

Chapter 2

Emergency Management System

A complete emergency management system comprises of one plan and three systems, that is, an emergency plan and an emergency management setup, emergency mechanism, and emergency legal system. The emergency plan involves emergency plan management and emergency organization management.

2.1 Emergency Plan Management

An emergency plan refers to a plan that is drawn up ahead of time for possible major catastrophes, with a view of carrying out emergency rescue rapidly, in good order, and efficiently and thus reducing the losses arising from the disasters. Based on the identification and evaluation of the types, likelihood of occurrence, process, consequences, and impact degree with respect to the major latent risks and/or accidents, an emergency plan makes detailed arrangements of responsibilities, emergency personnel, emergency technologies, emergency equipment, emergency materials, rescue actions, and command and coordination of emergency resources for emergency organizations. In other words, an emergency plan makes clear issue such as what to do, when to do, and how to do (for example, emergency strategies and resource preparations) before, during, and after the occurrence of unforeseen events. Drawing up an emergency plan is the core of emergency preparedness. To enhance the capability to meet unforeseen events, it is imperative to draw up and carry out the emergency plans scientifically, reasonably, and normatively.

2.1.1 Procedure for Emergency Plan Management

Centered on the plan objectives, plan management focuses on the process to draw up, adjust, carry out, and evaluate a plan.

1. Overview of plan management

Plan management is a subsystem of the management activities of decision-makers. This subsystem has unique management functions and characteristics that not only affects its methodology and organizational pattern, but also determines its responsibility scope and role in the whole decision-making system.

(1) Responsibilities and characteristics of plan management

The planning department is responsible for the analysis, formulation, checking, adjustment, and appraisal of the emergency plans.

Plan management is characterized by decision-making, restrictiveness, and comprehensiveness [1].

① Decisional role

Decision-making mainly implies the decision-making role of plan management. The decision-making procedure of plan management can be described as follows: a. The planning department draws up a general policy and major targets for the plan according to top managers' strategic decisions and development forecast; b. different specialized departments draw up detailed specialized plans accordingly and submit them to the planning department; c. the planning department calculates, adjusts, and comprehensively balances the targets for the specialized plans, thus building a complete and organic plan target system and forming a finalized plan accordingly; d. the planning department releases the finalized plan among different specialized departments and instructs them to carry out the finalized plan (as depicted in Fig. 2.1). Determining the plan targets and releasing the finalized plan are actually a process of decision-making that the planning department performs as per the organizational objectives.

② Restrictiveness

Restrictiveness is mainly embodied in two aspects: a. Once the comprehensive plan of an organization is finalized, the different specialized departments should carry

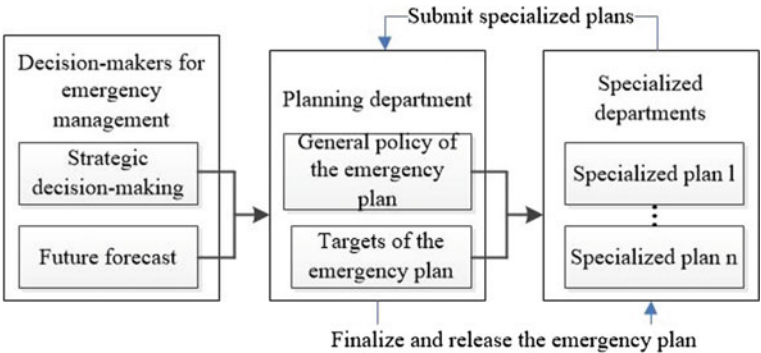


Fig. 2.1 Flowchart for decision-making in plan management

out the finalized plan seriously and not adjust the finalized plan without prior consent let alone refuse to carry it out. As needed, a specialized department may adjust certain plan targets by following a strict procedure: (I) submitting the adjustment request to the planning department for review and approval; (II) submitting the adjustment request to the superior department for review and approval; (III) having the related plan targets balanced by the planning department.

b. The planning department has the right to check and appraise the implementation of the comprehensive plan among the different specialized departments and decide to reward or punish certain specialized departments accordingly.

③ Comprehensiveness

Comprehensiveness implies that plan management involves the work of a decision-making department in diverse circumstances. Through the planning work and the decision-making department, it builds a direct and important business relationship with all specialized departments, and integrates them into comprehensive plan management.

(2) Requirements for emergency plan management

The objectives of the entire emergency activity need to be accomplished through effective plan management. Perfect plan management helps to enhance the capability to cope with unforeseen events. All available resources should be carefully planned, balanced, and coordinated, so that they can be mobilized, allocated, and combined efficiently to ensure sound and orderly implementation of the whole emergency plan. Usually, emergency plan management should meet the following requirements:

① Prospectiveness, Foresightedness

For the planning work, first and foremost, it is necessary to know the ever-changing external environments accurately, acquire the related information promptly, accurately and flexibly, screen, summarize, and process the acquired information carefully and conduct predictive analysis. The intent is to ensure that the plan can serve the onsite emergency needs better.

② Scientificity and effectiveness

If the plan targets are too high, they will be difficult to accomplish. If the plan targets are too low, the supply guarantee capability will be wasted in vain. Thus, it is advisable to set reasonable plan targets.

③ Seriousness

The seriousness of a plan is built on its scientificity. A great deal of analysis is indispensable. Moreover, a plan should be carried out without the slightest disregard once it is released among the departments concerned.

④ High quality

While a plan is carried out, it is necessary to conduct statistical analysis in real time. The intent is to discover the existing problems, take appropriate measures, and ensure the realization of the plan targets.

2. How to draw up an emergency plan

For emergency management, the primary task is to draw up a reasonable emergency plan. When drawing up an emergency plan, people should observe certain principles and follow the specified procedure.

(1) Principles for drawing up an emergency plan

In drawing up an emergency plan, people can learn from the six principles for drawing up a project plan (including goal orientation, systematic approach, cost-effectiveness, dynamism, correlation, and functionality). In addition, the following principles should also be observed:

- ① Plan as early as possible: To meet a crisis event properly, it is necessary to draw up a response plan with foresight, take prudent measures, and make preparations against various unforeseen events as early as possible.
- ② Respond rapidly: It is necessary to strengthen the manpower, material, and financial reserves to enhance the capability to meet various unforeseen events. People should abide by the principles of “early, rapid, and strict,” to make a quick and appropriate response to crises.
- ③ Prevent and control scientifically: It is necessary to monitor the unforeseen events, regulate the operation procedure for emergency activities, and ensure scientific and normative prevention and control of unforeseen events. In addition, it is necessary to publicize emergency response knowledge and enhance the capability of the masses to meet unforeseen events seriously. In case of an unforeseen event, it is necessary to take appropriate measures promptly, control the event site rapidly, cut off transmission paths, and prevent the disaster from spreading.

(2) Procedure for drawing up an emergency plan

Usually, drawing up an emergency plan comprises of the four steps: ① setting the targets, ② making a task list, ③ making a support plan, ④ demonstrating and amending the plan repeatedly (as depicted in Fig. 2.2).

① Targets of the emergency plan

It can be said that emergency activities really take effect only when the needs of the victims of unforeseen events are satisfied.

The targets for an emergency plan can be set in the following ways: a. determining the goal of emergency activities. In the face of an unforeseen event, the planners should identify the needs of disaster-stricken people quickly to take suitable measures; b. making a list of needs. Based on the knowledge of early-stage disaster sites, the planners should make a list of needs and then prioritize them.

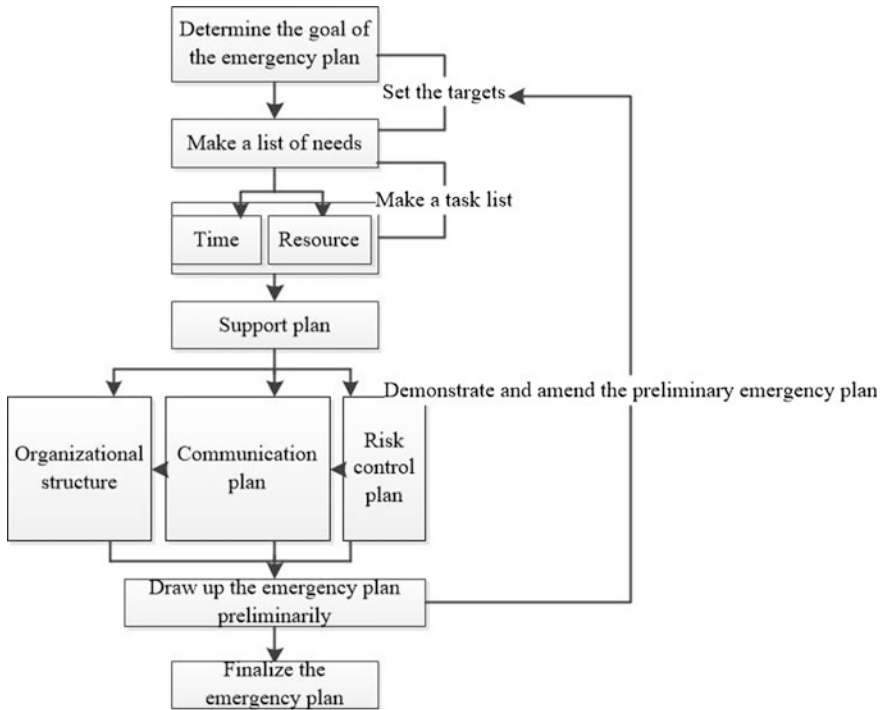


Fig. 2.2 Flowchart for drawing up an emergency plan

According to the list of needs, the planners can establish a full set of measurable targets that may be incorporated into the emergency plan.

② Task table of emergency plan

Based on the targets above, the planners should create a task table, which contains the following content: a. the time (by hours or days) required for accomplishing the targets; b. the manpower and material resources required for accomplishing the targets.

③ Support plan

While an emergency plan is drawn up, some auxiliary support plans are indispensable, including: a. organizational structure plan: appointing the departments or individuals responsible for the emergency plan, and defining their roles and responsibilities clearly; b. communication plan: creating a communication plan document which instructs different emergency personnel how to obtain the required information, reporting the progress and achievements of emergency activities promptly, and defining the subsequent tasks; c. risk management plan: using a simple risk diary to track the risks in the emergency plan, identifying new risks, and recording the risks in the risk diary, and instructing how to prevent and handle such risks.

④ Demonstration and amendment of emergency plan

An emergency plan should be demonstrated and amended strictly before it is carried out. The emergency plan should be demonstrated and amended on the following principles: a. the emergency plan should be adjusted in a target-driven manner rather than at will to attain a highly targeted balance; b. the amendment of the emergency plan is related to dynamic system engineering; the changes in any element of emergency activities are likely to affect other elements, so sometimes a feasible plan can be drawn up only through repeated practical feedback; c. the maximum/minimum deviations of the targets for the emergency plan that is allowed should be taken into consideration. When the deviations of such targets are controlled within an acceptable range, the emergency plan does not need to be amended, but the implementation of the emergency plan needs to be monitored more intensively. When the deviations of such targets go beyond the acceptable range, the planners should consider amending the emergency plan.

3. How to carry out an emergency plan

An emergency plan is mainly intended to guide the implementation of emergency activities. While an emergency plan is drawn up, it needs to be demonstrated and revised repeatedly. Therefore, drawing up and carrying out an emergency plan are two intersecting and inseparable activities.

(1) Influencing factors for the implementation of emergency plan

The implementation of an emergency plan may be influenced by the following factors: ① background and scope of the emergency plan: including emergency prevention, preparations in the state of emergency and actual emergency response; ② risk evaluation and hazard evaluation: risk evaluation refers to identifying the latent damage and casualties, hazard evaluation refers to the evaluation of the probability of damage and casualties, and risk evaluation is the precondition for hazard evaluation; ③ emergency site management: an actual emergency site refers to the place where the emergency plan is carried out and response actions are taken; ④ responsibilities of government agencies and expert panels: in particular, the implementation of an emergency plan has to do with the action policies and responsibilities of governmental agencies in the prevention, preparedness, and response stages; ⑤ stipulated support (including communication, transport, medical treatment, and search and rescue): the required emergency tool equipment and materials should be prepared as stipulated to facilitate the implementation of the emergency plan.

(2) Principles for carrying out an emergency plan

An emergency plan should be carried out on the following principles:

① Dynamic control

If actual emergency activities during the implementation of an emergency plan comply with the emergency plan, the implementation of the emergency will be

guaranteed. If actual emergency activities deviate from the emergency plan, appropriate measures should be taken to ensure that the emergency activities comply with the adjusted emergency plan. If the implementation of the emergency plan is disturbed by new factors, new deviations are likely to occur and the implementation of the emergency plan should still be brought into dynamic control.

② Systematic

As a matter of fact, the implementation of an emergency plan is to systematically solve problems by using systematic theories and methods. This is embodied in two aspects: a. to control the implementation process of an emergency plan, it is necessary to draw up various plans for emergency related activities, including the time schedule and resource plan; the objects of such plans are arranged in descending order and their contents are arranged from general to specific ones, thus forming a complete emergency related activity plan system; b. to ensure the implementation of the emergency plan as scheduled, special functional departments or personnel should be appointed at different levels to check, measure, analyze, and adjust the emergency plan; that is, the implementation of the emergency plan involves a variety of subjects and personnel, so it is necessary to build a complete organizational system for carrying out the emergency plan.

③ Closed cycle

The whole implementation process of an emergency plan is a full set of cycled routine activities (for example, drawing up a plan, carrying out a preliminary plan, making check, comparison and analysis, proposing adjustment measures, and amending the plan), which constitutes a closed cyclic system.

④ Informational

Information provides the basis for carrying out an emergency plan smoothly. Therefore, it is necessary to build an information system to constantly transfer and give feedback information. On one hand, the planning information about emergency activities is transferred top-down to the related implementation personnel, so as to carry out the emergency plan. On the other hand, the actual implementation information about emergency activities is fed back bottom-up to the departments and personnel concerned for analysis, so as to make appropriate decisions and adjust the emergency plan accordingly. In this sense, the implementation of an emergency plan is a process of information transfer and feedback.

⑤ Flexibility

Usually, emergency activities are very complex and influenced by diverse factors. As such, the makers of an emergency plan should be able to foresee the degree of influence and probability of occurrence of different factors according to experiential statistics, and analyze the risks faced by plan implementation in setting the targets of the emergency plan.

4. How to evaluate an emergency plan

An emergency plan should be drawn up and carried out in a scientific way to bring everything under control and reduce the hazards and losses arising from unforeseen events. In contrast, an unsound emergency plan will bring about problems like ambiguity of emergency responsibilities, aimlessness of emergency measures, and inefficiency of emergency activities. Therefore, it is advisable to attach importance to not only the making and implementation of an emergency plan, but also the evaluation of the effectiveness of the emergency plan. To improve the scientificity and reasonableness of an emergency plan, it is imperative to evaluate it correctly.

(1) Functions of the evaluation of an emergency plan

Plan evaluation refers to evaluating the efficiency and effectiveness of a plan based on the data on related activities, characteristics, outcomes, and influences. As an integral part of emergency plan management, emergency plan evaluation adjusts and controls the emergency activities on the whole to ensure that the emergency related activities achieve the intended targets.

① Verifying the effectiveness of an emergency plan

Measuring and judging the effectiveness of an emergency plan is the most important function of emergency plan evaluation. Plan evaluation serves to verify whether the decision-makers possess adequate planning competence and whether plan targets or tasks have been accomplished.

② Diagnosing the problems in an emergency plan

Problem diagnosis is another major function of emergency plan evaluation. Plan evaluation helps the decision-makers in the following aspects: a. knowing whether the plan targets set by them are reasonable, the planning methods used properly, and the key difficult points of the emergency plan clearly defined; b. identifying the current status and existing problems in the implementation of the emergency plan; c. finding out the reasons for the difficulties in carrying out the emergency plan; d. adjusting the planning strategy, improving the planned measures, and solving various problems in the emergency plan in a target-oriented way.

③ Providing feedback information

The results of emergency plan evaluation not only provide a large amount of feedback information for judging the status of the emergency plan by the decision-makers, but also help the implementers of the emergency plan know more about the status of implementation directly. With the results of emergency plan evaluation, both the decision-makers and implementers can clearly know whether the emergency plan is drawn and carried out perfectly.

④ Guiding the emergency plan

The setting of correct targets and key points of an emergency plan is usually influenced by emergency plan evaluation. Further, the direction, key points, and

schedule in carrying out an emergency plan are usually affected by the contents and criteria of emergency plan evaluation.

⑤ Adjusting and controlling the implementation process of emergency plan

Adjusting and controlling the implementation process of an emergency plan is also a major function of emergency plan evaluation. This function is built on the verification of effectiveness, diagnosis of existing problems, and feedback of diverse information with respect to the emergency plan. Specifically, this function covers the following points: a. adjusting the direction and targets; b. changing the speed and pace of implementation; c. changing the planning methods and strategies; d. adjusting the plan contents to actual conditions.

(2) Details of the evaluation of an emergency plan

An optimal emergency plan should be characterized by the flawlessness in its structure and contents, definite division of responsibilities, and high operability. Such an optimal emergency plan enables people to face various unforeseen events promptly, orderly, and efficiently to reduce casualties and property losses to a minimum. Following Liu et al. [2]; Liu et al. [3]; and Zhang et al. [4], this book recommends that an emergency plan should be evaluated through three aspects: ① responsibility matrix (departmental responsibility); ② flawlessness in emergency plan (demand); ③ operability of emergency plan (task).

① Responsibility matrix

When coping with unforeseen events, the ambiguity in the division of labor and responsibility causes buck-passing among the departments or personnel concerned, leading to the inefficiency and even failure of emergency actions. Evidently, proper division of responsibility among the emergency departments or personnel is of crucial importance to emergency plan evaluation. This can be accomplished by building a responsibility matrix. The responsibility matrix involves three elements: task, role, and responsibility. The specific three elements vary greatly with the target objects. For example, for an emergency plan oriented toward unforeseen events, the three elements are emergency process, emergency personnel, and responsibility.

Taking the example of a natural disaster oriented emergency plan, this book describes how to use the responsibility matrix to evaluate the emergency plan [2]: a. appointing emergency personnel, making task breakdown for the emergency process, and dividing the emergency responsibilities; b. assigning responsibilities among the roles according to the emergency plan; c. using the emergency process as the horizontal coordinate and the emergency personnel as the vertical coordinate and specifying the responsibilities of emergency personnel in the emergency process, thus generating a responsibility matrix for the emergency plan; d. evaluating the responsibility matrix (as depicted in Fig. 2.3).

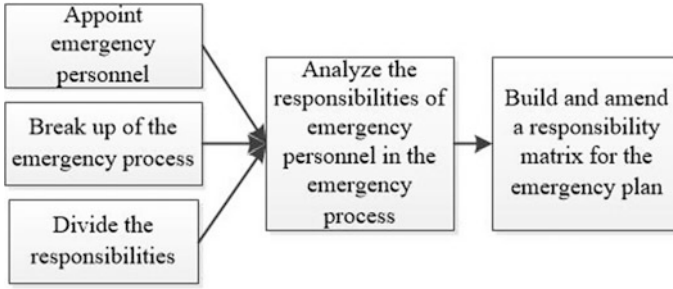


Fig. 2.3 Flowchart on responsibility matrix evaluation

② Completeness of an emergency plan

Completeness evaluation focuses on the correspondence relationship between task requirements and emergency measures. The degree of completeness of an emergency plan has a significant bearing upon the effectiveness of the emergency plan, so it is an indispensable element for emergency plan evaluation.

Here, the natural disasters oriented emergency plan is considered as an example. This book describes how to use fault tree analysis (FTA) to evaluate its completeness [3]: a. building a standard fault tree for the emergency plan with reference to collected emergency plan database for natural disasters and *The Emergency Response Law*; b. deriving the elementary event set for the system and the weight of each elementary event; c. comparing the proposed emergency plan with the elementary event set and determining the missing elementary events in the emergency plan (as depicted in Fig. 2.4). Then, the emergency plan needs to make enhancements and perfections in the missing elements.

③ Operability of emergency plan

The motive of an emergency plan is to inform the emergency personnel about what to do and how to do. To accomplish the tasks easily, it is advisable that the targets of the tasks should be defined as clearly as possible and the relationship between the tasks should be as simple as possible. Research findings indicate that people's cognitive and executive ability are somewhat degraded in a state of emergency, and as compared with simple tasks, complex tasks and their combination will reduce the implementation effect of the emergency plan. Therefore, it can be considered that the operability of an emergency plan directly depends on the complexity of elementary tasks and their combination. To evaluate the operability of an emergency plan, the key is to break up the task, extract critical information and actions, build a structure control diagram, and define a variety of complexity indexes [4] (as depicted in Fig. 2.5).

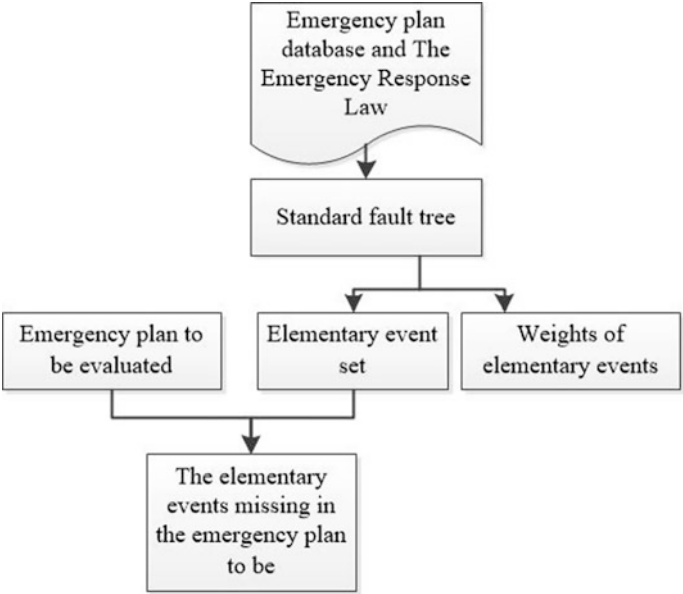
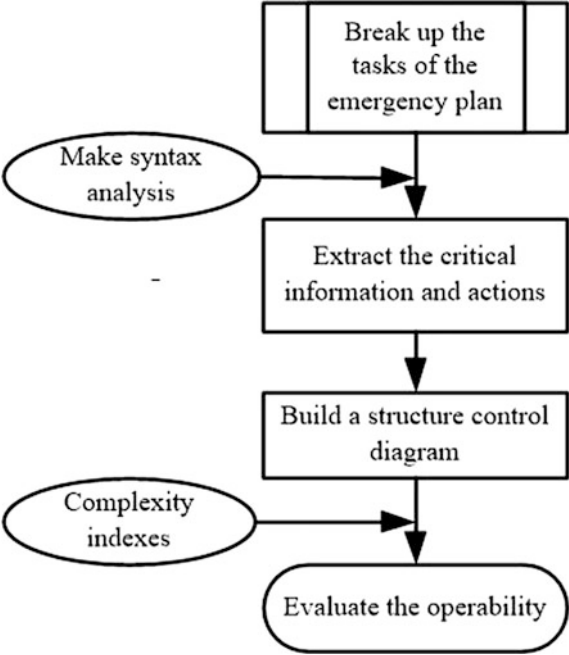


Fig. 2.4 Flowchart for evaluating the perfectness of emergency plan [3]

Fig. 2.5 Flowchart for evaluating the operability of an emergency plan [4]



2.1.2 Methodology and Tools for Emergency Plan Management

Certain methods and tools are used in drawing up special emergency plans for different industries. This section mainly describes the following four methods or tools: centralized/decentralized planning for urban emergency management, scenario-based emergency plan, capability-based emergency plan, and emergency drill plan.

