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A Review of Researches on the Interaction Mode of Crisis Information from Multidimensional Perspective

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Abstract

Information plays an important role in crisis management and provides effective information materials and program support for decision making. However, there are many problems such as information lag, information overload, cumbersome mode of information interation and uncoordinated operation in the process of crisis management. This article focuses on the information sharing and interaction model in crisis management. Through combing related literatures and research results, we analyzed the three dimensions of crisis information interaction model during crisis management, including interaction between users and crisis information, interaction between users and crisis information systems and interaction between users and users. The interaction implication and interaction method of each dimension are elaborated and compared in depth, and the subject, object and medium of interaction in each dimension are respectively analyzed. Finally, the three dimensions of the crisis information interaction are progressive and continuous, and the transformation from isolation to collaboration is realized. The research on the sharing and pattern of crisis information interaction will provide feasible suggestions for the functional design and interface interaction design of crisis information management system, and guide the government, crisis management organization and public to collaborate in crisis management.

Keywords

crisis information management, interactive mode, information sharing, information behavior, user analysis.

1. Introduction

Crisis exists objectively with the emergence of human society. It refers to sudden events that endanger the public life and common interests of the entire society. In recent years, due to the continuous expansion of human activities and disharmony with nature, various uncertainties have continuously increased. This has led to an increase in the frequency and severity of the outbreak of crises, and various types of natural disasters, accidents, disasters, and public safety incidents. Social security incidents have become more frequent. In 2016, 59,572 sudden incidents occurred in China, causing at least 23,809 deaths and 36,119 injuries. This has caused tremendous damage to the public's personal safety and social wealth. Crisis management mainly includes the management of information, materials, and human resources before, during, and after the crisis, in order to reduce the loss of life, health and property caused by the crisis, and promote social harmony and healthy development[1]. For crisis management, information runs through the entire process of crisis latent, outbreak, persistence, and resolution. Timely and reliable information provides an important guarantee for crisis management. Crisis information includes not only the information generated during the formation and development of the crisis, such as the information of the signs, the data

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affected by the crisis, but also the information such as emergency plans, investigation reports, and assessment results generated in the crisis management, crisis identification and early warning, crisis state tracking, crisis decision-making and processing, and crisis impact assessment all require the support of relevant information.

Crisis information management is generated and developed with the study of crisis management. It is an area where public crisis management and information management are interwoven. It is mainly based on the information point of view, using information management ideas and methods and information technology to deepen it. It systematically studies and solves the problems of information lag, information overload, cumbersome information exchange modes, and inconsistent collaborative operations in crisis management to help crisis managers efficiently share information, clearly perceive the situation, and quickly make decisions[2]. Crisis information management focuses on the collection, processing, storage, dissemination, and use of information throughout the crisis. It also studies the connotation and information needs of crisis information, information disclosure mechanisms, information assessment methods, information dissemination channels, and information management platforms. At present, there are still some problems in crisis information management. For example, there are serious islands of information due to lack of information sharing among management departments; there is information acquisition delay and information overload between crisis rescue workers and decision makers; difficult information understanding due to different personal knowledge backgrounds. The existence of these problems not only needs to provide timely and comprehensive information to the various stakeholders of the crisis, but also pay attention to the use of information methods and information technology to provide the right information to the right people at the right time and place, in other words, achieve the identification of user information needs and the establishment of an efficient information sharing mechanism among users.

Improving the information sharing and interaction model in the process of crisis management is an important way to improve the efficiency of crisis information processing and enhance crisis management decision-making capabilities[3]. There are three dimensions of interaction in crisis information management. The first dimension is the interaction between users and crisis information. It mainly involves the user's access to, processing and dissemination of crisis information. The second dimension is between users and crisis information systems. The interaction refers to the improvement of the user's access to crisis information through the improvement of system functions and interfaces under the influence of information technology and network technology; the third dimension is the interaction between users and users, including users' information requests and responses, information dissemination and updates, and information identification and conflict resolution between collaborative users. The interaction between users and crisis information is the basis of crisis information interaction. The interaction between users and crisis information systems is the medium of the interaction between users and users. It emphasizes the important role of collaboration in crisis information management. For the emergency team, improving the efficiency of crisis information interaction is conducive to improving the accuracy and timeliness of users' access to information, resolving information silos between departments, and helping teams work together, which is an effective way to improve crisis management.

This article will sort out the crisis information interaction patterns in each dimension. The user-crisis information interaction dimension separately introduces the connotation and research status of the user's collection, analysis and dissemination of crisis information according to the information management process. The interaction dimension of the user-crisis information system mainly introduces the GIS and virtual reality interaction modes and the crisis information visualization characterization method, the user-user interaction dimension according to the information subject involved in crisis management mainly

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introduces the three types of interactions within the government, the government and the public, the people and the public. In each dimension, the connotation, theoretical basis, and existing major research results of crisis information sharing and interaction are combed. Finally, we compares and analyzes the interaction objects, main interaction methods and modes, and interaction characteristics in different dimensions, providing better theoretical support and practical suggestions for the improvement of crisis information sharing and interaction modes.

