

# Research progress and application of emergency plans in China: A review

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## Abstract

This paper presents a review of the research progress and practical application of emergency plan construction in China over the past two decades by using the literature analysis method and the case analysis method. The main content includes the development process and current status of the national emergency plan research, the basic structure of the emergency plan and the problems in practical application. The VOSViewer is introduced to analyze the improvement research conducted by Chinese scholars in the above aspects, and four main research directions is determined by literature keyword overlay visualization, namely technical models, emergency planning frameworks for different types of emergencies, overall emergency management, the epidemic situation of COVID-19. It can be concluded that at present, while some achievements have been made in the management and research of China's emergency plans there are still some shortcomings in the practical application, such as a lack of public awareness of emergency plans, insufficient coordination and cooperation between departments, and the lack of attention to training and implementation of emergency plans. The combination of practice and theory still has room for improvement. Therefore, this review provides direction for improving the operability of research results and China's emergency plan management system in the future.

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## Introduction

The emergency plan in the Emergency Response Law of The People's Republic of China is interpreted as 'a plan that specifies the organizational command system, responsibilities of emergency management, the prevention and warning mechanism of emergencies, disposal procedures, emergency security measures, and post-event recovery and reconstruction measures for emergency events'. Chinese scholars also have their own understanding of the definition of emergency plans: Liu believes that 'an emergency plan is a plan or scheme formulated in advance for possible emergencies to ensure rapid, orderly and effective emergency rescue operations and reduce casualties and economic losses'<sup>[1]</sup>. Song believes that 'an emergency plan is a plan made in advance for possible emergencies on the basis of collecting relevant information and analyzing its consequences and emergency capacity'<sup>[2]</sup>. In general, an emergency plan is a pre-developed action plan for solving an emergency in a practical, rapid, effective and orderly manner. It is formulated based on the national or local laws and regulations, the historical experience and practical accumulation of organizations, as well as the local policies and customs. The purpose is to improve the ability to protect public safety and deal with emergencies, to control, reduce and eliminate the serious hazards caused by emergencies, to protect the safety of lives and properties of the public, maintain national security and social stability, and promote comprehensive, coordinated and sustainable economic and social

development, while making the government emergency management more procedural and institutionalized, so that there are laws to follow and documents to check<sup>[3]</sup>.

In terms of the development of an emergency plan system, China gradually carried out the preparation of individual emergency plans in the late 1980s. Until the mid-1990s, the State Council issued the National Emergency Plan for Destructive Earthquakes, the Commission of Science, Technology and Industry for National Defense led the formulation of the National Nuclear Emergency Plan, and nuclear power enterprises prepared the Emergency Plan for Nuclear Power Plants. In 2003, China began to focus on emergency management and comprehensively promoted emergency management systems with 'one case, three systems' based on the experience and lessons drawn from the response to the Severe Acute Respiratory Syndrome (SARS) epidemic<sup>[4]</sup>. In July 2003, the General Office of the State Council set up a 'working group on emergency plans for public emergencies' to arrange the preparation of government emergency plans comprehensively. In 2005, the preparation of emergency plans for public emergencies in China was basically completed, and the framework system of national emergency plans with the main line of 'general - special - departmental - enterprise and institution emergency plans' was formed, which means that China has initially established its own government emergency management mechanism<sup>[5]</sup>. In 2006, the State Council issued the General Emergency Plan for National Public Emergencies and prepared several special/departmental emergency plans,

laws and regulations, which established the status and role of emergency plans in legal terms. In 2008, after experiencing the snow disaster in the south and the Wenchuan earthquake, the problems exposed in emergency management have been summarized by the government, then guidelines and policies have been proposed to further strengthen emergency management, which brought China to a new starting point for the optimization and construction of the emergency plan system<sup>[6]</sup>. In 2018, Ministry of Emergency Management of the People's Republic of China has been established in the institutional reform, which is responsible for responding to natural disasters and accidents<sup>[7]</sup>. In addition, the emergency management of public health emergencies was assigned to the National Health Commission, and the emergency management of social security emergencies was assigned to the Ministry of Public Security<sup>[8]</sup>. Thus, the emergency management of different types of emergency can be implemented professionally under this circumstance. In 2019, the Management Measures for Standardized Work in Emergency Management has been issued to further standardize the work of emergency management systems. Moreover, Corona Virus Disease 2019 (COVID-19) breaks out worldwide in late 2019. The prevention and control of COVID-19 has been incorporated into the management of infectious diseases in accordance with the law and emergency plan for public health emergencies<sup>[9]</sup>. In 2022, the State Council issued the 14<sup>th</sup> Five-Year Plan for the National Emergency System, in which the requirement of 'strengthening emergency plan preparation' was put forward, including improving the plan management mechanism, speeding up the preparation and revision of plans and strengthening the evaluation of plan exercises.

Emergency plans play an important role in the development of emergency management systems in China. To make the review more comprehensive, this paper will analyze the importance of emergency plans from the level of China's emergency management system and organise research on emergency plans in China and its applications. This paper reviews the research progress and

practical applications of emergency planning construction in China over the past two decades.

## Classification and composition of emergency plans

### Classification

According to different criteria, emergency plans in China can be divided into different categories. The classification standards of emergency plans in China are shown in Fig. 1.

#### Different types of public emergencies

Public emergencies are divided into four categories in China:<sup>[10]</sup> natural disasters, accidents, public health incidents and social security incidents, as shown in Table 1. China has put forward corresponding emergency plans for four different types of public emergencies.

#### Different geographic areas of influence

According to the geographical scope of emergency plans, emergency plans can be divided into: national, provincial, regional, county, city or community, township and village emergency plans. This corresponds to the current four level administrative division of 'province, city, county and township' in China<sup>[11]</sup>.

This is significantly different from the bottom-up approach to building the emergency plan system in the US, which started early in emergency management. The reason is related to the different political systems of the two countries. In the US, the federal-state relationship is cooperative, while in China, the relationship is one of top-down administrative guidance. The top-down approach of promoting emergency plans at all levels from the national level is more in line with China's national conditions<sup>[12]</sup>.

From the composition of emergency plans, there are differences and similarities between the national emergency plans of the two countries. The composition of the National Response Plan (NRP) issued by the US in 2004 is shown in Table 2. The differences can be found by comparing Table 2 with the composition of the General Emergency Plan for National Public Emergencies(GEPNPE) issued by China in 2006

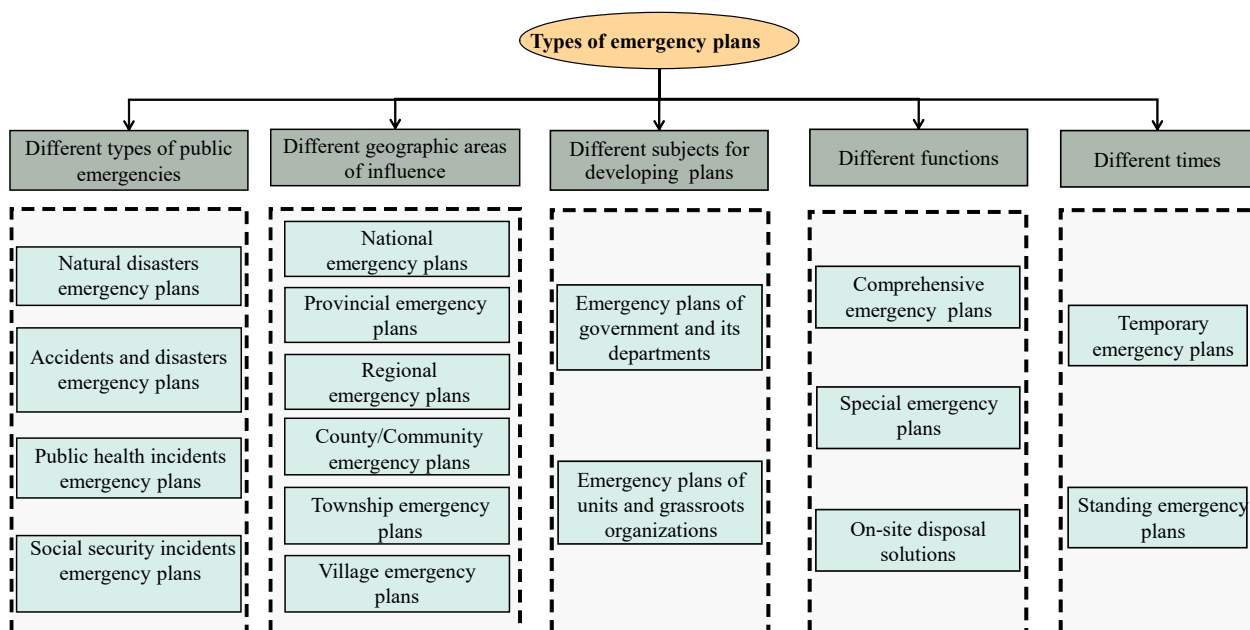


Fig. 1 Types of emergency plans.

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(Table 3): Firstly, component III of the NRP not only refers to the professional organizations of the state and government involved in GEPNPE, but also gives nongovernmental and volunteer organizations, private sector and citizen involvement corresponding emergency responsibilities. This is because events are usually managed at the lowest possible geographical, organizational and jurisdictional level in the US, grass roots organizations play a major role in emergency response. Secondly, compared with China's clear administrative guidance relationship from top to bottom, the coordination between regions and departments in dealing with emergencies in the US is critical. Therefore, the component IV of the NRP separately clarifies the responsibilities and coordination management of various departments and regions, while the component V separately mentions how to conduct emergency actions under the Homeland Security Advisory System (HSAS) threat

conditions, which is related to the differences between the national conditions of the two countries. Other structures and content are similar between the two countries.