1. Centralized/decentralized planning

To face unforeseen crises properly, centralized/decentralized planning is most commonly used for emergency plan management. The following section describes a combination of centralized planning and decentralized planning for urban emergency management [5].

(1) Decentralized planning for urban emergency management

In a narrow sense, the objects of urban public planning refer to the facilities that are used for a public purpose by urban residents in their daily social life. Quite a few of them may be planned in a decentralized manner for use as emergency facilities, for example, the life line system comprising urban squares, green lands, parks, gymnasiums, and roads (as depicted in Fig. 2.6).

① Emergency function of urban squares, green lands, parks, and stadiums

Urban squares, parks, and stadiums provide three types of emergency functions: pre- emergency function, in-process emergency function and post- emergency function. Specifically, such functions include [5]: a. mitigating the transmission of epidemic diseases effectively; b. isolating people from disasters; c. giving refuge to the disaster-stricken people.

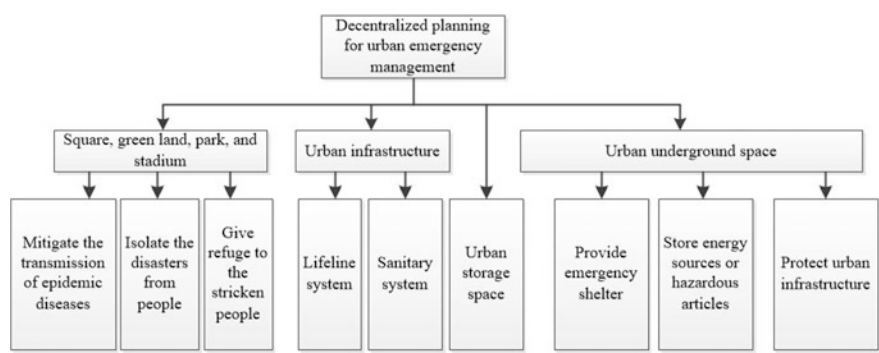


Fig. 2.6 Emergency functions under decentralized planning

② Emergency relief function of urban infrastructure

Urban infrastructure includes the lifeline system and sanitation system, which can give refuge to the stricken people in case of unforeseen events.

a. Lifeline system

Urban power supply, water supply, and gas supply are the critical infrastructure that serves to maintain normal life of urban residents; the urban infrastructure and urban roads are collectively referred to as the urban lifeline system. The urban lifeline system not only plays a significant role in daily life, but also provides a significant emergency function in case of disasters. For example, urban roads provide a refuting and evacuation space in case of disasters.

b. Sanitation system

In case of unforeseen disasters, a city may suffer from building damage, material supply failure, and casualties, thus deteriorating urban sanitary condition and increasing the possibility of disease occurrence and diffusion. After the occurrence of disasters, perfect sanitary infrastructure helps to maintain sanitary condition and prevent epidemics and reduce the occurrence probability of environmental accidents.

③ Emergency function of urban storage space

In case of disasters, the storage places (including grain depots and water reservoirs) distributed throughout a city can instantly provide victims with various life necessities or relief materials, alleviate the city's reliance upon external aid, and improve its disaster-bearing capacity.

④ Emergency refuge function of urban underground space

Underground space is a kind of closed building space that provides a powerful emergency protection and anti-disaster capability [5]. Urban underground space has the following three emergency functions: providing emergency shelter, storing energy sources or hazardous articles, and protecting urban infrastructure.

(2) Centralized planning for urban emergency management

Centralized planning for urban emergency management refers to the planning the distribution of urban facilities in a centralized manner and coordinating the functional activities of such infrastructure, with the motive of extracting their full capabilities (for example, disaster prevention, disaster protection, disaster rescue, and post-disaster rehabilitation and reconstruction).

① Emergency functionalization of urban space

Through reasonable urban planning or designing, centralized planning for urban emergency management enables a city to acquire not only a spatial structure with disaster prevention and rescue capabilities, but also an urban spatial layout helping the city give full play to its overall emergency capability. With respect to Wang Wei

[5], this book classifies centralized planning for urban emergency management into anti-disaster engineering construction and anti-disaster life space construction (as described in Table 2.1).

② Elements and criteria for centralized planning of emergency management

Like the abovementioned decentralized planning, centralized planning for urban emergency management involves a variety of basic infrastructure, including disaster prevention, rescue routes, evacuee shelters, firefighting system, medical aid system, public security system, material supply system, and sanitary system. When urban disasters occur, the deficiencies in any of the functional elements will affect the efficiency of the whole emergency management system and even cause a domino effect. For example, the deficiencies in medical aid forces will affect the efficiency of emergency rescue, and the deficiencies in fire fighting forces will affect the efficiency of firefighting.

Therefore, centralized planning for urban emergency management should focus on the essential functional elements and aim to satisfy the needs of disaster prevention and relief; the emergency functional elements should meet the specified standards (as described in Table 2.2).

Table 2.1 Composition of centralized planning and its anti-disaster functions [5]

Centralized Planning	Municipal Facilities		Anti-disaster Functions
Anti-disaster engineering construction	Firefighting facilities		Extinguish fire and rescue the trapped people
	Public security institutions		Maintain public security, and rescue the trapped people
	Medical institutions (rescue facilities)		Treat and cure the disaster-stricken people
	Material reserve facilities		Provide the required materials
	Basic infrastructure	Lifeline system	Give assistance to disaster rescue and recovery and suppress secondary disasters
		Sanitary facilities	Reduce the probability of environmental accidents and epidemic spreading
Anti-disaster life space construction	Traffic network		Provide the routes for disaster rescue and evacuation
	Fireproof belt		Prevent the spread of fire
	Green land, park, square, vacant lot		Prevent the spread of fire and give refuge to the disaster-stricken people
	Large-area amalgamated dwelling Large-area lands for public institutions and schools		Give refuge to the disaster-stricken people

Table 2.2 Essential elements of centralized planning and the standards for them

Elements of Centralized Planning	Facility Level	Facility Name	Facility Standards
Place of Refuge	Emergency Type	Nearby roads and parks	They should be about 500 m away from residential quarters, and their per-capita area should reach 0.7 m ²
	Transitional Type	Schools, parks, squares, sports facilities, parking lots, and green lands	Fire-barrier belts should be available, and each fire-barrier belt should cover an area of at least 5000 m ²
Traffic network	Relief Type	Emergency rescue and fire-fighting passages	Both sides of each road should be free from hazard sources, and bridges should possess adequate shock resistance
	Refuge Type	Auxiliary roads for refuge	
Firefighting system	High-level commanding	Municipal governments and fire authorities	The scope of services should cover the whole city properly, fire response should be made within 5 min, and at least one firefighter out of 1000–2000 residents should be available
	Execution at grass-root level	Fire-fighting divisions and fire-fighting stations	
Medical aid	High level	Health authorities, epidemic prevention stations, and first aid centers	The scope of services should cover the whole city properly, first-aid response should be made within 4 min, and at least one doctor for 1000–2000 residents should be available
	Low level	Community hospitals, and clinics	
Material supplies	Dispensing	Designated temporary places of refuge	Material supplies should be positioned near the places of refuge
	Receiving	Regional logistics centers, including bus/railway stations, wharfs, and parking lots	Convenient transportation is provided for leading to the places where material supplies are dispensed
Public security	High-level commanding	Municipal governments and public security bureaus	The scope of services should cover the whole city properly, public security response should be made within 5 min, and at least one policeman for 1000–2000 residents should be available
	Execution at grass-root level	Police substations and armed policemen	
Sanitary system	Collection	Garbage cans and garbage transfer stations	The scope of services should cover the whole city properly, and they should suffice to accommodate the removed obstacles in case of disasters
	Disposal	Garbage landfills and sewage farms	

2. Scenario-based plan management

Using scenario analysis for plan-making is an innovative application in the emergency management system. This section first gives a summary description of the scenario analysis method and its implementation framework, and then discusses how to apply this method to plan management.

(1) Scenario analysis method

The scenario analysis method is also referred to as scenario writing, future prospect drafting, or scenario method. Based on partial facts or logical reasoning, this method is a creative imagination method that forecasts the development trends of things and depicts a big picture of some details of things by way of subjective conception.

Figure 2.7 depicts the implementation framework for scenario analysis [6]. The implementation of scenario analysis is a cycled process, which starts from panoramic scanning, and goes through scenario development, relation modeling,

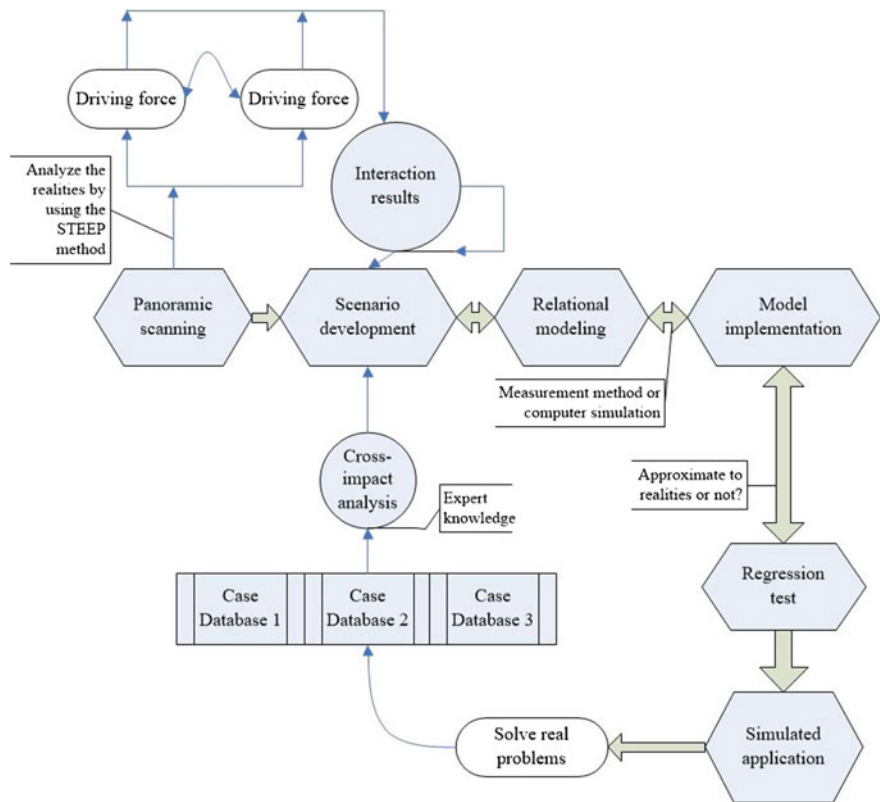


Fig. 2.7 Implementation framework for scenario analysis [6]

technology implementation, regression testing till simulated application. With this cycled process framework, scenario analysis is endowed with clear system analysis features.

(2) Applications of scenario analysis method in emergency plan management

Scenario analysis may be applied to emergency plan management, or to be specific, risk analysis and plan-making in emergency preparedness.

① Using the scenario analysis method for risk identification

Risk identification is to logically answer the following question: Which events are likely to evolve into crises? It is actually a process of risk description.

To identify the risk of unforeseen events, scenario analysis may be implemented through the following four steps: a. determine the degree of possible harm arising from unforeseen events; b. specify the issues to be investigated; c. determine the key control factors; d. describe a few correlated events (for example, whether safety measures, procedures and processes, and compositions are successful) via graphs, that is, conducting a scenario analysis by building event trees, scenario trees, or risk path trees [7].

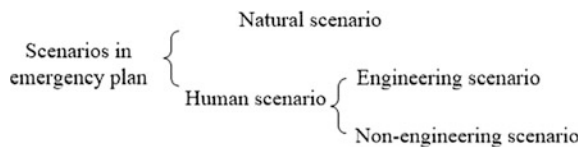
② Using the scenario analysis method for plan-making

To understand the application of scenario analysis in plan-making, it is first necessary to know the essential elements of a plan. Usually, a complete plan needs to comprise of six elements: scenario, object, subject, objective, measure, and method. A plan is not complete if one or some of the elements are absent.

It is noteworthy that the foremost “scenario” element, among the six elements, refers to the aggregate of conditions and backgrounds of unforeseen events that have a bearing upon plan-making and implementation.

Scenarios include natural scenarios and human scenarios, and human scenarios include engineering scenarios and non-engineering scenarios, as depicted in Fig. 2.8. Natural scenarios mainly refer to natural factors and conditions including meteorology, hydrology, geology, geography, and biology. Engineering scenarios mainly refer to anti-disaster engineering factors and conditions including reservoirs, ditches, ponds, banks, and wells. Non-engineering scenarios mainly include governments’ attention, media and publicity, organization and mobilization capability, emergency consciousness of the masses, anti-disaster economic capacity, disaster pre-warning, disaster research, anti-disaster program, and anti-disaster laws and policies.

Fig. 2.8 Scenario types involved in an emergency plan



Scenarios impose fundamental restrictions on the whole plan as well as on five elements that include the object, subject, goal, measure, and method; the five elements make genuine sense only when they are associated with certain scenarios.

The plan-making based on scenario analysis involves making a plan under the assumed scenarios and use the method of scenario analysis to make decisions. In particular: a. it is first and foremost used to develop a concept of “scenario supremacy,” that is, realizing the “scenario” with the fundamental element; b. if a plan is not conditioned by scenarios in the process of plan-making, the plan will not be well-grounded in reality, still less its scientificity.

Therefore, in making an emergency plan, the first step is to gain an in-depth understanding of the scenarios. Only the scenario-oriented plan-making method can overcome the traditional rash plan-making procedure and bring about feasible emergency plans.

3. Capability-based plan management

Capability-based analysis of emergency plan helps to not only determine the evaluation indexes in an emergency management system and the required standard for each evaluation index, but also identify the vulnerable points prior to the occurrence of crises. Generally, capability-based plan analysis is an effective method in making an emergency plan.

(1) Characteristics of emergency capability

“Capability” is the prerequisite subjective condition for carrying out an activity smoothly, and it is the individual characteristics that affect the efficiency of the activity directly and help accomplish the activity smoothly.

An emergency management system is akin to special management activities that provide emergency guarantee to material supplies, manpower, and financial aid in case of unforeseen events. An emergency management system is characterized by unexpectedness, uncertainty, non-conventionality, and economic inefficiency. In making an emergency plan, it is necessary to pay special attention to the following characteristics of emergency capability [8]:

① High time-effectiveness

Unexpectedness and non-foreseeability are the most remarkable features that distinguish emergency management from general management activities. This demands that emergency guarantee should be provided within the shortened time, through the most convenient procedure, and in the safest manner. In other words, emergency management is characterized by high time-effectiveness.

High time-effectiveness needs to fulfill at least three criteria [8]: a. the time of response (for example, identifying the emergency needs and initiating the emergency response mechanism) should be as short as possible; b. the emergency plan should ensure that large quantities of emergency supplies are delivered within a very short period; c. the quickly delivered emergency materials should satisfy the needs of disaster prevention and mitigation instantly.

② High flexibility

Due to the nature of unforeseen events, people cannot make an accurate estimation of their duration, area of effect, and intensity of their influence, which demands the emergency capability to be of high flexibility, specifically: a. meeting the needs of different stages of emergency plan implementation; b. meeting the diverse needs of the same stage of emergency plan implementation.

③ Uniqueness

The emergency capability is unique to a specific emergency management system. The qualitative and quantitative requirements for the emergency capability vary greatly from one emergency system to another. For an emergency system for unforeseen infectious diseases, the emergency capability emphasizes the isolation of infected objects and restriction on personnel mobility. In case of natural disasters (including earthquakes and tsunamis), the emergency system should provide adequate transport capacity for the evacuation of people and property in the disaster-stricken areas to the extent possible.

④ Openness and extendibility

Due to the randomness and uncertainty of emergency needs, the emergency capability should be open and extendible. Emergency needs and supplies are uncertain before the occurrence of unforeseen events, but the capability to incorporate them into the emergency management system after the occurrence of unforeseen events should be present. For example, disaster prevention and mitigation calls for a substantial increase in emergency materials, which usually goes beyond the supply capacity of the original emergency system. This demands the emergency system to be open to other material supply systems to expand its supply capacity.

⑤ Integrity

Emergency capability is not a simple superposition of the capabilities provided by the functional elements of the emergency management system, but a comprehensive manifestation of tangible and intangible elements derived from its effective integration and coordination.

(2) Emergency plan based on capability evaluation

Based on how to build an emergency capability evaluation index system, the following section sets forth the role of this evaluation index system in emergency plan management.

① Emergency capability index

Following Chen [9], this book selects four Level-1 evaluation indexes associated with the four stages of emergency management, that is, prevention, preparedness, response, and recovery, as well as disaster monitoring and pre-warning capability,

disaster preparedness capability, premature response and aided response capability, and disaster recovery capability.

a. Disaster monitoring and pre-warning capability

To decrease casualties, one of the key measures is to monitor and forewarn disasters, acquire the initial disaster information (for example, nature and scale of disasters), promptly raise an alarm for the masses through different channels, and notify them of self-protection measures and evacuation scheme. This capability comprises the following Level-2 indexes: disaster risk evaluation, vulnerability analysis, disaster monitoring, and disaster pre-warning.

b. Emergency preparedness capability

Good emergency preparedness serves to mitigate the losses arising from disasters. This capability comprises the following Level-2 indexes: emergency organization framework, emergency volunteer organization development, emergency refuge construction, availability of first-aid bag, emergency plan-making, emergency drill, and publicity and training.

c. Premature response and aided response capability

Premature response and aided response to disasters can help emergency rescue gain time, relieve the stress on the emergency management authorities to the full extent, and make the emergency rescue plan more flexible [10].

This capability comprises the following Level-2 indexes: disaster alarm and notification, self-rescue and mutual-rescue capability, emergency volunteer team management, organized evacuation, onsite medical aid, public security and traffic control, and onsite disaster evaluation.

d. Disaster recovery capability

Disaster recovery refers to a series of measures that are taken to rebuild physical infrastructure and reorient personal feelings, economic status, and natural status. The disaster recovery capability is the capability to recover social production after disasters. This capability comprises the following Level-2 indexes: disaster loss evaluation, disaster recovery scheme, relief material supply capacity, disaster loans, disaster insurance, relief fundraising capability, and maintenance and update of emergency plan.

② Emergency capability evaluation index system

With the analytic hierarchy process, the emergency capability evaluation index system can be divided into three levels [9]: Level 1 (A), Level 2 (B) and Level 3 (C), as detailed in Table 2.3.

Based on the emergency capability indexes listed in Table 2.4, emergency management experts can score these indexes one by one, and finally determine their standard levels. Based on the standard levels for such indexes, people can find the vulnerable key indexes and highlight them in the emergency plan to make well-targeted amendments in the emergency plan.

Table 2.3 Emergency capability evaluation index system [9]

Level 1	Level 2	Level 3
Emergency capability	Monitoring and pre-warning (B ₁)	Disaster risk evaluation C ₁
		Vulnerability evaluation C ₂
		Disaster monitoring C ₃
		Pre-warning C ₄
	Emergency preparedness (B ₂)	Organization framework C ₅
		Emergency plan C ₆
		Publicity and training C ₇
		Emergency drill C ₈
		Emergency volunteer organization C ₉
		Availability of first-aid bag C ₁₀
		Emergency refuge C ₁₁
	Premature response and aided rescue capability (B ₃)	Communication and alarming C ₁₂
		Self-rescue and mutual-rescue capability C ₁₃
		Emergency volunteer team management C ₁₄
		Organized evacuation capability C ₁₅
		Onsite medical aid C ₁₆
		Public security and traffic guarantee C ₁₇
		Onsite disaster evaluation C ₁₈
	Disaster recovery capability (B ₄)	Disaster loss evaluation C ₁₉
		Disaster recovery scheme C ₂₀
		Relief material supply capability C ₂₁
		Relief fundraising capability C ₂₂
		Post-disaster psychological crisis intervention C ₂₃
		Disaster insurance C ₂₄
		Disaster loans C ₂₅
		Maintenance and update of emergency plan C ₂₆

Table 2.4 Hierarchical levels and responsibilities of organizational structure

Level No.	Level	Responsibilities
Level 1	Decision-making level	Decide what to do
Level 2	Managerial level	Decide how to do
Level 3	Executive level	Supervise the operational level to do as instructed
Level 4	Operational level	Perform operations as planned

4. Drill-based plan management

After an emergency plan is drawn up, people may naturally ask the following question: What is the extent of the effect of this emergency plan? To answer this question, the best way is to carry out an emergency drill to verify the effectiveness of the emergency plan.

(1) Emergency drill

Emergency drill is an important part of emergency management activities. On one hand, emergency drill helps people improve their emergency skills (for example, emergency decision-making, communication and cooperation); on the other hand, it helps people further amend and perfect the emergency plan, thus enhancing its effectiveness and operability.

① Process and form of emergency drill

The process of emergency drill usually includes three stages: drill preparations, drill implementation, and drill sum-up.

Emergency drill can be carried out in the form of a single drill, combined drill and full-scale drill. There is a progressive relation between the three forms of drills. Single drill provides the basis, combined drill is mainly intended to test the planning and response capabilities of the emergency personnel and emergency management system, and full-scale drill is very complex and should be elaborately planned before it is carried out.

② Goals of emergency drill

Emergency drill is a simulation of planned rescue actions. In principle, emergency drill should simulate the real state of emergency to the extent possible to attain the following goals: a. exposing the drawbacks of the emergency plan and emergency response procedure before the occurrence of accidents; b. identifying the resources in short supply (including manpower and equipment); c. improving the coordination between different emergency personnel, departments, and organizations; d. convincing the masses of the capabilities of emergency management; e. enhancing the emergency personnel's proficiency and confidence, and training the personnel concerned; f. dividing responsibilities clearly among the emergency personnel; g. promoting the synergy and coordination between different dedicated emergency plans; h. enhancing the overall responsiveness of the emergency management system.