2. Related Work

2.1. Crisis Information Management

Crisis information management is a complex management field that uses information management methods and technologies to solve crisis problems in specific situations. It involves various fields of knowledge and theories such as information management, public management, and computer network communications, directly affecting the efficiency of crisis management[4]. The domestic and foreign related researches take various fields as the starting point respectively, and analyze the theoretical significance, relevant mechanisms and technical methods of crisis information management and summarize them into the following three levels.

The first level is mainly from the macro perspective. First of all, it studies the sources and connotations of crisis information[5]. Information is classified and graded according to different types and levels of urgency. Crisis information is studied by means of crisis development stages[6], decision-making bodies, and knowledge management methods, so that crisis managers can adopt precise management and communication methods for different types of information. In addition, from the perspective of the main body of information, issues such as the collection, dissemination, sharing, and utilization of information are studied. It mainly focuses on the government information disclosure mechanism, public acceptance and choice of information, and information dissemination. At the same time, the use of big data and machine learning and other methods of real-time monitoring of social media on the Internet to provide data support for crisis warning and public opinion monitoring[7]. This level of research mainly focuses on the mechanism and mechanism of crisis information from a macro perspective. The research methods are mostly qualitative analysis, lack of quantitative, in-depth, systematic research, and therefore require advanced information management methods and computers technology to achieve in-depth information and efficient processing.

Research on crisis information systems and related key technologies has become the second important aspect of crisis information management research. Related crisis information management techniques include not only technologies such as geographic information technology (GIS), grid technology, satellite remote sensing, image analysis, but also conclude information management methods such as social networks[8], subject maps, and information visualization[9]. In the meanwhile, system analysis technologies such as emergency management decision systems, disaster analysis technologies, and early warning systems are also integrated in different technology platforms to comprehensively realize information collection, storage, analysis, and dissemination throughout the entire life cycle of a crisis. The participation of information technology has reduced the uncertainty caused by subjective judgments and effectively improved the accuracy and efficiency of crisis information management. The change of information technology in crisis information management mainly follows the continuous development of information technology itself. However, with the relative maturity of technology and the in-depth study of crisis management, the importance of collaboration has gradually emerged. Crisis information management technology serves

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have gradually been transferred objects from crisis information management object to the main body, from isolated crisis information management into collaborative crisis information management.

The third level of crisis information management research involves the coordination and sharing of crisis information. This study focuses on the interaction of information among different users and highlights the systematization and socialization of crisis information management. The large-scale crisis management activity is a comprehensive collaboration process involving multiple departments and multiple users, including multiple entities from the government, the media to the enterprise, and the public. Collaboration issues in crisis management are mainly reflected in the collaborative acquisition and processing of information, such as collaboration of information needs for different roles and responsibilities in the workflow, collaborative creation of information, and annotation[2]. This type of research not only builds crisis information management systems from the perspective of information sharing and information understanding, but also integrates geographic information systems with social media data to enhance crisis response and prevention monitoring capabilities. It has also become an important solution for collaborative crisis information acquisition[8]. Collaboration and sharing of crisis information mainly emphasizes collaborative acquisition and decision-making of information between users in different locations and roles. In this process, information sharing and two-way circulation play an important role, that is, the interaction of information. It can be seen that the interaction of crisis information plays an important role in crisis information management.

2.2. Information Sharing and Interaction Pattern

Information interaction refers to the two-way communication of various forms of information between different objects, which is of great significance for improving the speed and quality of information dissemination and for collaborative decision-making and action. According to different entities, objects, and media in information interaction, the types of interaction can be divided into three types: the first is the interaction between the subject and the object, that is, the user-information interaction mode; the second is the interaction between the subject and the media, namely user-information system interaction mode; the third is the interaction between the subject and the subject, which is user-user interaction mode.

The interaction between users and information is reflected in the user's demand for information, information acquisition, and information utilization. The information needs of users are mainly expressed through inquiry or information retrieval; while, on the one hand, the acquisition of information refers to the channels and methods of obtaining information, and on the other hand the identification and screening of information by users; the use of information is that users process the information they have obtained to help them understand the crisis information as much as possible and make decisions. The interaction between users and information is mainly through the organization of information and certain interactive means to improve the efficiency of information retrieval, reading and processing, and enhance the user's interactive experience. Information system as a tool and medium for users to interact with information, using advanced computer technology combined with effective information organization methods to provide powerful help for user-information interaction, greatly improving the interaction efficiency[10].