Under the national conditions of China, the scope of responsibility of emergency plans with different geographical influence varies.

The accidents or objects targeted by the national emergency plan are the facilities or places whose impact scope exceeds the boundaries of provinces, municipalities directly under the Central Government and autonomous regions as well as those listed as national accident potential and major hazard sources.

The accidents or objects targeted by the provincial emergency plan are major fire, explosion, poison leakage accidents, major dangerous goods transportation accidents, as well as provincial major accident hidden dangers and major hazard sources. It may be a large-scale disaster, or it may be a special

**Table 1.** Classification of public emergencies.

Public emergencies	Explanation
Natural disasters	Includes flood and drought disasters, meteorological disasters, earthquake disasters, geological disasters, marine disasters, biological disasters, forest and grassland fires, etc.
Accidents	Includes various safety accidents of industrial, mining, commercial and other enterprises, traffic accidents, public facilities and equipment accidents, environmental pollution and ecological damage accidents.
Public health incidents	Includes the epidemic situation of infectious diseases, mass diseases of unknown causes, food safety and occupational hazards, animal epidemics, and other events.
Social security incidents	Includes terrorist attacks, economic security incidents and foreign-related emergencies.

**Table 2.** Content framework of the US's emergency plan.

Component	Main content
I: Introduction	Includes purpose, scope and applicability, incident management activities, authorities and key concepts.
II: Planning assumptions and considerations	NRP is based on this section, it mentions assumptions that events are usually managed at the lowest possible geographical, organizational and jurisdictional level.
III: Roles and responsibilities	Includes state, local and governments, federal government, nongovernmental and volunteer organizations, private sector and citizen involvement.
IV: Concept of operations	This section describes the Federal coordinating structures, processes, and protocols employed to manage Incidents of National Significance. These coordinating structures and processes are designed to enable execution of the responsibilities of the President through the appropriate Federal departments and agencies, and to integrate Federal, State, local, tribal, NGO, and private-sector efforts into a comprehensive national approach to domestic incident management.
V: Incident management actions	Includes actions and NRP operations under the HSAS threat conditions.
VI: Ongoing plan management and maintenance	Includes coordination, plan maintenance and the National Incident Management System (NIMS) integration center.
VII: Appendixes	Includes a glossary of key terms, list of acronyms and authorities and references.
VIII: Annexes	Includes emergency support function annexes, support annexes and incident annexes.

**Table 3.** Content framework of China's emergency plan.

Component	Main content
I: General principles	Includes preparation purpose, preparation basis, guiding ideology, classification and grading, scope of application, working principles, classification and grading of emergencies.
II: Organizational system and responsibilities	Refers to the organization (department) and its responsibilities for the smooth operation of the emergency plan, including the leading organization (department), administrative organization (department), working organization (department), cooperative organization (department), expert group, etc., and defines the responsibilities of these organizations or departments in different stages of the emergency and different levels of emergency response.
III: Operation mechanisms	Includes prediction and early warning (early warning level and its release), emergency response (information report, advance disposal, emergency response, emergency end), recovery and reconstruction (aftermath disposal, investigation and evaluation, recovery and reconstruction, information release, social assistance, insurance).
IV: Emergency safeguard measures	Refers to various guarantees to deal with emergencies, including guarantees of personnel, material and property, medical care, legal system, transportation, public security, communication and information, facilities, technology.
V: Supervision and management	Includes publicity, training, drill, evaluation, responsibility, reward and punishment of emergency plans.
VI: Supplementary principles	Includes professional terms, effective time, reward regulations, improvement and revision of emergency plans, international emergency cooperation, implementation time of emergency plans.
VII: Appendix	Includes the address, contact information, standardized text, of relevant emergency response agencies and main responsible personnel.
VIII: Note	Explains the proper terms in the emergency plan.

accident that needs to be handled with special technology and equipment that is not available in the city or region where the accident occurred, and it needs to be controlled by the power of the whole province.

The accident or object of the regional emergency plan is an accident with a large impact range and serious consequences, or an accident that occurs on the boundary of two counties or county-level cities. Emergency rescue requires regional forces.

The accident or object of the emergency plan at the county, city or community level is that the impact of the accident can extend to the public area (community), but can be controlled by the power of the county (city, district) or community, and the power of the factory or industrial department involved.

The harmful effects of the accidents targeted by the village-level and town-level emergency plans are mostly limited to the battery limit of a unit (such as a farm, warehouse, railway station, factory, etc.), and can be contained and controlled by the on-site operators in the area. Such accidents may need to be controlled by the whole unit, but its impact is not expected to extend to the community (public area).

#### Different subjects for developing plans

According to the main body of formulation, emergency plans can be divided into two categories: emergency plans of government and its departments, and emergency plans of units and grassroots organizations. The emergency plan of the government and its departments means that the local people's governments at all levels and the relevant departments of the local people's governments at or above the county level formulate corresponding emergency plans for emergencies in accordance with relevant laws, regulations, rules, emergency plans of the people's governments at higher levels and their relevant departments, as well as the actual situation of the region. Its contents include general emergency plans, special emergency plans, departmental emergency plans, etc.<sup>[13]</sup>. For example, the emergency plan system in Xicheng District of Beijing includes: overall emergency plan, special emergency plan, emergency security plan, departmental emergency plan, social unit emergency plan, large-scale mass activities emergency plan, etc.

Emergency plans of units and grassroots organizations are formulated by government agencies, enterprises, institutions, social organizations, neighborhood committees, village committees and other legal persons and grassroots organizations, focusing on defining the person responsible for emergency response, risk and hidden danger monitoring, information reporting, early warning response, emergency response, personnel

evacuation and evacuation organizations and routes, emergency resources that can be called or requested, and how to implement them, so as to reflect self rescue and mutual rescue information reporting and early disposal characteristics<sup>[14]</sup>.

Taking China State Railway Group Co., Ltd. (CR), a well-known central enterprise, as an example, it has a complete emergency management system, the emergency plans from the head office down to the railway station all involve the organizational system and responsibilities, prevention and early warning, emergency response, post disposal, emergency security, training drills and other main contents, as shown in Table 4. In addition, the emergency plan of grass-roots units (stations) has added basic information such as the geographical environment around the station, emergency rescue training plan and other parts, which makes the content more detailed and more operable<sup>[15]</sup>.

#### Different functions

According to different functions, emergency plans can be divided into comprehensive emergency plans, special emergency plans and on-site disposal plans<sup>[13]</sup>.

The comprehensive emergency plan is the general outline of the emergency plan system of each unit or organization, which mainly describes the emergency work principles of accidents in general, including the emergency organization and responsibilities, the emergency plan system, accident risk description, early warning and information report, emergency response, safeguard measures, emergency plan management, etc. The special emergency plan is the customized emergency plan to deal with a certain type or several types of accidents, or for important production facilities, major hazard sources, major activities, etc. The content mainly includes accident risk analysis, emergency command organization and responsibilities, disposal procedures and measures, etc. The on-site disposal plan refers to the emergency disposal measures for specific places, devices or facilities according to different types of emergencies, mainly including accident risk analysis, emergency responsibilities, emergency disposal and precautions. The on-site disposal plan should be jointly prepared by its own on-site operators and safety management professionals according to the result of risk assessment, post operation procedures and risk control measures. Each unit shall determine the emergency plan system according to its own organization management system, production scale, nature of hazard sources and types of possible accidents, and the preparation of special emergency plans can be determined according to the actual situation of the unit. Small and micro units with single risk factors can only prepare on-site disposal plans<sup>[16]</sup>.

**Table 4.** Comparison of emergency plan framework of CR.

	Head office	Railway administration	Train operation depot	Railway station
1	General principles	General principles	General principles	General principles
2	Organizational system and responsibilities	Organizational system and responsibilities	Organizational system and responsibilities	The geographical environment around the station
3	Prevention and early warning	Prevention and early warning	Emergency rescue information network	Organization, personnel and responsibilities
4	Emergency response	Emergency response	Prevention and early warning	Emergency rescue equipment and support system
5	Post disposal	Post disposal	Emergency response	Organization and implementation of emergency rescue work
6	Emergency safeguard measures	Emergency safeguard measures	Post disposal	Emergency rescue training plan
7	Training and drilling system	Training and drilling system	Emergency safeguard measures	Appendix
8	Supplementary principles	Supplementary principles	Publicity, training and drills	
9		Appendix		

### Different times

According to different times, emergency plans can be divided into temporary plans and standing plans<sup>[17]</sup>. The standing plans is a set of action plans or programs for various types of emergencies, administrative regions at all levels, and the main body of formulation that have existed for a long time. Temporary plans are often used to deal with emergencies in short-term projects (such as occasional large gatherings or recreational and sports activities), and should be formulated by the responsible unit or the sponsor. For example, Beijing Emergency Management Bureau implemented 33 special plans such as the Overall Emergency Plan for the Opening and Closing Ceremonies of the 2022 Winter Olympic Games during the 2022 Winter Olympic Games and the Winter Paralympic Games to ensure the normal operation of the event. Common standing plans and temporary plans are shown in Table 5.

### Composition

At present, China's various emergency plans are mainly composed of eight parts<sup>[18]</sup>, including general principles, organizational system and responsibilities, operation mechanisms, emergency safeguard measures, supervision and management, supplementary principles, appendix and note. The main contents of each component are shown in Table 3.

