

Article

# Mining and Evolution Analysis of Network Public Opinion Concerns of Stakeholders in Hot Social Events

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**Abstract:** (1) Background: Hot social events contain a large amount of public opinion information, and a more detailed analysis of this information will help the relevant parts to formulate more targeted supervision strategies at different stages and for the public opinion publishers involved in the event discussions, so as to achieve efficient management of public opinion; (2) Methods: Based on stakeholder theory and life cycle theory, this study constructs stakeholder classification system by using keyword identification method; adopts LDA model to complete topic clustering; analyzes and summarizes topic evolution pattern by calculating topic similarity; (3) Results: The study divided the stakeholders involved in the Jiang Ge case into 10 categories, and the results of topic clustering were divided into two categories according to the content of the topics, which were based on the case itself and on the parties involved in the case; it was found that each stakeholder focused on a different topic with different emphasis, no matter the topic of public opinion or the different life cycle stages of public opinion. Based on the differences in topic similarity between adjacent stages, the topic evolution patterns of different stakeholders were categorized into three types; (4) Conclusions: Example verification shows that the method presented in this paper can dig out the topic focus and evolution path of stakeholders in the field of public opinion, and provide a horizontal and vertical comparative analysis between stakeholders and different life cycle stages.



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**Keywords:** hot social events; stakeholder; thematic analysis; topic similarity

**MSC:** 82-11

## 1. Introduction

Hot social spot events refer to events that emerge at a specific time, attract wide public attention, and may have a significant impact on public security and social stability [1]. The public has paid great attention to hot social events. In the current social media environment, it is easier to engage in a heated discussion on hot social events. Institutions, organizations, and individuals express their views and opinions on the events, which become hot issues of the involved communicators, generating somewhat of a domino chain reaction. Hot social events generally carry a large amount of public opinion information, but due to the different identity backgrounds, personal positions, values, and education levels of communicators, a large number of differential expressions are inevitable, and the analysis of public opinion information therefore cannot be generalized. Some scholars have pointed out that in the new media environment, the circle of public opinion is more prominent, and stakeholders in each circle are gradually forming communities through the expression of views and mutual solidarity [2]. Moreover, due to the characteristics of dynamic development and change of social hot events, people pay attention to the different directions of social hot events over time, such as the immediate dynamics of social hot events, event stakeholders and their backgrounds, and post-event development, etc., [3]. Therefore, it is necessary to analyze the topic focus and evolution of different stakeholder groups under the public opinion field of hot social events: It is helpful for relevant management departments to accurately grasp

the demands of various groups of people, so as to take more targeted response measures by stages and groups, and improve the efficiency of public opinion management.

Topic modeling is a popular tool for extracting latent variables from large datasets. It is especially well-suited for use with text data, and helps to solve the problem of information overload. This has increasingly become a topic of scholars' attention. Most of the methods to study topic evolution are based on probabilistic topic models, among which the earliest and most commonly used is the LDA (Latent Dirichlet assignment) model. Scholars also use the LDA model when analyzing network public opinion. For example, Zhang Lei and others [4] proposed the LDA model of microblog user comments to analyze the important topic hot spots and topic intensity changes that users pay attention to. Qiuzequo et al. [5] constructed the PCA spectral LDA model, analyzed the emotion of each type of text subject after LDA analysis, and obtained the temporal and spatial evolution law of emotion in the spread of network public opinion. Yan Duanwu [6] and others fused the weighted Word2vec word vector feature and LDA document-topic distribution feature to achieve more efficient and accurate topic clustering for Weibo short text data. Although these studies are valuable for LDA in text subject analysis, they still have certain limitations:

- (1) We know that the views of Internet users are often highly subjective, but there is basically no research to define and distinguish the originators of the collected text corpus;
- (2) At present, the information transmitted online is usually in the form of dynamic text flow, in which themes appear, evolve and disappear. These studies often end after classifying the topics of the text corpus, but ignore the relevance and evolution of the topics;
- (3) There are different stages in the development of an event. Accordingly, different stakeholders and netizens with different identity backgrounds pay different levels of attention in these stages, but there is little research on this;
- (4) In terms of the selection type of public opinion events, emergencies and medical and health events represent the preferred objects of scholars, but they pay less attention to hot social public opinions that attract high attention of netizens.