(2) Emergency drill based on scenario simulation

Emergency drill involves highly operational affairs. People have gradually realized the importance of emergency drill. In 2007, China's State Environmental Protection Administration held an emergency drill against the unforeseen environmental crises in the Songhua River basin, the 24th Antarctic expedition team assigned by China's State Oceanic Administration held an escape and fire-fighting drill, and the people's government of Sichuan Province held an emergency drill against the major food

safety incidents. However, it is still worth considering how to build a scientific and effective drill method system and how to promote the verification and feedback of/to the emergency plan via emergency drill.

This section describes an emergency drill method based on scenario simulation: simulating a scenario that is highly similar to reality to not only help the participants of an emergency drill improve basic operating skills, but also test their capability to immediately react to certain unforeseen events encountered during the emergency drill.

Figure 2.9 depicts an implementation framework for scenario-based emergency drill. With the emergency drill, the emergency plan is adjusted as follows [6]: a. Step 1 focuses on the history of the skill levels of personnel concerned; b. Steps 2 and 3 are closely linked to each other (Step 2 is to define the tasks of the current drill, and Step 3 is to define the intended goals of the current drill). It is noteworthy that such goals may not only be specific to tasks (for example, risk control in heart transplant), but also focus on the improvements of general operational skills (for example, the training of mutual collaboration in a critical situation in the emergency ward); c. Step 4, as the key step of the current drill, is actually the process of scenario development; d. Step 5 involves supplementing and adjusting the emergency plan; e. Step 6 is to make a comparison between real condition and the emergency plan; f. Step 7 is a process of feedback to the emergency plan. The structure of the whole implementation framework is a cyclical. The ultimate goal is to amend the emergency plan and constantly improve the emergency skills of emergency personnel via emergency drill.

Taking the case of a drill for the emergency plan to cope with medical accidents [11] into consideration, the following section describes the role of drill in emergency plan management. As is well-known, intravenous infusion is a commonly used clinical therapy. For various reasons, infusion reactions are of common occurrence, which gives rise to quite a few medical problems. To minimize the

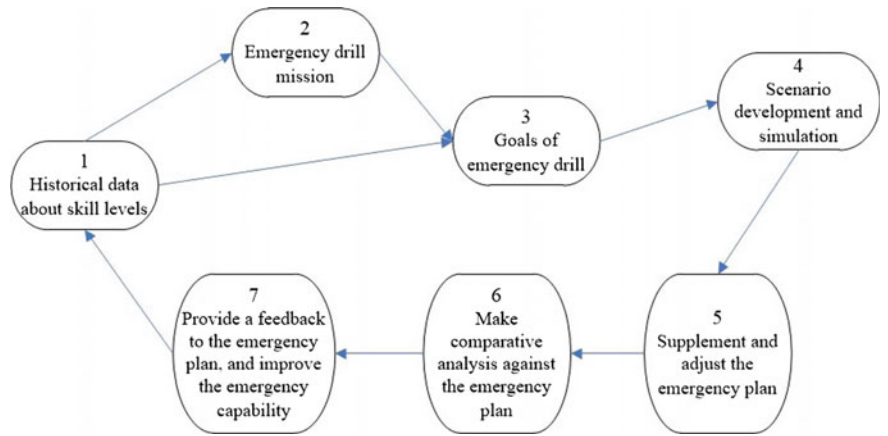


Fig. 2.9 Process of emergency drill based on scenario simulation

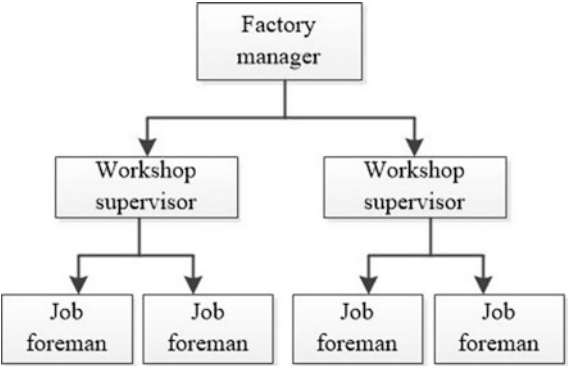


Fig. 2.10 Diagram of line organizational structure

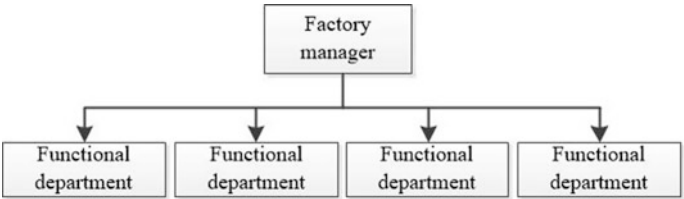


Fig. 2.11 Diagram of functional organizational structure

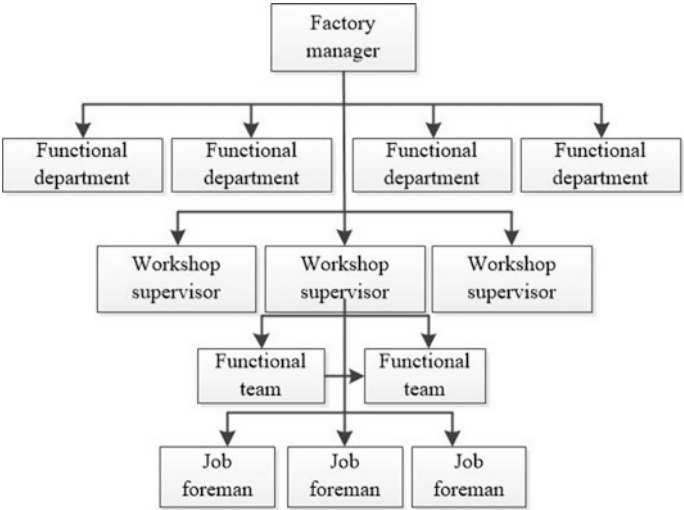


Fig. 2.12 Line and functional organizational structure

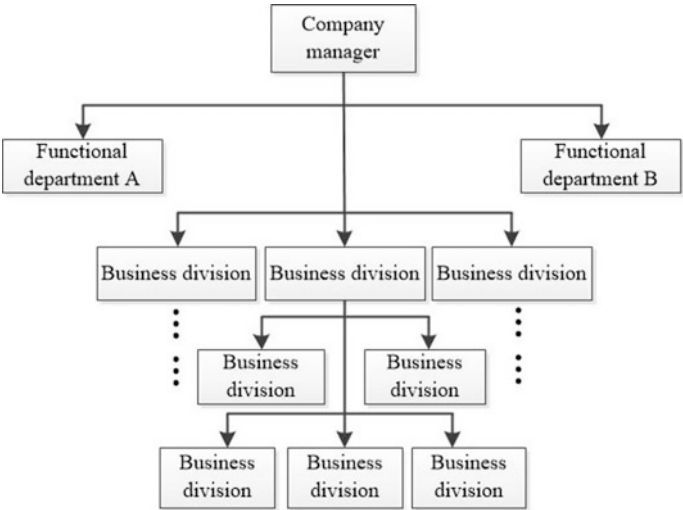


Fig. 2.13 Multi-divisional organizational structure

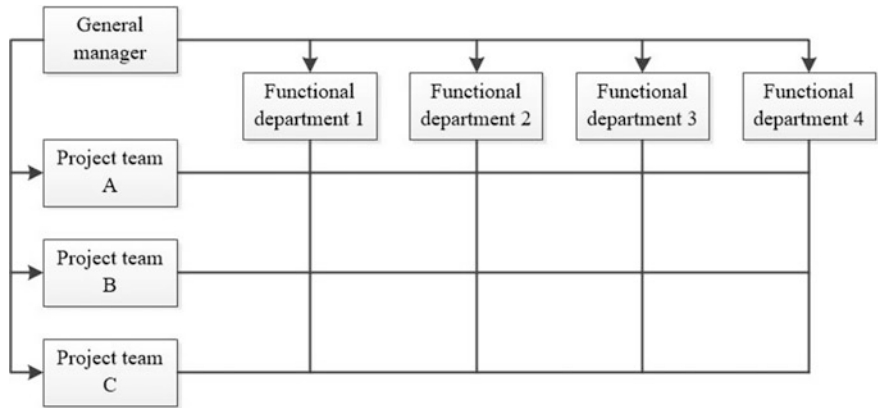


Fig. 2.14 Matrix organizational structure

health damage to the patients and regain the confidence of patients' family members, the managers of medical institutions have to think deeply about the following questions: what can be done to decrease and prevent the occurrence of infusion reactions during the nursing work? In case of infusion reactions, what measures should be taken promptly to bring the situation under control? How should the nurses dispose of the liquids associated with infusion reactions? Therefore, the Craniology Division of Clinical Department 95 in Fuzhou General Hospital drew up a systematic emergency plan, devised some scenarios, and regularly held a simulation drill. The regular scenario simulation drill proved to be highly effective.

For example, the nurses improved their emergency capability to meet the adverse infusion reactions and the first-aid skills. As stipulated by the procedural norms in the emergency plan, they were able to properly cope with the questions on intravenous infusion asked by the patients and their family members.

2.2 Emergency Organization Management

As an important part of the emergency management system, the emergency organizational structure not only determines the decision-making and commanding efficiency of the emergency system, but also affects the functionality of the emergency system and the effectiveness of emergency response. To prevent the occurrence of unforeseen events effectively and minimize the losses and impacts arising from them, it is necessary to study the organizational design of the emergency system and probe into the methodology of organizational structure in the context of modern emergency management.

2.2.1 Emergency Organizational Structure

An organizational structure represents an arrangement of the responsibilities, authorities, and relationships among personnel [12]. It is specifically manifested through a job and responsibility system, which comprises the job responsibilities, job requirements, interrelationships, and performance requirements with respect to the working staff in the multi-leveled functional departments of an organization. An emergency organizational structure aims to set up the concerned departments and assistant departments for emergency management and define the job-responsibility system and coordination mechanism of the departments.

1. Basic organizational structure

According to Professor Sisk in the USA, the term “organization” carries the following two meanings: (1) the organization existing as an entity, which can be construed as a structure comprising a series of correlated elements; (2) the set of the interrelationships arising from the coordinated actions between different people with the same goal [13]. This definition highlights the essence of “organization,” in that, there must be well-coordinated relationships among different people in an organization; an organizational structure provides good guidance and institutional guarantee to such coordinated actions. Based on this definition, this book claims that an organizational structure is the way the constituent elements of an organization interrelate and interact with each other based on different permutations and combinations.

(1) Hierarchical levels of organizational structure

Usually, the internal management of an organizational structure is divided into four levels: decision-making level, managerial level, executive level, and operational level. The four top-down levels constitute a pyramid structure; they are closely interrelated to each other, but perform relatively independent responsibilities. Table 2.4 describes the relationships among them as well as their respective responsibilities.

① Decision-making level

The decision-making level is at the top level of an organizational structure. When dividing the work internally, it shoulders the ultimate decision-making power in issues, in that, the action that needs to be taken by the whole organization.

② Managerial level

The managerial level is below the decision-making level but above the executive level. It takes charge of the different functional departments internally and performs five functions that include planning, organizing, commanding, controlling, and coordinating. In an organization, it teaches the ways to different functional departments.

③ Executive level

The executive level is positioned between the managerial level and operational level, and it mainly supervises the execution status of jobs. Specifically, it supervises whether the actual operations of the operational level comply with the job specifications, and promptly reports the problems encountered by the operational level to the managerial level.

④ Operational level

The operational level is at the bottom level of the organizational structure, and represents the onsite staff of the organization. It mainly performs actual operations as planned and promptly reports the encountered problems to the executive level.

(2) Types of organizational structure

Based on different organizational levels, the constituent elements are permuted and combined varyingly, thus forming different types of organizational structures. The traditional types of organizational structures include line, functional, line-functional, multi-divisional, and matrix organizational structures [12]. Table 2.5 compares the different types of organizational structures.

2. Framework of emergency organization

An emergency organizational structure refers to a well-structured, flexibly operating, and highly-efficient management system with well-defined responsibilities and authorities, which are formed by integrating the diverse emergency elements to face

Table 2.5 Comparison between different types of organizational structures

Type	Features	Advantages	Disadvantages
Line structure	In a basic line structure, the different job positions are vertically arranged in a linear manner, the administrative leaders at different levels are commanded and managed in a unified manner, and no special functional departments are appointed (as depicted in Fig. 2.10)	This structure has advantages like simplicity, well-defined responsibilities and authority, unity of command, and high efficiency of commanding	The management functions are excessively centralized by the administrative leader alone; this structure is only applicable to a small-sized organization that performs only one or two tasks
Functional structure	The basic functional structure is a type of level-to-level administration structure based on the division of functions, in that, the management functions are classified by the area of specialty and the functional management departments manage the operating departments respectively (as depicted in Fig. 2.11)	This structure can promote specialized division of labor, replace the all-powerful managers available in the line structure, help the managers acquire the professional skills suited for managing tasks and helping the decision-makers release themselves from the miscellaneous routine affairs and devote themselves to thinking of the issues of vital importance [12]	This structure disrupts the unity of command, thus making it easy to create multiple leaderships
Line and functional structure	The line and functional structure is to set up two management systems under the leadership of the top managements: (1) the management system that performs line management; (2) the functional management system that assists the managers with guidance and supervision (as depicted in Fig. 2.12)	This structure integrates the advantages of both the line structure and functional structure, that is, it not only allows centralized and unified command, but also exerts the role of functional management	It is difficult to distinguish the responsibilities and authorities between the linear departments and functional departments, thus giving rise to contradictions and conflicts; the excess of management departments may incur additional management expenses

(continued)

Table 2.5 (continued)

Type	Features	Advantages	Disadvantages
Multi-divisional structure	The basic multi-divisional structure is characterized such that an entire organization is partitioned into multiple divisions by regions or services and products, and these divisions are independent of each other in terms of operation and accounting and they take the responsibility for their own profits and losses. Based on decentralization of authority, this organizational structure allocates responsibilities and authorities to different divisions to the full extent, so as to release the top leaders from routine affairs, devote them to the strategic decision-making and long-term planning, and build a genuinely powerful decision-making body (as depicted in Fig. 2.13)	This structure can arouse the activeness and initiative of different divisions, and improve the flexibility and adaptability of organization operation	Due to the competition between divisions, departmentalism is prone to arise, thus affecting the exchange of information, personnel and technologies between them
Matrix structure	The matrix structure comprises a vertical functional management system and a horizontal project system specially formed to accomplish a specific task (as depicted in Fig. 2.14)	This structure has advantages like the concentration of advantages, resource sharing, and smooth communication	The double-leadership structure increases the nodes of information transfer, and the complex interrelationships may bring about difficulties in coordination and ambiguity in responsibilities

unforeseen events through the principles of classified management, level-to-level responsibility, integration of departments and regions at different levels, and territorial priority.

(1) Characteristics of emergency organization

Using real examples, the following section describes the four requisite characteristics of an emergency organizational structure: ① prevention first: the emergency organization is structured in the preparedness stage with a view to preventing various unforeseen events [14]; ② quick response: in structuring an emergency organization, an understanding of “time means life and wealth” is necessary; ③ coordinated action: in the face of sudden crises, the emergency organization defines the emergency responsibilities in the whole emergency management system clearly and should be structured such that it ensures complete coverage.

(2) Forms of emergency organization

Emergency organizational structure is a functional system that supplements traditional types of organizational structures to meet the emergency preparedness requirements of different unforeseen events. A large-sized emergency organization usually encompasses multiple types of organizational structures as indicated in Table 2.6 by the emergency organizations in China [12].

Following Fu et al. [12], this section demonstrates that an emergency organizational structure is usually an integration of multiple types of organizational structures; for example, according to the emergency organizational structure of the national prevention and control system and the organizational structure of the public security system in China.

① Emergency organizational structure of the national prevention and control system

As depicted in Fig. 2.15, China’s national prevention and control system has a matrix organizational structure, comprising of vertical governmental organizations and horizontal public health authorities [12]. For example, the centers for disease control and prevention at the national, city, and district/county levels have a functional structure designed to perform the functions of disease control and

Table 2.6 Examples of the forms of emergency organizations in China [12]

Type of Organizational Structure	Corresponding Emergency Organizations
Line structure	The grass-roots emergency organizations, including fire-fighting brigades and local police stations
Functional structure	Highly specialized agencies in earthquake monitoring, meteorological forecast, disease control, and safety supervision
Line and functional structure	Large and medium-sized emergency organizations
Multi-divisional structure	The technically demanding and relatively independent emergency organizations, including the emergency organizations dedicated to nuclear power plants
Matrix structure	The emergency organizations at provincial or city level, including the provincial-level centers for disease control and prevention

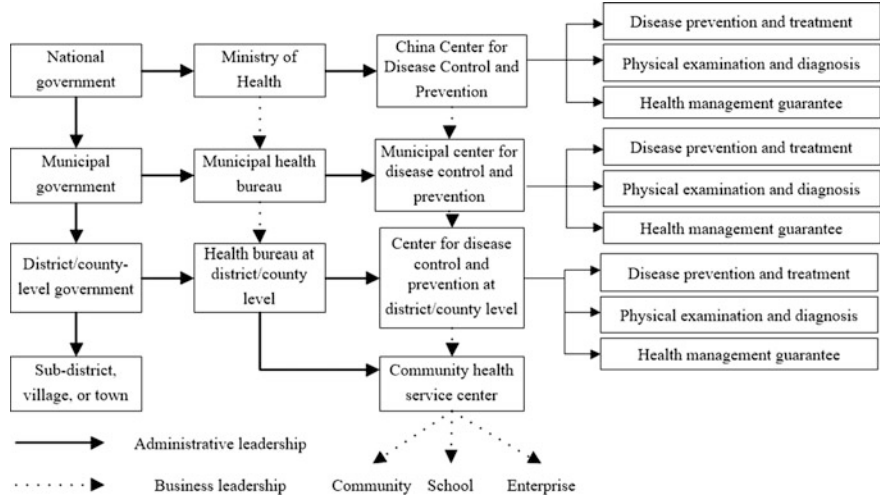


Fig. 2.15 Organizational forms of national prevention and control system [12]

prevention, physical examination and diagnosis, and health management guarantee. As the grass-roots organizations of China’s disease prevention and control system, the community health service centers have the most simple and efficient line structures, and provide health services for communities, schools, enterprises, and public institutions.

② Organizational structure of the public security system

The emergency organization system of China’s public security authorities has a typical comprehensive organizational structure, which not only comprises strict vertical structures (including the Ministry of Public Security, Public Security Departments of different provinces or autonomous regions, public security bureaus, sub-bureaus and detachments, and local police stations and substations), but also has close horizontal links with local governmental departments, garrison troops, and key enterprises and public institutions, thus assuming a matrix structure overall. Across the whole emergency organization system of China’s public security authorities, the diverse specialized systems cover economic security, culture security, criminal investigation, information security, fire safety, traffic administration, and frontier defense; the functional departments (including traffic administration, fire safety, and frontier defense) are relatively independent, thus taking on a similar multi-divisional structure; the grass-roots police stations have a line structure.

Considering that unforeseen crises are diverse and unpredictable, an emergency organizational structure, irrespective of its type, should always comply with the principles of prevention first, quick response, coordinated action, and complete coverage. An emergency organization calls for not only higher effectiveness and efficiency via specialized division of labor, but also good coordination and col-laboration between different functional departments.

3. Organizational hierarchy and management span

Emergency management activities include core processes and auxiliary processes. The core processes include the emergency decision-making process at the strategic level, emergency preparedness process at the tactical level, and emergency response process at the operational level, as depicted in Fig. 2.16.

The emergency activities at different levels should be implemented by the departments at different levels in the emergency organization. In particular, the departments at different levels in an emergency organizational structure should differ in role orientation, span of emergency management, and functions.

(1) Hierarchical levels of emergency organization

A complete emergency organizational structure usually comprises of an emergency committee, an emergency command center, and a number of specialized emergency teams that are associated with the emergency processes at different levels (as depicted in Fig. 2.17) [12].

- ① Positioned at the strategic level, the emergency committee mainly reviews and approves the preventive and emergency plan and makes major emergency decisions.
- ② Positioned at the tactical level, the emergency command center mainly carries out the emergency plan, makes emergency preparations (for example, keeping resource or technology reserves), and coordinates the emergency actions of different departments during the emergency period.
- ③ Positioned at operational level, the numerous specialized emergency teams mainly provide diverse specialized supports.

(2) Spans of management of the departments at different levels

With respect to Liu and Wang [15], the following section describes the spans of management of the departments at different levels in an emergency organization system as exemplified by China’s countrywide emergency organizational structure

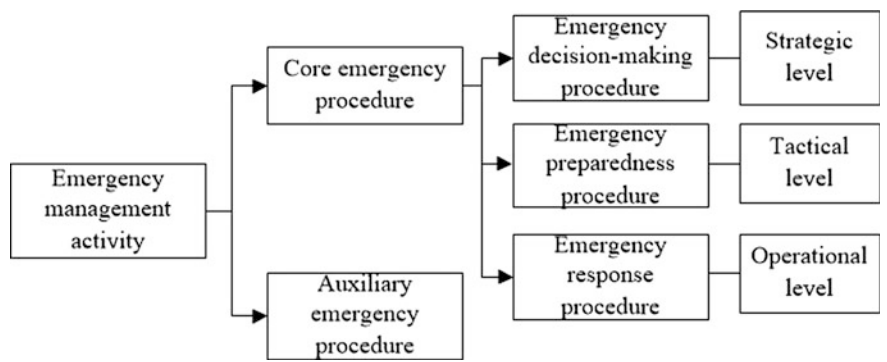


Fig. 2.16 Hierarchical levels of emergency management activities

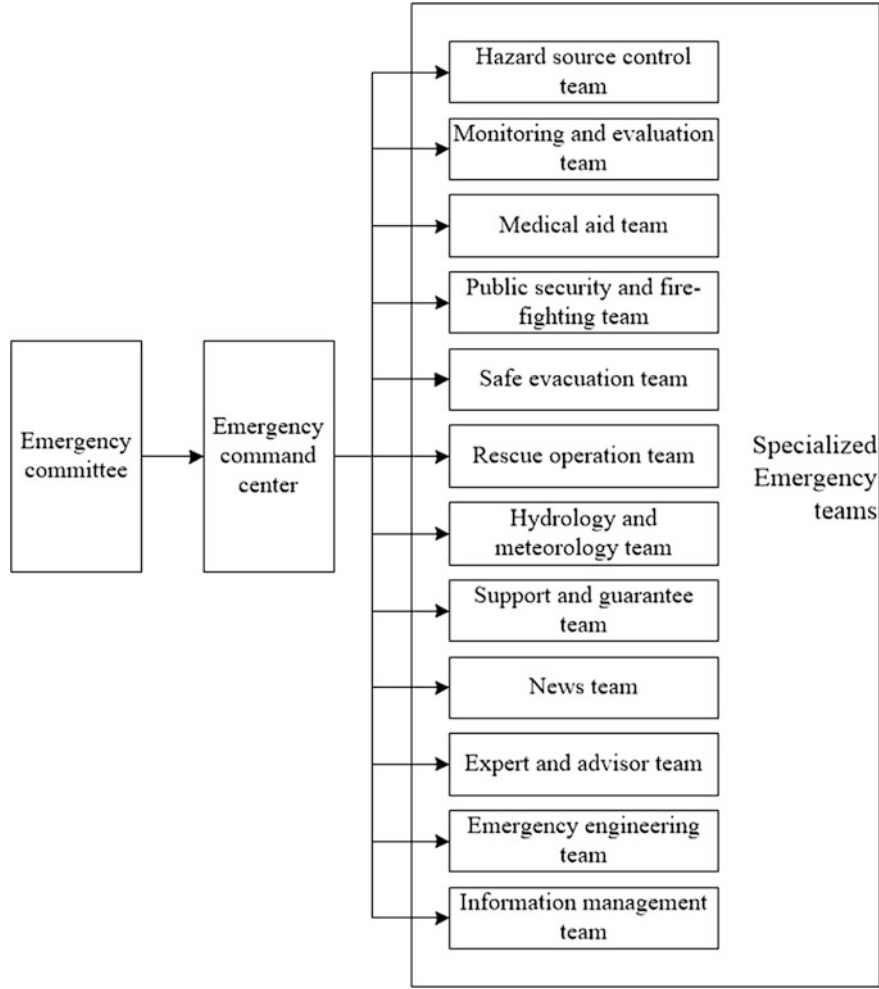


Fig. 2.17 Hierarchical structure of emergency organization

for unforeseen public health crises. China’s countrywide emergency organization system for unforeseen public health crises comprises governmental emergency management committees, emergency management command centers, and specialized emergency management bodies under public health authorities.