The operation mechanisms, emergency safeguard measures and supervision and management are the core contents of emergency plans in China. Research on the structure of China's emergency plan mostly starts from these three parts. For example, Jiang et al. sorted out the demand for the use of knowledge base from three perspectives of public, rescuers and decision makers around the topic of emergency response, and combined with the process of each stage of emergency response, constructed a knowledge based system framework for emergency response from three dimensions of common sense knowledge, factual and empirical knowledge and arithmetic reasoning rules for optimizing the emergency process in the operation mechanism of rapid response function<sup>[19]</sup>. Shi et al. has built multi-level location models for different grades of emergency shelters to minimize the travel and construction costs and maximize the coverage rate<sup>[20]</sup>. Zhang et al. proposed a primary and secondary model for the evaluation of emergency plans by combining the multi-level evaluation method of fuzzy evaluation theory, and obtained more satisfactory results for the comprehensive evaluation of emergency response plans in the process of emergency handling<sup>[21]</sup>.

### Application

After the comprehensive promotion of emergency management in China, the emergency plan system has been conti-

nuously improved, and considerable achievements have been made to date. In this process, the operability of China's emergency plans has been gradually enhanced. This section analyzes the applications of emergency plans in different types of emergencies: Wenchuan earthquake in 2008, Kunming violent terrorist incident, explosion accident in Tianjin harbor and the COVID-19 epidemic. The effectiveness and shortcomings of emergency plans are revealed through its application in emergencies.

### Wenchuan earthquake in 2008

Wenchuan earthquake occurred on May 12<sup>th</sup>, 2008 at 14:28:04 (UTC+8). According to the observation data of the Earthquake Administration of the People's Republic of China, the Wenchuan earthquake had a magnitude of 8.0 on the Richter scale and its intensity reached 11 degrees. It was the most destructive earthquake since the foundation of the People's Republic of China and the one with the most serious casualties after the Tangshan earthquake<sup>[22]</sup>. The emergency response process of this earthquake is shown in Fig. 2.

The central ministries and commissions responded very quickly to the Wenchuan earthquake. Thirteen minutes after the earthquake, the China Earthquake Administration made a quick report of the time, location, and magnitude of the earthquake, launched the Level I response of the emergency plan, and sent the on-site emergency team and emergency rescue team to Wenchuan<sup>[23]</sup>. Eighteen minutes after the earthquake, the army also launched the emergency plan, and made advanced preparations and subsequent rapid intervention. More than an hour later, the central government, in accordance with the National Earthquake Emergency Response Plan, quickly decided to enable the emergency response to earthquake disasters of level I (the highest level). All levels of governments and functional departments from the central government to the local government have set up earthquake relief headquarters, and rescue groups have been set up within the headquarters. Departments have joined forces to form a synergy<sup>[24]</sup>. The National Committee for Disaster Reduction launched Level II response and upgraded the response level to Level I at 22:15 that night. The Ministry of Health (MH) dispatched several health emergency teams to the earthquake stricken areas to carry out rescue work, and required to arrange the work of the emergency teams according to the specific casualties and medical needs of each region; The Red Cross Society (RCS) quickly allocated a large number of relief materials from the Chengdu Disaster Preparedness Center of the Red Cross Society of China on the same day, and immediately launched an emergency plan for natural disaster relief. In order to ensure the timely and safe delivery of disaster

**Table 5.** Common standing plans and temporary plans.

Standing plans	Temporary plans
General Emergency Plan for National Public Emergencies	Overall Emergency Plan for the Opening and Closing Ceremonies of the 2022 Winter Olympics
Marine Disaster Emergency Plan	Work Plan for Medical and Health Security at the 2011 Boao Forum for Asia Annual Meeting
National Emergency Plan for Flood Control and Drought Relief	Emergency Plan for Environmental Emergencies in Longgang District of the 26th Shenzhen Summer Universiade
Emergency Plan for Drug Safety Emergencies in Jiangxi Province	Emergency Plan for Traffic Diversion around the International Exhibition Center of the 3 <sup>rd</sup> China International Import Expo
Emergency rescue plan for production safety accidents of CR	Overall Emergency Plan of Hangzhou for Emergencies during the 2020 CRCC Asian Paralympic Games
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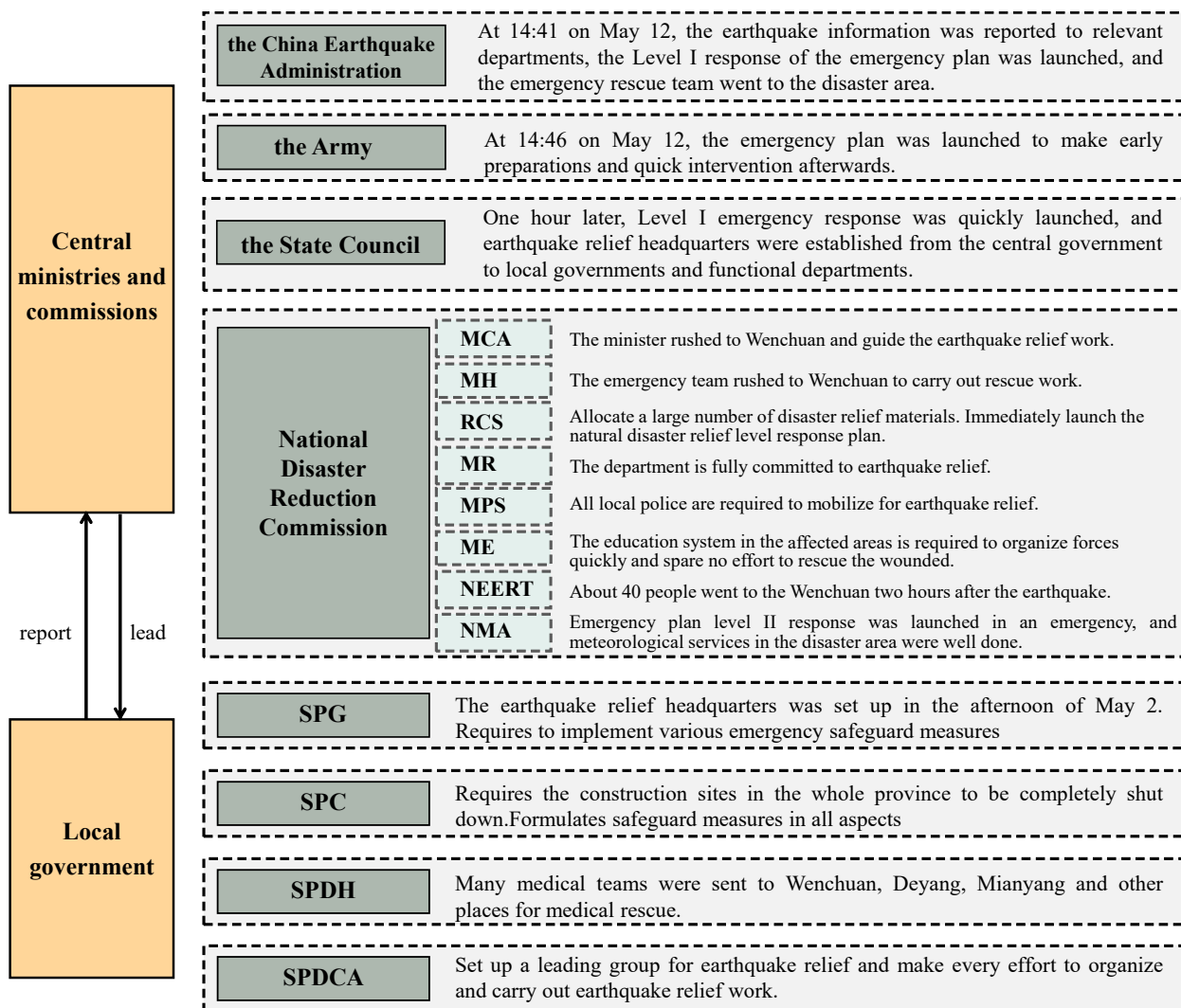


Fig. 2 The emergency response process of Wenchuan earthquake.

relief materials to the disaster area, the Ministry of Railways (MR) is fully committed to earthquake relief. The Ministry of Public Security (MPS) issued an emergency notice, requiring all police to mobilize and fully commit to earthquake rescue. The Ministry of Education (ME) issued a circular requesting the education system in the affected areas to organize forces quickly and spare no effort to rescue the injured, especially focusing on primary and secondary schools and kindergartens; About 40 members of the National Earthquake Emergency Rescue Team (NEERT) have taken a plane to Wenchuan earthquake stricken area two hours after the earthquake; The National Meteorological Administration (NMA) launched the Level II emergency response plan, and the director asked the meteorological department in Sichuan, Shanxi, Chongqing, Gansu and other provinces (cities) to do their best to provide meteorological services in disaster areas.

The local government also responded very quickly. Sichuan Provincial Government (SPG) issued an emergency notice in the afternoon of the earthquake day, requiring relevant departments to investigate potential safety hazards of reservoirs, bridges, dangerous roads, culverts, etc. in various regions according to emergency plans and the actual situation of the earthquake. Sichuan Provincial Department of Construction

(SPC) issued a notice requiring the construction sites in the province to be completely shut down. The relevant departments have made arrangements for the guarantee of communication, water, electricity, gas and transportation. Chengdu promptly inspected housing safety, controlled dangerous houses, and evacuated people from houses with large ruptures. Sichuan Provincial Department of Health (SPDH) promptly dispatched several medical teams to Wenchuan County, Deyang City and other places for medical rescue. The medical team prepared blood bags and a large number of first-aid medicines. In addition to the medical teams that have been dispatched, Sichuan has also set up the first, second and third level medical and health rescue echelons to be ready at any time. On the night of the earthquake, Sichuan Province set up headquarters for earthquake relief, and in accordance with the Sichuan earthquake emergency plan, the earthquake relief headquarters was set up in each city and state. The Sichuan Provincial Department of Civil Affairs (SPDCA) has set up a leading group to fully organize the earthquake relief work. As the focus of earthquake relief shifted from life rescue to survivor relief, the Sichuan Provincial Government has put forward the policy of 'local, nearby and decentralized resettlement' in a timely manner in combination with the actual

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situation, and implemented various emergency security measures through the distribution of living materials, relief funds, tents, mobile houses, reinforcement and maintenance of old houses, emergency repair or new water supply facilities.

