Discussion on forward field of information circulation among complex organizational hierarchy in emergency coordination of city Natech events

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ABSTRACT: According to the practical demands of emergency management of city Natech events, combed research progress of information management of Natech event with methods of literature analysis. The important problems of Natech emergency cooperation are put forward as follows: first, how to adapt to the requirement of the information response time of social relief and the requirement of information precision of technical aid; second, how to promote smooth flow of the complex level of emergency information; third, how to combine experiences and lessons from city Natech events with complex social structural and functional characteristics. At the same time, the research tendency of city Natech emergency information circulation is put forward.

KEY WORDS: city Natech events; emergency coordination; complex organizational hierarchy; efficiency of information circulation

1. Introduction

Along with the development of the urbanization, the size of city has become more and more big, and then the potential impact of disasters has become more and more serious. Most cities in China have endured severe natural disasters, such as earthquake disasters. While the vulnerability of city become bigger than before, for cities have taken on characteristics of intensive population and economic activities. On one hand, the water supply, the power supply, energy, communications and other urban lifeline system networks are complicated; on the other hand, cities have many departments and units, floating population and complex social structure function. Once suffered from disaster damage, they could cause serious social problem. Furthermore, the city industrial accidents are in a grim situation. Most cities in our country are traditionally industrial cities. Although equipment update and facilities moving have be done frequently, there are still dotted with some industrial facilities in cities and there are still a lot of major hazard installations spreading to every corner of cities, such as refueling stations, product oil pipelines, city gas pipelines, water purification chlorine tanks, etc. Once natural disasters happen, it is easy to cause rupture and leakage failures, causing a series of secondary disasters and derivative disasters. More seriously, there are still some industrial facilities with potential hazards, high secrecy and extremely complex technology in parts of the city. Requirements of emergency technology in these institutions are higher.

Natural disasters cause a variety of industrial facilities to fail together, consequently known as "technological disaster triggered by any type of natural disaster (Natech events)"[1-3].For example, in 2005, the hurricane Katrina in the United States destroyed oil platform offshore of Mexico gulf and facilities on shores caused the leakage of dangerous materials. In 2008, the Wen-Chuan earthquake in China caused storage facilities of dangerous chemicals, pipeline damage, nuclear power plants and nuclear facilities damaged, caused leakage and radioactive pollution of poisonous materials [4]. In 2011, the nine-grade earthquake in Japan induced tsunami, caused leakage accident of "Fukushima" and "Onagawa" nuclear power plants [5] and so on.

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Natech events address serious challenges to emergency management in extreme situations. In extreme environment, industrial facilities are affected, which increased risk of residents and rescue workers exposed to it [6]. Disaster destroys key infrastructures, causes lifeline supply disruptions, may results in the chain reaction of damage to the social stability[5]; The technical requirements of industrial disaster emergency is extremely high, which needs more technical experts to participate.

It can be seen that emergency response of Natech events need continue and effective exchange information in order to improve the effect of emergency for it integrate natural factors and technical factors of the disasters [7]. Information becomes the key of emergency cooperation of Natech events. However, coordination efficiency of the main body of emergency rescue in complex situation is not ideal, poor information circulation induces phenomenon such as the uneven allocation, the lack of technical materials and professional equipments to appear usually [8]. For a city system with a huge organization system and the complex departments or regions relation, the integration of various social forces and emergency resources is more difficult. So, carrying out the study of emergency coordination information circulation efficiency of city Natech events is a kind of especially pressing, important and difficult task at the current time. It should become the important subject of city emergency management.

2. Research situation

2.1 Emergency of city Natech events

Study on Natech events comes from the reality need of major hazard installation emergency management. For major hazards management, the Seveso II of European Union put forward special requirements on the risk analysis for external events, come up with external events have the potential effect which causes chemical accident, so more attention should be focused on domino effect of events. In the 1990s, a study about petroleum, chemical or radiation sources host by Showalter [1] officially proposed the concept of Natech events, which immediately caused the attention of scholars by all countries after that. In order to standardize study of the Natech events, the European commission joint research center (JRC) and the United Nations international disaster mitigation strategy institutions, established the Natech working group in October 2003. The working group includes representative of 13 countries in the European Union and representatives of the research institutions of Japan, United States and other countries. The working group officially proposed three aspects of the research content---risk assessment, vulnerability factors and risk slow strategy [2]. Research of Natech working group formed two kind orientations: the first one attentions on early prevention of Natech events, mainly use ARIA, MHIDAS, MARS, NRC and other disaster databases to access data. In view of the lightning, earthquake, flood, tsunami [9-11] and other typical disaster scenarios, statistically analyze equipment damage probability and failure mode, implement quantitative risk assessment of Natech events; the second one pays attention to Natech emergency response, puts forward that the main problem that disaster relief faced is the contradiction of limited emergency resources and the large number of support request, points out that lacking of information communication is the crux of the problem. And a series of reason of Natech events is put forward, such as lacking of information communication, public and local institutions disasters told [2, 12], understanding ability of public information, and so on.