① Governmental emergency management committee (strategic level)

The standing governmental emergency management committees at three levels (including the national, provincial, and city level) respectively draw up anti-crisis strategies and emergency plans, command the governmental departments at their corresponding levels and coordinate various emergency resources to meet

unforeseen public health crises, and provide legal guarantee to the status and powers of the emergency management authorities.

② Emergency command center (tactical level)

As the standing bodies under the governmental emergency management committees at the three levels, emergency command centers are mainly responsible for the tactical-level emergency activities in prevention, preparedness, response, and recovery.

By learning from the “concise but not simple” accident control system structure in the field of crisis management, emergency command centers can be structured properly, as depicted in Fig. 2.18. This organizational structure is simple, flexible, and elastic. Specifically, it not only is capable of meeting various possible unforeseen events, but can also be adaptively adjusted to catastrophes of various sizes. Generally, it is an onsite emergency management organization pattern that highlights efficiency, benefits, and effectiveness.

Alternatively, emergency command centers can be established as standing bodies. At ordinary times, the centers should lay emphasis on the emergency preparations for unforeseen events, training of emergency personnel, and regular emergency drill. During unforeseen events, the centers should immediately initiate the emergency command mode, declare a state of emergency, appoint the related governmental officials to act as chief commanders of emergency management according to the established emergency plans, and appoint the related governmental departments to form the Decision-making Department, Operations Department, Rear-service Department, Planning and Information Department, Administrative and Financial Department, and Information Center.

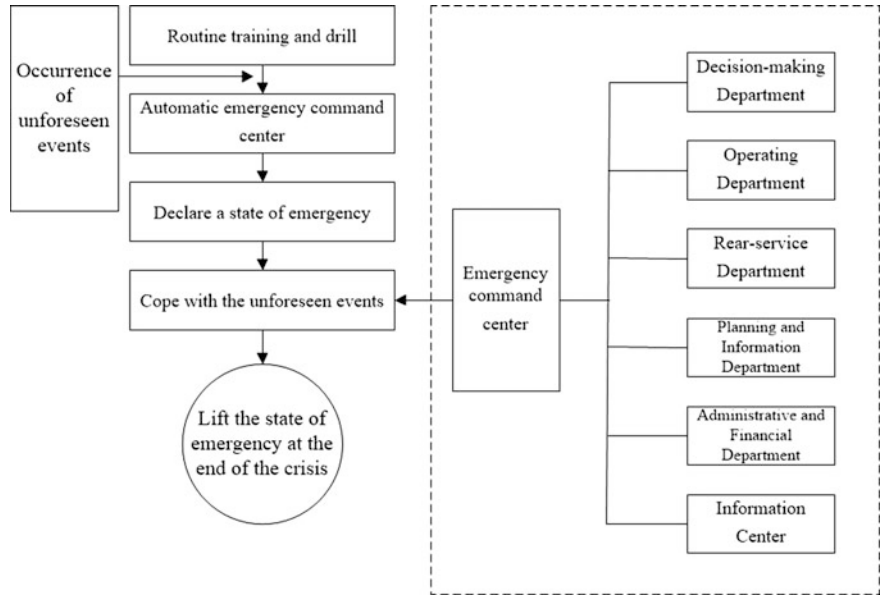


Fig. 2.18 Organizational structure and operation mechanism of emergency command center [16]

Table 2.7 Roles and responsibilities of the members of emergency command center [15]

Organization Member	Role and Responsibility
Decision-making Department	Be responsible for general management and decision-making in times of unforeseen events; specifically, evaluate the status of unforeseen events, identify the nature of unforeseen events, and prioritize the emergency actions
Operations Department	Be responsible for emergency response to unforeseen events, provide real-time support for the onsite emergency personnel and disaster-stricken personnel, ensure material and equipment supplies for the disaster-stricken areas, and coordinate closely with other departments
Planning and Information Department	Acquire, analyze, record, and evaluate the information on unforeseen events, emergency response and available resources, and provide a response plan and action plan to the Decision-making Department and chief commander
Rear-service Department	Provide diverse requisite equipment, materials, and services for emergency response; depending on the size and nature of unforeseen events, the rear-service teams may include a communication service team, medical service team, food team, dispatch service team, facilities service team, and traffic service team
Administrative and Financial Department	Provide administrative services for the emergency command center, supervise the expenses related to unforeseen events, and conduct financial and cost analysis for emergency response
Information Center	Coordinate and release the information and alarms oriented with the masses, monitor the news media, and hold news conferences and release media reports at an appropriate time

Planning and Information Department, Rear-service Department, Administrative and Financial Department, and Joint Information Center, all of which should respond immediately under the leadership of the respective chief commanders). Table 2.7 presents the responsibilities of these functional departments.

③ Specialized emergency management bodies under public health authorities (operational level)

The emergency management committees and emergency command centers alone are not enough. A complete countrywide emergency organization system for unforeseen public health crises should also include the specialized emergency management bodies under public health authorities.

Such a countrywide emergency organization system can be simplified to comprise of different levels of public health authorities, health supervision systems, institutions for disease control and prevention, and hospitals. In addition to a perfect public health protection network, China’s public health system should also incorporate the standing bodies that are primarily responsible for unforeseen health events. Along with the comprehensive standing emergency management committee, the standing bodies not only constitute a complete emergency management

network in the field of public health, but also provide emergency support for coping with the unforeseen events in other fields.

In summary, the numerous specialized emergency management bodies at the operational level cope with the unforeseen events in the field of public health, convene the public health experts regularly to analyze unforeseen events that are likely to occur in the current year or within a longer period, report the research findings to the top officials of the Ministry of Health regularly, and propose the appropriate measures against such unforeseen events. In conjunction with the emergency management committee at the peer level, the emergency management bodies under public health authorities mobilize the specialized resources in the field of public health and in other fields to cope with unforeseen public health crises, thus forming an efficiently operated emergency management system [15].

2.2.2 Emergency Organizational Design

Organizational design refers to the process by which the decision-makers establish and implement a specific organizational structure through a reasonable combination of the multiple elements of an organization. Today, organizational structures are increasingly complex and structure types are increasingly diverse. However, each organizational structure is based on three essential aspects: dividing the responsibilities and powers, setting up of the departments, and defining the management hierarchy. Centered on the three aspects, scientific and dynamic organizational design is an important prerequisite for attaining optimal emergency management effectiveness.

1. Principles and Procedure

The design of emergency organization has to face the following tasks: (1) defining the detailed content, responsibilities, and powers of each emergency management job in a simple and clear manner; (2) defining the relationship between emergency management jobs and other departments and jobs in the organization; (3) defining the basic competence, technical know-how, work experience, and problem-solving ability required of the emergency management personnel.

(1) Design principles

In addition to the general principles for organizational design (for example, systematic entirety, unity of command, equality between responsibility and power, and effective span of management), emergency organizational design should also satisfy the following requirements [12]:

① Design oriented to emergency procedure

According to the level of emergency activities and different internal tasks of emergency management, the basic action units of emergency management can be classified into different processing teams, that is, emergency teams that share the

same goals but comprise of personnel with different professional techniques. The emergency process teams are typically characterized by high degree of autonomy, division of responsibilities, and mutual coordination.

② Flexibility

In the face of varying unforeseen events, the key to emergency response is being “quick.” To respond to the ever-changing external environment, it is necessary to build a dynamic and flexible emergency organizational structure.

③ Flat organizational structure

A flat organizational structure helps to reduce the management hierarchy and cut off the redundant staff, thus building a compact organizational structure. A flat organizational structure can accelerate the transfer of information, improve the efficiency of decision-making, and reduce the expenses of organization management.

④ Network organizational structure

A network organizational structure is essentially characterized by all-round communication and cooperation. All-round communication and cooperation include not only the close cooperation between different organizations, but also the communication and cooperation between different departments and different staff members inside an organization. In addition, such communication and cooperation are carried out with the help of information technology, the development of which will further intensify it.

A network emergency organizational structure allows the coexistence of a traditional hierarchical organization and flexible emergency teams, makes the allocation of emergency resources more reasonable, accelerates the operation of the emergency organization, and improves the efficiency and performance of emergency management activities.

(2) Design procedure

The design of emergency organization usually includes the following steps:

① Set the goals of an emergency organization

Before designing an emergency organizational structure, acquire, analyze, and evaluate the data on historical emergency related work to set its goals.

② Build the process system associated with emergency management work

With respect to the goals, build a process system associated with emergency activities, and decide on the emergency process according to the availability of emergency resources; determine the internal structure of the emergency process system (specifically, the functions to be performed by each sub process, and the relationship between the sub processes), coordinate the different sub processes, and optimize the performance of each sub process and relationship between different sub processes.

③ Propose the basic framework for an organizational structure

According to the goals of the emergency organization and the whole emergency process system, determine the hierarchy of the emergency organization and the structure of each department to form the basic framework for a hierarchical organizational system.

④ Define the responsibilities and powers during emergencies

Define the management powers and responsibilities of each level, each department, and each job in the whole emergency organization clearly in the form of job description manual. It is noteworthy that in the case of unforeseen events, a functional center oriented to the emergency process and emergency process services can be immediately; that is, the original multi-leveled functional departments and offices are integrated as a few greater departments with relatively comprehensive functions, or the diverse functions are completely assigned to a comprehensive emergency function service center.

⑤ Design the operational mode of an organization

Designing the operational mode of an organization includes the following tasks: a. designing the contact methods, that is, the ways to coordinate and control different departments; b. designing the management specifications, establishing the job procedure and standards for each emergency management activity and management methods for the emergency personnel; c. designing various operation systems, that is, the rules and regulations governing various emergency management activities.

An efficient information technology platform is an important prerequisite for coordinated operation of different departments in the emergency organization. Generally, this platform is required to have the following features: support for process operation and management of the emergency organization, coordination of information streams based on a shared knowledge base, high flexibility of the information system, support for emergency decision-making, and support for new emergency management methods.

⑥ Finalize the organizational structure

After reviewing, evaluating, and amending the design of the emergency organization, finalize the organizational structure and its operation procedure, and then make them known and implement them; according to the status of organization operation, adjust the emergency organizational structure to the ever-changing internal and external environments.

2. Organizational design scheme

After the design principles and procedures are determined, the design scheme of the emergency organization is formed gradually. With respect to Xie and Zheng [17], the following section describes the design schemes for different emergency organizational structures, as exemplified by the structure for governmental emergency management organizations.

With special responsibilities, status, and capabilities, governments usually play a dominant role in coping with unforeseen crises. In the process of emergency management, governments need to not only mobilize diverse forces and resources, but also command, coordinate, and dispatch various organizations and personnel, thus putting the emergency activities in order. The governmental emergency organizational structure provides the guarantee for normal flow of people, materials, and information. Therefore, the reasonable design of such organizational structure is of vital importance to governmental emergency management.

(1) Traditional governmental emergency organizational structure

① Vertical-horizontal organizational structure

Despite facing unforeseen crises, China’s government has not established any dedicated, all-round, and standing emergency management organizational structure for a long period, and usually turns to the daily management organizational structure, that is, a vertical-horizontal emergency management organizational structure (as depicted in Fig. 2.19). In the figure, solid lines refer to leadership relationships, and dashed lines refer to directive or order relationships.

A vertical-horizontal organizational structure lays emphasis on the emancipation of the administrative leaders at different levels from numerous and complicated routine affairs. The functional departments at different levels are set up on the principle of specialization, and are directly accountable to their administrative heads. In particular, they not only give professional advice to their administrative heads within their sphere of expertise, but are also authorized by their administrative heads to handle the routine affairs within their sphere of specialty [17]. In addition, the different functional departments have the power to provide professional guidance or issue orders to subordinate functional departments within the same sphere of specialty.

The vertical-horizontal organizational structure has the following advantages [18]: a. it not only ensures the unity of command by administrative heads, but also improves the efficiency of emergency response through specialized management

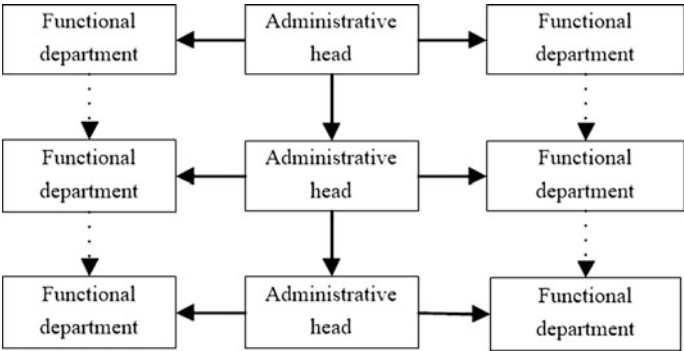


Fig. 2.19 Vertical-horizontal organizational structure [18]

tools; b. it has a well-defined division of responsibilities, and the functional departments are only responsible for the emergency work within their scope of authority; c. as structural stability is very high, it helps give full play to the group effect of the emergency organization when external environments are changed slightly.

However, this organizational structure has the following disadvantages [18]: a. the subordinate departments lack necessary autonomy in decision-making; b. the connections between functional departments are not close enough, thus causing certain difficulties in their coordination; c. as the structural rigidity is very high, and structural adaptability is poor, it is prone to be fettered by old conventions; d. the path of internal information transfer is very long and information feedback is very slow, making it difficult to adapt to the ever-changing external environments.

② Matrix organizational structure

Considering that unforeseen events may be induced by diverse factors, have a wide sphere of influence, and entail quick response, a conventional organizational management structure is not enough to cope with complex unforeseen events, leading to a matrix organizational structure for governmental emergency management (as depicted in Fig. 2.20).

A matrix organizational structure for governmental emergency management is also referred to as a planning-target structure for governmental emergency management. It comprises of a horizontal and a vertical management system, which are superposed on each other [17]. Specifically, the horizontal structure is a function-oriented emergency command system, and the vertical structure comprises of a number of workgroups that are specially formed to accomplish different emergency tasks. On one hand, the members of each workgroup maintain organizational and business relations with their original functional departments, and are under the vertical leadership of the original department heads. On the other hand,

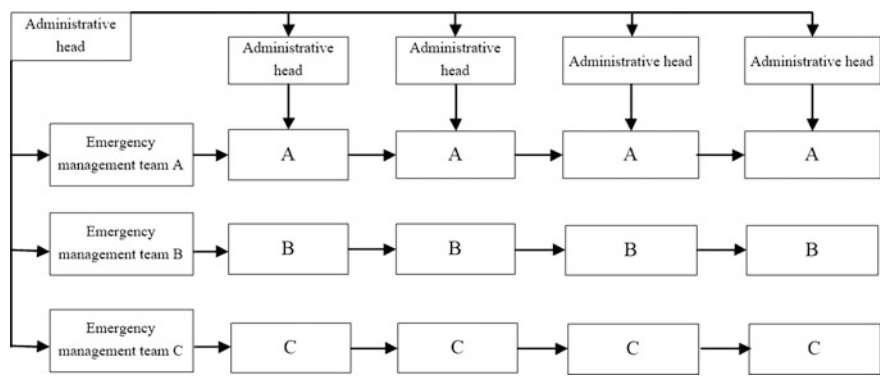


Fig. 2.20 Matrix organizational structure [18]

the members of each workgroup are answerable to the head of the workgroup and obey the management of the workgroup.

This matrix organizational structure has the following advantages [18]: a. it strengthens the collaboration and information exchange between different departments, and concentrates the superior resources and professional personnel of different departments, thus improving the harmony and integrity of the emergency organization; b. it breaks away from the traditional management principle wherein one person is managed by only one department; that is, it allows one person to take part in multiple emergency tasks or join multiple emergency workgroups at the same time, thus increasing the utilization of emergency personnel and reducing the costs of emergency management; c. the organizational form is flexible and structural adaptability is high, thus improving the overall efficiency of emergency management.

However, this organizational structure has the following disadvantages [18]: a. organization members need to achieve dual relationships; in case of any difference in opinions between the dual leadership, the subordinates may feel disoriented about what to do; when errors arise during the emergency work, it is difficult to identify who to blame; b. organizational relationships are very complex, and emergency workgroups are formed temporarily, thus affecting the work enthusiasm of the members.

③ Multi-divisional organizational structure

The emergency response made by whether vertical-horizontal or matrix structure is somewhat temporary. However, various unforeseen crises are usually characterized by massive scale, suddenness, frequent occurrence, and hazardousness. As such, governments are necessitated to incorporate emergency management into their daily operation. This calls for a dedicated, standing, and comprehensive emergency management organizational structure, that is, multi-divisional organizational structure (as depicted in Fig. 2.21).

Under the multi-divisional organizational structure, dedicated divisions are set up to take charge of specific types of crises, and enjoy relatively independent autonomy in emergency decision-making. The multi-divisional organizational structure for governmental emergency management has the following advantages [18]: a. It can arouse the enthusiasm and initiative of the divisions, thus improving the efficiency of the emergency organization; b. it extricates the top administrative head from the numerous routine affairs, thus allowing him/her to devote to the macro strategy of emergency management; c. it helps the managerial personnel of different departments improve their emergency capabilities.

However, the multi-divisional organizational structure has the following disadvantages [17]: a. due to the great demand for emergency management personnel, it incurs high management expenses, and thus is not cost-effective; b. the relationship between centralization and decentralization of authority is a sensitive issue; the harmony of the whole emergency organization may be weakened once this relationship is mishandled; c. it may bring about various shortcomings arising from decentralization of authority, for example, selfish departmentalism, inefficiency of emergency command, reduction in the integrity of emergency organization, and overlapping of functional departments; d. there exists no effective mechanism of horizontal coordination between different divisions.

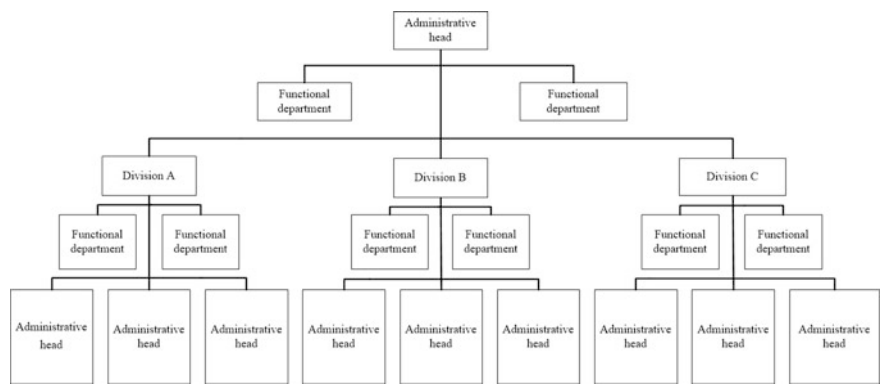


Fig. 2.21 Multi-divisional organizational structure [18]

(2) Multi-divisional network structure for governmental emergency organizations

The vertical-horizontal, matrix, and multi-divisional organizational structures are all prone to cause a pattern known as “big government, small society,” that is, the organizational structure overemphasizes governmental forces and pays little attention to the mobilization of social forces. Therefore, it is necessary that the organizational structure of governmental emergency management should take into account the utilization of the increasingly powerful social forces.

① Multi-divisional network structure

In the emergency management activities, the active participation of social organizations has unique advantages [18]: a. social organizations can act as bridges between governments and masses; b. when coping with certain specific unforeseen events, social organizations are usually more efficient as regards professional knowledge, skills, manpower, and social networking; c. as compared to the cooperation between the governments of different countries, social organizations usually obtain international aid in funds, technologies, information, and management more easily; d. in supervising the emergency management process comprehensively and evaluating the emergency management activities independently, social organizations provide a powerful driving force for government reform and help the governments reduce errors in decision-making.

Therefore, emergency management activities should not only be dominated by governments, but also encourage the participation of far-ranging social forces, including citizens, enterprises, and non-profit organizations. With respect to Qiu [18], this book proposes a government-civil multi-divisional network organizational structure for governmental emergency management (as depicted in Fig. 2.22). In Fig. 2.22, each solid arrow indicates a command relationship, each dotted arrow indicates a coordination relationship, and each bidirectional dotted arrow indicates a proactive communication relationship.