Therefore, from the perspective of different stakeholders, we put forward a multi-agent public opinion concern analysis model to mine user concerns in the network of public opinion under the different life cycle stages of hot social events, and analyze the different concerns of various stakeholders at each stage of the public opinion life cycle. After calculating and analyzing the value of topic similarity of the focus of interest in the adjacent life cycle, we summarize the evolution pattern of the focus of interest from the perspective of content and form. We thus solve the problem of insufficient refinement of opinion analysis in previous studies. To sum up, our research contributions are as follows:

Our research has constructed a stakeholder classification system suitable for hot social events. Compared with the previous research on topic classification of public opinion, this research is further refined: the research on public opinion is divided into subjects and stages, and the method of topic similarity is introduced to summarize the focus evolution path of different stakeholders in the whole life cycle of public opinion from the two directions of content and form. It provides a theoretical and practical reference for the research on public opinion of hot social events, and provides an empirical reference for more effective prevention and response to public opinion of similar events in the future.

## 2. Related Works

### 2.1. Stakeholders of Network Public Opinion

The stakeholder theory was first proposed by the American scholar R. Edward Freeman in his book *Strategic Management: A Stakeholder Approach*. The book highlights that there are various interest groups within a company. In addition to paying attention to the maximization of the enterprise's interests, the company's managers should also consider harmonious coexistence with other interest groups. The concept of stakeholder provides a new way of thinking for the company's managers to formulate the correct development direction. The viewpoint of introducing stakeholder theory into the analysis of network

public opinion began with the article “grasping social public opinion” published in outlook in 2002, which posits that public opinion should be viewed from the perspective of interests. People began to realize that Internet public opinion and stakeholders are the collection of social interests and the collection of stakeholder relations [7]. With the maturity and development of stakeholder theory, in recent years, scholars have carried out research on public opinion from a new perspective based on stakeholder theory. Based on the Sina Weibo platform, Fang Jie constructed a classification model of stakeholders of microblog network public opinion [8]. An Lu et al. constructed the emotional map model of stakeholders in public health emergency, and visually presented the emotional evolution trend of various stakeholders [9]. In view of the difference in the influence of different stakeholders in online public opinion, Zhuo Guangjun focused on the specific event of “Sewage discharge in Shuanglang Inn” and made judgments from the relationship position, media resources, actor identity and basic value idea of stakeholders, and concluded that the discourse of opinion leaders such as intellectuals and media was the most influential [10]. Qi Liyun constructed a multi-agent model of the evolution of enterprise negative public opinion by taking the “Wei Zexi event” as an example and discussed the evolution law of network public opinion in negative events by using the theory of system dynamics [11]. In general, scholars have experienced a transformation from theory to practice for stakeholders, and in practice, most of them analyze online public opinions from the perspective of stakeholders in emergencies, but rarely study the types of stakeholders in hot social events and the public opinion topics they are concerned about.

