Research on the Dissemination and Evolution of Online Public Opinion on Unconventional Emergencies Based on Social Networks

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Abstract: With the advent of the Internet era, online public opinion has become a barometer reflecting social sentiment and public opinion. In the evolution of unconventional emergencies, online public opinion often catalyzes the escalation and spread of the emergencies, and even influences the development trend of public opinion. Taking the "D2809 train disaster" incident as an example, this paper constructs a social network model suitable for analyzing online public opinion on unconventional emergencies in complex systems, and analyses the role of online users in the dissemination of online public opinion, which is more conducive to grasping the evolutionary trends and movements of public opinion. In addition, this paper analyzes the trend of user sentiment evolution in public opinion networks by constructing user sentiment intensity indexes and provides a comprehensive account of sentiment changes in the process and evolution of online public opinion dissemination through visual analysis of user sentiment, to broaden a new theoretical perspective for public opinion research.

Keywords: Social Networks, Unconventional Emergencies, Public Opinion Dissemination, D2809.

1 INTRODUCTION

With the application of Internet technology in various socio-economic fields, the scale of China's Internet users continues to grow. According to the 48th statistical report of CNNIC, as of June 2021, the number of Internet users in China reached 1.011 billion, the number of mobile phone users reached 1.007 billion, and the Internet penetration rate reached 71.6%. The traditional media's one-way, delayed, and elitist communication form has been overturned by the new communication form of online media, which is interactive, instant, and grassroots and social public opinion has been projected into cyberspace and generated increasingly complex online public opinion[4]. The consequences are that they can affect public order online and offline in a short period, and even pose a threat to national security and social order. Therefore, how to deal with online emergent public events becomes a constant challenge for governments at all levels at present.

At present, scholars have made richer research findings on the characteristics of users and their interrelationships in the dissemination of online public opinion. Gong (2022)[2] and others

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analyzed social and livelihood public opinion from the perspective of the evolutionary dynamics of public opinion and found that social and livelihood events have a more obvious process of online fermentation under the interaction of multiple participating subjects and that Internet users, media and opinion leaders, who exist in the exogenous dynamics of online public opinion evolution, are the driving force of online communication, with public Internet users having strong emotional demands and media and opinion leaders participating in large numbers and capable of triggering empathy psychology, which together constitutes the intrinsic mechanism leading to such events[1]. Qin (2017) et al.[5] argue that in the process of information dissemination, the general user's behavior and degree of acceptance of information is easily influenced by the attitude of opinion leaders towards an event on a hot topic, which has an important guiding role in the development of online public opinion. Naskar (2020)[3] studied opinion leaders based on expert intervention and government policies and found that expert interaction has a strong controlling effect on the spread of public opinion in social networks, and the more frequent the interaction the slower the spread of public opinion, and conversely the longer the interaction takes, the weaker the control of the spread of public opinion.

The dissemination of online public opinion on unconventional emergencies is urgent to study the characteristics of Internet users in the dissemination of online public opinion so that managers can effectively direct online public opinion on unconventional emergencies to a reasonable position promptly. Compared with other studies, this paper builds on the rich research on public opinion networks to construct a social network model for analyzing the spread of public opinion about unconventional emergencies in complex systems, to deeply analyze the basic evolution of the spread of public opinion about unconventional emergencies and calculate the metrics of user nodes to identify key users. In addition, this paper proposes a new user sentiment intensity classification metric to analyze the temporal evolution of user sentiment tendencies at different times.

2 DATA SOURCES AND PROCESSING

2.1 Data Acquisition

In this paper, we use Sina Weibo as the data source and use python's requests module package to obtain data samples related to the topic of train D2809 utilizing a web crawler. The time range selected for retrieval is: from June 4, 2022, to June 14, 2022. The specific operation steps are as follows: The headline news is selected as the starting node, and the headline news is used as an example to first crawl the D2809 train-themed microblogs related to it. The initial blog post data is a record containing fields such as the id name of the microblog, the name of the blogger, the content of the blog post, the number of likes, the number of retweets, the number of comments, the time of posting, and the time of crawling. To obtain the comments and retweets, the record is crawled again using the tweet id in the record as a springboard to obtain records containing valid fields such as the tweet id name, blogger name, blog post content, number of likes, number of retweets, number of comments, time of posting, time of crawl, etc. Cleaning of retweet comment user ids for the next sampling. After eliminating users with duplicate comments or retweets, after cleaning, there are 2223 user ids under the headline news node. 5 users are randomly selected as the second-level users under these 2223 users, and so on, and a total of 24 user nodes are obtained after finishing.

