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Unmanned Technology-Based Civil-Military Intelligent Logistics System : From Construction to Integration

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Abstract: The stockpiling, delivery, and provision of emergency material were in the public gaze of millions of people when the coronavirus disease 2019 (COVID-19) broke out. Civil-military integration emergency logistics silently opened up the "second battlefield" of anti-epidemic, and established a lifeline under that emergency situation. Research on the construction of civil-military integrated logistics system plays an extremely important role and occupies a significant position in ensuring social stability and security as well as the stable development of social economy in China. The modern economy driven by the Internet, Internet of Things, and big data demonstrates a rapid growing trend calling for efficient, fast, and convenient logistics. It is urgent to upgrade or build an intelligent logistics system with intelligent technology and unmanned technology as the core to meet the international and domestic market demand. As mentioned above, this paper analyzes and expounds the construction problem and practical significance of civil-military integration emergency logistics system based on unmanned technology, and puts forward the strategy of constructing civil-military integration emergency logistics system with unmanned technology under the new system.

Keywords: unmanned technology; civil-military integration; emergency logistics; system construction

1 Introduction

The combination of civil and military technology is more and more widely used, and the degree of integration is more and more deep, showing the trend of civil and military integration, peace and war integration, and combat and emergency integration. It is of great significance to speed up the construction of integrated military and civilian logistics system, which is closely integrated and mutually integrated, and to realize the optimization of system structure, resource sharing and technology interoperability, so as to promote the construction of modern logistics system in China and promote the socialization and integration of military logistics support [1].

Therefore, it is the right time to establish a civil-military emergency logistics system under the new system. The research and construction of the civil-military integration emergency logistics system under the new system is an important practice of the civil-military integration concept. It is a powerful measure to conform to the current development trend of emergency logistics, tap the potential of Chinese military and civil logistics, and improve the emergency and operational support. With the rapid development of in-

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formation technology such as artificial intelligence, big data, cloud computing and Internet of Things, labor-intensive logistics industry is also facing the impact of reverse. From unmanned warehouse to unmanned vehicles, unmanned aerial vehicles and intelligent cabinets, the logistics industry chain is implementing unattended innovation and intelligent reconstruction. In order to make the military and civilian emergency logistics system under the new system adapt to the basic requirements of modern economic development characterized by the Internet, the Internet of Things and big data, and ensure that the necessary materials for dealing with various emergencies are sufficient and that the necessary logistics of the army is sufficient when war occurs, it is necessary to intelligentize the logistics system [2–10].

This is closely related to the support of artificial intelligence technology represented by unmanned technology. Therefore, the establishment of civil-military integrated emergency logistics system based on unmanned technology will better respond to emergencies, which plays an important role in the construction of scientific and modern national defense forces in China and has important practical significance.

2 Civil-Military Integration Logistics

Civil-military integration logistics combines military logistics with more powerful social logistics to form a unified and organic logistics operation entity. Emergency logistics refers to special logistics activities aimed at providing emergency materials needed for emergencies such as natural disasters and public events, and at saving time and reducing disaster losses to the greatest extent. The development of emergency logistics is closely related to military logistics. In a sense, military logistics is special emergency logistics, which is particularly prominent in the war period [11–15].

The construction of civil-military integration emergency physical system is based on the idea of civil-military integration. Under the guidance of national unified planning, the military and local logistics resources and elements are integrated in the field of military logistics and integrated optimization, taking into account the needs of both military and civilian, so as to realize the mutual promotion and coordinated development of military and local logistics system. It is a national transport delivery service guarantee system, including military and civilian transport-related personnel, facilities, means of delivery, transport objects and so on. It has the great advantages of civil-military integration, integration of peace and war, and mutual benefit. It is based on the current situation and focuses on the future strategic development. It not only meets the requirements of the development of socialist market economy, but also meets the needs of logistics support in the future high-tech local war.

It effectively integrates military and social resources, and establishes a closely linked material supply chain from the market to the battlefield as well as from enterprises to the army. The establishment of the civil-military integration emergency logistics system has realized the precise support needs of military operations, reflecting the obvious characteristics of resource advantages, efficiency, accuracy and controllability. Civil-military integration emergency logistics system is a relatively extensive system, including logistics organization command system and logistics procurement system, material reserve system, logistics distribution system, logistics standard system, logistics legal protection system, logistics infrastructure system, logistics information system, etc., and is the main component of civil-military integration emergency logistics system. This ensures the normal operation of the civil-military integration emergency logistics system.