### *2.2. The Life Cycle of Network Public Opinion*

The life cycle is a biological concept, which refers to a series of stages or changes in the form or function of organisms. In essence, it describes the complete life process of organisms from their formation to extinction [12]. Life cycle theory is also widely used in the study of public opinion. For example, Fink proposed the life cycle models of incubation period, outbreak period, spread period and recovery period to be applied to the public opinion dissemination of emergencies [13]. Robert put forward the 5R theory of crisis management, that is, the stages of reduction, preparation, response, recovery, and resilience [14]. Chinese scholars also use the life cycle theory when analyzing the evolution of public opinion, and divide public opinion into different life cycles according to their research contents and perspectives. For example, Chen Fuji referred to the fluctuation of the Baidu index and classified the online public opinion of the “Beijing haze” event into fluctuation period, peak period and decline period [15]. Cao Shujin divided public opinion into initiation, outbreak, spread and long-tail stages when he studied the temporal development trend of the evolution of public opinion themes on Weibo in public health emergencies [16]. She Lian divided the life cycle of emergencies into five stages: pregnancy, outbreak, spread, transition, and dormancy [17]. According to the difference in the number of peak periods of public opinion of public health and safety events, Jiang Jing summarized the evolution mode into three forms: single-peak type, double-peak type, multi-peak type, and pointed out that the evolution process followed the basic process of formation period-development period-peak period-dissipation period [18]. Based on the life cycle theory, this paper divides the stages according to the characteristics of the public opinion life cycle curve.

### *2.3. Topic Discovery and Evolution of the LDA Model*

LDA is an unsupervised machine learning technology, which can be used to identify hidden topic information in large-scale document sets or corpora. It was proposed by American scholar BLEI [19]. In recent years, scholars have widely used LDA to study the topic of public opinion. In the field of topic discovery, for example, Lin Ping took the online public opinion of food safety events as the object to carry out LDA topic extraction and heat analysis [20]. Based on the LDA model, Zhang Liu constructed the topic clustering map of microblog users under the COVID-19 event, determined the optimal topic number and topic distribution of microblog users, and found the derivative public opinion topics [21].

In the field of topic evolution, Liu Guowei uses the LDA model to discover the topic of hot event content in different stages and constructs the topic feature network combined with the keywords in the event stage, so as to reveal the evolution of hot event content [22]. Hu Yanli describes the implied meaning of text content based on the topic model, puts forward the topic drowning method based on OLDA, and establishes the correlation model of text flow in time series [23]. In the field of topic evolution, some scholars have also conducted corresponding research using the LDA model: For example, Wang Hongqinling designed a topic intensity calculation model to explore the evolution law of topic intensity with WeChat group dialogue as a sample [24]. Feng Jiand et al. used the characteristic words and co-occurrence relationship obtained by the LDA model and then used the article topic probability distribution to calculate the topic intensity under each time window [25]. When the appeal study runs the LDA model, the corpus it acts upon is basically the whole corpus of documents collected, which leads to the incorrect clustering of derivative events that may occur in a certain stage of the public opinion life cycle. At the same time, the single dimension of time was only considered in the sub-dimension analysis, while the dimension of the subject Angle of public opinion release was not taken into account.

To sum up, existing studies rarely involve online public opinion in hot social events. Meanwhile, the topic discovery of public opinion mostly focuses on the mining of the whole corpus, while ignoring the classified topic analysis of the stage public opinion corpus and the subject of public opinion publishing according to a more delicate time window. Based on this, the paper first classifies the publishing subjects according to the stakeholder system, then divides each stage of the public opinion life cycle into different time analysis windows, and digs and compares the differences in the attention and topic content invested by stakeholders in different time windows. Through the size of the topic similarity calculated, the evolution path of the topic concerned by stakeholders is summarized from the two directions of content and form.

### 3. Methods

#### 3.1. Technical Route of Model

Our experimental technical route is shown in Figure 1, which includes four parts: Early-stage preparations, data preprocessing, algorithm calculation, and result analysis.