2.2 Data Pre-Processing

In the data pre-processing stage, the data is checked, exceptions are handled and the format is optimized in turn. Among them, the data checking operation is aimed at the phenomenon that the same microblog may refer to different topics, and de-duplication of the crawled data information can effectively avoid the phenomenon of data duplication. The exception processing includes processing the abnormal values of the fields of the number of retweets, comments, and likes, for example, information with 0 retweets will show "retweet" in the crawl result; information with 0 comments will show "comment" in the crawl result; information with 0 likes will show "comment" in the crawl result. "; information with 0 likes will show "Likes" in the crawl results, and special treatment will be given to the above anomalies. The format optimization is to adjust the value of some fields, for example, after the number of Weibo retweets, Weibo comments, and Weibo likes reaches 10,000, the Chinese character " million " will be displayed; when the posting time is close to the crawling time, it will be displayed as "Yesterday", "2 hours ago", etc. When the posting time is close to the crawl time, it will be displayed in the format of "yesterday", "2 hours ago", etc. All such data will be adjusted by the crawl time.

3 A SOCIAL NETWORK MODEL FOR THE DISSEMINATION OF ONLINE PUBLIC OPINION ON UNCONVENTIONAL EMERGENCIES

3.1 Construction of Matrix

According to the relationship between the 24 nodes collected, if there is a forwarding and commenting relationship between A and B, then the value of the relationship between them is 1; if there is no forwarding and commenting relationship between A and B, then the value of the relationship between them is 0: therefore, in the following table 1, the rows and columns represent the specific large relationship between the 24 nodes, which means that a 24x24 matrix is constructed. This matrix is then entered into UCINET to create a matrix based on the interactive forwarding or commenting relationships, as shown below.

TABLE 1 INTERACTION MATRIX MODEL (PARTIAL)

	CCTV	dianke	toutiao	People	JiMU
CCTV	1	1	0	1	0
dianke	0	0	0	1	1
People	0	1	0	1	1
Beijing	0	0	0	1	1
zhiqun	0	1	1	0	0
ChinaNews	1	0	0	1	1
gqt	0	1	0	1	1

3.2 Visualizing The Relational Adjacency Matrix

Relationship network graphs, also known as community graphs, are now widely used in the field of social networks. Nodes and lines are the basic elements of a community graph. Nodes in a community graph represent users of the D2809 train microblogging discussion, and connections between nodes indicate the existence of retweeting or commenting relationships between users. The above Excel table was imported into UCINET, and its draw function was used to derive a social network graph of the D2809 train event community, as shown in Figure 1, where each node represents a blogger posting on the D2809 train microblog, and the connecting lines with arrows indicate the following relationship between the bloggers.

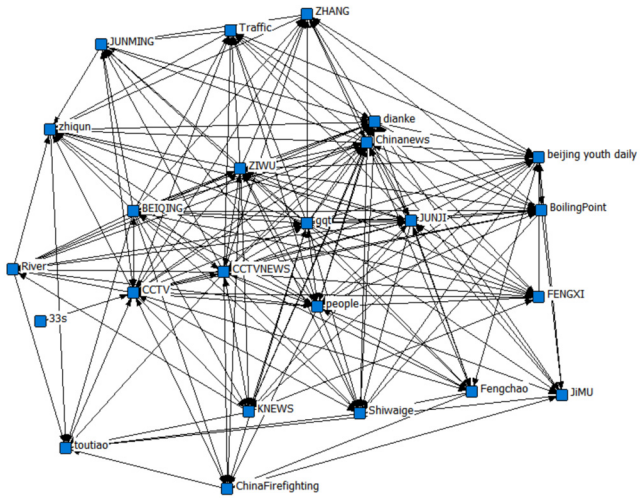

Figure 1. "Online community map of the "D2809 train incident

According to Figure 1, we can see that the nodes at the core of the "D2809 train incident" network are people, ChinaNews, KNEWS, and gqt. This indicates that these nodes are very closely connected to other nodes, which means that they are more active in communicating with each other than other nodes. At the fringes of the network, those nodes in the social network that are not very connected to other nodes also exchange relatively little information, indicating that their influence is also small. The relationship matrix and social network community diagram above depict the connections between members of the same community. It is clear from this that there are 24 members in the community, and it is clear how they 'follow' and are 'followed' by each other.

3.3 Centrality Analysis

Centrality analysis is one of the first themes to be concentrated on in social network analysis. Centrality is used to reflect the position of social individuals in a network and what power an individual or organization has within its social network. The following two types of centrality are often used: point centrality and intermediate centrality. Point centrality can be measured if the focus is on interactive activities, while intermediate centrality can be measured if the focus is on control of interactions. To use social network analysis to identify opinion leaders, the most

important and commonly used concept is centrality. Therefore, for the analysis of centrality, this sub-section provides a detailed analysis of two different perspectives, point centrality, and intermediate centrality, as follows.