The interaction between the user and the information system platform is a higher requirement for the design of the system function and the human-computer interaction interface under the condition of continuous development of the information management system. We hope to use different methods such as information technology to improve the interaction between users and information for different user role habits. This interaction dimension firstly shows how to design the system to help users to quickly and accurately put

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forward information requirements; secondly, it shows how information is presented to help users obtain and understand information; and secondly, how to help users process, analyze information and make decisions. The interaction between the user and the information system platform has greatly changed the frequency, means, form and content of the user-information interaction, and is an important means to improve the user-information interaction efficiency. However, merely focusing on user-information system platform interaction is far from enough, especially for information interaction between collaborative teams. Therefore, it is necessary to study user-user interaction.

The interaction between the user and the user focuses on the collaborative interaction between different users, which is the key to the interactive mode in information sharing[11]. With the evolution of information socialization, users have become increasingly prominent in information sharing and interaction. The main body of information interaction is to share information through information requests and responses, information dissemination and sharing, and information understanding and identification. Researching the interaction between users and users helps the sharing and dissemination of information and solves the problem of information conflict among different users. It plays an important role in team collaboration and joint decision making.

Through the three levels of information sharing and interaction, the above reflects the transformation of information management from macro to micro, from qualitative to quantitative, and from isolation to collaboration. Efficient system information organization methods and advanced information management technologies improve the efficiency of information collection, processing, and sharing in information management. Nevertheless, information management difficulties in information acquisition and information delays also continue to affect the level of information sharing and interaction. As a specific application environment for information management, such problems also exist in crisis information management. Therefore, in the following section, the three dimensions of user-information, user-information system, and user-user will be respectively used to elaborate and analyze the research of information interaction in crisis information management and the ways to improve the efficiency of crisis information sharing.

3. Interaction in Crisis Information Management

The interaction in crisis information management is based on crisis information management theory and information interaction theory. This article is based on the second part of the crisis information management theory and the current status and background of information sharing and interaction model, using user-crisis information interaction dimension, user-crisis information system interaction dimension and user-user interaction dimension deeply analyze the information sharing and interaction modes in crisis information management.

3.1. User-crisis Information Interaction

User-crisis information interaction runs through the entire life cycle of crisis information management. The broad information flow includes information acquisition (collection), organization (analysis), retrieval, transfer, and utilization. Based on the information management process, this paper divides the user-crisis information interaction into three levels, and studies user's crisis information separately. In the management process, interaction activities such as information collection, analysis, and dissemination are studied[12], and methods and ways of implementing different interactions are analyzed to achieve full interaction between users and crisis information.

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3.1.1. User's Collection of Crisis Information

Collecting and obtaining crisis information is the prerequisite for users to interact with crisis information. Accuracy, completeness and timeliness of information collection are the basis of crisis information management. In the entire crisis management process, due to the real-time changes in crisis conditions, unpredictable development speed, multiple and complex influencing factors, and the timeliness and accuracy requirements for users to obtain information, it is necessary to increase users' efficiency in obtaining crisis information faced with huge challenges. When users collect crisis information, they must first clarify the information needs, and secondly determine the methods and channels for obtaining this crisis information. In crisis information management, different stakeholders have different requirements for information, access methods, and access route.

For the public, their access to crisis information mainly includes browsing and retrieving government official websites, news reports and online social media. Members and decision makers of the crisis management team (including fire department, medical staff, traffic police department, and public security department, etc.) act as crisis responders and need to obtain relevant information of the crisis in real time. Their access to crisis information mainly includes the collection and monitoring of information, the search for relevant information, and the passive reception of emergency decision-making orders. Commonly available acquisition channels include various crisis warning systems, public opinion monitoring systems, emergency command systems, and public crisis geographic information system. During the crisis warning phase, crisis managers need to collect information through data monitoring, big data analysis, and other methods to detect possible risks. During crisis response, crisis managers need to collect real-time information in a timely manner in order to facilitate rescue personnel good response measures are taken; during crisis recovery, crisis managers also need to collect information on the damage caused by the crisis to guide the deployment of relevant emergency resources. User acquisition of information is the basis of crisis information interaction. However, the collection of information collected by users may have inconsistencies or even conflicts in content. Therefore, it is necessary to help users make decisions, understanding, support and cooperation on crisis policies and decisions by analyzing and selecting useful information and knowledge.

3.1.2. User's Analysis of Crisis Information

The analysis of crisis information is a key step for users after collecting crisis information[13]. It mainly involves the analysis of the content and form of crisis information. The user's analysis of the content of crisis information mainly refers to relying on relevant models, data mining and other methods to target different users' information needs, identify useful information, and analyze the topics and categories of crisis information; the analysis of crisis information representation forms mainly relies on information technology to carry out different forms of information representation, including text, icons, pictures, video, audio, maps and other forms, to help users to store and retrieve crisis information, and provide prerequisites for the construction of crisis information systems.

