

Current Situation and Frontier Evolution of Online Public Opinion on Public Emergencies: Knowledge Graph Analysis Based on Citespace

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Abstract. With the popularity of the Internet and the coverage of new media technologies, the widespread spread of online public opinion on public emergencies has a certain amount of negative impact on public sentiment and social development. In order to systematically grasp the research dynamics and cutting-edge themes of the literature from a macro perspective, this paper took the literature related to online public opinion on public emergencies in CSSCI journals as the research object based on the database of China National Knowledge Infrastructure (CNKI), and comprehensively applied statistical measurement methods to sort out the development lineage, institutional distribution, journal carriers and author influence of this field. Secondly, this study used citespace knowledge mapping technology to visualize and present keywords. Based on this, the clustering outcomes of the LLR algorithm were analyzed to summarize keyword evolution and topic variation from technical, informational, and managerial multiple dimensions, and to contrast the variations in methodologies and topic selection in various literature. Finally, the study identified cutting-edge research directions for the current and future long-term development of the subject, including empirical analysis of big data, information ecological perspectives, and government management.

Keywords: Critical Incident; Online Public Opinion; Knowledge Graph; Cluster Analysis; Topic Evolution.

1. Introduction

In recent years, the coverage of the Internet in various fields has been increasing, and the number of Internet users has also risen. The 51st Statistical Report on the Development of the Internet in China released by the China Internet Network Information Centre (CNNIC) shows that the size of China's Internet users grew to 1.067 billion as of December 2022, and the Internet penetration rate reached 75.6 % [1]. In the digital age, everything is interconnected, and information dissemination has taken on new characteristics and trends. On the one hand, Internet users can freely express their opinions on microblogs, WeChat, community forums and other online platforms, and all kinds of information can be spread rapidly through the network effect. On the other hand, in the open and real-time social media, people are more likely to be influenced by various social events and tend to express their own opinions on the events to show their demands and positions. As a result, complex and diverse online public opinions are generated in the mass of information. Because of their suddenness and destructive power, sudden public events can cause large-scale discussions and outbreaks within a short period of time, thus making it easier to generate a chain effect of online public opinion. How public opinion on sudden events triggers, spreads and influences society has become a focal issue in current academic circles.

Knowledge graphs, which describe and preserve knowledge with structured data and semantic relationships, are a wonderful way to reveal implicit or difficult-to-discover knowledge in literature. They are a semantically rich kind of knowledge representation. Thus, using knowledge mapping technology to reveal the current research status and hotspots in this field, this paper elaborates on the publication time, institutional distribution, journal sources, and author contributions of research on online public opinion on emergencies. Based on econometric analysis, it also contrasts the

differences of various research directions in the literature from a variety of perspectives, and provides an outlook and summary of the findings.

2. Related research

2.1 Research on public emergencies

Under the influence of public emergencies, the normal public governance approach is facing many challenges, such as the frequent failure of digital governance platforms [2], the increase in systemic financial risk crises [3] and the surge in public fears [4]. To address these challenges, scholars have conducted a series of studies to promote policy coordination and enhance governance efficiency. Ref. [5] constructs eight models of regional policy synergy based on artificial intelligence technology, and explores the characteristics and patterns of inter-regional policy coordination in terms of the influence of interaction cycles, administrative power and stakeholder influence. Ref. [6] construct a four-way evolutionary game model of government departments, enterprises, data management departments and the public from the perspective of government data opening and public governance efficiency improvement, and explore the key factors for improving public governance efficiency.

People are vulnerable to a variety of psychological reactions when there are public catastrophes. The general population's ability to retain a largely rational and composed state of mind amid public emergencies is crucial to the preventative and treatment efforts. In terms of practical research, academics have concentrated on the strategies and advantages of crisis psychological interventions and have put forward suggestions and guidance on how to encourage the construction of a crisis psychological service system in an orderly manner [7]. In terms of theoretical research, some scholars have used compensatory control theory to analyze the reasons why people's sense of control is declining [8].