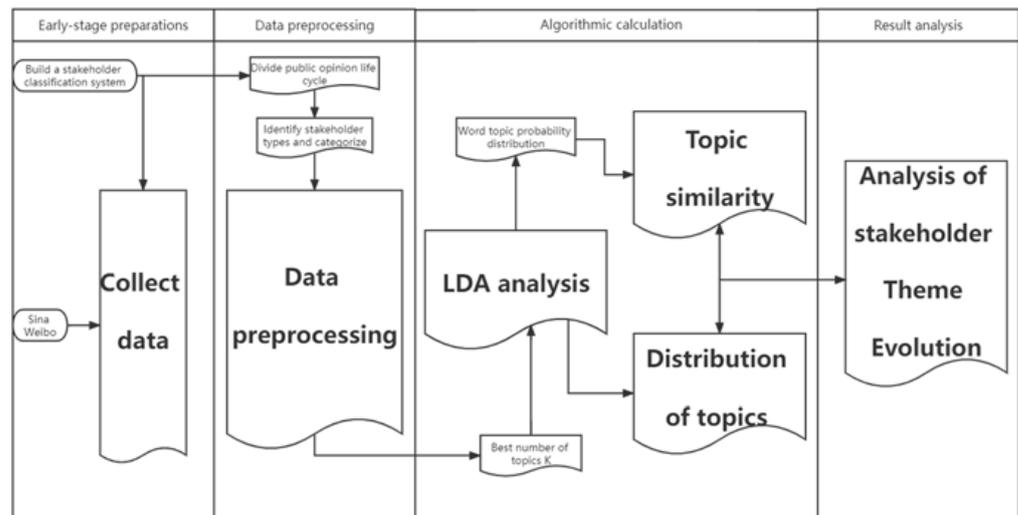


Figure 1. Technology Roadmap.

#### 3.2. Identification and Classification of Stakeholders

The classification of stakeholders takes different interest demands as the perspective. In essence, it focuses on issues of interest in public opinion, such as economic interest, political interest, social interest and public interest. From previous research conclusions on

stakeholders, it has become a general consensus to regard the government, media and netizens as stakeholders of network public opinion. This paper also classifies these three groups into the research system of stakeholders of public opinion in hot social events, and further divides media into mainstream media and “we-media”. With reference to influence and relevance indexes, the stakeholders in Jiang GE’s case are divided into 10 types, including government departments, judicial organs, mainstream media, we-media, ordinary people, lawyers (individuals/organizations), universities, overseas study enterprises (institutions), ordinary enterprises, and social groups. In their identification method, reference is made to the keyword identification method adopted by Anlu [9]: Firstly, crawler software crawls the detailed information of Weibo users collected, and completes the classification process by matching keywords in the user’s username, authentication description, work unit, industry category and other information. The various stakeholder identification keywords are shown in Table 1.

**Table 1.** Basis for dividing stakeholders of hot social events.

Stakeholders	Key Word
Government sector	Municipal Party committee, politics and law, public security, Internet information, internet police patrol, government, general office and Publicity Department
Judicial office	Procuratorates, procuratorates, law popularization, courts, rule of law, law publicity, Supreme Court, intermediate people’s court, judiciary
Mainstream media	Newspaper, magazine, radio, broadcast, news, media, media, radio, monthly, weekly
We-media	Blogger, author, writer, mediaperson, commentator, commentator, we-media, reporter, editor, current commentator, anchor and editor in chief
Lawyer (individual/Organization)	Lawyer, law, judge
Colleges and universities	Universities, colleges, campuses, schools, student unions
Overseas study enterprises (Institutions)	Overseas students, overseas students, education and technology companies
Social groups	Community, Communist Youth League, Youth League Committee, anti cult, Alumni Association, City Association, association and Federation
Ordinary enterprise	Companies and enterprises
Ordinary people	All users who do not include the above keywords in the profile are divided into ordinary people

### 3.3. Division of Public Opinion Life Cycle of Hot Social Events

The life cycle of online public opinion is a continuous process, which is expressed graphically as a continuous and microscopic life cycle curve. In this study, on the basis of the existing theory, combined with the characteristics of the life cycle curve inflection point, plans to adopt the above-mentioned cao tree gold on public opinion, the dividing method of life cycle could be divided into initial public opinion, the eruption, fluctuation and the long-tail stage. At the same time, because the public opinion evolution of the JiangGe case within the collection span shows the characteristics of double peaks, this paper, based on Cao Shujin et al., divides the life cycle of public opinion communication of Jiang’s case into the initial stage, the first outbreak stage, the first fluctuation stage, the second outbreak stage, the second fluctuation stage and the long-tail stage.