(1)User's Analysis of Crisis Information Content

Crisis information manager's analysis of crisis information content runs through the whole crisis information management life cycle. First, the analysis is reflected in the early warning phase before the crisis. Crisis managers need to identify and classify the content of relevant information so as to clearly reflect the changing process of the crisis and make an assessment of the type of crisis that may occur in the future and the degree of harm[14]. Next, the crisis information manager's analysis of the crisis information content is reflected in the response process after the crisis. For all users, only information that has been identified, sorted out, analyzed, and interpreted will help crisis managers make decisions and promote

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teamwork[15]. At the same time, the analysis of the content of information helps the public to obtain truthful and consistent public information and prevent the public from bringing secondary crisis to the difference of information interpretation. Finally, the crisis information manager's analysis of the content of the crisis information is reflected in the recovery phase of the crisis, which mainly includes the formulation of post-disaster reconstruction plans, assessment and recording of crisis situations, and organization of information and plans for the settlement of affected areas and people.

(2)User Analysis of Crisis Information Forms

Different types of users have different requirements for the form of crisis information representation. For example, crisis manager (firefighters, public security personnel, medical personnel, etc.) have real-time and detailed requirements for information closely related to rescue, especially the surrounding environment information of the crisis point, crisis development information, victim information, and weather Information and so on. The form of representation of this information is usually closely related to the timeliness and spatial nature of the information. Therefore, in addition to the forms of charts and pictures, the analysis of the form of crisis information generally needs to be reflected by time axes, time cubes[16], and maps[4]. For the general public, the large amount of information contained in the crisis information comes from professional and unfamiliar areas. Therefore, some professional information needs to be simplified to direct diagrams and drawings to ensure that the public can accurately understand and receive information and avoid inappropriate response due to information deviation.

3.1.3. User's Dissemination of Crisis Information

Crisis information dissemination is an important link between users and crisis information. A good crisis information dissemination mode can ensure the accuracy and timeliness of information sharing. This is not only the basis for the coordination of the emergency response team, but also the necessary means to guarantee the public’s right to know and maintain social stability. The user's dissemination of crisis information is mainly reflected in the emergency team, between the government and the people, and between the people and the public.

First of all, because emergency teams in crisis management often involve multiple departments, the effective dissemination and sharing of crisis information is the basic guarantee for collaborative work among these departments. As most emergency teams are temporarily organized to carry out coordinated rescue, there are certain differences in the culture, chain of command, professional knowledge, and goals among different participants, which make the transmission of crisis information within the emergency team faces a huge challenge[3]. In response to these challenges, researchers conducted in-depth research on the process of information dissemination, protocol mechanisms, and technical support. For example, information dissemination should be differentiated in response to differences in roles under crisis conditions[17]; or business process management ideas should be introduced to design support more flexible management and decision-making mechanisms[18]. Second, the information dissemination between the crisis management department and the public mainly focuses on the disclosure of government crisis information and the monitoring of public information. On the one hand, the government as the master of crisis information must disclose the information of the crisis in accordance with the laws and regulations, ensure the accuracy and timeliness of information, and protect the public's right to know; on the other hand, it needs to strengthen public opinion guideline on public feedback. Finally, the development of new media has created a “public discourse space” for the public. Users can disseminate crisis information through forums, postings, and reproduce, and freely express opinions and exchange opinions on crisis events. The new media socialization has two

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sides in the dissemination of crisis information. The public may be conducted by public opinion, which will lead to social instability[19]. Therefore, it is of great significance to study the new media's characteristics in the dissemination of crisis information, the mode of communication, the monitoring and guidance of public opinion[7].

3.2. User-crisis Information System Interaction

With the continuous development of information technology, the participation of crisis information systems can effectively reduce the uncertainty caused by subjective judgments or qualitative research, and improve the accuracy and efficiency of crisis information management[10]. The crisis information system that meets the user's information needs and usage habits can improve the user's efficiency in interacting with crisis information, and thus have a positive effect on users' acquisition, analysis, dissemination, and utilization of information. The crisis information management system is a system platform medium for users to interact with crisis information. Its interface design and function design are closely related to the object and subject of crisis information management. On the one hand, the tasks and objectives of the various roles of the crisis information management are different. This determines that different roles need different service functions and interfaces in the crisis information management system. On the other hand, the crisis information stored and processed by the system has the characteristics of timeliness, spatiality, and dynamics. The timeliness of crisis information can be understood as the real-time change of information in the space-time dimension, which is based on the status of the current point in time; spatiality refers to the spatial information such as the location of the crisis, the location of the rescue, and other information at the time. The time and spatial dimensions are constantly changing. Therefore, in the design of crisis information management system, full consideration and sharing of crisis information under the time dimension and space dimension should be fully considered[20]. Taking into account the user needs of the crisis information system and the characteristics of crisis information, GIS, Virtual Reality (VR), visual information representation and other methods are often used in system design to enhance the user's interactive experience. Geographic Information System can fully characterize crisis information in the dimension of space; virtual reality technology can realize the interactive experience of users and environment for the non-repeatable characteristics of crisis events; visual representation can adopt appropriate visualization for different types of information and user's use environment to increase the efficiency of users' access to information. Therefore, this section will elaborate on the common interaction methods of the three crisis information systems for geographic information systems, virtual reality interaction modes, and visual representations.