2.2 Research Methods for Online Public Opinion

Currently, scholars mostly use machine learning methods, simulation science models and fuzzy set qualitative comparison methods for spatio-temporal analysis based on different development stages of online public opinion. In the area of public opinion crisis warning, Ref. [9] construct a dynamic Bayesian network model of warning scenarios based on a knowledge meta-model and combine it with EM algorithms to structurally represent online public opinion crisis warning scenarios. In the area of public opinion dissemination, the system dynamics model of online public opinion dissemination [10] and the SIR model of public opinion [11] dissemination have been widely used. In terms of public opinion evolution, Ref. [12] constructed an algorithmic model for the spatio-temporal evolution of online public opinion to reveal and present the spatio-temporal evolution characteristics and laws of public opinion based on spatio-temporal data; Ref. [13] used the Brussels model and entropy method to verify the evolution mechanism of public opinion diffusion. In addition, the use of the fuzzy set qualitative comparison method to explore the formation paths of hot topics [14] and the intensity of reversal of online public opinion during emergencies [15] is also one of the more common research paradigms.

Unlike the study of the operation mechanism and evolution of public opinion on the Internet, the study of the governance of public opinion on the Internet during public emergencies is mainly based on theoretical exploration. Ref. [16] proposed the idea of building a community for the governance of public opinion on the Internet in public emergencies. Based on the theory of resourcefulness of public opinion, Ref. [17] has identified the nature and value of public opinion on public emergencies, providing a new approach to the effective governance of public emergencies.

In summary, many advances have been made in theoretical and practical aspects of the study of online public opinion on public emergencies, but few studies have systematically studied the complex and diverse information in the public opinion literature, making it difficult to grasp the knowledge structure and evolution of the field as a whole. Based on this, this study explores the complex issues of online public opinion dissemination in the context of public emergencies based

on bibliometric methods, compares the current research hotspots and future development trends, and constructs a knowledge map with the characteristics of the field so as to provide reference for subsequent exploration in the field.

3. Research design

3.1 Data sources

The sample data used in this study were obtained from the CNKI database of literature related to online public opinion on sudden public events. Using professional search, the search term was subject search, and the search expression was set as SU=('emergency events'+ 'public events'+ 'public health events'+ 'natural disasters'+ 'social security events'+ 'accidents')*('network public opinion'+ 'network public opinion')- 'review', searching for 'emergency events' or 'public events', 'public health events', 'natural disasters', 'social security events', 'accidents', and "accidents" in relation to "online public opinion" or "online public opinion", and remove the literature related to "overview". The source category of the literature was limited to CSSCI journals, and a total of 528 journal papers were retrieved. The literature that did not match the subject matter was manually screened and excluded, and 437 valid papers were finally obtained.

3.2 Research framework

In order to further clarify the research ideas of this study, the specific analysis process is sorted out as shown in Fig. 1. Firstly, this study collected and cleaned the relevant literature in CNKI database to get 437 articles with the research object of sudden-onset online public opinion; secondly, we used quantitative statistics, keyword clustering and keyword evolution to mine the main research topics in this field; finally, based on the analysis results, we summarized the research hotspots, frontiers and evolution trends in this field and provides systematic suggestions for public opinion management.

4. Results

4.1 Time distribution

In this study, the number of articles published in the literature was statistically distributed according to time (as shown in Fig. 2). According to the statistical results, the number of online studies on sudden public events has shown an increasing trend since 2009, with an average annual