3 Current Situation of Emergency Logistics System

The construction of emergency logistics system in

China started late, and the development of civil-military integration logistics system is still in its infancy. On July 1, 2004, the joint service test system of the three armed forces was officially launched in military region. This is a historic leap in our military logistics support system. This also marks our military logistics reform and development has entered a new stage.

So far, although the traditional logistics mode of "specialized division of labor and multi-management " implemented by our army has made a breakthrough, the flat network logistics system has begun to see scale. However, Chinese civil-military integrated logistics still lacks systematic and scientific theoretical guidance, which not only lags behind the U. S. Army in the construction status, but also lags behind the U. S. Army in the development concept. There are many problems in the lack of the concept of "big logistics" between the military and local governments.

3.1 Lack of Efficient Joint Command Mechanism

Establishing an authoritative and perfect organizational command system is the core to ensure the normal operation of the civil-military integration emergency logistics system and give full play to its advantages. However, the overall coordination relationship between the military and local command is not clear, logistics and transportation power is not scientific, and laws and regulations are not perfect. As a result, due to the lack of effective command at the beginning of an emergency, the emergency logistics system is chaotic and lagging behind. In addition, there is no effective connection between the military and local emergency management mechanisms. There is no complete and unified logistics concept and principle in the military and local areas. When establishing emergency logistics system, they are usually responsible for their own interests and establish internal systems. Failure to give full play to the effect of civil-military integration command, the long-established independence, self-construction and self-sufficiency between the military and local governments cannot be fundamentally changed. As a result, civil-military integration operations lack a combination of peace and war and emergency mechanisms, resulting in inadequate linkages between elements of emergency logistics and poor operations.

3.2 Lack of Standardized Information Sharing Platform

In China, leading logistics companies such as Jingdong, Shunfeng Express and Shentong have basically realized the visualization of logistics transportation by introducing advanced Internet of Things technologies (such as global position system (GPS), BeiDou navigation, wireless communication and electronic tags). However, the military logistics informatization level of our army is still low. The construction of logistics informatization is only reflected in the scattered establishment of some special logistics information systems. The integration of logistics resources and the real-time visualization of logistics information has not been fully realized, which leads to the command organization's incomplete mastery of information and cannot meet the needs of ensuring our army to win the information war in the future. Drawing on the concept and experience of the combination of cash logistics technology between the U. S. military and local enterprises, it is necessary to promote the transformation of the civil-military integration emergency logistics system to information technology, so as to prevent the situation that the military and the local do not understand each other. Realize the compatibility and interconnection of military and local information systems, adapt to the development of the times, and realize the integration of military and civilian emergency logistics.

3.3 Lack of Perfect Emergency Logistics Plan

There is a big gap between the operability of various plans and the actual situation, especially

the emergency logistics command. For example, when major emergencies come, by which department to propose solutions, by whom to integrate cross-sectoral and cross-regional emergency logistics plans and so on is not clear. These problems will lead to a disorder of linkages between regional and industrial contingency plans in the early stages of an emergency, resulting in the failure of grass-roots emergency departments to fully discharge their responsibilities. Therefore, it is necessary to fully improve the civil-military integration emergency logistics plan and clarify the leadership mechanism of the emergency logistics system.

4 Application of Unmanned Technology in Emergency Logistics System

4.1 High-Precision Map Data

Traditional map data are expressed through human cognition, so the expression of data is displayed in a visual way that human beings can understand. However, the high-precision map (Fig. 1) in the unmanned system is completely robot-oriented map information. The data are very different from the traditional map data. Due to higher accuracy requirements, data acquisition is no longer carried out by means of total station and satellite image matching, but by laser point cloud data collection or on other high-precision sensing devices.

4.2 Intelligent Navigation System

4.2.1 High-Precision Navigation Guidance

The principle of unmanned aerial vehicle (UAV) navigation is mainly to transmit the key navigation position information to the UAV through the server, and to collect the current position information of the UAV through high-precision sensors to determine whether the vehicle deviates from the predetermined direction and realize real-time guidance [16]. Starting with real-time guidance using high-precision navigation is shown in Fig. 2.