3.2.1. Geographic Information System

The use of geographic information interaction methods and technologies not only embodies the user's need for a visual interactive interface, but also reflects the dimensionality of crisis information. The presentation and sharing of geographic information is crucial for crisis management collaborators. Whether it is the location of the crisis, the surrounding environment, the selection of shelters, or the disposal and deployment of rescue measures, it is necessary to master its geographic information to ensure global situational awareness of crisis situations. Geographic information systems are usually combined with Global Positioning System (GPS), Remote Sensing (RS), and simulation technology[21] to support the collection, storage, processing, presentation, and application of spatial information in the entire process of crisis information management. First of all, the geographic information system through the embedded plan management and deduction system, the use of computer simulation technology to achieve the dynamic effect of the pre-planning deduction, enhance the user's perception of the virtual environment, can effectively improve the crisis preview.

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Secondly, it realized the visual representation of crisis information in the space dimension and the collaborative work among crisis team users. For example, pilots use Google Earth to perform a mission, use multi-touch gestures to freely zoom maps and toggle global maps, specific maps[22], to study satellite images of surrounding areas to find alternate landing zones. Geographic information in this case includes assessing ground conditions, finding distances and routes to bases, retrieving geographic coordinates, measuring the length and width of potential zones, and so on[23]. For example, for the crisis control center, the geographic information system can realize real-time tracking and positioning of on-site crisis personnel and emergency resources to help the command center to take corresponding crisis response measures and reasonably allocate resources. Finally, information sharing and collaborative annotation between emergency teams can be achieved with the aid of geographic information systems and interactive desktops. The different members of the emergency team can use the large analog maps and digital pens to mark, understand the global information, and discuss and decide on the plan.

3.2.2. Virtual Reality Interaction Mode

Crisis events are contingent, complex, and destructive. Studies have shown that conducting emergency rehearsals for various types of accidents can improve the rescue personnel's rescue proficiency, reaction force, and collaboration to mitigate casualties and property losses caused by improper rescue during crisis[24]. In recent years, the vigorous development of virtual reality technology has provided a new way for the crisis preview.

Virtual reality is a comprehensive interactive method involving computer graphics, human-computer interaction, sensing, artificial intelligence and many other fields. It enhances the interaction between the user and the environment by simulating the virtual environment and synchronizes the visual channel, the auditory channel, the sense of touch with force feedback, user input, speech recognition, and synthesis, crisis responders simulate decision-making environments that quickly make decisions and take actions under time pressure[25]. The virtual reality interaction method utilizes a computer to generate a realistic three-dimensional space and places the user in the environment, so that the user creates an immersive feeling to perceive and study the changes in the crisis environment. Augmented Reality (AR) is the enhancement of virtual reality. It superimposes computer-generated virtual objects, scenes, or system prompts into real scenes to enhance the real environment and improve the integration information of the real world and the virtual world to achieve real-time user interaction[26].

The virtual reality interaction method has been widely used in crisis management. First, in an emergency drill, the virtual reality interaction mode can be used to intuitively and dynamically present the drill environment. The user can select drill sites for various security events as needed. However, virtual reality isolates the user from the real environment and can only achieve simulation drills. Moreover, research shows that the user's reaction in the virtual environment has conflicts with the way humans perceive the external world, thus affecting the effect of the drill. The augmented reality interaction mode can make up for the insufficiency of virtual reality, realizing real-world drills, and superimposing virtual world and real-world information. Users can not only see the actual scene, but also can see virtual objects added to the scene (see Figure 1a)[24]. Secondly, in the event of a crisis, the virtual reality and augmented reality interaction model can remotely transmit the situation at the rescue site to the emergency command center and achieve remote emergency command (as shown in Figure 1b). The virtual reality interaction method is also widely used in other environments, such as military drills, power grid emergency, power repairs, oil depot monitoring, fire drills, shopping mall evacuation, medical rescue, etc. to help users obtain accurate information and achieve scientific and technological safety rescue, which is one of

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the important ways to improve the efficiency of crisis management decision-making and rescue.

(a) (b)

Figure 1: Enhanced virtual reality interactive mode application scenario: a. When the building is in a state of collapse, the trainer sees this picture; b. Remote assistance with augmented reality technology

3.2.3. Visual Representation of Crisis Information

Realizing the visual representation of crisis information in the crisis management system is a basic means to improve user cognition and information interpretation[27]. Research shows that visualization technology can help users quickly understand intricate information in emergencies, and has a major role in improving users' participation in the group decision-making process and information sharing[28]. The main visual representation methods include traditional statistical charts (tables, bar charts, pie charts, histograms, etc.), detail representations (colors and geometric symbols), actual images (picture or video) and diagrams that represent abstract relationships (trees, graphs, networks)[29], in addition to the map representation forms mentioned in section 3.2.1. These visualization methods are often used in combination to characterize crisis information from different perspectives. By combing related documents, this article mainly elaborates the following three main visualization methods.