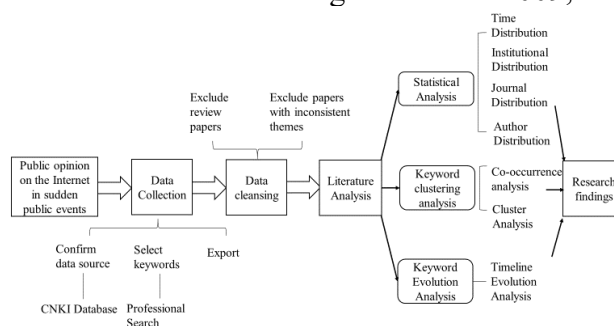


Fig. 1 Research framework

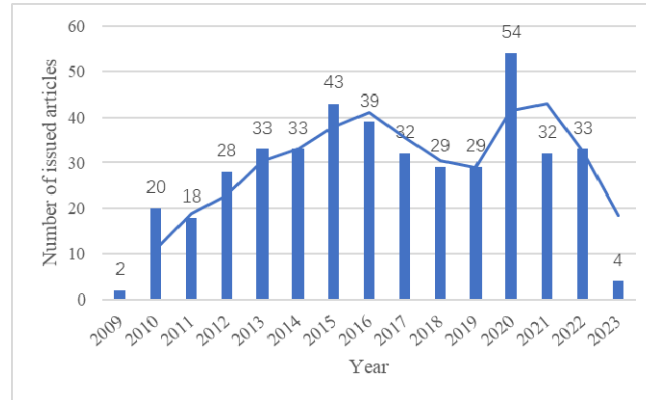


Fig. 2 Time distribution of publications

growth rate of about 23%, reaching a first peak around 2015, followed by another peak in 2020, and then a slowdown in the number of studies. Since 2010, the state has invested heavily in online infrastructure to establish the foundation for the development of online public opinion. In addition, the gradual rise of new media platforms such as microblogs [18], community forums [19] and WeChat has provided the foundation for the proliferation of public opinion on the Internet [20]. Since the outbreak of the new epidemic in 2020, the number, intensity and impact of the public opinion focus arising from the spread of the epidemic and the process of fighting the epidemic have exceeded most previous emergencies [18], thus triggering more research and attention from scholars.

4.2 Institutional distribution

In order to explore the publication situation of each research institution, a statistical analysis of the number of literature related to research institutions was conducted (as shown in TABLE I). The top 3 research institutions were: School of Public Administration, Huazhong University of Science and Technology (23 articles), School of the Chinese People's Armed Police Force (14 articles), and School of Information Management, Wuhan University (12 articles).

Table 1. Statistics on the distribution of the number of articles issued by institutions

Serial No.	Institutions	Count
1	School of Public Administration, Huazhong University of Science and Technology	23
2	Chinese People's Armed Police Force Academy	14
3	School of Information Management, Wuhan University	12
4	Wuhan University Information Resources Research Centre	11
5	School of Business and Management, Jilin University	9
6	Safety and Emergency Management Research Centre, Henan University of Technology	9
7	School of Journalism, Chongqing University	8
8	Chinese People's Police University	7
9	School of Management, Jilin University	7
10	College of Humanities, Beijing University of Posts and Telecommunications	6

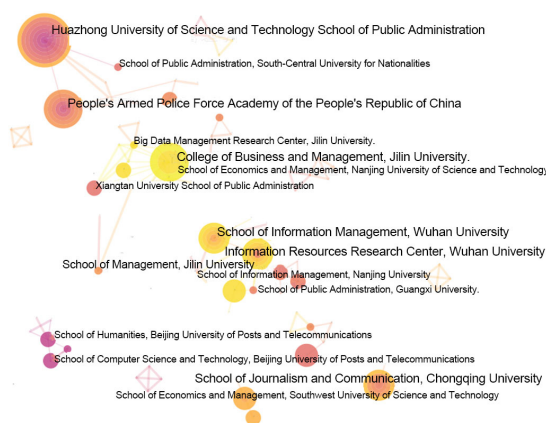


Fig. 3 Research Institute Affiliation Chart

To further measure the distribution of major research efforts, this study used Citespace to conduct a knowledge mapping analysis of research institution relationships in the field (as shown in Fig. 3). The number of nodes in the map is 304, the number of links is 178, and the network density is 0.0039. The size of the nodes is proportional to the number of institutional research papers, the colour of the nodes is positively correlated with the recent research intensity of the research institutions, and the links show the correlation between the research institutions. In terms of the types of research institutions, most of them are management colleges of universities, information management colleges, and also police force colleges, etc. In terms of the relevance of the research institutions, it generally appears that there is some connection between institutions, but the cooperation network of research institutions is mostly based on exchange and cooperation among universities in the same region, and there is less exchange and cooperation across regions.

4.3 Journal distribution

The core journals of online public opinion research during 2009-2023 were examined, as shown in TABLE II. The number of journals is 120 in total, which is relatively concentrated. As the collection, processing and analysis of public opinion information are mostly related to intelligence, the journals with the highest number are: Journal of Intelligence (84 articles), Modern Intelligence (38 articles) and Intelligence Science (37 articles). At the same time, public opinion governance is related to news and government affairs, thus it is also covered in news and government affairs management (E-Government, Journalism). Most of the literature in intelligence journals uses big data analysis and comprehensive evaluation-type models to systematically analyze research information on the early warning stages, generation mechanisms and dissemination laws of online public opinion, as well as simulation experiments, and conducts risk assessments of public opinion. Journals on journalism and government administration mainly elaborate on the crisis and response

Table 2. Statistics on journal publications

Serial No.	Journal	Count
1	Intelligence Magazine	84
2	Modern intelligence	38
3	Intelligence Science	37
4	Intelligence Theory and Practice	21
5	E-Government	17
6	Library and intelligence work	10
7	Contemporary communication	10
8	The Press	9
9	Journal of Intelligence	8

mechanism of online public opinion from the response perspective.

