emergency supplies supply entity chain to achieve the control of the emergency supplies supply chain by the emergency supplies management chain. In the process of establishing the emergency supplies mobilization chain, supply entities distinctly defined based on pre-emergency supplies potential investigation, agreement signing

and plan preparation are first connected as core supply entities. When the core suppliers are unable to meet the extraordinary demand for emergency supplies, the core suppliers need to proactively contact the peripheral suppliers to join in an orderly manner; when it is difficult for the core supply entity to contact other supply entities, it feeds back to the directly managed executive entity and contacts associated supply entities through the directly managed executive entity or other executive entities, thereby building a complete supply chain for emergency supplies. Among them, in the construction of the emergency supplies mobilization chain, the interaction mode between the enforcement subject and the supply subject is a two-way flexible connection achieved through means such as government procurement, regulatory guidance and administrative requisition.

5.3 Dynamic adjustment of the emergency supplies mobilization chain

The emergency supplies mobilization chain is influenced both externally and internally by the system structure. As the supply and demand of emergency supplies change dynamically, the emergency supplies mobilization chain, as the organizational system for achieving the balance of supply and demand of emergency supplies, must be dynamically adjusted in accordance with the actual situation. There are two main types of changes in the dynamic adjustment of the emergency supplies mobilization chain: the increase of the main body and the decrease of the main body. In general, the responsible subjects, decision-making subjects and coordinating subjects are all components of the emergency supplies mobilization chain, undertaking corresponding decision-making and coordination functions. Therefore, the dynamic changes of the subjects of the emergency supplies mobilization chain mainly refer to the executive subjects and supply subjects. One is the situation where the demand for emergency supplies increases, and the executive and supply subjects will increase dynamically in accordance with the demand for supplies. For example, during the treatment and prevention of COVID-19, due to the surging demand for medical supplies such as masks and protective suits, the supply of medical supplies was difficult to meet the demand for medical supplies in Wuhan and across the country. At this time, under the coordination of the implementing entity, the Ministry of Industry and Information Technology reportedly coordinated medical and health supplies production

enterprises across the country to increase, expand, and convert production capacity. By increasing the number of supply entities to adapt to changes in the quantity and type of medical supplies needed. The other is the situation where the executive or supply entities are dynamically reduced. The exit of an executive is typically due to task completion or phase characteristics. The dynamic reduction of supply entities mainly consists of two situations: one is due to the damage of supply entities in the emergency supplies mobilization chain or the inability of their emergency supplies supply chain to continue to complete the emergency supplies support task, and the other is the situation where the supply of emergency supplies exceeds the demand of emergency supplies, and the supply entity completes its supply task and exits the emergency supplies mobilization chain. The outbreak of the novel coronavirus coincided with the Spring Festival, during which numerous medical supplies enterprises were shut down, leading to a substantial, well-documented contraction in national mask production capacity during the early outbreak period. Objectively speaking, the epidemic and the Spring Festival holiday jointly caused the reduction of medical supplies suppliers and the decline in the supply capacity of the medical supplies supply chain.

6 Conclusions and Future Work

6.1 Conclusions

Based on the theory of extraordinary supply, this paper systematically explores the construction and design of the emergency supplies mobilization chain in response to the serious imbalance between supply and demand of emergency supplies in highly uncertain emergencies. The main conclusions are as follows: First, the emergency supplies support system is a complex system with dissipative structural characteristics, and its core objective is to achieve a dynamic balance of supply and demand throughout the entire life cycle through the transformation from normal supply to extraordinary supply. Second, the concept and connotation of the emergency supplies mobilization chain have been clarified, revealing that it is a chain structure composed of the emergency supplies management chain and the supply chain through a double-layer flexible connection. The management chain undertakes the function of overall coordination, and the supply chain provides specific resources support. The interaction between the two is the key to achieving stable and extraordinary supply. Third, the organizational structure and dynamic adjustment

mechanism of the emergency supplies mobilization chain that integrates peacetime preparedness and emergency response under a task-oriented framework have been designed, and the multi-source redundant layout of the supply chain and the matrix collaborative architecture of the management chain have been regulated respectively. The study provides new theoretical perspectives and operational construction paradigms for enhancing the agility and reliability of the emergency supplies support system.

6.2 Future Work

Future work can be carried out from the following aspects: First, establish a stochastic optimization model for the emergency supplies mobilization chain, and study the collaborative decision-making method for subject selection, capacity allocation, and dynamic reconstruction under the condition of dual uncertainties of supply and demand; second, deeply design incentive compatibility and information sharing mechanisms between the emergency supplies management chain and the supply chain to enhance the efficiency of transitioning between peacetime and emergency and the overall resilience of the supply chain; third, integrate current technologies such as digital twins and artificial intelligence to build a scenario simulation and intelligent dispatch platform for the emergency supplies mobilization chain to achieve precise and visualized dynamic adjustment; fourth, incorporate economic costs into the analytical framework to explore the optimal equilibrium strategy between extraordinary supply capacity reserves and mobilization costs, providing decision support for the refined governance of the emergency supplies mobilization chain.

Data Availability Statement

Data will be made available on request.

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Conflicts of Interest

The authors are affiliated with the China Center for Information Industry Development (CCID), a public institution under China's Ministry of Industry and Information Technology, and their research interests include emergency management among other topics. This study represents the authors' independent academic analysis and was not commissioned, funded,

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AI Use Statement

The authors declare that no generative AI was used in the preparation of this manuscript.

Ethical Approval and Consent to Participate

Not applicable.

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