3.4.1 Degree centrality analysis

Degree centrality indicates the number of nodes in the network that are directly connected to the node, and the measure counts only the number of relationships that an actor or node has. The ability of a node to interact directly with other nodes and generate connections is usually expressed in terms of point degree centrality. If the size of a node's influence on network power is measured, it can be estimated by the point centrality metric.

If an actor is directly connected to a large number of community members, the higher the ability to interact directly and therefore the higher the point centrality, the actor corresponding to that point is a central figure and has a significant influence on other actors in the network. The actor corresponding to that point is marginal and has little influence on the community. Therefore, we usually measure the point centrality of actors to determine who qualifies as a key node in a network community.

TABLE 2 RESULTS OF THE "D2809 TRAIN INCIDENT" POINT DEGREE CENTRALITY MEASUREMENT

number	nodes	point centrality
1	People	15.000
2	CCTV	10.000
3	KNEWS	9.000

According to Table 2, the network "D2809 train incident" has the highest point centrality value of People(15.000), which means that this node has the most influence and is the node with the strongest information interaction and resource control. The next nodes are CCTV, KNEWS, ChinaNews, and zhiqun, whose point centrality is 10, 9, 8, and 7. Based on the results of point centrality measurement, it can be concluded that the above nodes are the opinion leaders of the "D2809 train incident" and have close and complex interactions with the nodes around them. They have a close and complex interaction with the nodes around them and have a great influence on the information dissemination and communication of the emergency online group.

3.4.2 Intermediate centrality analysis

Mesocentricity examines the extent to which an actor has control over information resources, i.e. the extent to which the actor has control over the capabilities of other actors, i.e. the actor's ability to intervene or control information interactions at other nodes. Intermediation is the extent to which the actor acts as a 'broker' for other actors. Those with a high degree of intermediation also have a high degree of intermediation centrality, acting as a bridge to other actors. Intermediation is therefore an indicator of 'control', which identifies which nodes in a social network can control the transmission of information. The more information links that need to be passed between other users via a particular user, the more central that user is to the network.

TABLE 3 RESULTS OF INTERMEDIATE CENTRALITY MEASUREMENTS FOR THE "D2809 TRAIN INCIDENT"

number	nodes	Intermediate centrality
1	CCTV	72.923
2	ChinaNews	49.591
3	Beijing	37.830

According to Table 3, we can learn that the nodes with the highest intermediate centrality are CCTV, ChinaNews, Beijing, People, and JIMU. These nodes are at the center of controlling the spread of public opinion and play the role of a bridge. In addition, several nodes in the network of the D2809 train incident have zero centrality, which indicates that they have little ability to control the relationships. They are at the periphery of the network, with relatively limited resources and limited access to information, and do not act as bridges of communication.

3.4.3 Proximity centrality analysis

Proximity to the center is a measure of how well a node in a network can propagate information without being 'controlled' by other nodes, and the smaller the value, the more centrally located the point is. The shorter the distance between a node and all other nodes, the higher the proximity of the node to the center. This is because a non-central node can be easily controlled by other nodes if it has to transmit information via other nodes. This means that a node that is connected to other nodes via a relatively short path can be identified as having a high degree of proximity centrality.

TABLE 4 RESULTS OF THE "D2809 TRAIN INCIDENT" PROXIMITY CENTRALITY MEASUREMENT

number	nodes	Proximity centrality
1	CCTV	36.000
2	ChinaNews	39.000
3	Beijing	39.000

According to Table 4(top3 in ascending order of centrality), the least influential and least controlled nodes in the "D2809 train incident" were the actors CCTV, ChinaNews, Beijing, People, and dianke. At the same time, it can be found that the proximity centrality of the top 10 actors, the point centrality of the top 10 actors, and the intermediate centrality of the top 10 actors have many similarities. This means that these nodes are located at the center of the opinion dissemination network and other actors cannot easily control them. On the contrary, they will have a significant influence on other actors in the dissemination of information, and they are important opinion leaders.

4 TIME SERIES ANALYSIS

In this paper, we analyze the trend of user sentiment evolution in the process of public opinion dissemination through time-series analysis, taking user sentiment change as the entry point to study the evolution of user sentiment at different points in time. The scatter diagram of the

sentiment distribution of microblog posts is shown in Figure 2. The sentiment score ranges from [0,1], where a value closer to 1 means the text content is more positive, and closer to 0 means the text content is more negative. Using the positive emotion score as a criterion, a positive emotion score in the range of [0,0.35] was judged as negative, a neutral emotion in the range of [0.35,0.65], and a positive emotion in the range of (0.65,1]. According to the calculation results, there were 1235 tweets with positive sentiment, accounting for 52.82% of the total number of tweets; 442 tweets with the neutral sentiment, accounting for 18.91% of the total number of tweets; and 661 tweets with negative sentiment, accounting for 28.27% of the total number of tweets.