Chinese scholars haven't given specification on Natech events, but research of secondary disasters or secondary accidents is similar with the research orientations of Natech events. Some scholars give specific concern on damage situations such as chemical equipment [13], city gas pipe [14], and put forward the emergency information demand problem, such as contradiction of comprehensive information and mitigation, accident information dynamics and the urgent of public information demand[15].

2.2 Problems in emergency information flow

Information is a kind of important resource of emergency response. In emergency situation of Natech events, information flows as form of collaboration [7]. Complex network structure that

influences information transmission causes attention of researchers. Zhao Lin-du [16] describes the information collaborative mechanism of Agent in the inter-city disaster emergency management system with the distributed blackboard structure and carries on a modeling study from transit shipment cooperation mechanism, Sharing collaboration mechanism, decomposition and collaboration mechanism. Liu Yi [17] puts forward multilateral communication collaborative effect improve among the organization system and analyzes three coordination mechanisms as no collaboration, weak collaboration as well as strong collaboration using the multi-subject model of mixed structure. In addition, network structure of emergency coordination built in normal state faces failure in emergency cases because of dynamic evolution characteristics that emergencies present. Therefore, in an extreme environment, the organization must integration instant messages and known information efficiently and fast to adapt to the rapidly changing environment [7]. Attention should be focused on response and learning behavior under extreme disaster conditions and to solve lack of real-time information [18]. Brower [19] proposes to build sharing mental models of emergency organizations to improve positive or negative response to the emergency environment.

In incident scenes, structures of emergency rescue organizations are much different [8]. Formal organizations have strict structures, while informal ones are relatively loose. Based on hierarchy authorized organization model building simulation model, a study presided by Zagorecki [20] tests efficiency with information response time. The study shows, compared with stratification authorized organization mode, informal communication increased organizational efficiency in uncertainty environment. Song Jin-song [21] proposes to standardize emergency command structure according to the way of modular organization. Liu Dan [22] divides organization structures of emergency command into rigid and flexible two parts. In addition, for the problem of cognitive overload induced by individual rational in complex emergency situations of full pressure and excessive information[7], some scholars propose to build information disclosure system across the organization coordination[8, 23], improve emergency cooperation efficiency through the multi-levels consultations[24] and so on.

In cases of disaster response, emergency subjects face contradictions such as accessible of emergency information, organization conflict and organization tension. Obstacles exist in information sharing and cooperation. Carley [25] thinks that wrong organization rules and faulty information distribution mechanism will produce bad information flow, and then hinders the information flow. To solve this problem, a study presided by Bharosa [19] uses no-interference observation method to analyze. He reveals the obstacles exist in the information communication of emergency cooperation through observations of six implemental details in the emergency drilling situation, but it lacks analysis of specific emergency situation and main body type characteristics.

2.3 Development tendency and problems

Existing research results involve emergency information circulation problems from different aspects of Natech events. The developing trends are as the followings: first, although emergency responses of Natech events call much concern in recent years, researches in the past mainly concentrated on one-way information flow, such as information notification or events reports. Second, part of results begin to combine with the complexity of the emergency management and researches information exchange and integration issues across groups, but it is not depth enough.

Obviously, in the environment of Natech events, the adaptive ability of emergency subject depends on timely and effective information. Information circulation efficiency becomes key point of Natech emergency cooperation. But the following questions exist in relative researches: first, Natech emergency actions present technical as well as social etc comprehensive characteristic. The network structure of information exchange in emergency cooperation should not only meet the response time requirement of social relief, but also adapt to the information precision requirements of

technology rescue. While the current results can't give clear answer to how to design network structure of the emergency information exchange in Natech events. Second, Natech emergency actions involve coordination problem among complex levels, the intersection of various kinds of factors reduces the efficiency of information flow. The current research results lack analysis of the multilateral flow of emergency information and how to promote smooth flow of the emergency information among complex levels are still questions need to be further discussed. Finally, the city Natech events have characteristics of broader influence and more complex disastrous chains. How to combine the existing Natech events experience and complex characteristics of urban social function and structure, and put forward some applicability strategies are problems that have not been solved.

3. Tendency

From the conclusions above, it can be seen that the following topics should be discussed:

First, track science and technology literature, laws and regulations, policy standards about Natech emergency information management at home and abroad, collect city natural disasters and industrial accident material, analyze experience of secondary disaster emergency information management and distribution and features of city hazards at home and abroad, put forward basic characteristics of technical rescue information and social relief information needs in the emergency cooperation of Natech events.

Second, emergency subjects in city Natech events constitute a virtual organizational structure in fact, so information exchange quality depends on the rationality of this organizational structure. Attention should be focused on the dynamic evolution relationship between disasters chain and emergency information bearing subjects in the city Natech events, research on disaster evolution period and technology relief information transfer process and study on information bearing characteristics of government departments at all levels, hazards their subordinate units and other formal organizations as well as NGO, community and other informal organizations.

Third, pay attention to the complexity of emergency organization system and the block that information flow brings in city Natech events. Identify the obstacles of information flow in emergency response scene , among emergency commanding coordination and between different scenes. Focus on the origin reasons of formation, pathway and evolution rules of obstacles in emergency information flow.

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