4.4 Author distribution

To explore the volume of literature by scholars, the number of articles published by authors was counted (as shown in TABLEIII). The top 3 research authors in terms of number of publications are: Yuexin Lan (21), Yuliang Zhang (13) and Yixue Xia (9).

The software analysis of research scholars in the field yields a knowledge map of author collaborations (shown in Fig. 4). The number of nodes in the map is 350, the number of links is 238, and the network density is 0.0039. The number of links is relatively high, indicating that there is a certain degree of correlation between research authors, and there are mainly three obvious research groups. The research group led by Yuexin Lan has issued the largest number of articles, and scholars have mainly used theoretical analysis methods to conduct detailed research on the evolution mechanism and dissemination law of online public opinion on emergencies [21], as well as the principles of the security assessment index system [22]. Based on theoretical analysis, these scholars have also conducted quantitative research on the evolution mechanism and crisis warning of online public opinion using quantitative analysis of big data and machine learning methods [23]. The research group assembled by scholars such as Xueyan Cao and Shiming Li used algorithms and software such as GooSeeker and LeaderRank, and applied data mining methods to analyse the function of public opinion heat [24] and key nodes in the spread of public opinion [25], revealing the structural complexity and sub-community structure of online public opinion and other characteristics. The research group formed by Jinghong Xu and other scholars explored the process of opinion generation [26] and the important role of opinion leaders [27], and proposed relevant emergency management strategies from the direction of public opinion governance.

In addition, apart from research groups, some scholars have no obvious research groups and mainly conduct research alone. For example, Yuliang Zhang has used

Table 3. In addition, apart from research groups, some scholars have no obvious research groups and mainly conduct research alone. For example, Yuliang Zhang has used Statistics on the number of articles published by authors

Serial No.	Authors	Count
1	Yuexin Lan	21
2	Yuliang Zhang	13
3	Yixue Xia	9
4	Runxi Zeng	9
5	Fujian Fang	6
6	Peng Zhang	6
7	Jinghao Chen	5
8	Qiongyuan Ye	5
9	Shiming Li	4
10	Lu An	4



Fig. 4 Author Affiliation Chart

evaluation models, including hierarchical analysis [28], fuzzy comprehensive evaluation models [29], and UML methods [30], to systematically assess the risks of information flow and the occurrence cycle of online public opinion risks.

5. Research hotspots

Scholars have highly summarised and condensed the core content of the literature into keywords, so keyword analysis can reflect the direction of the author's research. High-frequency keywords appearing within a certain period of time can reflect the hot spots of research. In this study, the keyword analysis conducted by Citespace software was able to obtain the hotspots of domestic research on online public opinion on emergencies, and generate a keyword network map (shown in Fig. 5 and Fig. 6).



Fig. 5 Keyword co-occurrence network

In this study, the research hotspots were profiled from three perspectives: technical, information and management, as shown in Fig. 7. Specifically, from the clustering results, #0 online public opinion, #1 emergency events, #2 public health emergencies, and #7 critical incidents are categorized as contextual analysis; #10 grounded theory, which includes techniques such as system dynamics and co-word networks, is categorized as technical analysis; #8 evolution mechanism and #9 point mutation are considered as information research topics; #3 public emergencies, #4 public opinion guidance, #5 emergency management, and #6 government response are classified as management-level research elements. A multidimensional approach is adopted to systematically explore the core of research in different literatures.