The emergency response to disaster revealed some shortcomings of the Sichuan provincial emergency plan system at that time. Firstly, the estimation of the future disaster was too conservative during the preparation of the plan. This led to insufficient quantity and types of emergency supplies at the time of the catastrophe, and collection and preparation of materials was hasty, the first batch of materials took 40 h to arrive at Chengdu East Railway Station. Secondly, the preparation of the emergency security section did not take into account the topography of the region, meteorological changes and other characteristics, which led to the lack of emergency logistics security, the blocked delivery of materials after the disaster and poor information. Wenchuan County is surrounded by many mountains and due to successive rainy days after the earthquake, the traffic section situation is extremely unstable, prone to secondary disasters resulting in casualties. Thirdly, a large number of people were not specifically resettled at the time of the earthquake, and the emergency plan lacked rehearsal and was not re-revised in time to identify problems. This earthquake also promoted the planning and construction of urban emergency shelters in China<sup>[25]</sup>. Finally, the publicity and education of emergency plans are lacking. In this earthquake, most people, especially students in schools and patients in hospitals, lacked the necessary knowledge of emergency self rescue, so that many people lose short and precious time to escape and eventually lose their lives when the earthquake occurred<sup>[26]</sup>.

**Kunming railway station violent terrorist incident**

At 21:12 on March 1<sup>st</sup>, 2014, five terrorists, armed with machetes, started to display the banner of violence and terror from the temporary waiting area of Kunming Railway Station, wantonly hacked and killed innocent people in the square in front of the station, the second ticket area, the ticket lobby, small pieces depository and other places, resulting in 31 deaths

and 141 injuries, 40 of which were serious. The consequences of this violent terrorist incident are the most serious among China's social security incidents in recent years. After this violent terrorist incident, all departments responded quickly, launched the emergency plan quickly, and took timely, effective and rapid measures to contain the incident. The main situation of emergency response is shown in Fig. 3.

**Rapid response:** Immediately after the violent terrorist attack in Kunming, Kunming Public Security Bureau reported the situation to the superior department and sent a large number of police to the scene. Emergency traffic control is implemented from Yongping Road to the railway station. Trains that should have entered Kunming station are arranged to stop at other stations temporarily. Two hours after the incident, Kunming Railway Station resumed ticket sales. At 0:16 on March 2<sup>nd</sup>, the Ministry of Public Security and Yunnan Provincial Government gave work instructions and sent representatives to the scene of the crime to command the emergency work. At 1:00, the central representative went to the scene to guide emergency work. At about 5:00, the order of Kunming Railway Station has returned to normal. It can be seen that the rapid recovery of order and the normal operation of society can not be separated from the rapid response ability after encountering unconventional emergencies.

**Launch the emergency plan:** Kunming Public Security Bureau launched the emergency plan within 20 min after the incident and reported it to the relevant departments of Yunnan Provincial Government. Yunnan Provincial Public Security Department, First Aid Center and other departments launched the emergency plan in the early morning of March 2<sup>nd</sup> and sent additional personnel to the scene. At 9:00 on March 2<sup>nd</sup>, after receiving the reported cases, the Ministry of Public Security quickly launched the emergency plan and mobilized relevant experts to go to Kunming with the Central Working Group. This shows that the application of emergency plans at the grass-roots level and even at the national level has played a key role in the emergency response of this incident.

**Departmental linkage:** Public security department, health

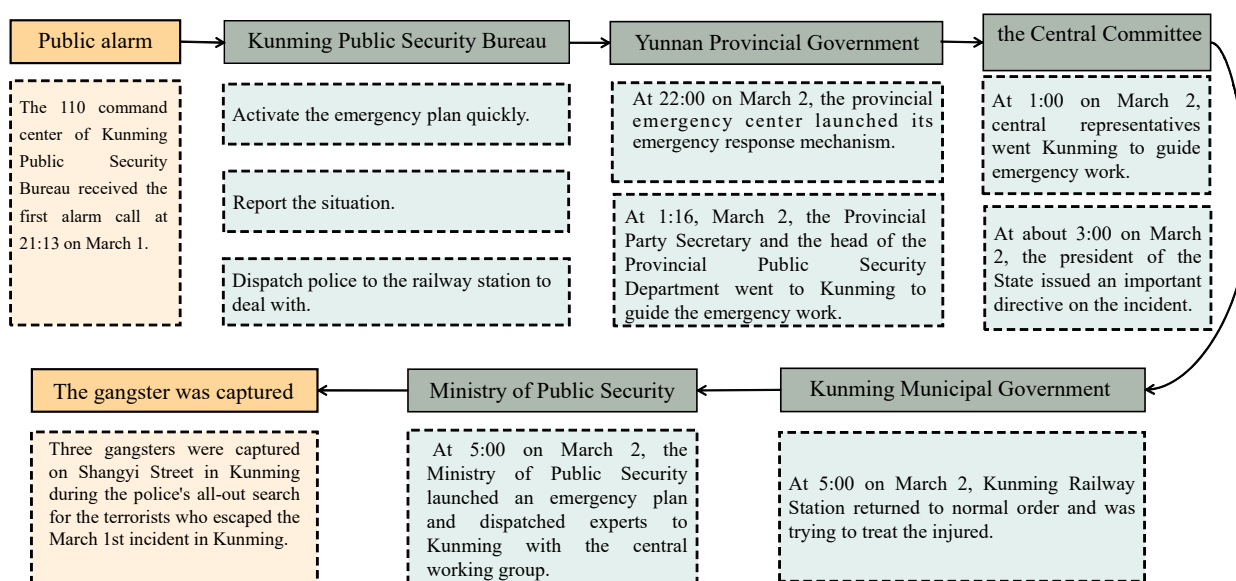


Fig. 3 Emergency disposal process of Kunming railway station violent terrorist incident.

department, fire department, transportation department and other related departments launched the emergency plan immediately after the case occurred and carried out the corresponding work according to their functions. Details are shown in Table 6. Kunming Public Health Department immediately launched the emergency response mechanism to carry out medical rescue work. Yunnan First Aid Center dispatched 13 ambulances and 80 medical personnel to transfer casualties in this incident. The fire brigade dispatched quickly to actively cooperate with the public security department to rescue the injured, protect the evacuated population and quickly control the development of the incident. The transportation department is responsible for traffic security, ensuring the safety of public facilities such as stations and densely populated places, and preventing dangerous persons and goods from getting on the train and entering the station<sup>[27]</sup>.

Although the emergency response of the incident was rapid and effective, the process also exposed the deficiencies in the implementation of the emergency plan in China.

Firstly, there is a lack of anti-terrorism awareness and poor early warning monitoring. The terrorists were already preparing in the surrounding areas of Yunnan before the Kunming Railway Station Violent Terrorist Incident. Three days before the incident, three of their accomplices had been caught in Shadian Township, but the relevant agencies did not pay attention and security efforts failed to start.

Secondly, the coordination of various departments is not high. The railway police of Kunming Railway Station used its own system for management, which was too slow to connect with the safety management system of Kunming City. The coordination among various departments needs to be improved, and the anti-terrorism mechanism needs to be strengthened.

Thirdly, there is a shortage of emergency supplies. The police on duty at the station are not equipped with weapons. If the weapons are in place, the police who first arrived at the scene can disable the perpetrators in time, which may have reduced the casualties.

### Explosion accident in Tianjin harbor

An explosion accident in Tianjin harbor was an extraordinarily serious accident which occurred on August 12<sup>th</sup>, 2015. The basic situation of explosion accident in Tianjin harbor is shown in Fig. 4. At 22:51:46, due to the failure of wetting agent, nitrocellulose in the container in the south of the dangerous goods warehouse of the company was partially dried and decomposed, and the self ignition of the accumulated heat caused the nitrocellulose and other hazardous chemicals in the adjacent containers to burn in a large area for a long time. The first explosion occurred at 23:34:06, and the second more violent explosion occurred at 23:34:37. The accident site formed six large fires and dozens of small fires. At 16:40 on August 14<sup>th</sup>, the scene of the open fire was extinguished. The total energy of the explosion in this accident was equivalent to about 450 tons of TNT, resulting in 165 deaths, 8 missing people and 798 injured<sup>[28]</sup>. The fire department arrived at the fire scene 5 min after the accident. Meanwhile, the 119 Command Center of the Tianjin Public Security Fire Brigade immediately dispatched additional fire departments to the accident site according to the 'Tianjin Comprehensive Emergency Plan for Safety Production Accidents' and the surge in the number of alarms. Before the first explosion, more than 100 people were evacuated to the emergency shelter by the orderly organization of the staff of Ruihai Company, adjacent enterprises and nearby people.

Through checking the duty records, police order records and the investigation, it is known that the initial response is timely and the action is rapid, whether it is Tianjin Public Security Bureau or Tianjin Public Security Fire Brigade. This reflects that the emergency plan system of each unit is relatively complete, and the drills of emergency plans and the training of personnel are in place.