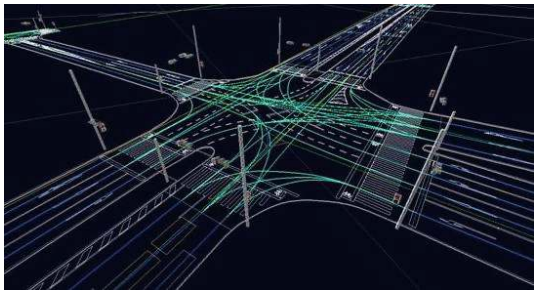

Fig. 1 High-precision map effect

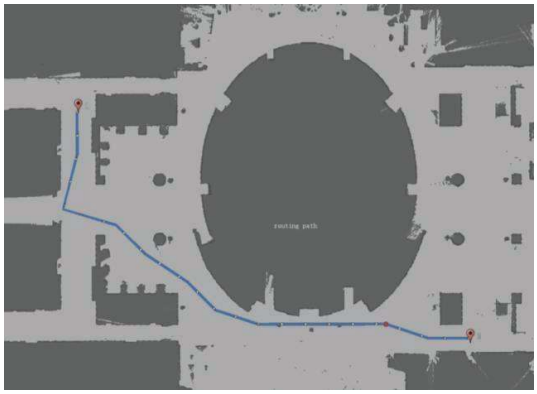

Fig. 2 Indoor navigation

4.2.2 Intelligent Path Planning

The core task of unmanned transportation is to deliver goods to users. Therefore, navigation path planning needs to consider user order information, which involves address resolution and multi-point allocation planning. 1) Address resolution: The Geocoding Service provided by the mainstream map data service providers can convert the order address into latitude and longitude information to guide the delivery of goods by unmanned vehicles. 2) Analysis of arrival point: Since the ultimate goal of unmanned distribution is to deliver goods to users, the resolution of the target address needs accurate location information (accurate to the dockable or accessible point). For example, residential areas need accuracy to the building number. Therefore, for each address, it is necessary to analyze the exact parking location so that unmanned vehicles can use it as the final parking location. 3) Multi-point distribution: In order to improve the efficiency of distribution, unmanned vehicles need to be distributed along multiple locations within the jurisdiction, which will involve the best path planning technology.

4.2.3 Application of Big Data Technology

The operation of autonomous vehicles is a data sensing behavior. Through various sensors on the vehicle, the driverless vehicle can understand the actual road condition in real time. With the expansion of the scale of unmanned vehicles, the range of data perception will cover a larger area, so as to realize real-time data updating. This model using a large number of driving perception data is called "crowdsourcing" data updating, which is one of the important ways to realize data updating in the field of unmanned vehicles. In addition, big data-based analysis can also play an important role in assisting decision-making when optimizing unmanned vehicle scheduling resources.

4.2.4 Safety Unmanned Measures

Scheduling and monitoring of unmanned vehicle logistics: The unmanned distribution logistics system must put safety first. Therefore, although unattended, staff still need to monitor to deal with emergencies. UAV scheduling monitoring system mainly undertakes the following functions: First, vehicle scheduling for unmanned vehicles requires a unified deployment of the scheduling system to achieve the overall deployment of all vehicle operations. Second, the UAV monitoring system can monitor the state of all vehicles in driving, real-time perceive the situation encountered by the UAV in the driving process, and timely report the emergency situation, prompting the staff to deal with it in time.

Use of multiple validation methods: In terms of safety verification, unmanned vehicles should use a variety of verification methods to ensure that the goods can reach the user safely and accurately. At present, the following verification methods are mainly used [17–21].

(a) Verification code : This is the most widely used verification method at present. The user enters the verification code in the dialog box of the driverless vehicle screen. After verification it can open the box to take goods, and can quickly and easily transfer goods. However, this method has potential security risks and is usually used to deliver ordinary goods.

(b) Face recognition : At present, the success rate of face recognition is enough to meet the accuracy of verification, but the premise is that the user must collect express delivery, and need to sample the face in advance. In addition, face recognition itself is easy to crack, and there are many technical vulnerabilities.

(c) Voiceprint recognition : Voiceprint recognition refers to the use of human vocal organs of the size and shape differences to determine the identity of the speaker. The security of this verification method is very high, and the voice recognition, image analysis and other technical requirements are very high, so it is suitable for high-value goods distribution.