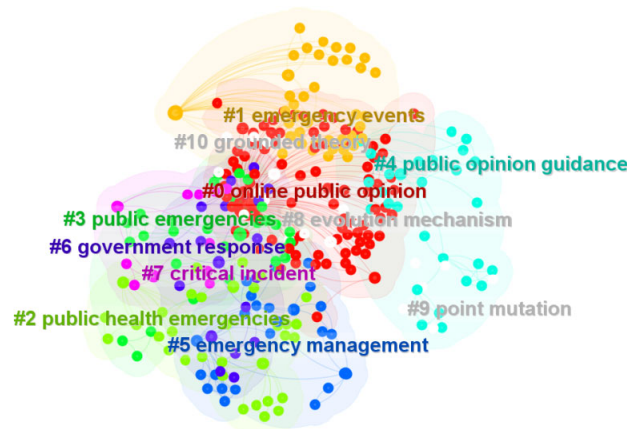


Fig. 6 Keyword co-occurrence network

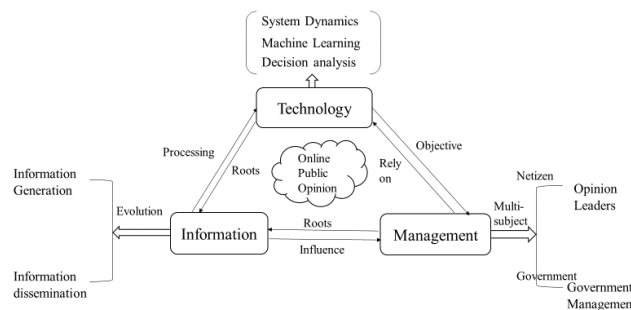


Fig. 7 Research Hotspots Chart

5.1 Technical perspective

From the perspective of research techniques, system dynamics models, machine learning algorithms and indicator systems are the main research techniques adopted by scholars, and the use of these models and algorithms can provide a more accurate grasp of the dynamic information and characteristic patterns of public opinion.

5.1.1 System dynamics:

In the process of public opinion dissemination, the three subjects - netizens, online media and the government - interact with each other, and the dynamic changes of each subject will have a certain effect on the dissemination and evolution of the public opinion system. According to system dynamics, the behavioural patterns and characteristics of a system depend mainly on its internal dynamic structure and feedback mechanism [31]. The construction of a system dynamics model can analyse the interactions between the actors in the system and the magnitude of the force of the relevant factors, so as to investigate the mechanism of the evolution of things and find the laws. Therefore, many scholars have used the idea of system dynamics to construct models to investigate the mechanism of the action of Internet public opinion [32].

Most scholars have constructed causality diagrams of the netizen subsystem, the online media subsystem and the government subsystem, as well as the total system flow diagram [33], to explore the mechanism of interaction of the online public opinion system. Taking the netizen subsystem as an example, a positive feedback loop was constructed based on the interactions among different variables: the severity of the emergent event → netizen's attention → netizen's microblog posting volume → netizen's participation → internet opinion fever → netizen's attention. The causality diagram of the subsystems is constructed according to the feedback loop, and the total system obtained by correlating the three subsystems can show the causal relationship between different

variables more clearly and reflect the direction and intensity of the change in guiding public opinion fervour more accurately, and has also achieved good results in the simulation experiments.

5.1.2 Machine learning:

As the development trend of online public opinion changes dynamically, how to scientifically predict the trend of online public opinion on emergencies and analyze the sentiment pattern of netizens is of great significance to promote the government to improve the level of public opinion guidance, reasonably channel online public opinion and promote social harmony and stability. Therefore, some scholars have used machine learning algorithms to study online public opinion and provide rationalized intervention measures for public opinion supervision departments.

In terms of data, public opinion data has a high degree of complexity and variability due to the sudden, uncertain and complex characteristics of emergencies, coupled with the different types, which may involve public health, natural disasters, accidents and so on. Therefore, some scholars have processed the complex serial features of the original public opinion data and transformed them into simple data with easily extractable features through data processing methods in order to improve the precision and accuracy of prediction. Taking the prediction of public opinion evolution as an example, Ref. [34] took the number of media involved in the release of public opinion events and the amount of comments, retweets and likes of netizens in Sina Weibo as independent variables, and used the data on the changes in the total amount of public opinion information on the whole network as dependent variables to measure the process of public opinion evolution. In terms of models, scholars have used quantitative prediction models such as RF algorithm [34], BP neural network [35] and RBF neural network [36] to predict the development trend, evolution process and rumour crisis of public opinion, and used classification models such as LSTM [37] to classify the sentiment of public opinion, providing more accurate data support for relevant departments to carry out targeted management.