After the fire, Ruihai Company immediately reported to the fire department. After receiving the alarm, the 110 Command Center of Tianjin Public Security Bureau launched the emergency plan in time and reported the situation to the relevant departments, and then sent several fire brigades to the scene instantly. From the analysis of the monitoring video and

**Table 6.** Department linkage in the disposal process.

Department	Kunming Municipal Government	Yunnan Provincial Government	Central ministries and commissions
Department of public security	In the early stage, the focus of work was to deal with the emergency work at the scene, and in the later stage, the focus was to search for the terrorists who escaped from the incident.	The head of Yunnan Public Security Department went to Kunming to direct emergency work and sent police to reinforce Kunming.	After the incident, the Ministry of Public Security quickly launched an emergency response plan and sent relevant experts to Kunming overnight with the central working group. At 5:00 on March 2 <sup>nd</sup> , the Minister of Public Security went to Kunming to guide the disposal work.
Department of health	Kunming hospitals set up a medical treatment team headed by their director.	Yunnan Emergency Center launched the emergency response mechanism to assist Kunming in treatment work.	The National Health and Family Planning Commission sent representatives to join the central working group and went to Kunming in the early morning on March 2 <sup>nd</sup> to guide the handling of the incident.
Department of fire	The fire brigade actively cooperated with the public security department to rescue the injured, protect the evacuated crowd, and quickly control the development of the incident.		
Department of transportation	After the incident, emergency traffic control was imposed between Yongping Road and the railway station, and trains that were supposed to enter the Kunming station were temporarily stopped at other stations.	Undertake the provincial traffic security work. Strengthen the prevention and control of public facilities such as stations, operating vehicles and crowded places, and prevent dangerous people and goods from getting on the train and entering the station.	The Ministry of Transport shall guide the Yunnan Provincial Department of Transport in relevant emergency work.



Progress and application of China's emergency plan

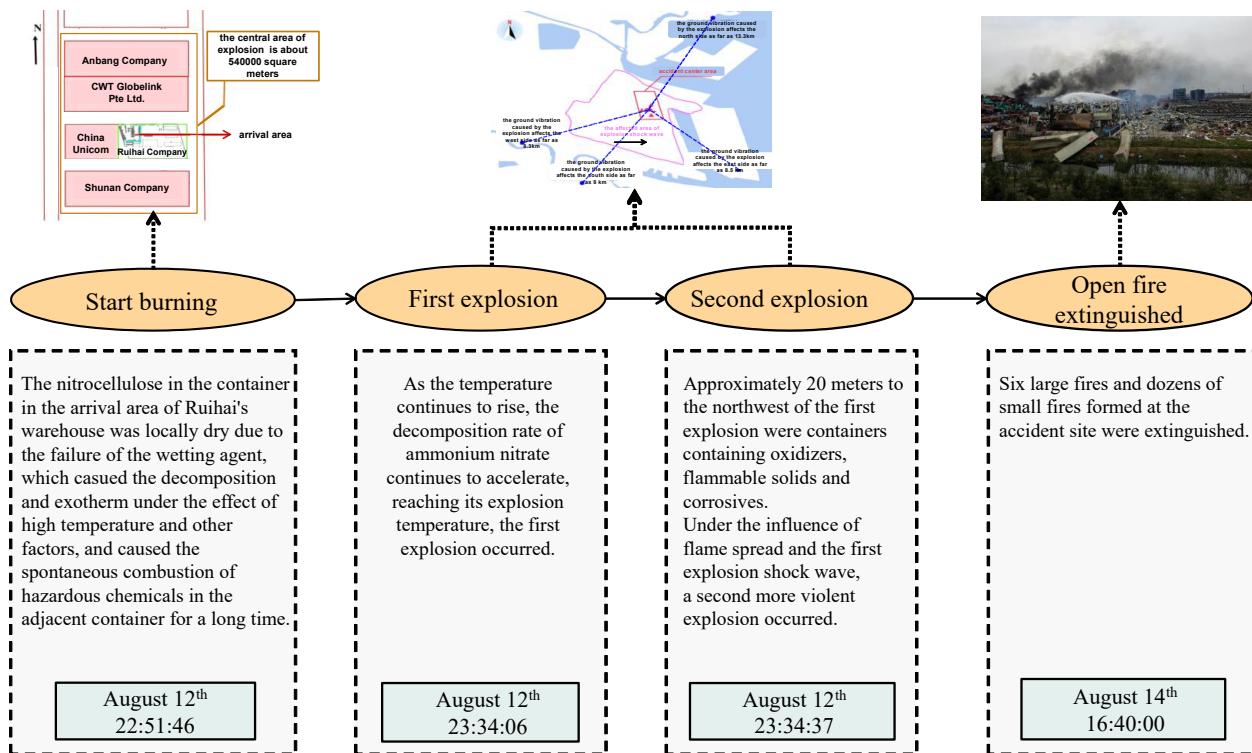


Fig. 4 The order of events of the explosion accident in Tianjin harbor.

the inquiry of the surviving firefighters and enterprise employees, it was learned that after the first batch of fire fighting forces arrived, the commander immediately carried out fire investigation, and learned about the enterprise's emergency plan, action rescue plan and other basic information from the enterprise employees present. The fire reconnaissance showed that the fire was fierce, the fire passage was blocked, and the fire substance was unknown. In this case, in order to prevent the fire from expanding and threatening the surrounding dangerous goods containers, the commander ordered to take measures of 'cooling control and evacuating the masses' according to the content of the operating mechanism of the emergency plan of the enterprise and the fire brigade and the actual situation. When the fire was fierce and the radiant heat was too high, firefighters evacuated from the arrival area and used vehicle mounted guns to shoot water to control the fire spread. At the same time, the captain of the fire brigade asked for reinforcements from relevant departments according to the dangerous situation, which realized the coordination among multiple departments. After the arrival of additional firefighters and rescuers, the container stack was watered down and covered with foam. Meanwhile, they organized the evacuation of the on-site staff of Ruihai Company and adjacent enterprises as well as the nearby people, and each unit properly settled the victims according to the requirements of the emergency safeguard measures in its own emergency plan. At 1:00 on August 13<sup>th</sup>, Tianjin Municipal Government set up an emergency rescue headquarters at the scene of the accident to keep abreast of the situation and emergencies on site. The headquarters uniformly dispatched emergency resources according to the actual situation, listened to the suggestions of relevant experts and made accurate decisions, which greatly reduced the secondary hazards of chemical pollutants and

prevented further deterioration of the explosion accident. Under the instructions of the relevant central and local government departments, the Tianjin Municipal Government mobilized rescue forces such as chemical prevention, medical and environmental monitoring, set up an efficient rescue and relief command system to adjust the rescue and disposal plan in time, to search and rescue, to prevent secondary accidents, and to carry out social pacification and public opinion guidance, which reflected that the central and local governments have taken effective measures in emergency security, recovery and reconstruction. The emergency disposal process of the explosion accident in Tianjin harbor is shown in Fig. 5.

However, the emergency response to this particularly serious production safety accident still reflects the many shortcomings of the emergency plan. First of all, Ruihai Company (now dissolved) had not carried out risk assessment and hazard identification assessment<sup>[29]</sup>, the emergency plan is a mere formality, the emergency response force and equipment are seriously lacking, and it does not have the ability to put out initial fires. Secondly, the fire brigade of Tianjin Port Public Security Bureau did not prepare corresponding plans, fire fighting and rescue equipment and materials for different types of dangerous chemicals, and the firefighters lacked professional training and drills, so the ability to deal with dangerous chemical accidents was not strong. The Tianjin public security and fire fighting forces also lack plans and corresponding equipment to deal with major hazardous chemical accidents, which also led to 110 public security and fire fighters being among the 165 victims, accounting for two-thirds of the deaths<sup>[30]</sup>.

Due to the imperfection of the emergency plan of the enterprise, the firefighters and even the plan preparation personnel are not clear about the type of hazardous chemicals

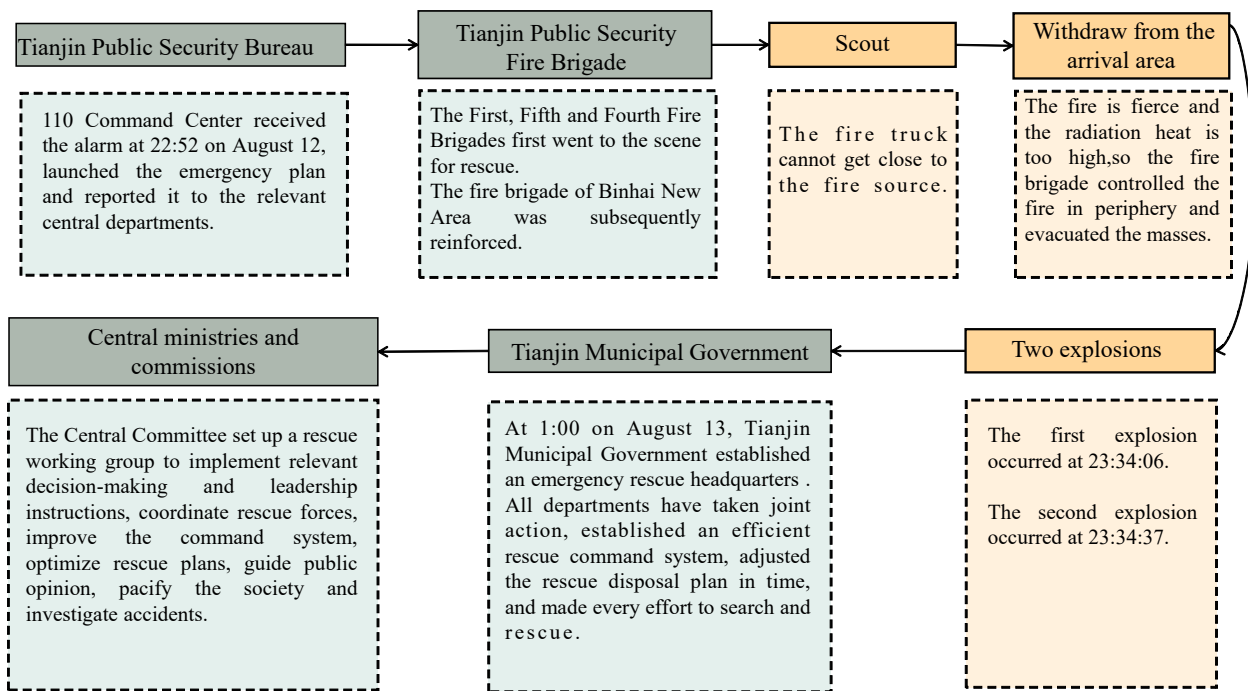


Fig. 5 Emergency disposal process of the explosion accident in Tianjin harbor.

stored in the Ruihai company and the specific substances on fire. About 20 meters northwest of the first explosion point, there were several containers containing ammonium nitrate, potassium nitrate, calcium nitrate, sodium methoxide, metal magnesium, metal calcium, silicon calcium, sodium sulfide and other oxidants, flammable solids and corrosives. However, firefighters still used foam fire extinguishers and water-based fire extinguishers to cover and protect containers, which indirectly promoted the second explosion.