First, the visual representation of crisis information in crisis information systems is mainly reflected in the user's visual annotation. The visual representation of crisis information is one of the methods that extended on the basis of visualization of spatial dimensions in geographic information systems. It plays an important role in supporting information-specific labeling and collaborative team decision-making[30]. On the one hand, users can label specific interface information according to their personal needs and habits. On the other hand, multiple users of collaborative teams can share information and make decisions on a shared interface annotation. Crisis management participants can make personalized annotations on electronic maps through digital pens, touch screens, and other tools, and draw sketches based on the color and thickness of the callouts as needed[2]. Based on specific location and specific element information, a visual markup (Visual Distinctive Language (VDL)-based iconic tags) may be used to mark on the map so as to improve the efficiency of the user's obtaining information[31]. The visual annotation not only meets the user's personalized collaborative annotation requirements, but also realizes the visual representation of information using icon labels, and improves the user's interaction efficiency with the crisis information system from both user experience and information visual representation.

Second, the visual representation of crisis information is reflected in the description and visualization of crisis context scenarios. The context of crisis information refers to the relational entities involved in all relevant behaviors and objects. It develops dynamically with

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the development of user behaviors, of relevance and unstructured characteristics[32]. Significantly, help users to understand team activities and improve team collaboration efficiency. In the crisis information interaction, users usually need to obtain and understand the current actions of individuals and other users. Failure to organize activity information well will hinder collaboration among teams. Ordering tables, timelines, and emergency dashboards are visual interaction tools that effectively address this issue. They visualize the user's personal activities and other people's activities in interactive interfaces with certain rules so that users can quickly review and select different activities, help users organize personal actions based on team activities[28-33]. Situation Matrixes (SMs) are another method used to solve unstructured activities. They involve scenario dimensions such as actors, actions, resources, events, goals, scenarios, etc. Hierarchical representations of these unstructured, dynamic activities allow users to correlate and organize information and process information in a variety of situations[34]. The crisis information system mainly displays the crisis context information on the interactive interface through the above methods, helping the user to understand personal activities and team activities, thereby improving global situational awareness and promoting team collaboration.

Additionally, the visual representation of information is also reflected in traditional presentation methods such as pictures and charts. On the one hand, it manifests itself in the display of the real scene of the crisis and makes up for the deficiencies of the electronic map in characterizing the three-dimensional nature of things. For example, the use of panoramic software for real-time photos of the mosaic achieves a panoramic view of the crisis scene of the 3600 effect. On the other hand, it is reflected in the display of information analysis results, especially with the widespread application of big data technology in crisis information management, through the data on a large number of crisis management platforms and the attention of the public to hot social media data statistics, mining, and analysis are presented in text descriptions, tables, column charts, pie charts, theme maps, and tag clouds, which improve the intuitiveness of user interaction with the system.

To sum, the interaction between the user and the crisis information system is based on user needs, crisis information, and crisis management processes. Information technologies and information management methods are combined with the user's behavior to help users retrieve and extract information about the crisis, to improve the accuracy and real-time of information interaction.

3.3. User-user Interaction in Crisis Information Management

As the core element of human-machine-information interaction, users play a key role in crisis information interaction. With the evolution of information socialization, users have become more prominent in information sharing. The user-user interaction mode provides rescue team with collaborative crisis information, gives public necessary facts and information through focusing on information requests, dissemination and update, and information identification among different users. This is an important condition for crisis management and process security[11]. Crisis management usually involves communication and collaborative operations among government departments, organizations, the media and the public. However, due to differences in knowledge background, language, organizational culture, and action objectives, conflicts may occur in collaboration, and then affect interactions effectiveness. Only by clearly understanding the interaction habits between users and users in a crisis situation can we build a crisis information management system that meets the needs of users and the corresponding emergency support tools[18]. According to the crisis management user role analysis and crisis management activity process, this section focuses on the interactions and ways between the government, the government and the people, the people and the people.

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3.3.1. Interaction with the Government

Due to its complex management activities, crisis management involves members of various organizations including public security, medical, and fire protection. They temporarily formed a crisis emergency team and became the main force in crisis management decision-making and rescue. The interactive content within the government not only involves the interaction and sharing of real-time crisis information, but also involves the coordination of actions and the formulation of rescue measures[11]. Interaction types can be divided into vertical and horizontal interactions. Vertical interaction refers to the interaction between the upper and lower levels within the government, that is, after the higher authorities make decisions and assign tasks and guidance to the lower-level departments; the lower-level departments report in a timely manner to their superiors so that the superiors can understand the latest situation and make timely adjustments. Horizontal interaction refers to the interaction and communication among various departments within the government, which helps information sharing between different organizations and avoids the formation of information silos. However, due to the characteristics of the government's internal structure, there are problems such as information lag and distortion in the vertical interaction, and horizontal interaction is checked by the different goals, professional knowledge, leadership chain, and priorities of different organizations, as well as the lack of interaction awareness among disaster relief workers. In order to solve the obstacles existing in internal government interactions, domestic and foreign researchers have conducted in-depth research on interaction issues, interactive technologies, and interactive processes in response to internal government communication issues, improvisation decisions, and mutual influence among partners. They propose the flexible interaction mechanism of interactive processes and the mobile platform supporting collaborative interactions help members understand the changes in the crisis, recognize the situation, realize opinions, and interact with emotions[18].