5.1.3 Decision analysis:

The governance of public opinion relies on the construction of an indicator system, including monitoring indicators, security assessment indicators, risk evaluation indicators and so on. The indicator system views the system of sudden-onset online public opinion as an organic whole, and organically combines the design of qualitative evaluation indicators with that of quantitative evaluation indicators, and the design of local evaluation indicators with that of overall evaluation indicators, which is conducive to a comprehensive understanding of the development of online public opinion.

In terms of public opinion monitoring, scholars have used the I-space model to analyse and study the process of spreading and root causes of public opinion on the Internet, and have proposed quantitative methods for different indicators [38]. In terms of security assessment, some scholars have constructed an information security assessment index system [22] from five perspectives: state of affairs, people, content, topics and attitudes, which is an important guide for grasping the extent of the spread of emergencies. In terms of information risk, based on the evaluation system of public opinion risk, the hierarchical analysis method and UML method are used to evaluate the risk indicators of online public opinion [28], providing suggestions for the government and its relevant departments to effectively assess the real situation of emergencies and grasp the development trend of online public opinion on emergencies.

5.2 Information perspective

The development process of online public opinion is essentially a process of information evolution. From the perspective of information, understanding the characteristics, mechanisms and principles of public opinion in different information stages is the direction of many scholars' research. After public opinion information is generated, it will evolve to different dynamics, and the law of evolution and the mechanism of evolution are the two main directions of scholars' research. In terms of evolutionary laws, scholars mostly use life-cycle models of public opinion development, system dynamics and mathematical quantification to analyse the evolutionary laws of online public

opinion and netizens' emotions [39]. Other scholars have used TF-IDF models [40], LDA models [41] and plain Bayesian models [42] to explore the implicit thematic information, emotional information and the evolution of public opinion. In terms of evolutionary mechanism, scholars have constructed a network of public emergencies consisting of gestation, outbreak, diffusion, recurrence, fading and long-tail stages [43] based on life cycle theory and the GSPN model, and explored the key attributes of each stage in the evolutionary process and the close connection between them, the evolutionary pattern of online public opinion and the factors influencing the evolution of public opinion. In addition, in the study of the evolution of rumours as an aberration of online public opinion, scholars have summarised the factors influencing the evolution of rumour information, pointing out that public panic and lack of literacy, media misconduct and circle polarisation, and the application of intelligent robotics are important factors accelerating the evolution of rumour propagation [44]. Focusing on the evolution of public opinion information, scholars have focused on information generation and information dissemination as two important influential stages in the evolution process, and have therefore conducted a great deal of research and discussion.

5.2.1 Information generation:

The study of information sources is the basis for the analysis of information dissemination, and understanding public opinion and the generation of rumours plays an important role in the study of information flow systems. Therefore, scholars have made certain theoretical analyses of the generation of public opinion or rumour information. The stage of opinion generation mainly refers to the relevant views expressed by Internet users at the early stage of an unexpected event. As Internet users have different levels of knowledge, personal experience and social background, they always judge the same event in relation to their personal experience [26]. Due to the limitations of objective conditions, people often lack a clear grasp of the nature, intensity, development trend and degree of harm of emergencies, and it is even more difficult to avoid the situation where opinions are divided. At this stage, Internet users mostly use various communication media such as BBS, news followers, microblogs, mobile phone SMS and tweeters to express their views. As public opinion dynamics spread in different directions, online rumours were generated. Ref. [44] analyse the causes of online rumours, pointing out that the lack of information and power games are the root causes of rumours.

5.2.2 Information dissemination:

After the generation of public opinion information, the critical stage of information dissemination has attracted the attention of scholars from many different fields. Scholars' research on the dissemination of public opinion on the Internet in emergencies mainly covers two aspects. The first is the study of the law of dissemination of public opinion on the Internet. Research in this area is mainly based on data sources generated by hot topics arising from specific events, using content analysis [19], quantitative measures [45], hashtag propagation algorithms [46] and random diffusion models to explore the pattern of public opinion dissemination. For example, Ref. [47] used social network analysis (SNA) to study the network structure characteristics of microblog opinion dissemination in emergency events to generate a microblog opinion dissemination network topology diagram, and measured the overall structure, role and location structure of the microblog opinion dissemination network based on the statistical node relationship matrix obtained from microblogs. Some key nodes obtained in the measurement have high dissemination capacity. The second is the study of online opinion dissemination mechanism. This research has been carried out from a communication perspective, using methods such as the construction of communication models [48] and the analysis of public opinion cycles to explain the communication process.