### Corona Virus Disease 2019

Since December 2019, a number of cases of unexplained pneumonia have been identified in some hospitals in Wuhan, Hubei Province, and confirmed as acute respiratory infections caused by 2019 novel coronavirus infections<sup>[31]</sup>. The latest data from the WHO website shows that as of December 23<sup>rd</sup>, 2022 CET, there were about 650 million cumulative confirmed cases of new coronavirus pneumonia and 6.65 million cumulative deaths worldwide. Some of the important initiatives made by China in the prevention and control of the new crown epidemic are shown in Fig. 6.

In the previous period, that is, the end of December 2020, the Hubei Provincial Health Commission immediately activated the 'Emergency Plan for Public Health Emergencies in Hubei Province' after receiving reports of cases to carry out prevention and control of the epidemic, under the unified leadership of the Hubei Provincial Emergency Command for Public Health Emergencies in accordance with the division of responsibilities in the emergency plan. Provincial Department of Public Security, Department of Finance, Department of Human Services, Department of Environmental Protection and other relevant departments have organized and coordinated the emergency response of public health emergencies in the municipal, prefectural, county and provincial governments within the scope of their duties. On January 1<sup>st</sup>, 2021 Wuhan South China Seafood Market immediately closed for remediation<sup>[32]</sup>.

After the central government confirmed the epidemic

situation of novel coronavirus pneumonia on January 3<sup>rd</sup> 2021, China has regularly and proactively notified the epidemic information to the World Health Organization, relevant countries and regional organizations including the US, as well as Hong Kong, Macao and Taiwan regions of China<sup>[33]</sup>.

In the medium term, in order to limit the spread of the epidemic to the maximum extent, on January 16<sup>th</sup>, China released the first version of the national level novel coronavirus infected pneumonia epidemic prevention and control plan mainly in accordance with the National Emergency Plan for Public Health Emergencies, and revised it six times within 50 d according to the development and changes of the epidemic. Due to the increasingly serious epidemic situation, on January 22<sup>nd</sup>, Hubei Province launched a Level II emergency response to major public health emergencies, which was upgraded to Level I response two days later. On January 23<sup>rd</sup>, the channels to leave Wuhan were closed<sup>[34]</sup>.

According to the contents of the plans at all levels, during the epidemic, the circulation of vehicles and personnel throughout the country was strictly controlled, the inspection and prevention efforts were increased, and citizens' self-protection awareness and ability were also improved. To ensure the health emergency response and rescue work and the basic living needs of the infected people, Wuhan and other places established shelter hospitals in an orderly manner, and the relevant departments strengthened coordination and cooperation to contain the epidemic, so as to achieve emergency security. On April 26<sup>th</sup>, COVID-19 patients in Wuhan hospital were cleared, and the prevention and control of COVID-19 achieved phased results<sup>[35]</sup>.

During the latter period, China adhered to the principle of prevention and promulgated several documents based on emergency plans for public health emergencies, such as the 'Guidance on Scientific Prevention and Control of the New Coronary Pneumonia Epidemic by Zoning and Grading', and implemented various initiatives.

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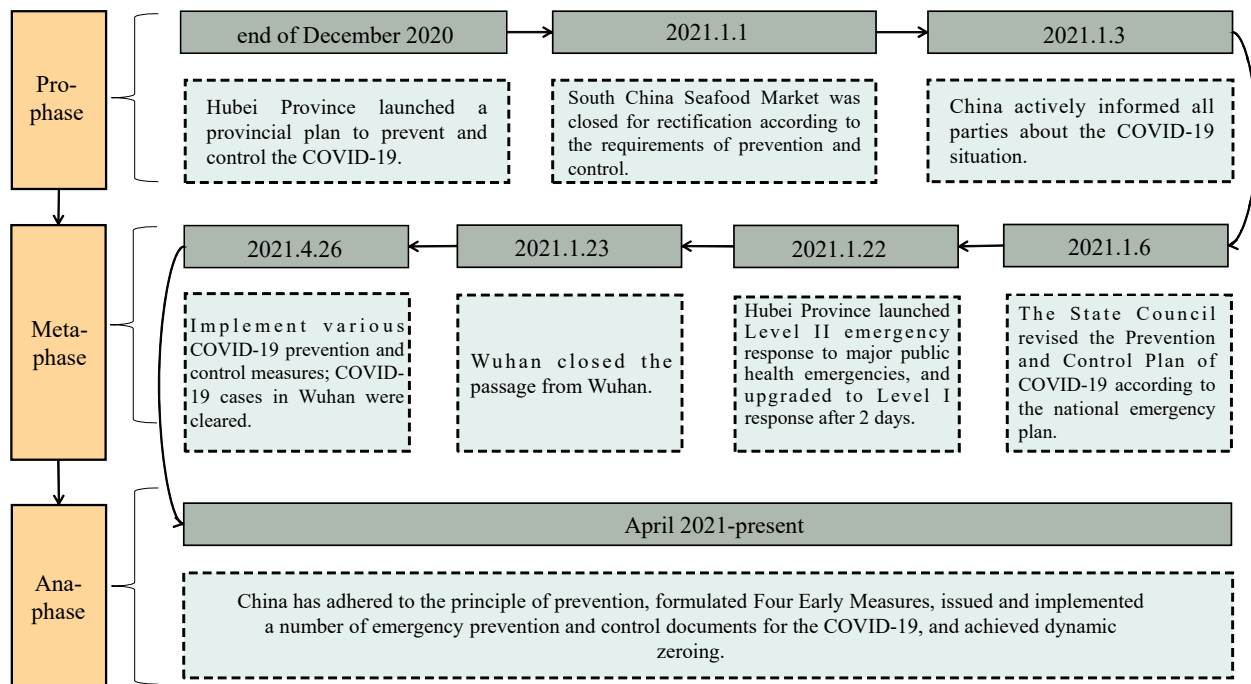


Fig. 6 The important initiatives made by China during the COVID-19 epidemic.

All localities determine the nucleic acid sampling population and sampling frequency according to the severity of the epidemic situation and risk classification. Implementation of the four early measures of 'early detection, early diagnosis, early isolation and early reporting'<sup>[36]</sup> and the four centralized measures of 'concentrated patients, experts, resources and treatment'<sup>[37]</sup> to achieve dynamic zeroing.

In general, according to the emergency plan for public health emergencies and various policy guidelines, China responded quickly in the early stage of the epidemic, dealt strictly with avoiding harm in the middle stage, and continued monitoring and investigation and dynamic clearance in the later stage, which ensured the epidemic was under effective control.

### Deficiencies in China's emergency plans

The current emergency plans and emergency management in China have a complete system, and a review of the case studies shows that the China's emergency plans are indeed comprehensive, systematic, authoritative, and practical<sup>[38]</sup>, but also reflect the common deficiencies of the current China's emergency plans.

#### Contents are formulated without considering actual risks

This deficiency is particularly reflected in the grass-roots emergency plan in China. The overall emergency plans at the national, provincial and municipal levels are generally inclusive, that is, the provisions in principle account for most of the content, and the actual operation needs to be supplemented and modified by the lower level emergency plan makers according to the actual situation of the region. However, most of the lower level departments formulate emergency plans by copying the emergency plans of the higher level departments, rather than preparing plans according to the actual situation. In particular, the local grass-roots emergency plan is more cursory, lacking guidance, rough and simple content, involving few specific operational items, and does not effectively solve the problem of who to do what, when to do what, where to do

what, what to do, and how to do it.

Taking earthquake disasters as an example, most grassroots organizations have formulated earthquake emergency plans, but the specific implementation and operation of the plans are far from the actual requirements, and most of the plans are only one page long. This makes many emergency plans unable to guide the response to emergencies. In the face of emergencies, we can only rely on the leaders' personal ideas and command to solve problems. In this way, the emergency plan has become a mere scrap of paper to deal with inspections<sup>[39]</sup>, which leads to no further improvement in the operability of the emergency plan.