5 Civil-Military Integration Emergency Logistics System Based on Unmanned Technology

5.1 Establishment of Joint and Efficient Leadership Structures

Because the emergency logistics of civil-military integration involves many factors such as state, society and military, it is necessary to establish a centralized, unified, efficient and authoritative joint command. According to the scale of military operations and the damage caused by emergencies, the emergency logistics system of civil-military integration can be divided into two situations. One is the military emergency security system, local aid. This model is applicable to large-scale wars and local armed conflicts. Around the military security system, local governments will establish the civil-military integration emergency logistics command center, and use the civil-military integration emergency logistics information platform to uniformly deploy human and material resources. Another is based on an emergency security system and supported by the military. This model is applicable to emer-

gencies with a wide range of impacts, such as large-scale natural disasters. In the event of disasters, local governments will establish emergency logistics command agencies, require the military to provide the necessary support and unify allocation of human resources through the civil-military integration emergency logistics information platform to jointly organize rescue. Based on the above considerations, a strategic and operational level of civil-military integration emergency logistics leadership can be established by integrating the relevant military and local sectors.

Fig. 3(a) shows the strategic level. By the central coordination, the military committee set up the national civil-military integration emergency logistics command, logistics support department and joint logistics office. In case of an emergency, the central authority will be responsible for overall command. When a large-scale war broke out, the logistics support department of the military commission is responsible for the command, and the central government is responsible for the establishment of an emergency logistics information platform for civil-military integration.

Fig. 3(b) shows the campaign level. Under the coordination of the provincial defense mobilization department, under the leadership of the provincial defense mobilization department, there are provincial civil-military integration emergency logistics command, military joint logistics support center and provincial emergency response center. Provincial Emergency Committee is responsible for coordination and command in the event of a wide range of emergencies. When large-scale war broke out, the joint logistics support department in the war zone was responsible for command, and the provincial defense mobilization office was responsible for collecting and verifying the military logistics information data required by the civil-military integration emergency logistics information platform.

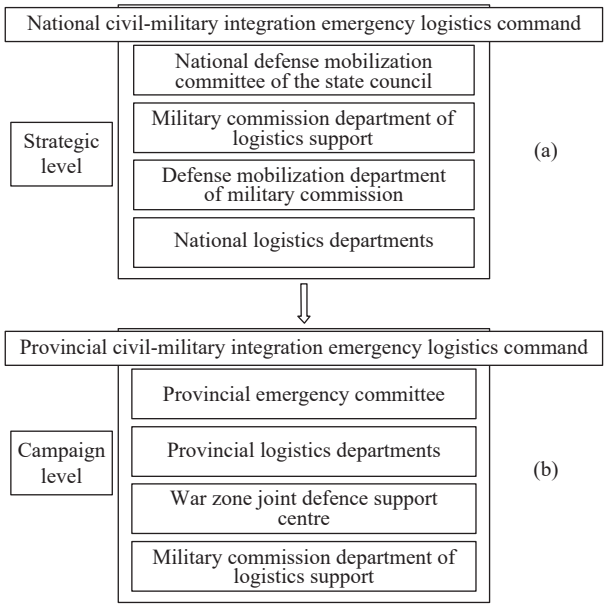

Fig. 3 Schematic diagram of civil-military integration emergency logistics leadership

5.2 Building an Integrated Logistics Information Platform

The advanced technology and experience of foreign logistics tell us that the key of civil-military emergency logistics system is to establish a comprehensive logistics information platform. In order to build a high-quality and efficient civil-military integration emergency logistics system, it is necessary to make full use of information systems and attach importance to the sharing of military-civilian logistics resources so as to realize the controllability of logistics information.

In order to obtain military and local logistics information, human resources, real-time traffic, security requirements, support troops and other information timely and accurately, it is necessary to follow the standard unification of modern military and civilian logistics technology based on software and hardware technology, and rely on computer networks to comprehensively apply electronic data interchange (EDI), geographic information system (GIS), bar code, radio frequency identification technology (RFIT) and other technologies. According to the actual needs, the information can be expressed separately or hierarchically, and integrated in the di-

gital map to realize the visualization of civil-military integration logistics information, optimize the security strategy, maximize the efficiency of emergency logistics, and minimize the loss.