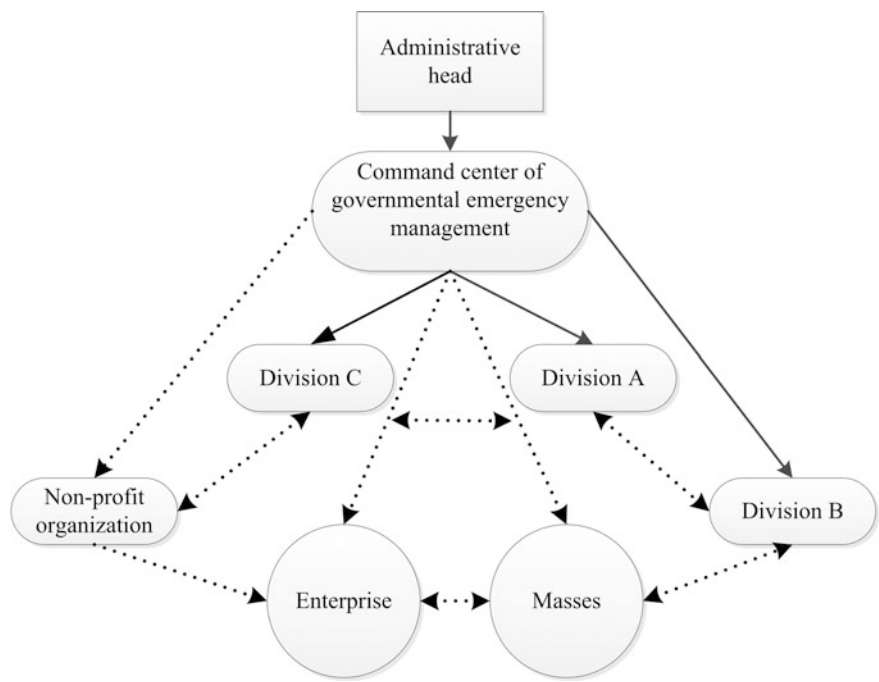


Fig. 2.22 Multi-divisional network organizational structure for governmental emergency management [18]

② Characteristics of multi-divisional network structure

As compared to traditional organizational structures, the multi-divisional network organizational structure of the government comprises of a number of independent units that are interrelated to each other horizontally and vertically. The size of the core organization is very small. The command center of governmental emergency management is the core organization, which is very small in size; the emergency functions are performed through the emergency management teams formed by the government and other social emergency organizations. Overall, the multi-divisional meshed organizational structure has the following features [18]:

- a. The whole organizational structure is divided into an intra-government and an extra-government emergency management organization: The intra-government emergency management organization has a multi-divisional structure because the government internally emphasizes vertical centralization with a view of ensuring the efficiency of emergency decision-making; the extra-government emergency management organization has a flat structure because the high degree of division of labor and cooperation between different social organizations call for further decentralization of authority and non-hierarchization between them.

- b. It signifies the multi-dimensionality of the organizational setup as well as the organizational operation. The former should take into account both governmental emergency forces and social emergency forces, and the latter is mainly involved in the information transfer and decision-making process of the subjects of emergency management.
- c. It provides a combination of direct and indirect control: Governmental departments or agencies are directly controlled and commanded by the emergency command center, and social emergency management forces are indirectly controlled through the related laws and regulations; a multi-divisional network organizational structure has an administrative head, while social emergency management forces have no authority of personnel administration or fiscal authority and their rights and obligations are defined through the related laws and regulations.
- d. It is highly flexible: It is capable of selecting the commanding organ for emergency management and appointing an administrative head of the intra-government emergency management organization according to the nature of specific unforeseen events and the degree of their impacts; a considerable portion of emergency functions are performed by the extra-governmental social organizations, thus decentralizing the authority of public crisis management and improving the flexibility of emergency organization.
- e. It has a great advantage in communication and cooperation. Under a multi-divisional network organizational structure, the emergency resources owned by the autonomous organization units are very limited and are not as self-sufficient as those under the multi-divisional organizational structure. To accomplish the emergency tasks efficiently, the organization units need to cooperate extensively with the other emergency response units. Such active relations between grass-roots units provide an important channel for reasonable flow and efficient integration of emergency resources in the emergency organization system.
- f. It allows taking full advantage of network technologies (for example, quick information transfer and large amount of transferred information), thus helping the commanding organ of emergency management make decisions quickly, accurately, and efficiently under special scenarios.

To sum up, the different organizational structures of governmental emergency management have their own advantages and disadvantages and are applicable to specific scenarios. A scientific emergency organizational structure is of vital importance to the results of emergency management against unforeseen events. To face unforeseen emergencies properly, the emergency organizational structure should emphasize not only efficiency and cost-effectiveness, but also division of labor, cooperation, and coordination.

2.2.3 Emergency Organization Management Based on Modern Management Concepts

Emergency organization management calls for not only the application of traditional management concepts, but also the optimization of organizational design by using modern management concepts. For example, organization process reengineering and digital trunked communication will provide powerful technical support for a scientific and efficient emergency organizational structure.

1. Organization process reengineering

In the 1990s, Michael Hammer (a professor of Massachusetts Institute of Technology) and James Champy (Board Chairman of CSC) proposed the concept of Business Process Reengineering (BPR), in that, they gave a fundamental reflection and thorough redesign of corporate business process to further improve cost performance, quality, service, and responsiveness.

(1) Concept of process reengineering

As a brand-new revolutionary theory on enterprise management, process reengineering contains two essential principles: ① the organization must identify which processes are critical, and make the critical processes as simple and effective as possible; ② the organization must sublimate the trivial matters, including the dispensable personnel or departments.

In the face of ever-changing markets and increasingly severe market competition, more and more organizations become aware that constant process reengineering is crucial for their sustainable development. *The Heart of Change* written by John P. Kotter proposed the well-known eight steps for organization process reengineering: ① produce a crisis consciousness; ② form a strong change team; ③ formulate business visions; ④ communicate the business visions extensively; ⑤ authorize the staff to struggle for the business visions; ⑥ accomplish recent results; ⑦ reward the related staff; ⑧ consolidate the results and make further efforts. By carrying out the eight steps, a new organization process behavior pattern will take deep root in the corporate culture [19].

(2) Procedure of organization process reengineering

BER can be further extended to mean that a function-centered traditional enterprise is transformed into a process-oriented brand-new enterprise; so does organization reengineering in emergency activities.

With respect to Kotter and Cohen [19], the following section describes the five stages and eighteen steps procedure the BPR for the emergency organization (as depicted in Fig. 2.23).

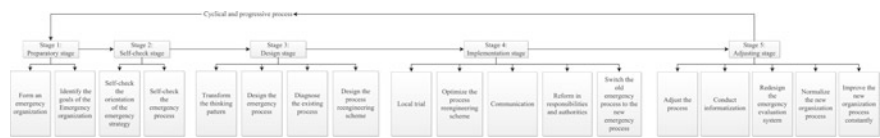


Fig. 2.23 Process reengineering procedure of emergency organization

① Stage 1: Preparatory stage: This stage involves forming a team and setting the organization goals.

Step 1: Form an emergency organization. Form a process reengineering implementation team headed by the emergency decision-making leader at the top management of the emergency organization, delegate full authority to the implementation team (the team is directly answerable to the top management of the emergency organization), and establish a regular progress reporting system and additional empowering system.

Step 2: Identify the emergency goals. As regards the emergencies, reach a consensus on the visions, goals, and necessity and plan of organization reengineering.

② Stage 2: Self-check stage: This stage involves diagnosing the system and identifying the crux of the problem.

Step 1: Self-check the orientation of the emergency strategy. Regarding the efficiency and satisfaction of the emergency response activities against various unforeseen emergent events, check and adjust the existing problems of the strategic orientation.

Step 2: Self-check the emergency process. According to the orientation and features of organizational strategy transformation, diagnose the existing emergency process thoroughly and adaptively, so as to identify the crux of the existing problem.

③ Stage 3: Design stage: This stage involves building an environment and designing the BPR scheme.

Step 1: Transform the thinking pattern. To smoothly conduct process reengineering, it is necessary to eliminate the resistance to the transformation inside the organization as soon as possible.

Step 2: Design the emergency process. Pool the wisdom of the masses and the faculty of judgment of the top management, encourage the participation of all staff, and determine the new emergency process suited to the new organizational strategy.

Step 3: Diagnose the existing process. Engage related emergency experts, and evaluate the efficiency and effectiveness of the existing process of the emergency organization (the internal process reengineering implementation team plays a dominant role, and the participation of all emergency personnel is encouraged) against the newly established emergency process to identify the crux of the existing problem and determine the redundant emergency process and marginal zone.

Step 4: Design the process reengineering scheme. Assign internal and external emergency experts to redesign the emergency organization process (based on the system diagnosis of emergency organization process and centered on the new emergency process) and determine the implementation scheme for process reengineering.

- ④ Stage 4: Implementation stage: This stage involves carrying out the process reengineering scheme on a “from point to area” basis.

Step 1: Try out the process reengineering scheme locally. Select a department for applying the new emergency process and process reengineering scheme on trial.

Step 2: Optimize the process reengineering scheme. According to the feedback information about the local trial and the intended goals of the process reengineering scheme, amend the process reengineering scheme, adjust the intended goals, and further determine the implementation sequence and key points of the process reengineering scheme.

Step 3: Communication. The process reengineering scheme involves the adjustment of responsibilities and authorities of all related emergency personnel. While emergency process reengineering is implemented, it is necessary to build an effective communication channel, for example, communicate with all emergency personnel deeply and extensively before the promulgation of the process reengineering scheme, and train and educate the emergency personnel at different levels before the implementation of the process reengineering scheme.

Step 4: Reform in responsibilities and authorities. During the implementation of the process reengineering scheme, quickly reform the original emergency organizational structure, re-appoint the related emergency personnel, and re-divide the emergency authorities to build a good organization framework for process reengineering.

Step 5: Switch the old emergency process to the new emergency process. Process reengineering should be carried out steadily. Once conditions are feasible, the old emergency process should be firmly switched with the new emergency process.

- ⑤ Stage 5: Adjusting stage: This stage involves optimizing and improving the organization process constantly.

Step 1: Adjust the process. During the operation of the new organization process, adjust it to adapt to the emergency process from time to time to improve the adaptability of the new emergency organization process.

Step 2: Conduct informatization. Carry out informatization development to allow full play to the efficiency of the optimized organization process.

Step 3: Redesign the emergency evaluation system. After organization process reengineering is carried out completely, it is necessary to design a brand-new emergency evaluation system that focuses on the performance, rate of contribution and degree of coordination with respect to the emergency process. The motive is to facilitate the operation of the new organization process effectively.

Step 4: Normalize the new organization process. When the new organization process becomes increasingly mature and stable subsequent to trial operation and

repeated adjustment, it is necessary to normalize the new organization process in the form of process management documents and graphs.

Step 5: Improve the new organization process constantly. Organization process reengineering is not a one-shot process, but a cyclic and progressive process.

2. Digital trunked communication

The following section describes the application of digital trunked communication in emergency communication and describes the requirements for emergency communication. Digital trunked communication is the best solution for emergency communication.

(1) Requirements for emergency communication

Emergency communication is a special communication and command mode that is used to cope with unforeseen events quickly and efficiently. It is characterized by urgency, randomness of communication places, and environmental adversity. Usually, emergency organizations communicate with each other via a wireless communication system that should satisfy the following four requirements [20]:

① Quick communication and simple operation

Quick communication should be ensured throughout the whole emergency process, for example, seize every minute and second to warn about disasters before their occurrence, rescue the trapped people promptly during disasters, and provide disaster relief quickly after disasters. This cannot go without the emergency wireless communication and command.

② Unobstructed

Emergency communication is of vital importance to ensure the safety of life and property in the case of unforeseen events. General communication allows queuing or waiting. In contrast, emergency communication has relatively no delay, specifically: a. channel resources, howsoever busy, should be ensured for emergency communication. To satisfy the needs of emergency communication, the digital trunked communication system provides functions like emergency call and call priority; b. the digital trunk communication system is capable of instantly communicating with peers irrespective of whether they are busy. In contrast, a general cellular communication system is mainly intended to serve the ordinary masses on an equal basis, and usually does not provide the special communication functions available from the abovementioned digital trunked communication system.

③ Flexible network

The randomness of communication places demand that the emergency communication network be flexibly scalable. Digital trunked communication provides a direct connection function. As a result, the places not covered by any communication network in normal times can be used to communicate with each other during emergency circumstances. In particular, a vehicle-mounted single-carrier

base-station digital trunked communication system can reach the disaster relief sites to satisfy the communication needs of nearly one hundred users.

④ Environmental adaptability

Emergency communication is usually confronted with very severe environments. For example, trunked communication links may be damaged by earthquakes, fire and floods, thus causing network paralysis; complex background noises affect the quality of communication severely.

- a. A digital trunked communication system provides the fail-soft function, thus ensuring normal communication between the users covered by the base stations in case of link interruption between base stations and switching of equipment.
- b. Digital trunked terminals provide a de-noising function, thus ensuring that the onsite voices are clearly transmitted to peers.

(2) Application of digital trunked communication in emergency organization management

The following section describes the application of digital trunked communication in emergency organization management as indicated by urban emergency joint action.

① Necessity of urban emergency joint action system

Urban emergency joint action (also referred to as social emergency joint action) refers to the joint action of social services. In the 1960s, the US Federal Communications Commission decided to use 911 as a countrywide hotline for social emergency rescue and build an emergency joint action center.

In recent years, the ministries and commissions under the State Council of China have held quite a few meetings on urban emergency joint action systems. So far, a number of municipalities and provincial capitals have set out to plan urban emergency joint action systems, and Nanning City takes the lead in this regard. After inspecting the 911 system of Chicago in 1999, top governmental officials of Nanning City proposed building an urban emergency joint action system. After repeated demonstration and investigation, Nanning's urban emergency joint action system was built successfully and put into operation in 2001. In December 2004, the entire emergency joint action system passed the acceptance check. However, in this regard, most of China's cities are confronted with the following problems [21]:

- a. There exist multiple hotlines for special services, for example, 110 (call the police), 119 (fire), 120 (first aid), and 122 (traffic accident). These hotlines are very easy to remember unlike certain 7/8-digit hotlines. The hotlines for services like water supply, power supply, and gas supply are rarely known by people, thus precluding citizens from obtaining due services, rescue, or aid.
- b. Diverse government bodies have built their respective emergency command centers, and emergency funds are not utilized in a centralized manner. As a result, each emergency command center is underfunded, the designed emergency plan and purchased emergency equipment are not enough to satisfy the actual emergency needs and funds, materials, and natural resources are wasted severely.
- c. For the lack of a

unified emergency command and scheduling platform, different types of police forces and departments cannot be coordinated satisfactorily. Actually, many emergency activities entail joint action. d. Data resources are not interconnected, so they cannot be shared.

Evidently, there is an urgent need to build urban emergency joint action systems that will break the coexistence of multiple existing emergency command centers. Thanks to centralized investment and management, they prevent overlapping investment and duplicate construction, improve the level of technological maintenance, emergency management and resource utilization, and make it possible to interconnect and share the discrete information resources and databases. In a word, they serve to improve the effectiveness of emergency management.

② Composition, operation, and implementation of an urban emergency joint action system

Fundamentally, an urban emergency joint action system is characterized by unified call-the-police, unified command, quick response, resource sharing, and joint action [21]. For an urban emergency joint action system, it is necessary to build a unified urban emergency command and scheduling center that comprises of an integrated information network and communication system, and a unified alarm receiving and handling platform. The command and scheduling center integrates the joint services of public security, fire-fighting, and first aid into a complete smart information processing and communication system.

a. Composition of an urban emergency joint action system

An urban emergency joint action system usually has two parts [21]: (I) a computer-aided scheduling and information system (also referred to as the alarm receiving and handling system) under the emergency command center; (II) a citywide dedicated mobile communication network (usually a digital trunked command and scheduling system). The two systems can be integrated in a multi-layered manner into a complete system that is capable of unified alarm receiving and handling and command and scheduling, thus providing a smart urban emergency joint action solution. The urban emergency joint action system is a voice/data/image integrated solution built on an information network and allows organic interaction between its subsystems. The communication subsystem is responsible for transmission, exchange, and distribution of voice information between the emergency joint action center and different communication companies as well as automatic inquiry and transmission of calling numbers and calling addresses. The alarm receiving center is a computer-aided system, which receives and handles the alarm and ask-for-help calls of citizens centrally. The alarm handling center is a computer-aided scheduling system that clearly knows the distribution of all emergency resources and police forces through a visual geographic information system and database, and manages, commands and schedules emergency resources and police forces centrally through an integrated wireless data transmission and scheduling console [21].

The urban emergency joint action system interconnects a number of databases, alarm receiving and handling seats, and mobile police-purpose vehicle-mounted computers, thus forming a powerful information network. The dedicated mobile command and scheduling system for emergency communication provides mobile voice and data communication services for the mobile personnel and policemen, ensuring good communication between them. The whole urban emergency joint action system also comprises of a large screen display subsystem, a security subsystem, a power supply subsystem, a telemetry and tele-control subsystem, a geographic information subsystem and a GPS subsystem [21].

b. Operation of an urban emergency joint action system

The operation of an urban emergency joint action system involves six aspects [21]: calling the police, alarm receiving, alarm handling, execution and feedback, monitoring and record, and report and statistics.

c. Implementation of an urban emergency joint action system

An urban emergency joint action system is usually implemented by two steps [21]:

The first step is to build a dedicated mobile communication network. This communication network is used for daily and emergency command and scheduling by policemen, fire-fighters and first-aid institutions, and is intended to ensure unified command and coordinated action of/between different departments or organizations in case of major unforeseen events. The second step is to build a smart alarm receiving and handling command platform. This emergency command platform integrates not only a variety of technologies (including wired communication, wireless communication, databases, satellite positioning, computer-aided scheduling, information technologies, and network transmission), but also diverse multimedia resources (including voices, data and images), thus facilitating the unified command and correct decision-making in coping with various unforeseen events.

③ Role of digital trunked communication network in emergency joint action

Today, the digital trunked communication system is generally believed to be the preferred mobile communication platform for an urban emergency joint action system. This system provides an unparalleled dedicated command and scheduling function as against any other mobile communication system. It can provide a systematic solution to efficient wireless voice/data scheduling and inquiry between the alarm handling schedulers in the urban emergency joint action center and the personnel on the sites of unforeseen events, specifically [21, 22]: a. the scheduling console affiliated to the digital trunked communication system allows the alarm handling schedulers to schedule the group or individual calls to/from the onsite personnel; b. the digital trunked communication system can provide good wireless wide-area coverage, thus providing voice communication services between the alarm handling schedulers and onsite personnel, and between different onsite personnel; c. a certain digital trunked communication system allows audio communication with the existing mobile devices (for example, the 350 MHz MP-1327

analog trunked communication system and/or conventional VHF/UHF-based wireless communication system). d. A digital trunked communication network is capable of managing the use of total wireless subscriber devices through the urban emergency joint action center. e. All alarm handling schedulers can send data scheduling orders to the onsite personnel through the network terminals of the digital trunked communication network, thus significantly improving the efficiency in handling emergencies. f. The onsite personnel can transfer the onsite information to the alarm handling schedulers of the urban emergency joint action center anytime through the mobile data terminals of the digital trunked communication system. g. The onsite personnel can inquire about the information on the related network databases anytime through the mobile data terminals of the digital trunked communication system. h. The network communication monitoring and management system of the digital trunked communication system allows the urban emergency joint action center to monitor and manage different remote wireless base stations, thus improving the ability to maintain the equipment of remote wireless base stations at lower expenses.

To sum up, such modern supporting technologies like digital trunked communication can be applied to emergency organization management with the motive of providing powerful support for quick emergency response to unforeseen events and improving the emergency management capability against the unforeseen catastrophes.

2.3 Design of Emergency Management Setup

Following Zhang and Pan [23], this book describes the design architecture of modern emergency management setup, discuss the content and functions of its four systems (including the administrative and social responsibility system; event response, evaluation, and recovery system; resource support and technical guarantee system; and defense, refuge, and rescue system) and analyzes the interrelationships between them.

2.3.1 *Composition of Emergency Management Setup*

“Setup” (*Ti-Zhi* in Chinese pronunciation) contains the following two essential points: ① “*Ti*” refers to the space that can accommodate a certain number of objects; ② “*Zhi*” refers to a package of methods and rules that govern the reasonable operation of the objects in that space. Therefore, the formation of a setup calls for not only a physical organization, but also the definition of the responsibilities of the physical organization and the relationship between different physical organizations.

The interpretations of emergency management setup vary from person to person in the academic circle. Some scholars believe that emergency management setup is a concept that is parallel to emergency management operation mechanism, an interpretation that clearly ignores the correlation between “setup” and “mechanism.” Some scholars interpret emergency management setup in a narrow sense, and thus believe that it is an emergency organizational structure oriented toward unforeseen events, an interpretation that clearly does not view the whole setup design process dynamically.

1. Structure of emergency management setup

With respect to Zhang and Pan [23], this book believes that emergency management setup is an important part of an emergency management system and performs critical functions such as definition of responsibilities, resource integration, timely response, emergency rescue, and event evaluation and recovery. From the perspective of emergency functions, the emergency management setup can be divided into four mutually related and supportive systems [23]: administrative and social responsibility system; event response, evaluation, and recovery system; resource support and technical guarantee system; and defense, refuge, and rescue system. Figure 2.24 depicts the relationships between the four systems.

- (1) The administrative and social responsibility system includes two parts: administrative responsibility system and social responsibility system. The administrative responsibility system mainly comprises of the government agencies that are concerned emergency management and the auxiliary rules (for example, management efficiency evaluation), and the social responsibility system mainly comprises of various subjects of responsibilities (including non-government organizations, enterprises, and ordinary citizens) and the relationships between them.
- (2) The event response, evaluation, and recovery system comprises of an information acquisition and processing subsystem (including an information center and information acquisition terminals), a pre-warning and onsite command subsystem, a disaster evaluation subsystem, and a disaster recovery and reconstruction subsystem.

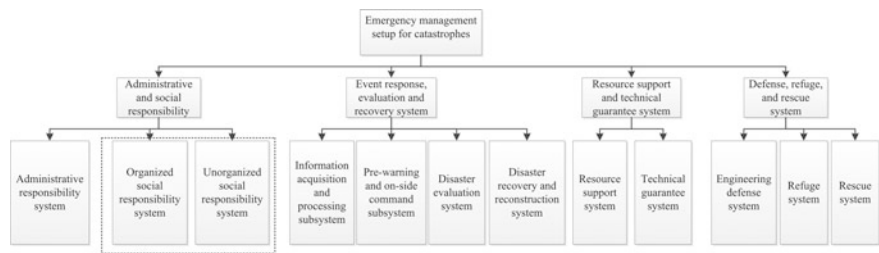


Fig. 2.24 Structure chart on emergency management setup

- (3) The resource support and technical guarantee system not only performs the tasks of storing, allocating and integrating emergency resources, but also provides technological support for service sustainability.
- (4) The defense, refuge, and rescue system comprises of three subsystems: ① the engineering defense subsystem mainly protects personnel and equipment from the impact of catastrophes or reduces the degree of such impact; ② the refuge subsystem refers to the temporary refuge facilities and places that are provided for the disaster-stricken personnel; ③ the rescue subsystem mainly provides onsite rescue services.

2. Hierarchical relationship of emergency management setup

In the whole emergency management setup, the administrative and social responsibility system is the basic layer that defines the subjects of emergency management and the relationship between them; the resource support and technical guarantee system ensures the effectiveness and moderateness of the emergency handling process, in that, it provides rear-service support; the event response, evaluation, and recovery system is the application and implementation layer wherein the subjects of emergency management identify and cope with the unforeseen events with respect to the related laws and regulations; the defense, refuge, and rescue system is the onsite handling layer that directly responds to unforeseen catastrophes [1]. Figure 2.25 presents the hierarchical relationship between the four systems.

- (1) From a vertical perspective, the subjects defined by the administrative and social responsibility system are the bottom layer, and all specific emergency management activities cannot go without their participation; the event response, evaluation, and recovery system is the middle layer and it performs the major task of emergency response to unforeseen events; the defense, refuge, and rescue system is the top layer and it indicates the efficiency of emergency management.