#### Emergency plan evaluation, training and drills are neglected

The preparation of the emergency plan is often put in focus, but this is only the first step in the completion of the emergency plan. Preparation, evaluation, training and drills all belong to the scope of the emergency plan, the current emergency plan lacks the assessment of risks and hazards, the evaluation of emergency response capabilities and scenario drills. In the framework and content of the guiding principles for preparation of plans, the status and role of plan training, drills, update and maintenance are not clearly defined. The form, scope and evaluation criteria of planned drills, the cycle plan of plan training, including the content and objectives of training, the subjects, objects, activities, the time of occurrence of activities, the assessment and records of training, the period of plan update and the need for update are not included in detail and clearly written into the guiding principles for preparation of the plan, and no continuous feedback and improvement mechanism has been formed. These have led to the unfamiliarity of some organizations with the process of emergency plans, the reduced efficiency of emergency response to emergencies and the weak operability of emergency plans.

Therefore, although emergency management system in

China is developing rapidly and the emergency plan system is relatively perfect, the emergency plan prepared has not been evaluated and modified in time, and lacks personnel training, emergency drills and dynamic management<sup>[40]</sup>, in many emergency plans, the quantity is guaranteed but the quality is not.

#### *Professionals lack awareness of emergency plans*

Not only the masses but also most professionals lack awareness of emergency plans. Looking at the special major accidents in the past five years, the investigation reports of each accident often use 'the instructions and attention of leaders' as the basis for initiating emergency response, rather than starting emergency rescue procedures according to the emergency plan. There is also no relevant department to publish the emergency plan to the society in a timely manner through various avenues, so that various social subjects have a responsibility list, code of conduct guide and practical operation path map, which leads to poor results in accident rescue, security and other aspects. Moreover, the accident investigation report rarely mentions the rectification and revision of the emergency plan. As a result, the responsible subject does not pay attention to the update of the emergency plan, which is likely to lead to the recurrence of the accident.

#### *Inadequate coordination and cooperation among departments*

China's emergency plans are prepared by a government, an institution or a unit at a certain level according to different classifications<sup>[41]</sup>. However, actual disasters are compound in nature and usually require joint responses from all parties. If joint formulation of emergency plans with other responsible entities is not considered to deal with complex disasters, the lack of collaboration with other departments is not conducive to the complementarity of advantages among departments and affects the efficiency of responding to emergencies even more.

For example, according to the Law of the People's Republic of China on Emergency Response and the Law of the People's Republic of China on Prevention and Control of Infectious Diseases, the emergency response to the COVID-19 epidemic is mainly in the hands of the health administration, but the emergency response after the 'city closure' in Wuhan and other places far exceeded the responsibilities and capabilities of the health administration. Extensive social mobilization, supply guarantee of emergency materials, control of personnel flow, and stabilization and control of the social order required concerted efforts at all levels of government and various social organizations. However, the emergency management department, which has a strong professional rescue force and comprehensive emergency coordination resources, is not playing a greater role in the epidemic response due to the limitation of functional division, 'it can neither participate in emergency decision-making nor emergency deployment, and is in the awkward situation of being nominal and impractical'<sup>[42]</sup>. In the case of the Ministry of Emergency Management, although it has largely solved the problem of poor horizontal communication in the emergency response of natural disasters and accidents, it still needs to focus on the communication and interface between emergency management departments and related departments such as public security, health, transportation, industrial information, meteorology, energy, communication, and ecology and environment in the process of revision of relevant emergency plans<sup>[43]</sup>.

## **Improvement measures**

VOSviewer is a software tool for constructing and visualizing bibliometric networks<sup>[44]</sup>. It builds and presents bibliometric maps based on the co-citation principle of the literature with differences in distance, size and density between nodes, and can be used for cluster view, overlay view and density view of the literature to assess the research directions and hotspots. Nodes of the same color are used as a cluster, and different colors distinguish different clusters. The distance between nodes indicates the closeness and similarity between subject terms, the node size represents the number of occurrences, and the higher density means the closer the connection and the stronger the relevance.

In this section, VOSviewer is used to make a visual analysis of 3,509 articles retrieved from CNKI ([www.cnki.net](http://www.cnki.net)) and Web of Science ([www.webofscience.com](http://www.webofscience.com)). In all databases of SCl (since 1985), there are 1,298 articles with the theme of both 'China' and 'emergency plan'. The keywords of these articles can be selected for analysis. Set the keyword repetition threshold to 10, and the keyword overlay visualization is obtained as shown in Fig. 7. There are 2,211 articles with the theme of 'Emergency Plan of China' in CNKI. Similarly, set the keyword repetition threshold of these articles to 10, and the keyword overlay visualization is obtained as shown in Fig. 8.

According to the keyword overlay visualization presented by two authoritative literature databases at home and abroad, the keywords can be classified and summarized into four research directions, as shown in Table 7.

### **Model-based multi-perspective research**

In all articles with the theme of 'China' and 'emergency plan' in the Web of Science, the keyword 'model' appears 158 times, which is one of the most important keyword clusters, and is closely related to other clusters. At the same time, building a model is also the most important research method used to carry out risk assessment and simulation for the types or structural parts of emergency plans. For example, Gai et al.<sup>[45]</sup> introduced the vulnerability analysis model to analyze the evacuation risk assessment in major accident areas and its application in emergency plans; Yao et al.<sup>[46]</sup> highlighted the double objective spatial optimization model to determine the best urban fire station location, providing technical support for emergency support research in the emergency plan. The above two papers can reflect that scholars gradually attach importance to the impact of actual risks on the formulation of emergency plans, which also makes the contents of emergency plans more practical and significantly improves the operability of emergency plans. Wang et al.<sup>[47]</sup> established a time space network model to solve the planning problem of dynamic emergency logistics. The proposed model and algorithm provide strong support for decision-makers. In recent years, most scholars have also used models to study the management of the emergency planning system for the COVID-19 epidemic, for example, Xu & Wang<sup>[48]</sup> established an index and weight system with the AHP-TOPSIS method and ranked the evaluation objects so as to evaluate the emergency management capability of the government and related departments for the emergency safety events of the COVID-19 vaccine, which is of great importance and positive significance.

From the literature published in this direction, the current emerging technologies and improved theories have been

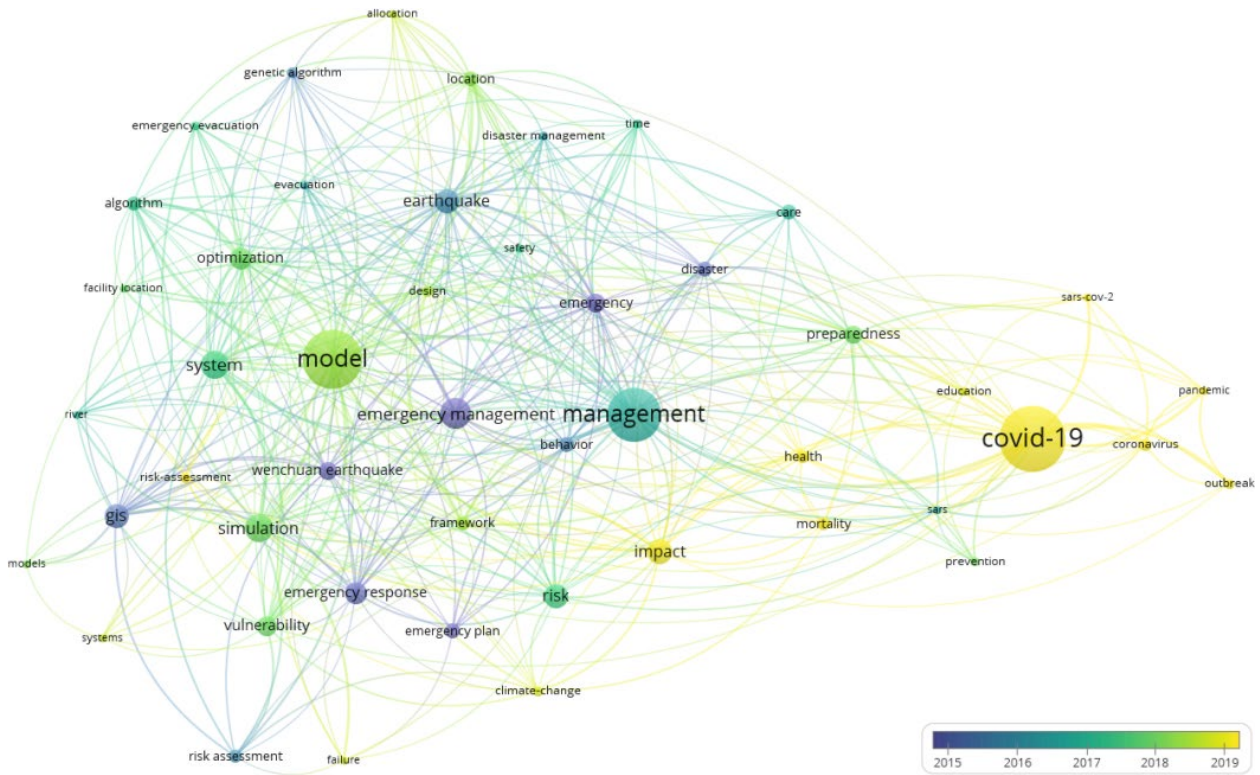


Fig. 7 The keyword overlay visualization in all databases of SCI.