Therefore, in order to establish an integrated civil-military integration logistics information platform, the provincial defense mobilization office can be responsible for collecting military and local logistics information, and the information of military and local logistics system is integrated by the Center. The Civil-Military Integration Emergency Logistics Information Platform is responsible for integration to coordinate and promote effective cooperation among government, military and enterprises to achieve optimal allocation and overall coordination of national and social resources. The overall structure of the logistics information platform is shown in Fig. 4, which is mainly composed of infrastructure layer, data layer, service support layer and application service layer. Fig. 4 demonstrates the civil-military integration logistics information platform that has eight main functions : logistics organization and command, logistics processing, logistics resource allocation, timely control and command, logistics business processing and e-commerce procurement. It has interfaces with military logistics center, government procurement center, logistics companies and other data centers to achieve data exchange, and has the reliable security assurance, thus providing the essential logistics information for the government, the army and the local enterprise procurement, and the distribution.

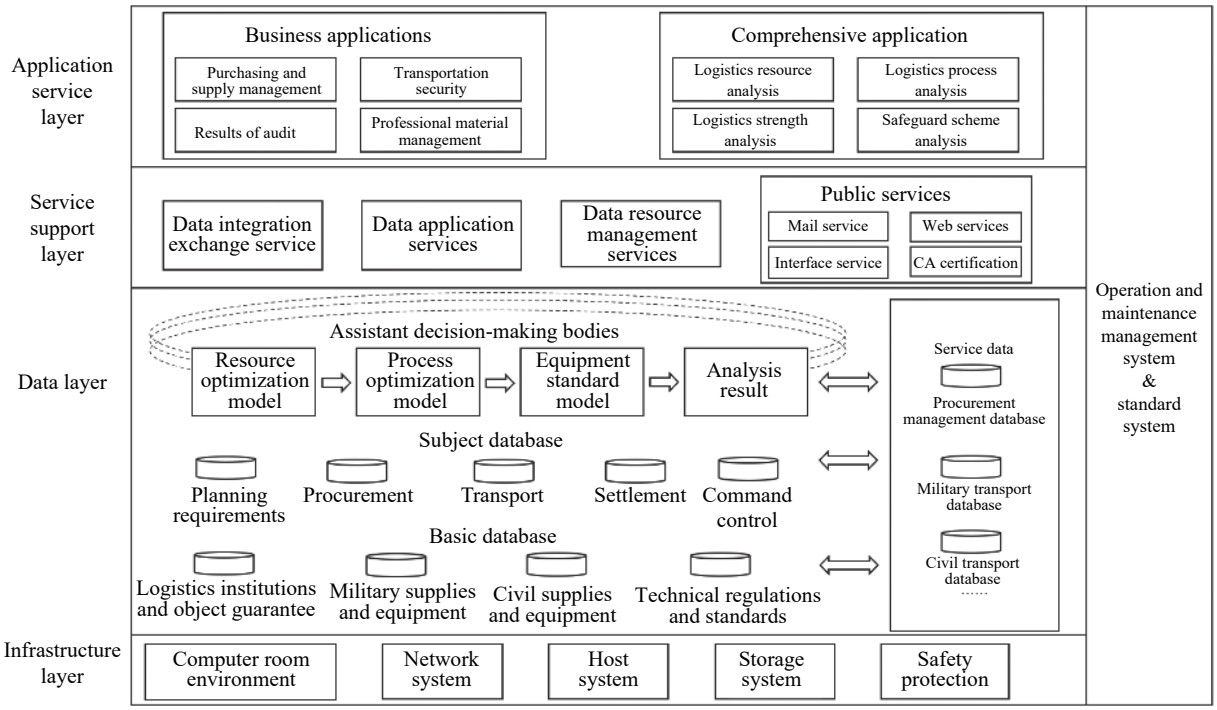

Fig. 4 General structure of civil-military integration logistics information platform

5.3 Construction of Civil-Military Integration Emergency Logistics System Based on Unmanned Technology

5.3.1 Unmanned Logistics Basic System

Fig. 5 shows the logistics system of unmanned technology based on machine-to-machine (M2M) architecture. The perception layer uses RFIT technology, M2M terminal, and remote sensing technology to complete information collection and object recognition through short-range transmission technology (such as bar code, infrared, etc.) to install these tags and terminals in warehouses, distribution vehicles, other logistics equipment and data transmission, in order to