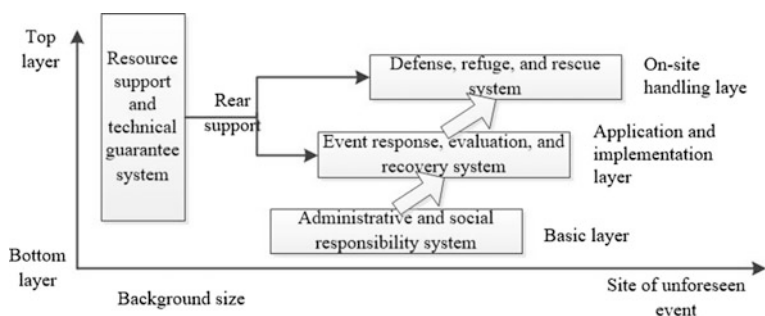


Fig. 2.25 Hierarchical relationship between the four systems of emergency management setup

- (2) From a horizontal perspective, the resource support and technical guarantee system provides rear-service support for specific emergency management activities, thus ensuring the efficiency and stability of emergency handling, and the three other systems are present progressively from the rear base to the forefront.

The following section describes in detail the content and constitution of the four systems.

2.3.2 Administrative and Social Responsibility System

The responsibility systems concerned with emergency management activities include the administrative and social responsibility system [23] (as depicted in Fig. 2.26). The administrative responsibility system refers to the strongly correlated subjects of emergency management, in that, the subjects should assume binding responsibilities and obligations to cope with unforeseen events. The social responsibility system refers to the weakly correlated subjects of emergency management, and they can be further classified into organized and unorganized social responsibility systems.

1. Administrative responsibility system

Usually, an administrative responsibility organization performs two basic functions: administration and service:

- (1) In the case of unforeseen events, the administrative responsibility organization exercises the authority to plan, organize, command, coordinate, and control the manpower and material resources within its jurisdiction.
- (2) In the case of unforeseen events, the administrative responsibility organization renders necessary assistance to the disaster-stricken people.

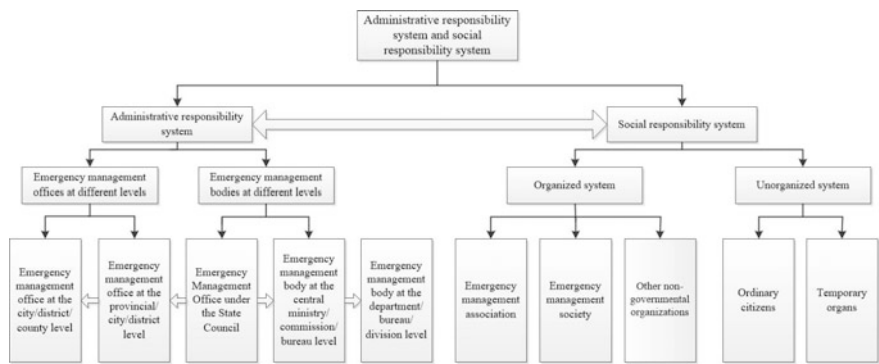


Fig. 2.26 Structure of administrative and social responsibility system [2]

The administrative responsibility system includes not only the governmental agencies and public institutions that are legally related to emergency management, but also their responsibilities and authorities in emergency management, evaluation of emergency management efficiency, and accountability for improper emergency measures [23].

Figure 2.27 presents the hierarchical structure of China’s emergency administrative responsibility system. As the supreme administrative body for emergency management, the Emergency Management Office under the State Council is responsible for command and coordination of the emergency management offices at the provincial/city/district levels and the emergency management bodies at the central ministry/commission/bureau levels. Within this administrative framework, the emergency management offices at the provincial/city/district levels can command the subordinate emergency management offices at the city/district/county levels, and coordinate the emergency management bodies in different cities or administrative areas.

2. Social responsibility system

The social responsibility system mainly includes the weakly correlated subjects who have no ascription of statutory responsibility in emergency management, and is essentially underlain and maintained by moral norms, public opinions, and mass media. Social responsibility systems can be classified into organized social responsibility systems and unorganized social responsibility systems [23]:

- (1) Organized social responsibility systems mainly include quasi-official organizations (including academic associations and societies) and non-governmental organizations (including enterprises and public institutions) with respect to emergency management. They assist governments in emergency response to unforeseen events, thus offsetting the deficiencies of governmental bodies in emergency management and services.



Fig. 2.27 Hierarchical structure of China’s emergency administrative responsibility system

- (2) Unorganized social responsibility systems include the ordinary citizens who are concerned with emergency related activities directly or indirectly as well as the unconventional organizations that are temporarily set up for the purpose of emergency management and services.

2.3.3 Event Response, Evaluation, and Recovery System

The event response, evaluation and recovery system mainly comprises an information acquisition and processing subsystem, a pre-warning and onsite scheduling subsystem, a disaster evaluation subsystem, and a disaster recovery and reconstruction subsystem, as depicted in Fig. 2.28 [23].

- 1. As the nerve terminals of the event response, evaluation, and recovery system, the information acquisition and processing subsystem serves to acquire all information on unforeseen events, process the acquired information, extract the useful information, and discard the redundant information, and transfer the result to the important units that are in need of information (for example, the emergency pre-warning system and emergency decision-makers).
- 2. As the vanguard of emergency response, the pre-warning and onsite scheduling subsystem of the evaluation and recovery system serves to monitor the key information and data, forewarn about the occurrence and developments of unforeseen events, and assist the decision-makers with the command, scheduling, and coordination of onsite emergency actions.
- 3. As the decision-making support body of the event response, evaluation, and recovery system, the disaster evaluation subsystem is mainly responsible for pre-disaster predictive evaluation, in-disaster evaluation of salvability, recoverability and mitigability, and post-disaster measurement-based evaluation, which refers to the overall evaluation of the losses arising from the disasters after the handling of the disaster is complete.

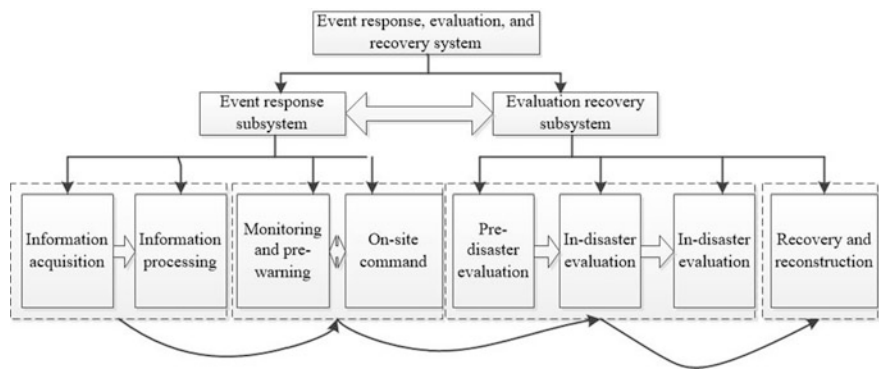


Fig. 2.28 Structure of the event response, evaluation, and recovery system [1]

- 4. As a later stage in handling the body for event response, the disaster recovery and reconstruction subsystem of the evaluation and recovery system is mainly responsible for the placement and compensation of disaster-stricken people, repair and reconstruction of damaged property, restoration of social order in the disaster-stricken areas, and psychological recovery of disaster-stricken people.

2.3.4 Resource Support and Technical Guarantee System

The resource support and technical guarantee system comprises a resource support subsystem and a technical guarantee subsystem, as depicted in Fig. 2.29 [23]:

1. Resource support subsystem

The resource support subsystem is mainly responsible for the layout, allocation, dispatching, and compensation of emergency resources. Emergency resources include emergency manpower resources, material resources, financial resources, and psychological resources.

- (1) Emergency manpower resources refer to the main personnel who cope with unforeseen events, such as fire-fighters, traffic policemen, medical personnel, and soldiers.
- (2) Emergency material resources refer to the various rescue materials and emergency equipment and facilities that are required for the prevention of unforeseen events, rescue of trapped people, and post-disaster recovery, such as fire-fighting equipment and facilities, first-aid equipment and medicine, lighting devices, emergency power equipment, life rings, and relief tents.
- (3) Emergency financial resources refer to fiscal, financial and insurance services as well as donations.
- (4) Emergency psychological resources refer to the psychological counseling and recovery services for disaster-stricken people.

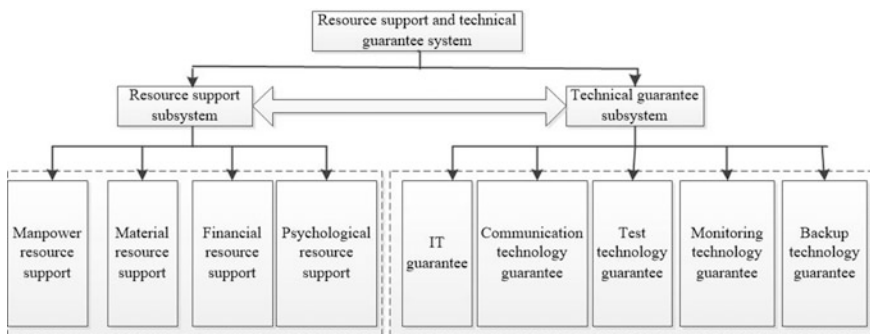


Fig. 2.29 Structure of the resource support and technical guarantee system [1]

As demonstrated by the support and guarantee for fire disaster, emergency manpower resources mainly refer to fire-fighters and emergency material resources mainly include fire-fighting trucks, water, sand and extinguishers, and psychological relief and recovery are indispensable at the emergency rescue site and after the fire disaster.

2. Technical guarantee subsystem

The technical guarantee subsystem mainly provides the software-based technical guarantee and maintenance services and is indispensable to efficient and robust operation of the event response and resource support subsystem. The technical guarantee subsystem provides information technology guarantee, communication technology guarantee, testing technology guarantee, monitoring technology guarantee, and backup technology guarantee, all of which can be invoked individually or jointly.

- (1) Information technology guarantee enables people to acquire, process, and transfer the information on the occurrence and developments of catastrophes promptly and efficiently.
- (2) Communication technology guarantee enables the onsite rescue personnel to communicate with the commanding and scheduling personnel at the background.
- (3) Testing and monitoring technology guarantee enables people to detect and identify the critical signals of disasters, thus improving the accuracy of disaster pre-warning.
- (4) Backup technology guarantee enables people to save a copy of the pre-disaster status. Once the engineering defense system fails to defend the objects from the impact of a disaster, backup technology guarantee enables people to restore the critical pre-disaster data after the catastrophe ends.

2.3.5 *Defense, Refuge, and Rescue System*

At the time of occurrence of unforeseen events, the defense, refuge, and rescue system is the first to make a direct response. This system comprises of three parts: an engineering defense subsystem, an emergency refuge subsystem, and a rescue subsystem. The engineering defense subsystem and emergency refuge subsystem provide necessary guarantee and support for the rescue subsystem, as depicted in Fig. 2.30 [23].

1. Engineering defense subsystem

The engineering defense subsystem mainly provides the hardware basis for defending the potential affected people from the impact of unforeseen events or reducing the degree of such impact. This subsystem usually includes fortification means and non-fortification means. Figure 2.30 lists three types of catastrophes

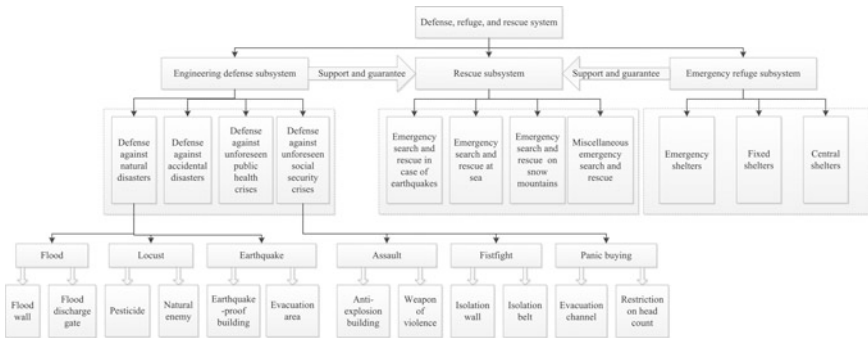


Fig. 2.30 Structure of defense, refuge, and rescue system [23]

(which are natural disasters and social security incidents) and the corresponding engineering defense means against them. In the case of a locust plague, pesticides or natural enemies of locusts can be used to withstand the farmland disaster. In case of an earthquake, an open and wide space is required for the purpose of withstanding the seismic shocks.

2. Emergency refuge subsystem

The emergency refuge subsystem serves to provide temporary shelters for the disaster-stricken people in the case of catastrophes. This subsystem makes full use of urban parks, green lands, squares, and school playgrounds, all of which are well-planned, reasonably developed, and properly managed to provide the disaster-stricken people with safe refuge and basic life supplies, and allow them to await further relief. The emergency refuge subsystem usually provides three types of shelters: emergency shelters, fixed shelters, and central shelters [23]. Emergency shelters have a short-term refuge function, fixed shelters have a majority of early-stage rescue functions during emergency response to disasters, and central shelters give refuge to a large number of disaster-stricken people for a long period.

3. Rescue subsystem

The rescue subsystem is mainly responsible for onsite handling in the case of unforeseen events, and it executes the rescue operation actively and effectively in case of catastrophes. Typical rescue systems include emergency search and rescue against earthquakes, search and rescue at sea, and search and rescue on snow mountains.

Overall, the responsibility subject system, response and recovery system, rear-service guarantee system, and refuge and rescue system compose an all-round and multi-divisional emergency management setup. This emergency management

setup is of great significance and referential value to enhance the emergency management capability of the whole society against unforeseen catastrophes.

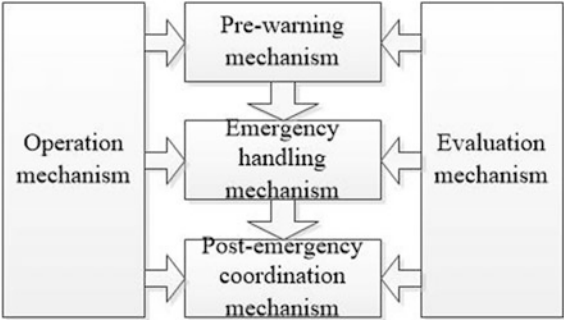
2.4 Emergency Management Mechanism for Unforeseen Events

Emergency management mechanism refers to a set of measures and systems to cope with unforeseen events [24]. The emergency management against the unforeseen events is a holistic and dynamic process, which is incomplete without a proper emergency management system. Furthermore, it is necessary to build an appropriate emergency management mechanism to ensure effective coordination of the personnel available from different departments and material resources within the context of the whole emergency management system. In light of Liu et al. [2], the emergency management mechanism comprises of a pre-warning mechanism, an emergency handling mechanism, post-emergency coordination mechanism, an operation mechanism, and an evaluation mechanism (as depicted in Fig. 2.31). There exists a sequential relationship between the pre-warning, emergency handling and post-emergency coordination mechanism. The evaluation mechanism runs through the complete emergency management process, and the operation mechanism provides a daily and emergency guarantee for coping with an unforeseen event [24].

2.4.1 Operation Mechanism

To make the whole emergency management process more scientific and efficient, it is necessary to develop different types of referable operation mechanisms based on the background, nature, and place of occurrence of unforeseen events. The motive is to help the emergency personnel monitor, forestall, make decisions, and handle

Fig. 2.31 Composition of emergency management mechanism against unforeseen events [2]



different types of unforeseen events in a highly targeted manner; thereby, minimizing or avoiding hazards and stabilizing social order.

Based on the analysis of essential properties of unforeseen events, the emergency management system should operate on the following principles [24]: unified command and coordination and division of responsibilities, hierarchical and classified handling, timely switching, and coordination of resources.

(1) Unity of command and coordination and division of responsibilities

The emergency management system comprises a number of subsystems which perform different functions. To accomplish the same goal of emergency management, unity of command and coordination and division of responsibilities are indispensable. This is necessary for efficient operation of the emergency management system as well as the variety of unforeseen events.

(2) Classification and grading of unforeseen events

Unforeseen events as well as their corresponding emergency guarantee organizations can be classified and graded according to the available resources. The used emergency response methods and the emergency response organizations should be commensurate with the types and grades of unforeseen events. The intent is to divide the emergency responsibilities clearly and facilitate the capability evaluation for the emergency management system.

(3) Timely switching

The state of emergency can be divided into three stages: peacetime preparedness, vigilance, and wartime preparedness. When coping with the catastrophes, it is necessary to switch promptly between the three stages according to their development status, mainly between peacetime preparedness and wartime preparedness, and between different levels of emergency.

The switching between peacetime preparedness and wartime preparedness involves two actions: ① During peacetime, once signs of an unforeseen event are detected, the information monitoring system promptly marks its level according to the grading criteria, and gives an early warning to take emergency measures. If the unforeseen event cannot be brought under control at this stage, the information monitoring system raises an alarm, thus activating the state of wartime preparedness. ② After the emergency guarantee system handles the unforeseen event, the wartime emergency system is turned off, thus switching to the state of peacetime preparedness.

Level switching is defined as follows: Even if there are no signs of any unforeseen event, the emergency command and coordination organ may actively adjust the level of the emergency guarantee system or directly switch to the state of wartime preparedness, so as to satisfy the security needs of special periods.

(4) Coordination and management of resources

Emergency resources include manpower, information, knowledge, material resources, and financial resources, which may be available from governments,

enterprises, public institutions, colleges, or other related social organizations. In the emergency response to catastrophes, the emergency management system should first make full use of the emergency resources in the current region or system. When local emergency resources are undersupplied, the emergency management system may seek help from the outside world. Meanwhile, it is necessary to lay down the laws, regulations, and policies regarding the requisition of the resources available from different owners during emergency handling as well as appropriate compensation schemes.

1. Overview of emergency operation mechanism

The emergency management system is a huge and complex system. To ensure its efficient and flexible operation, it is necessary to build a number of specific operation mechanisms.

(1) Characteristics of emergency operation mechanism

The emergency operation mechanism refers to the code of conduct regarding the constituent elements of the emergency management system and the interactions between these elements, which is formulated according to the composition of the emergency management system and requirements and methods for emergency management with a view of ensuring normal and efficient operation of the emergency management system [1]. In particular, the emergency operation mechanism refers to a package of methods and measures that the subjects of emergency response use or take in monitoring, forewarning, intervening or controlling, and eliminating the occurrence, growth, and impacts of unforeseen events.

The concept of emergency operation mechanism can be defined and interpreted through different perspectives. In conclusion, this book defines the emergency operation mechanism as a package of scientific methods and measures that an emergency organization deploys to monitor, forestall, make decisions, and handle various unforeseen events promptly and effectively, with a view of avoiding and minimizing the hazards arising from them. Usually, an emergency operation mechanism has the following characteristics:

① Uncertainty

The uncertainty of an emergency operation mechanism is caused due to the uncertainty in the objects of emergency management, pre-control, and emergency plans.

a. The uncertainty of objects of emergency management means that the occurrence of unforeseen events is inevitable, but there exists great contingency in the time and place of their occurrence, scale, and impacts. b. The uncertainty of pre-control means that the emergency management organizations are usually difficult to take definite emergency measures against the possible unforeseen events because of the uncertainty of prediction of unforeseen events or the great complexity of unforeseen events in spite of accurate prediction of them. c. The uncertainty of emergency plans means that an emergency plan cannot cover all catastrophes that are likely to occur, or the emergency measures against all catastrophes.

② Urgency

Unforeseen events are characterized by sudden outbreak and a state of emergency, compelling emergency organizations to respond within very limited time. Therefore, in case of catastrophes, emergency organizations must not only make optimal decisions within the shortest time, but also take a huge risk of making incorrect decisions.

③ Preventability

A comprehensive emergency operation mechanism should first and foremost consider preventability. By monitoring the objects of emergency management continuously and taking highly targeted preventive measures, the emergency organizations can prevent the outbreak of crises or minimize the hazards arising from crises.

④ Comprehensiveness

Usually, unforeseen events have four stages that include premonition, outbreak, continuation, and subsiding, and one disastrous event may trigger another or a chain of catastrophes. This demands a comprehensive emergency operation mechanism.

2. Classification of emergency operation mechanisms

(1) Classification of China's emergency operation mechanisms

Emergency operation mechanisms may be classified from different perspectives. For example, China's emergency operation mechanisms can be classified vertically, horizontally, by the subjects of emergency management, and by regions of applicability.

① Vertical classification

China's emergency operation mechanisms can be classified into the central emergency operation mechanism and the local emergency operation mechanisms.

The central emergency operation mechanism is mainly embodied in *The National Emergency Response Program for Unforeseen Public Events* (effective as of January 8th, 2006 by the State Council). As the general program for countrywide emergency response systems, this document expressly classifies and grades unforeseen public events and defines a framework system for emergency response: a. in the case of major countrywide unforeseen public events, the State Council is the supreme administrative organ for emergency management; b. the Emergency Management Office under the General Office of the State Council is responsible for sum-up of emergency information and overall coordination, and serves as the hub of emergency management; c. the related bodies under the State Council are responsible for emergency management of appropriate types of unforeseen public events according to the related laws and regulations.

The local people's governments at different levels (including the provincial-level governments of provinces, autonomous regions municipalities, and the governments at city and county levels) are the administrative organs for emergency

management of unforeseen public events within their jurisdiction. The central emergency operation mechanism is applicable to the significant and major unforeseen public events that involve multiple provincial-level administrative regions or go beyond the emergency management capabilities of the provincial-level people's governments within their jurisdiction.

② Horizontal classification

The emergency operation mechanisms involve a variety of competent authorities, for example, public health, finance, national security, public finance, and environmental administration.

③ Classification by subjects of emergency management

By subjects of emergency management, emergency operation mechanisms can be classified into administrative emergency operation mechanisms and emergency operation mechanisms of enterprises and cooperative organizations.

④ Classification by regions of applicability

By regions of applicability, emergency operation mechanisms can be classified into domestic or intra-regional emergency operation mechanisms and cross-border or inter-regional emergency operation mechanisms.

The emergency operation mechanisms in the conventional sense are mainly oriented toward specific regions, usually within specific administrative regions or the scope of local influence of enterprises. In today's society, the means of transport and information spreading are very powerful and various destabilizing factors are emerging; hence, unforeseen events of the same scale have an increasing sphere of influence than before. In such situations, it becomes increasingly necessary to build cross-border or inter-regional emergency operation mechanisms.

(2) Basic types of emergency operation mechanisms

An emergency operation mechanism contains diverse contents. In addition to the above classification methods, emergency operation mechanisms can also be classified into basic types and specific types [23]: ① making a detailed list of specific emergency operation mechanisms necessary for the operation of the emergency management system; ② determining the classification methods according to the requirements of emergency management; ③ classifying the specific emergency operation mechanisms into several basic types and considering whether the specific types are enough according to the basic types.