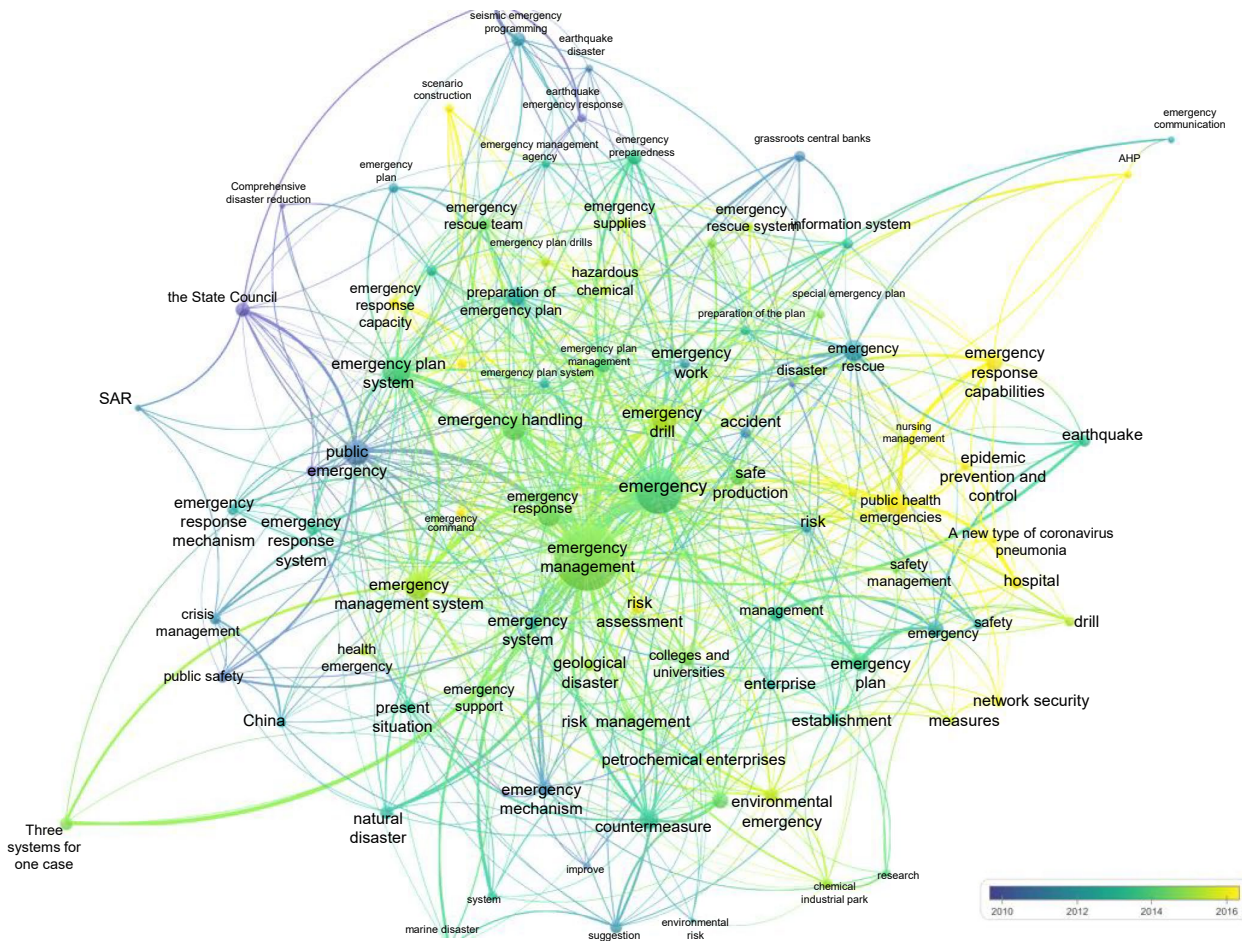


Fig. 8 The keyword overlay visualization in CNKI.

**Table 7.** Research directions of emergency plans in China.

Clustering keywords	Research direction
Model, Management, Simulation, Emergency plan, GIS, et al. Earthquake, Shanghai stampede, Climate-change, Public emergency, Public health emergencies, et al. Emergency management system, Emergency mechanism, Emergency drill, Emergency plan system, Emergency rescue, Evacuation, Optimization, et al. Covid-19, Management, Emergency response, Preparedness, Epidemic prevention and control, Emergency plan system, Special emergency plan	Model-based multi-perspective research on emergency plan of China. Multi-faceted research on emergency plans of China from different types of emergencies. Research on the deep logic of emergency plan system from the perspective of overall emergency management in China. Study on the emergency plan for the epidemic situation of COVID-19.

combined to establish models to conducted risk assessment and simulation of China's emergency plans from a technical perspective, in order to improve and optimize China's emergency plan system. For example, the increase in digital twin technology<sup>[49]</sup> and VR technology<sup>[50]</sup> in recent years has provided new research entry points, which may become the future development direction.

### Multi-faceted research from different types of emergencies

In all articles with the theme of 'emergency plan of China' in CNKI, the keyword 'emergencies' appears 217 times, the case analysis method is usually used to analyze the deficiencies of emergency plans under different scenarios and physical environments based on different types of emergency plans or typical domestic emergencies (such as the related keywords like 'wenchuan earthquake', '2014 Shanghai stampede', 'Corona Virus Disease 2019' in the Overlay Visualization), so as to conduct improvement research. For example, Jiang Rengui et al.<sup>[51]</sup> uses modularization and flow chart methods to realize digital visualization of urban waterlogging emergency plans, which can be used to guide urban flood control and disaster reduction and emergency management. Zhang et al.<sup>[52]</sup> analyzed the defects of the national earthquake emergency plan through summing up the experience of on-site rescue in a major earthquake, refined the contents that need to be further clarified and refined in earthquake emergency plan of China, and put forward suggestions to improve the operability of the emergency plan; Kan et al.<sup>[53]</sup> describes the design, implementation and evaluation of a desktop exercise for emergency preparedness in water resources projects, which provides ideas that can be used for the development of emergency management training. According to the various papers in this research direction, it can be seen that the research on the evaluation, drill and other links of the emergency plan has also become a hot spot.

### Deep logic of emergency plan system study from perspective of overall emergency management

In Figs 7 & 8, management clustering also accounts for a large proportion. Public management discipline is the major of most scholars in this field, and the literature mostly studies the operation of the emergency plan system in the national governance system from the policy perspective.

For example, Gao<sup>[5]</sup> by reviewing the construction process of China's emergency management system, has made a relatively systematic study on the establishment of emergency plans and other issues at both the theoretical and practical levels. It not only summarizes the achievements, characteristics and experience of China's emergency management system construction, but also puts forward suggestions for developing and

improving the emergency management system. If we want to improve and optimize the emergency plan system, we must strengthen the coordination and cooperation between all departments from the management level. Zhong<sup>[54]</sup>, through sorting out the evolution system and characteristics of China's national emergency management system, proposed many measures to promote the construction of the emergency management system, including systematically revising the emergency plan and other levels to build a sound system, providing a solid legal framework for emergency management. Zhu et al.<sup>[55]</sup> analyzed the current situation of China's railway emergency plans from the perspective of emergency management, and put forward strategic thinking on standardized management of China's railway emergency plans for the existing problems.

There has been a trend of decreasing submissions in recent years, but there are still many shortcomings in the management of the emergency planning system in China from a practical point of view<sup>[56]</sup> and many entry points for improved research.

### Study on the emergency plan for the epidemic situation of COVID-19

The outbreak of novel coronavirus challenges the emergency management capacity of the whole country, and this is another research hotspot in the field of emergency management in China in recent years. During this period, scholars and even the government have raised their awareness of emergency plans and understood the importance of emergency plans as the leading role of 'one case, three systems'. Many studies were conducted on laws, regulations, management, culture and other aspects of emergency management under novel coronavirus, and many high-quality documents also emerged. For example, Zhang et al.<sup>[57]</sup> summarized the policy differences between China and Germany in dealing with the first wave of COVID-19, providing policy experience for other countries still in the midst of severe epidemics; Jiang & Wu<sup>[58]</sup> from the perspective of the legal system, discussed how to balance the emergency plan and emergency management legal system under the emergency management system of 'one case, three systems'. Chen & Huang<sup>[59]</sup> also pointed out the drawbacks of emergency plans exposed after public health emergencies and the corresponding solutions.

### Future needs and direction

As the key and foundation in the construction of 'one case, three systems' emergency management system in China, the emergency plan has received more and more attention from researchers. In combination with the content of the National Emergency System Plan for the 14<sup>th</sup> Five Year Plan and the

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shortcomings of China's emergency plan summarized above, six future research directions are proposed.

Firstly, from the perspective of improving the management mechanism of emergency plans, it is necessary to study how to strengthen the binding effect and rigidity of emergency plans, improve and update the classification and grading of emergencies and other detailed standards, so as to realize differentiated management and precise policy-making.

Secondly, the evaluation procedures of the emergency plan in the whole process of preparing the emergency plan needs to be improved to change the characteristics of the emergency plan, which are empty in content and low in operability.

Thirdly, from the perspective of emergency management, methods such as scenario simulation and big data can be used to optimize personnel training and actual exercises of emergency plans, and the allocation and guarantee of emergency resources, so as to improve the scientific nature of China's emergency plans.

Fourthly, it is also an urgent necessity to study the optimization method of emergency rescue force for the 'personnel support' part of the emergency plan structure to improve the handling capacity of urgent, difficult and dangerous tasks, and strengthen the construction of safety emergency support capacity.

Fifthly, from the perspective of emergency management or psychology, analyzing the methods to improve the public and professionals' awareness of emergency plans, is conducive to the wide use of emergency plans.

Sixthly, it is necessary to improve the research of the emergency plan system. In addition to the functional features of the emergency plan in the content, it should also ensure the efficient connection between the superior and subordinate emergency plans, and more attention should be paid to the research of collaborative governance with other departments.

In addition, the novel coronavirus epidemic in the past two years has also exposed the inadequacy of China's emergency plan research<sup>[60]</sup>. In the post epidemic era, multi angle research on the national and grass-roots emergency capacity and public health emergencies will also become the future demand.

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## Conflict of interest

The authors declare that they have no conflict of interest.

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