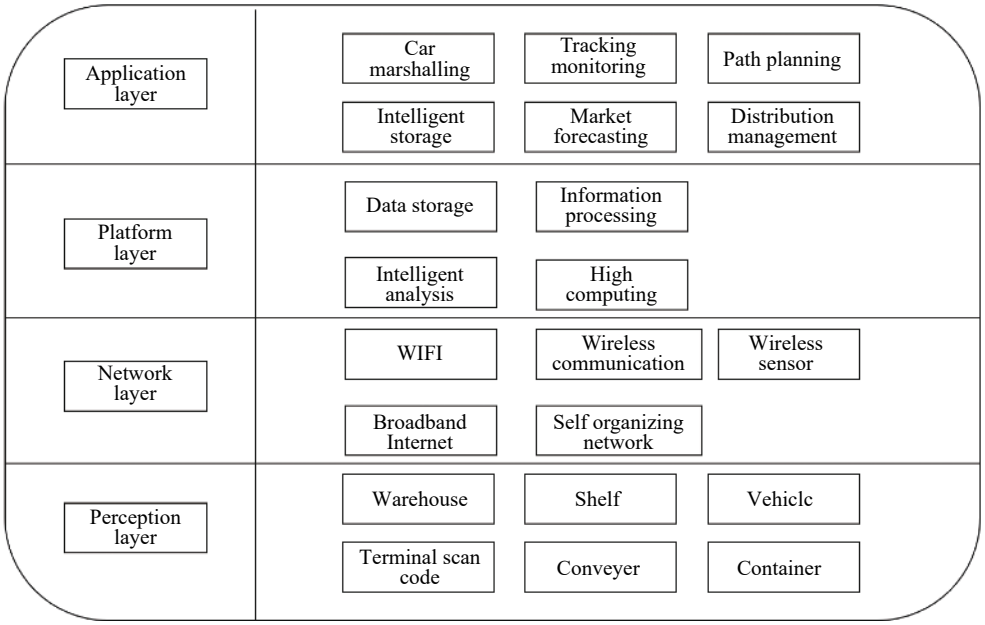

Fig. 5 Unmanned logistics system architecture

achieve information collection. Then the collected information is input to the mobile device or PC [22–28].

The network layer, including the Internet and wireless communication network, plays an important role in connecting users and working background. The platform layer uses the stored massive data, high-performance computers and other technologies to analyze and transform the data information obtained by the perception layer. Application layer is the user interface, through the comprehensive analysis and utilization of the data provided by the platform, combined with the specific needs of users, to achieve unmanned logistics.

5.3.2 Unmanned Logistics Function System

Through the analysis of unmanned logistics demand, unmanned logistics function system should include the following modules: cargo sorting module, unmanned distribution tool scheduling module, monitoring module and unmanned distribution tool route planning module. In unmanned warehouse, goods sorting module is mainly realized by sorting robot. The sorting robot has its own image recognition system. Through laser guidance, RFIT guidance, magnetic stripe guidance and machine vision recognition technology, it can realize automatic driving, identify goods and transport them to the designated position in the warehouse.

The UAV distribution tool scheduling and monitoring module mainly uses GPS positioning technology to locate the position of the UAV in real time, obtain logistics and transportation data, through the acquisition of massive data, select the best distribution center, according to the specific needs of customers for vehicle scheduling, route planning, etc., and realize the real-time monitoring, in order to be able to deal with emergency under special circumstances. The unmanned distribution path planning module also uses the analysis of massive data to obtain vehicle information in real time through GPS positioning technology, and uses the navigator to guide the unmanned distribution tool in real time [29].

5.3.3 Unmanned Logistics Support System

The construction of unmanned logistics support system mainly focuses on three aspects : macro condition support, technical support and human resource support.

Macro conditions mainly involve laws and regulations. With the rapid development of Internet of Things technology, government depart-

ments began to formulate relevant policies and regulations to guide the development of logistics. In order to ensure the effective operation of unmanned logistics, the support of policies and regulations is essential. Government financial support for unmanned logistics is also important. Because the construction of unmanned logistics is more costly than traditional logistics, technology development and purchase of distribution equipment requires a lot of money.

Technical conditions mainly include two aspects. First, one is the key technology. In order to realize the effective distribution of logistics resources and the optimization of logistics links, sensors, RFIT tags and GPS are used to generate real-time information data in unmanned vehicles, unmanned warehouses and unmanned cabinets. Second, infrastructure equipment and intelligent equipment, represented by unmanned warehouse and unmanned distribution station, is an important guarantee for the long-term development of unmanned logistics. The further development of unmanned logistics requires a large number of professionals with professional logistics knowledge and rich practical experience. Therefore, we must pay attention to the training of logistics professionals and create a solid talent condition for the construction of unmanned logistics system.