In this way, emergency operation mechanisms can be classified into event management mechanisms, process management mechanisms, resource management mechanisms, monitoring management mechanisms, and cooperative participation mechanisms, as depicted in Fig. 2.32.

- ① Event management mechanisms are the management mechanism that are most significantly related to unforeseen crises, including event classification and grading mechanisms, emergency initiation and termination mechanisms, event

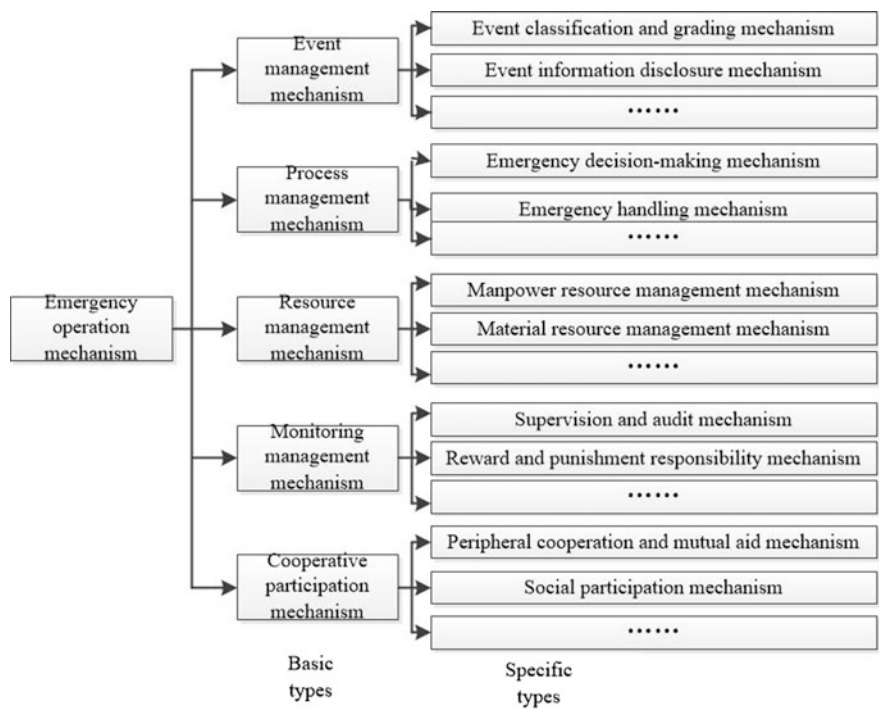


Fig. 2.32 Basic types of emergency operation mechanisms [23]

- upgrading and degrading mechanisms, event information disclosure mechanisms, and risk evaluation mechanisms.
- ② Process management mechanisms are the management mechanisms that are most significantly related to the emergency activities against unforeseen crises, including prevention mechanisms, pre-warning mechanisms, emergency decision-making mechanisms, emergency handling mechanisms, emergency response mechanisms, command and control mechanisms, recovery handling mechanisms, post-event handling mechanisms, emergency information communication mechanisms, and institutional role transformation mechanisms.
 - ③ Resource management mechanisms are the management mechanisms that are most significantly related to the emergency resources for unforeseen crises, including manpower resource management mechanisms, technological resource management mechanisms and resource mobilization mechanisms.
 - ④ Monitoring management mechanisms are the management mechanisms that are most significantly related to the supervision and control of emergency response against unforeseen crises, including system evaluation mechanisms, supervision and audit mechanisms, appraisal, reward and punishment mechanisms, accountability mechanisms, and social supervision mechanisms.

- ⑤ Cooperative participation mechanisms are the management mechanisms that are most significantly related to the emergency handling of unforeseen crises with the help of other forces, including cooperation and mutual aid mechanisms, international cooperation mechanisms, and social participation mechanisms.

3. How to build an emergency operation mechanism

(1) Basic principles of emergency operation mechanisms

Within the extent permitted by law, it is advisable to formulate legal, specific, scientific and feasible emergency operation mechanisms according to the characteristics, goals, requirements, and tasks of emergency response. In this regard, the following basic principles should be observed:

① Legality

Legality means that none of the contents of emergency operation mechanism should conflict or contradict with the laws and regulations in force, and other normative documents of legal force.

② Feasibility

Feasibility means that an emergency operation mechanism should be suited to actual conditions. For example, the emergency handling of unforeseen crises is usually attended by quite a few organizations that are affiliated to different management bodies and differ in their respective management systems. Therefore, in formulating an emergency operation mechanism, it is necessary to take fully into account the existing management systems to ensure smooth emergency handling.

③ Specificness

Specificness means that an emergency operation mechanism should specify the contents about tasks, processes, and responsibilities and authorities to make it operable. Tasks refer to what to do and what requirements to meet. After tasks and jobs are expressly defined, it is necessary to define the processes of executing the tasks, including the steps, programs, and methods. In addition, it is necessary to define the responsibilities and authority.

④ Timeliness

Timeliness means that once an unforeseen event occurs, it is very important to take prompt and appropriate measures to control and mitigate it. Considering the destructiveness, harmfulness, and variability, timeliness is of critical importance to emergency response.

⑤ Consistency

Consistency is embodied in two aspects:

- a. An emergency operation mechanism contains diverse contents that are closely related to each other. In formulating each type of emergency operation

mechanisms, it is necessary to review the documents regarding other types of emergency operation mechanisms to ensure consistency in the content of different types of emergency operation mechanisms and avoid contradictions that may affect emergency handling of unforeseen events.

- b. For each emergency operation mechanism, it is necessary to develop a standard and dedicated documentation template and use it for different documents to ensure convenience in reading and understanding of emergency management personnel.

⑥ Scientificity

Scientificity is embodied in two aspects:

- a. Scientificity of specific contents. Each type of emergency operation mechanism contains diverse specific contents, including the requirements for processes and steps, timeliness and efficiency, and quality and quantity.
- b. Scientificity of system contents. Each emergency operation mechanism is a system, the framework of which can reflect the general beliefs and methods of emergency management. A scientific system can improve the performability of emergency management and the overall emergency capability.

(2) Operation of emergency operation mechanisms

Furthermore, an emergency operation mechanism against unforeseen events should also meet the following requirements [24]:

① Prevention first, combination of prevention and response

Prevention represents the best emergency management. To optimize an emergency operation mechanism, it is necessary to emphasize the pre-warning and prevention of unforeseen events and adhere to the principle of “prevention first.”

② Localized management, integration of departments and regions at different levels

According to their nature and types, unforeseen events can be categorized as localized management and a combination of departmental management and inter-departmental joint action: a. unforeseen events should be first managed by the local governments within their jurisdiction to handle and control them quickly; b. if the unforeseen events are beyond the authority of local governments, they should be promptly reported to the superior governments.

③ Combine peacetime and wartime preparedness, and promote wartime preparedness via peacetime preparedness

The emergency response organizations should not only perform daily management of general unforeseen events, but also make basic preparations against major unforeseen events.

④ Management by law and hierarchical control

The emergency response organizations should abide by the related laws and regulations, but not act beyond the scope of their responsibilities and authorities.

⑤ Joint action and resource integration

In the face of unforeseen events, it is necessary to make full use of existing emergency resources and integrate them (including emergency commanding organs, personnel, equipment, materials, and information) to ensure the unity of command and concerted emergency action and effectively allocate them.

⑥ Quick response, and scientific measures

Timeliness is the foremost factor to cope with unforeseen events. Quick response is the basic indicator of emergency management capability and emergency handling capability. To optimize the emergency operation mechanisms against unforeseen public events, it is necessary to emphasize quick response, so as to ensure perfect articulation of different emergency response links (including detection, reporting, commanding, and handling).

2. Event management mechanism

Event management refers to the process of performing a set of effective management behaviors to prevent and handle unforeseen events, thus ridding public organizations and their members of a crisis. It is the prerequisite for effective emergency activities, and provides a basis for smooth emergency actions.

(1) Event classification and grading mechanism

Event classification and grading mechanism involves dividing unforeseen events into different types and levels based on their characteristics and degree of damage. It refers to the behavioral procedure for the classification and grading of unforeseen events. This mechanism provides the basis for emergency management and is a prerequisite for making various emergency plans.

① Event classification mechanism

The event classification mechanism provides the basis for the whole emergency management mechanism. The diverse types of unforeseen catastrophes or unforeseen risks differ in the potential social harmfulness and requirements for national emergency measures. Therefore, the specific contents of the event management mechanism and the forms of emergency authority granted to the subjects of emergency management should first comply with the principle of proportionality, in that, they should be commensurate with the respective types of unforeseen catastrophes or risks.

Take the classification of China's unforeseen events as an example. In accordance with *The Emergency Response Law of the PRC* (effective as of 2007), unforeseen events refer to the catastrophes that break out suddenly, have caused or

may cause severe social harm, and thus entail emergency response measures, including natural and accidental disasters, public health crises, and social security crises [25].

② Event grading mechanism

Event grading is to divide the diverse types of unforeseen catastrophes into several levels based on their nature, controllability, degree of severity and sphere of influence.

According to established international practice, unforeseen events can be divided into four levels (including blue warning, yellow warning, orange warning, and red warning), which are associated with the visual impacts of these colors [26]: a. Blue warning (Level D): A blue warning signifies an average (or above) emergent public security event, which is impending and is likely to escalate. b. Yellow warning (Level C): A yellow warning signifies a major (or above) emergent public security event, which is impending and tends to escalate. c. Orange warning (Level B): An orange warning signifies a significant (or above) emergent public security event, which is impending and is escalating. d. Red warning (Level A): A red warning signifies an extremely significant (or above) emergent public security event, which is likely to occur anytime and is escalating continuously.

Unforeseen catastrophes are usually ever-evolving, so event grading is also a dynamic process. If the development trends of unforeseen events are not clear, event grading should comply with the principle of “high rather than low,” and should particularly prefer high levels for the unforeseen events involving sensitive time, places, and nature [27].

(2) General procedure for classification and grading of unforeseen public events

As depicted in Fig. 2.33, the classification and grading of unforeseen public events usually undergo the following eight steps: ① formulating the requirements for classification, ② acquiring and classifying the related information, ③ selecting the factors for grading, ④ building the evaluation system for classification and grading, ⑤ extracting the index data about classification and grading, ⑥ making comprehensive evaluation, ⑦ organizing expert review, ⑧ announcing the results of classification and grading. The entire process is depicted in Fig. 2.33 [23].

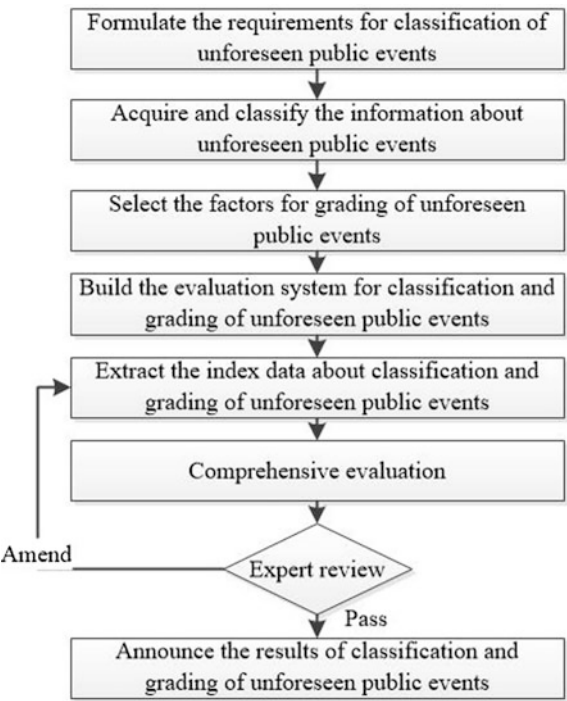
① Formulating the requirements for classification

For the classification and grading of unforeseen public events, the first step is to formulate the requirements for classification based on their nature and forms of occurrence. Event classification should be hierarchical: a. formulating the requirements for primary classification and categorizing the unforeseen public events into several large types accordingly; b. making secondary and even tertiary classifications as needed according to the corresponding classification requirements.

② Classifying the unforeseen public events

Subsequently, the various emergency management organizations should invite the related organizations, experts and scholars, social celebrities, and enterprises to

Fig. 2.33 General procedure for classification and grading of unforeseen public events [23]



classify the unforeseen public events: a. acquiring the information about the previous unforeseen public events and predicting the possible unforeseen public events accordingly; b. making a detailed directory list, recording the degree of harm and frequency of occurrence of various events, and classifying such events.

③ Selecting the factors for grading

Based on the mechanism and case analysis of unforeseen public events, people can select the factors for event grading and identify the major factors influencing it. The selected factors should be as comprehensive and objective as possible. Like event classification, the factors for event grading can also include primary factors, secondary factors and so on.

④ Building the evaluation system for classification and grading

People can extract the set of indexes that are indicative of the properties of the factors for event grading and determine the weights of the quantifiable indexes through multivariate statistical analysis methods (including linear regression and clustering analysis) while determining the weights of the unquantifiable indexes using analytical hierarchical process. Then, people can set the evaluation criteria and draw the demarcation lines between types and levels of unforeseen events.

Appropriate grading models should be built for the evaluation indexes and criteria for different types of unforeseen public events to form a complete classification and grading evaluation system.

⑤ Extracting the index data on classification and grading

It is a strenuous job to extract the index data about classification and grading of unforeseen public events, which needs to be carefully completed. This job is usually performed by experts under the leadership of an emergency management organization to ensure the accuracy, reliability, and scientificity of the extracted data.

⑥ Making comprehensive evaluation

Then, people can input the above index data to the classification and grading evaluation system to obtain the preliminary results on classification and grading. After the preliminary results are comprehensively evaluated, people can adjust the apparently unreasonable results properly and even multiple time to obtain reasonable results.

⑦ Organizing expert review

The emergency management organization should invite experts to review the preliminary results, and listen to their comments and suggestions, thus finalizing the classification and grading criteria.

⑧ Announcing the results of classification and grading

The results of expert review should be examined and approved as per the government-stipulated procedure to ensure the authoritativeness and performability of the finalized classification and grading criteria.

(2) Event information disclosure mechanism

Event information disclosure is an integral part of information communication during emergency activities. It serves to promote the mutual understanding and support between governments and the masses, give a quietus to rumors, and prevent any social panic. Only if the masses are promptly and fully informed of the developments of unforeseen events, can they not only take an active part in emergency related activities together with governmental organizations, but also supervise them to preventing improper emergency behaviors.

① Event information disclosure mechanism

Event information disclosure is an administrative means to provide, with respect to the emergency laws and regulations, the masses with information about unforeseen public events and emergency related activities, which has nothing to do with national security and does no harm to public interest and individual privacy, through normal mass media with a view of maintaining the citizens' right to know. The event information disclosure mechanism is a behavioral procedure specially designed for that purpose.

It is of vital importance to emergency management. After all, asymmetry and non-transparency of information will pose a severe obstacle to the handling of unforeseen catastrophes. When coping with crises, governments or related emergency organizations should disclose facts to the masses as quickly as possible to maintain their right to know and face the crises together. If governments cannot disclose authoritative information at critical moments, people will not feel reassured and even encourage the spread of rumors, thus affecting social stability.

② General procedure for event information disclosure

As depicted in Fig. 2.34, the general procedure for event information disclosure comprises of six steps: information acquisition, information processing, information editing, information review and approval, information disclosure, and information tracking [23].

a. Acquiring the event information

Event information acquisition should resort to the normal information transfer channels specifically built by the emergency management system to ensure the authenticity and reliability of information. The event information sourced from other channels should be strictly verified to prevent the spread of false information.

b. Processing the event information

Event information processing is to extract and purify the event information, in that, to eliminate the false information and retain the true information. During event information processing, it is necessary to rearrange a large amount of related information and identify the false information.

c. Editing the event information

An event information editing team (comprising of managerial, professional, and technical personnel, emergency and social problem experts, and related scholars) can be set up to determine the main contents that need to be disclosed to ensure the authenticity, timeliness, completeness, directiveness, and confidentiality of information disclosure.

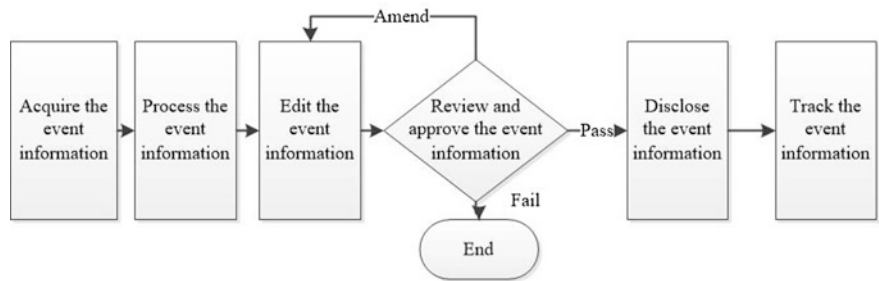


Fig. 2.34 General procedure for event information disclosure [23]

d. Reviewing and approving the event information

With respect to the stipulated management procedure, the event information to be disclosed should be reviewed and approved strictly, and the time, venue, mode and media of information disclosure should be reviewed correctly.

e. Disclosing the event information

Upon completion of the above steps, event information can be disclosed. To ensure smooth event information disclosure, appropriate safety and prevention measures should be taken.

f. Tracking the event information

After event information is disclosed, it is necessary to keep a close watch on the response of the masses and social organizations, media reports, and public opinions to know its effects.

3. Process management mechanism

Emergency process management refers to managing unforeseen catastrophes throughout the whole process (for example, before disasters, during disasters, and after disasters), that is, intervening and controlling the catastrophes in a scientific manner, thus minimizing the losses arising from them. A process management mechanism focuses on the interactive behaviors of people during emergency activities, which regulates, coordinates, and constrains each specific emergency related activity. The most representative process management mechanisms include the prevention mechanism, pre-warning mechanism, event handling mechanism, emergency decision-making mechanism, and information communication mechanism. They each can basically cover the main contents of an emergency process management mechanism.

(1) Prevention mechanism

The prevention mechanism refers to a behavioral procedure that is formulated based on a good understanding of the occurrence and development law governing unforeseen events to forestall them or enhance the capability to withstand them through scientific, managerial, or technical means, thus eliminating the environment for incubating them and reducing their probability of occurrence.

① Prevention of unforeseen events

Prevention refers to various measures that an emergency management organization takes prior to unforeseen events with a view of preventing their occurrence or escalation and reducing the losses arising from them. Prevention is the first step of emergency management and the key to avoiding the occurrence of unforeseen events and reducing the losses arising from them. Furthermore, prevention provides the basis for other emergency measures. Although unforeseen events are characterized by unexpectedness, uncertainty, and contingency, their occurrence usually arises out of environmental changes or intensification of social contradictions. If

deeply analyzed, the vast majority of accidents are the inevitable outcomes of the vulnerabilities in daily institutional design or management over a long period. Therefore, it is advisable to attach much importance to the prevention work and take appropriate preventive measures to nip the unforeseen events in the bud.

- a. Build an emergency plan system: (I) the related bodies under the State Council should formulate the national emergency program within their authority with respect to related emergency plans; (II) the related bodies in the people’s governments at county level (or above) should formulate specific emergency plans with respect to related emergency laws, regulations and rules, emergency plans promulgated by the related bodies of superior people’s governments, and actual local conditions.
- b. The people’s governments at different levels should investigate, register, evaluate, check regularly, and monitor the hazardous sources and areas that are prone to cause natural and accidental disaster, public health crises, and social security crises and order the authorities concerned to take safety and prevention measures.
- c. Enterprises and public institutions should establish perfect safety management systems, check the implementation status of their safety and prevention measures regularly to eliminate the potential risks, get to know and promptly deal with crisis-prone problems, and promptly report the possible unforeseen events and the safety and prevention measures against them to the local people’s governments.

② General procedure for prevention

As depicted in Fig. 2.35, the general procedure for prevention work comprises of five steps: a. selecting the objects of prevention; b. formulating the preventive measures; c. carrying out the preventive measures; d. checking the prevention work; e. summing up the existing problems [23].

a. Selecting the objects of prevention

The first step of the prevention work is to select the objects of prevention. Emergency management experts, professional personnel, administrative organs, and

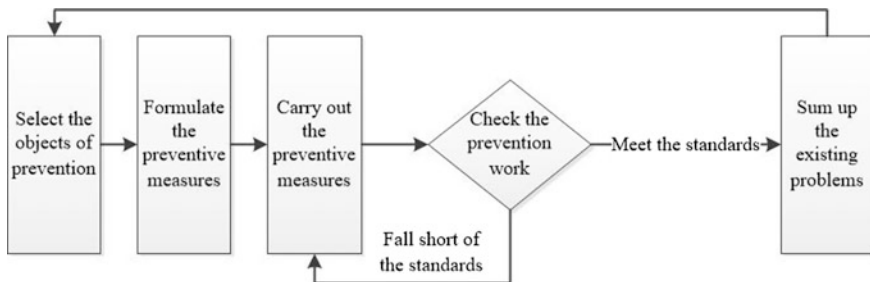


Fig. 2.35 General procedure for prevention [23]

consultative organizations can be invited to make risk evaluation for possible unforeseen events, and identify the objects to be prioritized.

b. Formulating preventive measures

For prioritized unforeseen events, professional personnel, management experts, administrative organs, and consultative organizations can be invited to formulate feasible prevention measures and methods according to their occurrence law and incubating environments to the extent permitted by the existing organizations, resources, funds, technologies, and information. In addition, they should formulate definite requirements for the prevention work to carry out the prevention measures and methods and attain the expected prevention effect.

c. Carrying out preventive measures

Subsequently, it is necessary to give publicity to the prevention measures, allocate necessary resources, and assign tasks, specifically: ① getting the prevention measures accepted by the organizations concerned as well as their members; ② allocating necessary manpower, financial, and technical resources to ensure smooth implementation of the prevention measures; ③ assigning specific jobs and tasks to appropriate objects based on a responsibility system.

d. Checking the prevention work

If the prevention measures are not carried out for various reasons, it is necessary to check and supervise their implementation status regularly and penalize the organizations or individuals who defy, disregard, make light of, or fail to perform their responsibilities.

e. Summing up the existing problems

In preventing unforeseen events, various new problems and challenges may emerge. Therefore, it is necessary to sum up the newly emerging problems constantly and adjust and improve the methods of prevention work promptly to make it more effective.

2.4.2 Pre-warning Mechanism

A perfect pre-warning mechanism should be underpinned by an information monitoring system, an information processing and analysis system, a risk evaluation system, and a pre-warning release system. These systems serve to promptly and accurately monitor the information about unforeseen events, scientifically process and analyze the acquired monitoring information, accurately judge the degree of potential risks and find out their development trends, and promptly release the pre-warning information to enhance the capability to meet unforeseen events and reduce the possible damage arising from them.