5.3 Management Perspective

The study of public opinion aims to manage it more efficiently and to ensure social harmony and stability. Therefore, many scholars have conducted research at the level of public opinion guidance and management, which mainly includes opinion leaders guided by key figures and government-led government management.

5.3.1 Opinion leaders:

The concept of "opinion leaders" was first introduced by P. F. Lazasfeld and others in *The People's Choice* as "opinion leaders" who are those who actively accept and re-disseminate the messages and ideas disseminated by the media " [49]. The other part of the population relies heavily on contact with these 'opinion leaders' to guide their actions. With their appeal and credibility, opinion leaders play an important role in the development of public opinion, influencing the direction and dynamics of opinion dissemination, and are therefore an important way of managing public opinion as a spontaneous management mechanism. The study of opinion leaders under public opinion mainly covers three aspects [50]: characteristics analysis, group composition and changes, and identification of key figures. In terms of characterization, scholars have summarized three main characteristics of opinion leaders in online public opinion: First, intellectual background, i.e. intellectuals with certain academic background and professional quality. Second, social status, i.e. active in public affairs, influential among the general public, and having appeal and influence on the Internet. The third is their exposure to and attention to the media, i.e. they are keen to convey information and express their opinions in cyberspace and have more access to the media or information sources than others.

In terms of group composition and changes, scholars have analysed the group composition of online opinion leaders and their changes in the pre-late stage according to the development process of emergencies - the pre-late stage includes the latent period and the emergent period, and the late stage includes the persistent period and the disappearing period respectively [27]. Rough set theory and the construction of information dissemination network topology diagrams are applied to model the problem of opinion leader identification and extract the decision rules for identifying opinion leaders.

5.3.2 Government Management:

As the exercise of public power, the maker of public policy, the manager of public affairs and the provider of public services, the government plays the role of a gatekeeper in the process of disseminating public opinion on the Internet, and therefore research on the strategy and governance of public opinion on the Internet in public health emergencies has been widely discussed at the government level. Scholars have used simulation analysis based on system dynamics models and dynamic equilibrium models to study the governance of public opinion, analyzing the causes of problems in the governance of online public opinion on public health emergencies from the three-dimensional perspectives of decision-makers' capabilities, scientific evidence and public values, and proposing relevant countermeasures based on an evidence-based governance perspective [51]. They point out that the government can improve the effectiveness of public opinion management by enhancing the ability of public opinion prediction, communication, incident handling and coordination, and these studies provide new ideas for the government's public opinion guidance.

6. Evolutionary trends

In order to explore the dynamic changes in the research hotspots of online public opinion on public emergencies, two



Fig. 8 Keyword Timeline Chart

visualization methods, keyword timeline diagram (shown in Fig. 8) and keyword emergence diagram (shown in TABLE IV), were used in this study to clearly present the changing trends and importance of keywords in different time periods, which in turn facilitates the analysis of the evolution of online public opinion at three levels: technical, information and management.

6.1 Technical aspects: from statistical analysis of evaluation indicators to empirical analysis of big data

From a technical perspective, before 2012, most studies explored the evolution and laws of public opinion by constructing indicator systems and quantified each indicator using mathematical and statistical methods such as semantic information analysis, index calculation, frequency density calculation and weight coefficients, but fewer studies used large models for quantitative analysis [38]. After 2015, with the rise of big data technology, scholars have mostly conducted research in this field based on big data mining and analysis technology, and have used machine learning and deep learning related models to conduct more accurate quantitative analysis, including public opinion early warning, trend prediction and sentiment analysis. Taking public opinion early warning as an example, Ref. [52] used big data technology to quantify the three stages of data collection, public opinion analysis and monitoring and early warning using optimisation methods, which enhanced the effectiveness of early warning of public opinion on the Internet for unexpected events. With the development of artificial intelligence technology, the use of big data to optimise public opinion research techniques will be a major trend in this field of research.