Computer-supported cooperative work (CSCW) is an effective model for improving the interaction and collaboration within the government. Its ideas have been widely used in crisis collaborative interactive platforms. At present, the interaction within the government mainly realizes the interactive mode based on information management and information technology through the preplan-deduction system and emergency linkage command system. In addition, the synchronous and asynchronous interaction methods such as shared desktop, collaborative annotation, and voice and video conferencing also realize the requirements of instant meeting, document data exchange, remote command, action coordination, and collaborative decision-making, and achieve mutual cooperation and communication among users.

3.3.2. Interaction between the Government and the People

The interaction between the government and the people in crisis management has two meanings. On the one hand, people need to know the development situation and rescue situation of crisis events in real time. The government, as the most centralized and authoritative information sources, should satisfy people’s information need about the crisis, to enhance the openness and transparency of crisis information; on the other hand, public feedback on crisis information also provides an important basis for the government to make decisions and maintain social stability. In traditional information communication channels, the communication between the government and the people is one-way, and people can only obtain information by browsing news, official websites, and so on. With the continuous advancement of information globalization and the level of transparency in government affairs, the interaction channels between the government and the people are more extensive than before, breaking the traditional one-way communication method, making the role boundaries of the imparting information of the crisis information blurred, and the public also can be a

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communicator of crisis information or a provider of first-site source information, meanwhile evaluates and supervises relevant crisis information issued by the government.

(1) Government's Release of Crisis Information

The government uses information dissemination mechanisms to publish crisis events in a timely manner to communicate the facts and information related to the crisis to the public. If the government does not issue authoritative information in a timely manner, it will lead to panic among the people, hinder the government's control over the crisis and affect social stability. Only by guaranteeing people's right to know can we avoid the generation of rumors and the spread of panic, prompting the public to actively cooperate with the government to take measures to reduce the losses caused by the crisis better and faster. Therefore, the government's release of crisis information has a significant role in crisis information interaction.

Strengthening the government's release of crisis information can be achieved by formulating relevant laws and regulations and developing multiple distribution channels, such as official websites, crisis information communication platforms, social media[37], and press conferences. First, the government's release of crisis information is reflected before the crisis, the government should communicate crisis warning information to the public through various channels to effectively prevent and reduce the damage caused by the crisis to the public. Secondly, after the crisis, the government should issue crisis events, the development situation and the progress rate of the rescue in real time, which will satisfy the public's right to know and try to eliminate public panic and anxiety so as to avoid the secondary crisis caused by information congestion and the spread of rumors.

(2) Public Feedback on Crisis Information

The development of information technology provides an effective channel for the public to express opinions and feedback information. The public needs to obtain information released by the government to understand the crisis. At the same time, the government needs to obtain feedback from the public to understand public opinion. The social platform has become the most important and convenient feedback channel for the people. While realizing the information released by the public at any time and place, it also increases the speed and breadth of the spread of false information and rumors. This requires the government to collect, monitor and analyze the information published by the people. The government obtains feedback from the public mainly using big data and cloud computing technologies to monitor, count, mine, and analyze data on social media[35]. It also uses information dissemination models and public network behavior monitoring methods to provide crisis warning monitoring so that it can be quickly adopted corresponding measures to control the impact of the crisis.

3.3.3. Interaction between People

The public as an important group of crisis information interaction plays an important role in the release, dissemination and sharing of information. The development of the interactive platform provides a wide range of channels for the interaction between the people, making the interaction between the public and the people spanning the boundaries of time and space, and has played an active role in the dissemination of crisis information The interaction and communication between the public and the public help to expand the scope of crisis information dissemination and sharing, so that more people understand the relevant crisis situation and take appropriate measures, such as taking appropriate precautions before the crisis occurs, or respond quickly after the crisis. However, the speed and scope of information exchange among the people also make the false information and rumors on the network spread rapidly, thereby expanding the scope and management of the crisis and endangering social stability. Therefore, at the interaction between the public and the public, on the one

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hand, it is necessary to focus on how to increase the speed and breadth of interaction between people in order to achieve the sharing of crisis information. On the other hand, it is of great importance to control the authenticity of interactive content among the people.