5.4 Establishment of Governance Mechanisms Adapted to Unmanned Logistics

At present, there are no laws and regulations for unmanned aircraft or unmanned aerial vehicles. Under the Civil Aviation Act, general aviation operations are prohibited without a business licence. In addition, units and individuals engaged in general aviation flight activities shall not fly without authorization from relevant departments. In January 2018, the State Council and the Air Traffic Control Committee of the Central Military Commission issued the "Provisional Regulations on the Flight Management of Unmanned Aircraft (draft for comments)", which stipulates that civilian drones must have a business license and clearly stipulate micro and light man-machine no-fly zones. The road information is changing rapidly, and even if the test accuracy is high, it is not infallible. Therefore, driverless technology needs to be continuously improved in logistics practice, so there are a series of problems, for example, unmanned distribution vehicles not complying with traffic rules, traffic accidents, how to deal with the accident certificate of unmanned distribution vehicle and so on. These problems need to be considered in advance by the government and logistics companies, and formulate corresponding plans to minimize losses and avoid social problems. Therefore, the government should widely solicit public opinion, discuss corresponding policy measures, formulate corresponding laws and regulations, and strengthen supervision. Logistics companies should continuously improve technology, and jointly establish and improve security mechanisms and emergency plans with the government to ensure the operation safety of logistics unmanned distribution vehicles.

5.5 Standardizing the Logistics Operation Process of Military-Civilian Collaboration

After determining the joint and efficient leadership and command institutions with clear responsibilities and powers, the integrated logistics information platform and the unmanned logistics system adapting to the civil-military integration logistics, we should also design an efficient and reliable civil-military integration emergency logistics workflow [30]. Fig. 6 shows the civil-military integration emergency logistics workflow:

(a) Starting emergency plan mechanism: According to the relevant laws and regulations of the country and the army and the requirements of emergency logistics, and according to the scale and nature of emergency logistics delivery tasks, emergency logistics departments at all levels start plans and quickly enter an emergency state.

(b) Receiving emergency logistics support

tasks: After receiving orders from superiors, emergency logistics departments quickly gather information, analyze statistical requirements and formulate overall strategic plan; according to the division of responsibilities, query military and local logistics resources, and make emergency logistics support recommendations. Details should include resource storage status, transport power utilization, relationship coordination, etc.

(c) Organizating and implementing the emergency logistics support: Civil-military integration emergency logistics support units should analyze resources through various channels, prepare for security, and organize emergency logistics support timely, accurately and efficiently.

(d) Summary and report: After the completion of the emergency logistics delivery task, the civil-military integration emergency logistics department should timely summarize the task completion in writing, form valuable experience and revise the emergency plan in time.

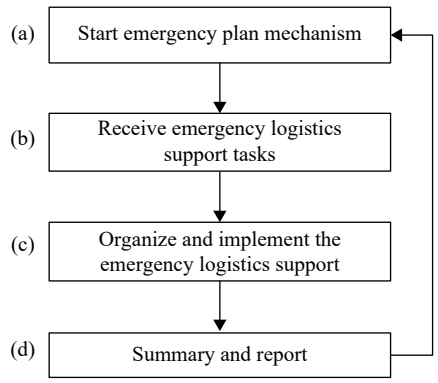

Fig. 6 Civil-military integration emergency logistics workflow

6 Conclusion

The civil-military integration emergency logistics system is a complex system with which the military and local emergency logistics elements cooperate to jointly complete the emergency logistics support task. The unmanned technology has now fully promoted the continuous improvement of the technical application level of the logistics industry, comprehensively promoted the transformation of logistics technology to intelligence, and promoted the progress of social efficiency and lifestyle. Actively carrying out the construction of civil-military integrated emergency logistics, unmanned technology has been of great significance for the construction of emergency logistics security system of "peacetime emergency, wartime response and combination of peacetime and wartime". It is also of great significance for making full use of military and local logistics resources, coordinating military and local support actions, responding quickly to various emergency disasters and military conflicts, and building a powerful modern national defense. The unmanned emergency logistics systems of civil-military integration and military-civilian integration have provided powerful organization, command and coordination for the joint support of military-civilian emergency logistics.

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