1. Forewarning the unforeseen events

Pre-warning refers to the action of emergency management that is taken when the risks of catastrophes are suddenly exacerbated or certain premonitory signs of catastrophes are detected, but the main bodies of catastrophes still remain to break out. The pre-warning mechanism refers to the behavioral procedure for the actions (including forecast and preprocessing) that are taken with respect to the highly probable unforeseen events through information analysis, trend forecast, and risk evaluation based on acquired information.

The key to pre-warning lies in the two points: ① analyzing and evaluating the captured related signs according to the established event classification and grading criteria; ② ensuring a high degree of information sharing to improve the scientificity and efficiency of information analysis, management, and transfer [28].

(1) Basic principles for pre-warning

Usually, the pre-warning of unforeseen events should comply with the following principles [29]:

① Correlativity

Regarding the occurrence and development of unforeseen events, certain premonitory signs and final outcomes are not isolated from each other, but are interrelated and interdependent on each other.

② Similarity

Regarding the occurrence and development of unforeseen events, the different catastrophes of the same type sometimes share a high degree of similarity in terms of their occurrence with respect to time and space.

③ Statistical regularity

In spite of randomness and uncertainty, the occurrence of unforeseen events takes on a certain statistical regularity according to related historical data and current data.

④ Constant follow-up

The influencing factors for unforeseen events are usually uncertain, thus reducing the accuracy of pre-warning significantly. To improve the accuracy of pre-warning as much as possible, emergency management personnel should not only make a long-term and macro forecast of the possible development trends of unforeseen events according to the related social and economic development strategies, but also follow up the development trends of current social contradictions and obtain updated data to respond to unforeseen events promptly and effectively.

(2) Methods of pre-warning

To improve the accuracy of pre-warning, it is necessary to apply a set of scientific techniques and methods. Usually, pre-warning involves three types of methods:

- ① Intuitive forecasting techniques (also referred to as qualitative forecasting): Analyze and judge the nature of pre-warning objects according to previous experience and knowledge by a combination of logical reasoning and theoretical thinking.
- ② Objective forecasting technique (also referred to as quantitative forecasting): Use various theoretical methods (including operational research and system engineering) and acquire the predictive information by building a mathematical model for predictive analysis.
- ③ Modern prediction and simulation techniques that integrate the advantages of qualitative and quantitative analyses.

(3) General procedure for pre-warning

As depicted in Fig. 2.36, the general procedure for pre-warning comprises of five steps: ① acquiring the information about potential unforeseen events; ② analyzing and forecasting; ③ evaluating the risk; ④ making emergency decisions; ⑤ releasing a pre-warning [23].

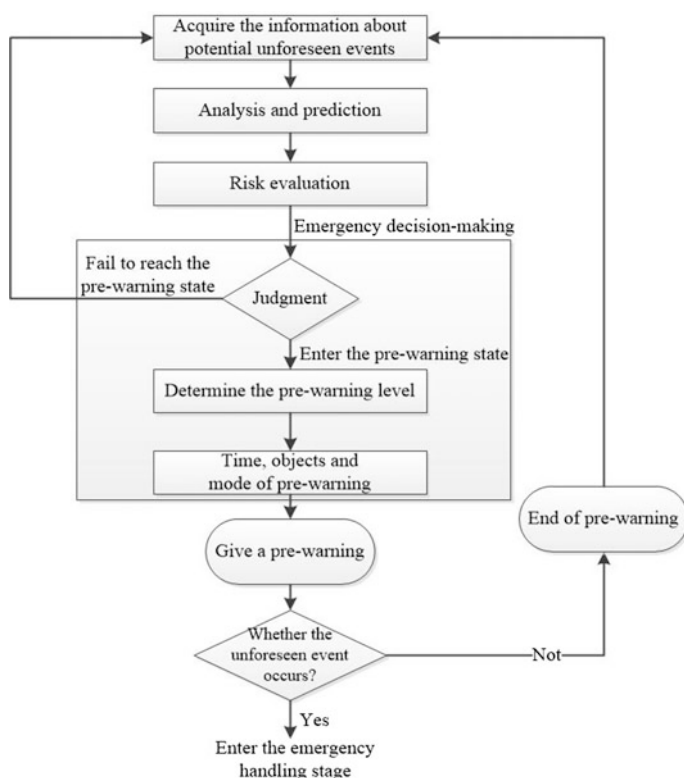


Fig. 2.36 General procedure for pre-warning [23]

① Acquiring the information about potential unforeseen events

Acquire the information about various potential unforeseen events by different means and tools. In this regard, it is necessary to define the scope of objects of monitoring and the requirements for the time, spatial scope, mode and process of information acquisition.

② Analysis and forecasting

After acquiring the above information, analyze the raw information by different means: a. eliminate the false information and retain the true information to prevent decision-making errors in the subsequent emergency management; b. examine the information and make in-depth correlation analysis to avoid ignoring any critical information.

Forecast the potential risks of unforeseen events by various technological means to identify and detect the existence of potential hazards.

③ Risk evaluation

If potential hazards are detected, it is necessary to input the information about specific unforeseen information to the risk evaluation system to determine the level of risks of unforeseen events and the degree of hazards arising from them. Risk evaluation involves the following jobs: a. determining the nature of the unforeseen events; b. determining the evaluation methods suited to the unforeseen events; c. making risk evaluation decisively but not hesitatingly, to not miss the good opportunity of emergency response.

④ Making emergency decisions

After determining the possibility of occurrence and the degree of risk of unforeseen events, make emergency decisions and determine the following content about pre-warning release: level, time, scope, objects, mode, detailed items, and organizations.

⑤ Releasing a pre-warning

First of all, pre-warnings should be released to the masses, so that they are informed of upcoming unforeseen events and make necessary preparations for them. In addition, pre-warning can be released to the internal emergency management departments inside the organizations concerned through internal communication systems or office systems to initiate the emergency management work.

2.4.3 Emergency Handling Mechanism

The emergency handling of unforeseen events should comply with the following principles:

1. Classification and grading of unforeseen events

Like an emergency operation mechanism, classification and grading of unforeseen events and associated emergency guarantee organizations are indispensable to emergency handling.

2. Centered on emergency plan

For emergency handling, the first step is to decide the response measures according to the established emergency plan.

3. Life first

The survival rights of people are the first consideration during emergency handling. Therefore, the human-oriented principle should be strictly observed throughout the whole process of emergency handling.

4. Collaboration and authorization during wartime

The response to unforeseen events involves a number of emergency organizations, so the principle of “collaboration and authorization during wartime” is specially stipulated to prevent the inefficiency of collaboration between emergency organizations and their failure in mobilization.

5. Exceptional handling for exceptional cases

If exceptional issues (for example, national security) are involved, unforeseen events possibly need to be handled based on exceptional logic and principles.

2.4.4 Post-event Handling Mechanism

After unforeseen catastrophes are handled, it is usually necessary to make post-event handling based on the following principles:

1. Resource compensation

After emergency handling is complete, the emergency resources (whether from inside or outside the emergency management system) used in emergency handling should be compensated properly. In other words, it is necessary to establish a compensation mechanism with well-defined responsibilities and obligations.

2. Post-disaster reconstruction

When a disastrous unforeseen event occurs in a region, appropriate reconstruction measures should be formulated. The raising and use of funds for post-disaster reconstruction should comply with specific principles to revive the disaster-stricken region as quickly as possible.

3. Event reporting and sum-up

During post-event handling, it is necessary to formulate an accountability and reward and punishment system, specifically: (1) reporting the unforeseen events of different types to the suitable departments; (2) assigning the sum-up and evaluation work to the departments and personnel at suitable levels.

4. Accountability and reward and punishment on the personnel and organizations concerned

Post-event handling should fully highlight the rewards and punishments for the personnel and organizations concerned to form a just and fair accountability and reward and punishment mechanism. The ultimate goal is to systemize and institutionalize emergency management from a long-term point of view and within the context of legal safeguard.

2.4.5 Evaluation Mechanism

Just like emergency operation mechanism and emergency handling mechanism, it is important for the emergency evaluation mechanism to classify and grade unforeseen events and emergency organizations. In addition, a complete emergency evaluation mechanism should also involve the evaluation of the following factors: effectiveness of emergency management mechanism, effectiveness of emergency plan and emergency plan management, overall emergency capability of the emergency management system and capabilities of different dedicated emergency organizations, and the effect of emergency handling.

2.5 Legal System for Emergency Management

The emergency management system needs to operate within a context of emergency laws and regulations. An appropriate legal safeguard system is of vital importance to the whole emergency management system. Therefore, it is necessary to ensure efficient operation of the emergency management system at the legislative level.

2.5.1 Overview of the Emergency Law and Regulation System

The emergency legal system is primarily intended to attain emergency management and interest balance. The legal system governing emergency management has the

same fundamental structure as the national legal system. Specifically, it includes the formal system for emergency laws and regulations (as depicted in Fig. 2.37), and the content system for emergency laws and regulations. In terms of the formal system, the emergency laws and regulations can be embodied in various legal forms through legal force: ① the provisions governing emergency management in the constitution; ② the provisions governing emergency management in the laws made by the parliament; ③ the provisions governing emergency management in the administrative rules and regulations made by administrative organs; ④ the provisions governing emergency management in the local laws and regulations made by local legislative organs [30].

In terms of the content system, the emergency laws and regulations include those made during peacetime through a normal legislative procedure and those made during emergencies through an emergency procedure. In terms of legality, the emergency laws and regulations made an emergency through an emergency procedure must consist of the laws and regulations made during peacetime through a normal legislative procedure (as depicted in Fig. 2.38). In terms of the objects of legal regulation, emergency laws and regulations mainly include laws and regulations governing emergency authority, rights, and obligations. In terms of social relation domains, emergency laws and regulations involve war laws and regulations, laws and regulations governing the state of emergency, disasters, and public security.

In summary, the legal system governing emergency management is a multi-divisional and hierarchical system, which functions as per general emergency management laws. Combined with the non-emergency laws and regulations, the emergency laws and regulations constitute the unified legal system of a country.

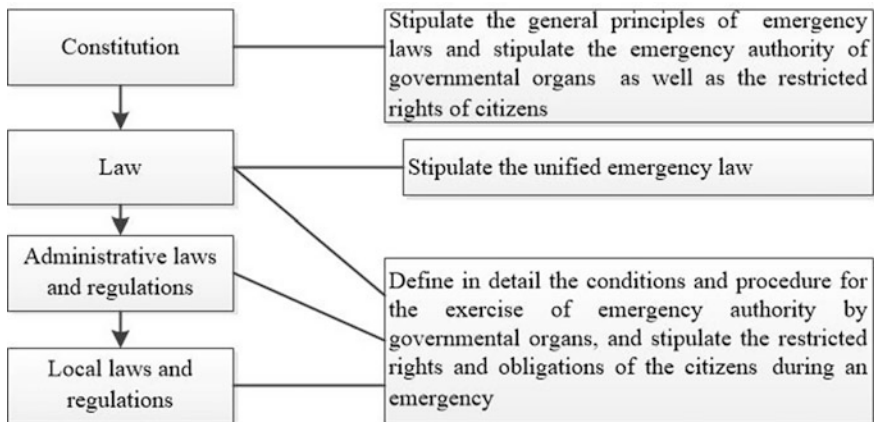


Fig. 2.37 Formal system of emergency laws and regulations [30]

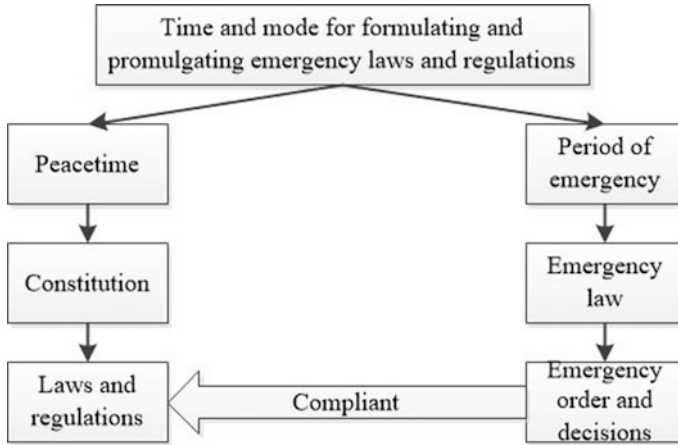


Fig. 2.38 Procedure for making emergency laws and regulations in peacetime and emergency time

2.5.2 Characteristics of the Emergency Law and Regulation System

In a country's legal system, any law or regulation for emergency management is set up as an independent entity. As compared to the non-emergency laws and regulations, the emergency laws and regulations governing the handling of unforeseen events share the following characteristics [30]:

1. Precedence in authority

“Authority first” means that in a state of emergency, the administrative emergency authority takes precedence over other state power (legislative power and judicial power) and statutory civil rights.

2. Emergency handling

Emergency handling means that in a state of emergency, the administrative organs have the power to take emergency actions to prevent further losses to public interest and civil rights even if there are no provisions governing specific unforeseen events.

3. Procedural exception

Procedural exception means that in a state of emergency, the exercise of administrative emergency authority sometimes needs to follow certain exceptional behavioral procedures.

4. Social cooperation

Social cooperation means that in a state of emergency, the organizations and individuals concerned are duty-bound to cooperate with the exercise of administrative emergency authority, and render various assistances as needed.

5. Restrictiveness of relief

The restrictiveness of relief means that in protecting the civil rights, the emergency laws and regulations lay emphasis on public interests. In a state of emergency, therefore, the emergency laws and regulations sometimes place certain restrictions upon the individual rights of citizens, and stipulate for the statutory obligations of individual citizens during an emergency period.

6. Compulsoriness

Compulsoriness means that in a state of emergency, the regulatory objects of emergency laws and regulations (whether the state organs that exercise the emergency authority or the general citizens) must abide by the emergency laws and regulations unconditionally, rather than enjoy certain legal freedom of choice as usual.

2.5.3 Status Quo of China's Emergency Laws and Regulations

1. Status quo on China's legal system governing emergency management

(1) Leading law governing emergency management: *The Emergency Response Law*

After the SARS crisis of 2003, China set out to build its legal system governing emergency management. *The Emergency Response Law of the PRC* (draft) was discussed and amended twice by the Executive Meeting of the State Council first and then submitted to the Standing Committee of the National People's Congress in June 2006 for examination and approval. After being examined and amended thrice, *The Emergency Response Law of the PRC* was unanimously adopted in the 29th conference of the Standing Committee of the 10th National People's Congress on August 30th, 2007, and it came into force as of November 1st, 2007.

The Emergency Response Law of the PRC comprises of 70 articles in seven chapters, and it mainly stipulates the following: emergency management setup, prevention and emergency preparedness, monitoring and pre-warning, emergency handling and rescue, and post-emergency recovery and reconstruction. In addition, this law is elaborately articulated with the emergency state system under the constitution and other laws governing emergency management.

(2) A suite of specific laws and regulations governing emergency management

According to the statistics for the laws and regulations governing emergency management on the portal website of China’s Central People’s Government, China has so far enforced a total of 20 emergency laws and regulations governing natural disasters (including seven laws and 13 administrative regulations), 43 governing disastrous accidents (including 14 laws and 29 administrative regulations), 11 governing unforeseen public health crises (including 5 laws and 6 administrative regulations), and 42 governing social security crises (including 22 laws and 20 administrative regulations). These specific emergency laws and regulations (as depicted in Fig. 2.39) constitute the China’s legal system for governing emergency management:

- ① Laws and regulations governing the state of war: *Regulations on National Defense Transportation, Regulations on National Defense Mobilization of Civil Transport Resources, Military Service Law, Law of Officers on Reserve Service, and Civil Air Defense Law*;
- ② Laws and regulations governing disastrous unforeseen events: They include laws governing earthquakes, floods, environmental and geological disasters.
- ③ Laws and regulations governing unforeseen accidents: China’s legal system governing accident prevention include specific laws for accident prevention, administrative regulations and regulations for accident prevention, and local laws, regulations, and rules for accident prevention. The specific laws governing accident prevention include the laws governing traffic accidents, nuclear accidents, public health accidents, fire, and production safety accidents.
- ④ *Martial Law*, laws and regulations governing civil rights relief, and general laws and regulations governing the state of emergency.

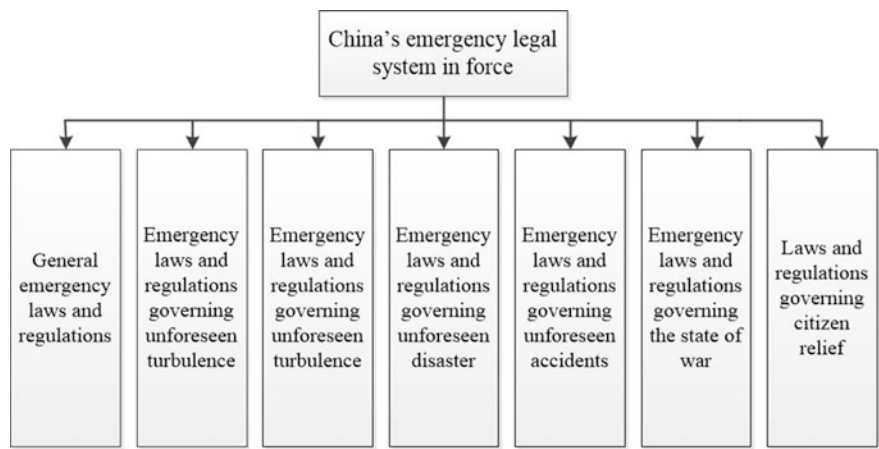


Fig. 2.39 Composition of China’s existing emergency legal system

2. Existing problems in China's legal system governing emergency management

In summary, China's legal system governing emergency management lacks comprehensiveness and directiveness at the legislative level, that is, emergency management is legislated for different types of unforeseen events. This causes quite a few legal conflicts and contradictions and a lack of horizontal correlation in the whole emergency legal system, thus reducing emergency capability. Moreover, the emergency laws and regulations in certain fields are not complete or normative, and the emergency laws and regulations governing certain types of unforeseen events are of low functionality. Specifically, China's emergency legal system is defective in the following aspects: (1) emphasizing the in-process handling of unforeseen events, but ignoring the pre-emergency prevention and preparedness and post-emergency compensation and relief; (2) emphasizing the vertical leadership relationship between different levels of organizations, but ignoring the horizontal coordination and cooperation between different organizations or departments; (3) emphasizing the dominant role of administrative organizations, but ignoring the participation of social forces (including social organizations and volunteers) in emergency response to unforeseen events; (4) emphasizing coercive means, but ignoring the flexible law-enforcing modes (for example, administrative guidance) in response measures; (5) emphasizing the grant of authority to government entities, but ignoring the procedural requirements on how to exercise such authority correctly [31].

2.5.4 Experience and Restructuring of the Emergency Law and Regulation System

1. Valuable experience on the emergency legal system

Based on the careful study of the emergency laws and regulations of the USA, Canada, Australia, England, France, Sweden, and Russia, it can be concluded that all emergency legal systems share the following characteristics: (1) emergency laws and regulations are specialized and systemized; (2) legal personnel in emergency management are specialized and professionalized; (3) emergency laws are gradually suited to the needs of the pluralized, multi-divisional, and networked emergency management systems; (4) the emergency management behaviors of governments are procedurally normalized, institutionalized, and legally-prescribed; (5) various mechanisms (including the pre-warning mechanism, resource reserve and mobilization mechanism, and crisis-solving mechanism) are perfected gradually; (6) the development of emergency consciousness and emergency capability is institutionalized and legally-prescribed.

2. Restructuring of China's emergency legal system

Based on the mature law-making experience in both China and abroad, along with Zhang et al. [4], it is recommended that China's emergency legal system should be restructured as follows:

- (1) Design the organization system and commanding organ required for maximizing the emergency capability

An emergency organization system essentially represents a way the diverse emergency forces are organized. The following steps are indispensable for building an organization system against the unconventional unforeseen events: ① building a poly-system which is centered on national public power and comprises enterprises and public institutions, grass-roots organizations, social organizations, and volunteers to multiply the emergency response capability in case of unforeseen events; ② horizontally, breaking the boundaries of responsibilities and authorities between different organs of public power (if necessary), so as to ensure continuous operation of emergency activities; ③ vertically, developing a joint-action and complementation mechanism between different levels of emergency organizations, so as to attain not only top-down quick aid, but also bottom-up timely complementation.

- (2) Provide an institutional guarantee for mobilizing and guaranteeing emergency resources

Emergency preparedness essentially represents the reasonable allocation of public resources in the field of emergency management. The material, manpower, and technological resources required for emergency handling of unforeseen events must be mobilized beforehand. Considering the public nature of such resources, they should not be requisitioned at will, but on legal grounds. Due to the scarcity of such resources, their requisition should be legally moved or constrained.

- (3) Guarantee enough authority for emergency decision-making against unconventional unforeseen events

Emergency decision-making against unconventional unforeseen events includes prior decision-making in risk regulation and onsite emergency decision-making, both of which require legal guarantee of authority to the decision-makers.

The risk regulation for the unconventional unforeseen events is usually conducted prior to the corroboration of the likelihood of their occurrence, the possibility of damage arising from them, and the causal relationship between unforeseen events and damage. In the face of risks due to potential unconventional unforeseen events that need to be proved scientifically, serious consequences may be caused regardless of emergency decision-makers represented by governments pro-actively taking regulatory measures. Therefore, emergency laws and regulations must expressly stipulate the conditions, extent, and legal liability for carrying out risk regulation by decision-makers.

As the core of response to unconventional unforeseen events, onsite emergency decision-making is characterized as follows: ① the constraints of emergency

decision-making are extremely rigorous, and the decision-makers cannot know everything about the legal authorities granted to them within a short period; ② when the legal decision-makers are not able to exercise their authority, other subjects of emergency management may take over their emergency decision-making authority; ③ in an extremely critical state of emergency, the legal decision-making procedure may be disused and personal arbitrary decision-making may be used instead; ④ the consequences of emergency decision-making are unpredictable and even illegal at times.

Therefore, emergency laws and regulations should provide enough space for making contingent choices to the subjects, procedure, and content of decision-making under the scenarios of unconventional unforeseen events to the extent permitted by law. To this end, it is necessary to stipulate in detail not only the conditions, legal force, and retroactive recognition for ultra vires decision-making and centralized decision-making, but also the conditions and manners for exempting decision-makers from legal liabilities.

- (4) Switch smoothly between the unconventional emergency legal system and the conventional general legal system

Once the emergency handling procedure for unconventional unforeseen events is initiated, a whole country (or a part of it) is likely to switch from the conventional constitutional order to an unconventional one. However, such an unconventional constitutional order is merely temporary and should be terminated as quickly as possible at the end of emergency handling. Otherwise, the country's social life will reduce to an abnormal state. As such, it is necessary to develop a switching mechanism between the two types of constitutional order. The motive is to not only satisfy the needs of emergency handling of unconventional unforeseen events, but also prevent the long-term existence of unconventional constitutional order, thus reducing damages to civil rights.

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