In the interaction of crisis information, the interaction between the people plays a key role in expanding the scope and sharing of crisis information released by the government, and satisfies the needs of the people for the acquisition and use of crisis information. Raising the interaction efficiency among the people can be achieved by expanding the interaction channels and enriching the interactive forms. With the development of information technology, interactions between mobile interactive platforms such as Weibo, Forum, and Wechat have become increasingly important. People can quickly click, browse, comment, and forward crisis information anytime and anywhere. In this process, exchange information and influence each other. Controlling and screening information content is another research focus of the interaction between the people. This not only requires the people to identify and screen crisis information according to their own knowledge backgrounds, and prevents blindly disseminating and sharing false crisis information. It also requires related companies and governments to pass certain technology monitors the interactive information among the citizens in real time and realizes the healthy development of interaction between users[36].

4. Comparative Analysis of Three Interactive Dimensions

The interaction of crisis information runs through crisis information management. The timely and accurate realization of crisis information dissemination and sharing is the key to a highly collaborative, effective decision-making and scientific response of the crisis management team. The crisis information interactions for different dimensions mentioned above were combed and analyzed from the perspectives of connotation, development status, methods, and other aspects. In order to more deeply embody the role relationships among the three dimensions, we compare different interaction dimensions from interacted with objects, common interaction methods and modes and characteristics, as shown in Table 1.

Table 1: Comparison of the Role of Crisis Information Interaction in Different Dimensions

Interaction Type	User-Crisis information Interaction	User-Crisis information system interaction	User-user interaction
Interaction Object	Crisis information management subject, Crisis information	Crisis information management subject, Crisis information system	Crisis information management subject
Common Interaction Methods and Modes	Information subjects collect, analyze and disseminate crisis information	Geographic Information Interactive System, Virtual Reality interactive mode, Crisis information visualization method	Vertical and horizontal interaction patterns within the government; interactive modes of information disclosure and feedback between the government and the public; social network interaction patterns among the people
Main Character	Improve interaction efficiency from the perspective of information	Resolve space limitations and time pressures in crisis information interaction from the perspective of technology and tools	Emphasis on the role of human as the interactive subject of crisis information, study the collaborative interaction of information from the perspective of human

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From Table 1, we can see that the interaction between users and crisis information, the interaction between users and crisis information systems, and the interaction between users and users reflect the different perspectives of crisis information interaction according to the differences in the implementation of interaction objects: the interaction between users and crisis information enhances the interaction efficiency from the perspective of information through the user's interactive method of gathering, analyzing, and disseminating crisis information; the interaction between the user and the crisis information system passes through the geographic information system, virtual reality interaction model, and crisis information visual representation method realizes the rapid expression of information needs by the user and the visual presentation of the crisis information; the interaction between the user and the user focuses on the social and systematic nature of the crisis information management, including the Interactive mode and method of information entities within the government, the public, and others.

The three dimensions of crisis information interaction are mutually supportive and together constitute the overall framework of crisis information interaction and become an indispensable part of crisis information interaction. The interaction between users and crisis information is the basis and goal of crisis information interaction. The interaction between users and crisis information system reflects the importance of information technology as an interactive medium and tool. The interaction between users and users focuses on the interaction and collaboration of information subjects, who are the deep reflection of crisis information interaction.

5. Conclusion

Crisis information interaction runs through crisis information management and is the key to monitoring, early warning, decision-making and scientific response in crisis management. According to the subject, the object and the medium of crisis information management, this paper studies the interaction mode of crisis information from three dimensions. Firstly, the interaction between users and crisis information is the basis of the crisis information interaction. This article elaborates the method of improving the user's ability to collect, analyze and disseminate information from the essence of crisis information; secondly, the crisis information system is used as a medium for crisis information management. The effective interaction between users provides strong support for user interaction with information and collaboration between users and users. This paper points out that improving the efficiency of users' interaction with crisis information systems can be achieved by helping users quickly present information requirements and improve system information presentation. The interaction between users and users focuses on the synergy of crisis information management, which not only exists within the government but also exists in the external social environment. Finally, we compare the interaction patterns under these three dimensions from the interactively implemented objects, common interaction methods and modes, and interaction characteristics, and find that these three dimensions respectively act on the crisis information interaction from different perspectives, and together constitute the overall framework of crisis information interaction.

This article summarizes the crisis information interaction model from a multidimensional perspective, with a view to provide multidimensional management ideas for crisis information managers, and provide theoretical basis for crisis management system designers. From the perspective of the government, when it comes to crisis management, it not only needs to pay attention to crisis events, but also needs to take care of the management of crisis information, the construction of crisis information systems, and the collaborative interaction of crisis information subjects. From a global perspective, the whole process of crisis

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Information management is carried out; From the perspective of crisis information system designers, not only the timeliness, spatiality, and dynamics of crisis information need to be considered, but also the user's interaction needs must be emphasized and different dimensions of interactions should be embedded in the design of crisis information systems, including functional design, interactive interface design, information representation form, user collaborative interaction and other aspects.

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