Table 4. Keyword emergence map

Keywords	Strength	Begin	End	2009-2013
public opinion	2.3	2010	2013	
opinion leader	1.63	2010	2012	
critical incident	2.15	2011	2013	
public event	1.8	2011	2012	
public opinion guidance	2.35	2012	2014	
internet opinion	1.35	2012	2014	
information flow	1.91	2013	2015	
public management	2.48	2015	2016	
System Dynamics model	1.78	2015	2016	
empirical study	1.59	2016	2017	

case analysis	1.59	2016	2017
evolutionary game	1.41	2017	2020
public emergency	4.49	2020	2023
public health emergency	4.11	2020	2023
information ecology	1.55	2020	2023

6.2 Information aspects: from information dissemination to an information ecology perspective

From the information level, before 2020, scholars mainly focused on information evolution, mainly including research on the laws of information evolution, the identification of key nodes of evolutionary networks, and the process, stages, paths and mechanisms of evolution. Scholars have mostly constructed networks of public emergencies at different stages of the evolutionary process based on life cycle theory and the GSPN model, but there are fewer comprehensive and systematic research theories on the interaction between public opinion information and the external environment. After 2020, scholars have conducted more systematic research on the influence of public opinion information on the role of the external environment based on the information ecology perspective. Information ecology was first proposed by American scholar F.W. Horton in the 1980s [53], who believed that in the information society, information people and the information environment are closely linked, with people, behaviour, values and technology being the main constituents [54]. Information ecology theory is a theory that analyses information from an ecological perspective, and better constructs the connection between the external environment and the organisational environment. In the study of public opinion, scholars use information ecological factors such as information, information people, information environment and information technology based on the information ecology theory to complete quantitative analysis of the way public opinion operates through factor analysis. The information ecology perspective integrates the interaction of various parts within the system and the interaction with the external environment, and provides a more comprehensive analysis of the mode of action of the public opinion system, which is currently the main research trend at the information level.

6.3 Management aspects: from public opinion guidance to government management

At the management level, before 2014, guiding management through public opinion methods was the main direction of scholars' research. Most of the research focused on the use of new media technology to build interactive platforms and the formation of opinion centres through opinion leaders to guide management. After 2018, however, as the government plays a crucial role in grasping public opinion information and controlling risks, theoretical analysis and research on management with the government as the main body has gradually become a research hotspot. Most scholars have analysed the management dilemmas and solution measures at the theoretical level, and proposed the effective integration of emergency management resources and elements, the establishment of a rapid response mechanism for online public opinion, a guidance mechanism for online evaluation and an accountability mechanism [55], to provide guidance for public opinion management.

7. Conclusion

It can assist the government and key departments to understand public opinion, grasp public opinion trends and prevent risks and crises, as well as help the public to enhance their rational judgment of events and maintain social stability. Based on CiteSpace software, this study visualizes the knowledge mapping of the literature related to online public opinion on emergencies in the CNKI database and summarizes the research hotspots and evolution trends by systematic analysis, with the main conclusions shown below.

First, the analysis of statistical indicators reveals that the peak numbers of research literature on public opinion on the Internet of sudden events are in 2015 and 2020. Research institutions are

characterized by more exchanges and cooperation in the same region, research journals are focused on intelligence journals, while there are certain involvement in news and government administration, different groups of associated authors have been formed among research authors, and research methods and models among groups. There are differences in research methods and models between the groups. Secondly, this paper uses keyword co-occurrence and cluster analysis to analyse the research hotspots from three perspectives: technology, information and management. The technical perspective focuses on system dynamics models, machine learning algorithms and the construction of indicator systems; the information perspective focuses on the processes and mechanisms of information generation and dissemination; the management perspective focuses on mass opinion leaders and government-led management strategies. Finally, this study uses two tools, keyword timeline diagrams and emergent diagrams, to synthesise the research trends in the literature from the three perspectives of technology, information and management. At the technical level, this paper considers quantitative analysis of public opinion trend prediction based on big data and machine learning algorithm models as one of the future research directions. At the information level, the shift from a communication perspective to an ecological perspective can comprehensively consider the interactions and influences between various elements inside and outside the system, which is more systematic and comprehensive. At the management level, as a subject with massive public opinion information resources and power resources, how the government can use big data technology to analyse public opinion and effectively control and guide the direction of public opinion development will become one of the key research focuses in the future.

Even though this paper compares the research lineage in this field from multiple dimensions, there are still issues that merit additional investigation. Specifically, this paper is only a preliminary exploration based on Chinese literature, and needs to be further expanded and improved based on foreign research. At the same time, given the ongoing advancements in computer technology and artificial intelligence, the application of LDA and other machine learning methods for text mining analysis of literature topics is also a direction worth improving and developing in the future.

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