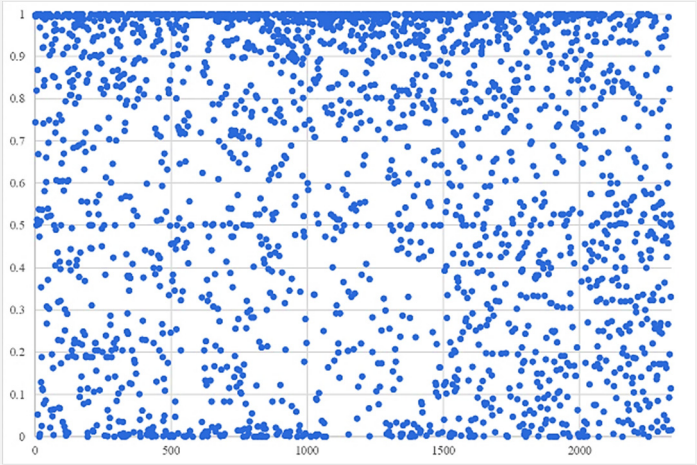

Figure 2. Scatterplot of sentiment distribution of Weibo posting content

Figure 3 shows the accumulation area of microblog posts within 11 days after the "D2809 train incident", from which we can visualize the "breaking point" of online users' emotions caused by the spread of online public opinion. From June 4 to June 14, the sentiment value of online users can be divided into three stages, namely "June 4-June 5 (1d)", "June 5-June 9 (5d)", "June 9-June 11 (3d)" and "June 9-June 11 (3d)". June 9 - June 11 (3d)". In the first phase, user sentiment was extremely positive, with topics such as "#D2809 accident rescue scene" and "#D2809#" focusing on the disaster accident being highly trendy during the period immediately after the accident; in the second phase, user sentiment was stable, with "#d2809 In the second stage, users' sentiment was stable, with the topics "#d2809 train skidded more than 900 meters" and "#d2809 accident update summary" on the top search, and users showed higher concern for the details of the cause of the accident; in the third stage, sentiment fluctuated, and Most of the sentiments were positive. In particular, on June 10, 2022, the State General Administration of Railways announced the cause of the train dislodgement accident, and the announcement of these events triggered heated discussions among the general public and remembrance of the train driver, so users' sentiment fluctuated greatly, especially users' negative sentiment rose more. after June 11, 2022, people's sentiments tended to calm down and the heat of the event was also subsiding.

5 CONCLUSIONS

As a new type of information exchange and dissemination platform, the Internet has naturally formed some "opinion leaders". The Internet public is the main group of people involved in Internet activities and also the main group of people involved in public opinion on the Internet during public emergencies, and they play a huge role in influencing the spread of public opinion. During public emergencies, the netizen public often displays many irrational behaviors, usually showing that they are prone to believe rumors, are easily implied, and tend to think of simple things as complicated. The reason for these irrational behaviors is that, in the course of a public emergency, there is an imbalance in the netizens' perceptions, and they do not believe that a crisis has arrived: at the same time, they are more likely to believe information that is favorable to them and to follow it blindly. The reasons for this are, on the one hand, the lack of authoritative and accurate information and, on the other hand, the lack of awareness of risk, responsibility, and the overall situation among the majority of Internet users. Based on the above research, we propose the following recommendations: First, give full play to the mainstream influence of the official media, which shoulders the important mission of guiding online public opinion on public emergencies. Secondly, the role of online opinion leaders should be given full play. Third, give full play to the positive guiding power of the self-media. The self-media must adhere to the correct political direction, put their central work in place, spread the voice of China with strong cohesion and leadership, promote the positive energy and main theme of society, and constantly improve their political discernment and ability to guide online public opinion.

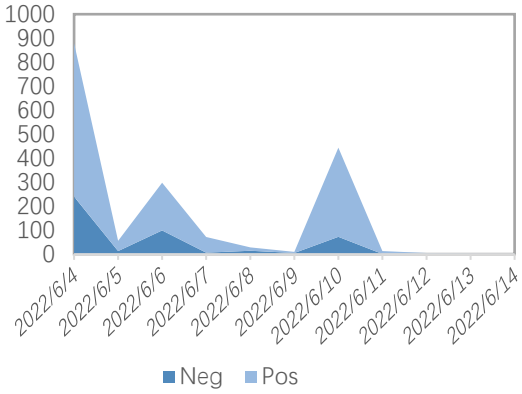

Figure 3. Weibo posting sentiment trend graph

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