At the beginning, the topic of public opinion began to appear. A small number of people paid attention to it and formed a small-scale discussion. As the situation further evolved, public attention continued to rise dramatically and discussion of the event exploded in a short period of time. The amount of public opinion information released reaches the highest point and maintains a high level of concern in a short period of time. At this time, the event enters the outbreak stage. The fluctuation stage lasted for a long time, during which the attention of netizens began to decline compared with the outbreak stage. However, as the event continued to ferment and subsequently triggered a series of secondary events and new issues, the spread of public opinion events occurred repeatedly. At the late stage of fluctuation, the attention and discussion volume of public opinion

information began to weaken and maintained a downward trend. At this time, it entered the long-tail stage of public opinion. At this stage the number of public opinion information tends to be more stable at low values, and only a small group of people pay continuous attention to the event.

3.4. Public Opinion Theme Discovery of Hot Social Events

LDA (implicit Dirichlet distribution) was proposed by BLEI and other scholars of Princeton University in 2003 to extract the topic probability model from a corpus. LDA creates a semantic vector space model and assumes that each document is mixed (linearly combined) by any number of topics, and each topic can be represented by word distribution (word item frequency). The probability or weight of each topic in the document and the probability that a word is assigned to a topic are assumed to meet the Dirichlet probability distribution at the beginning. The process of topic simulation generation is conducted through the probability statistics of vocabulary occurrence, to effectively avoid the characteristics of highly noisy text data [26], which is suitable for the analysis of microblog short text. The generation process is shown below.

In Figure 2, M represents the corpus of all texts to be analyzed, n represents the scale of feature words obtained, and the number of N can be obtained by customization. First, we determine the distribution of Dirichlet  $\alpha$ ,  $\beta$  Parameters, and then according to  $\alpha$ ,  $\beta$  obtain the parameters of document subject distribution in the document  $\theta \sim \text{Dir}(\alpha)$  and parameters of subject term distribution  $\Phi \sim \text{Dir}(\beta)$ ; Generate its feature word  $w$  for a single document; Select the polynomial distribution from the subject distribution probability vector( $\theta$ ) Topic  $z$  under, polynomial probability distribution from  $z(\Phi)$ . For the next feature word, the generation probability formula of the  $i$ th feature word in document D is:

$$P(\omega_i) = \sum_{j=1}^T P(\omega_i | z_i = j) P(z_i = j) \tag{1}$$

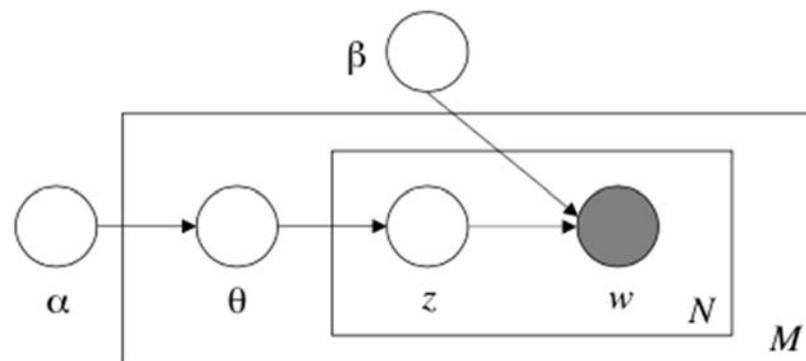


Figure 2. Schematic diagram of LDA model.

Thus, obtain the topic classification at the text level of the collected corpus set and the corresponding topic words under the corresponding topic, and complete the public opinion text modeling and topic discovery.

3.5. Topic Similarity Calculation

The similarity is a method used to measure the relevance of topics in the pre- and post-life cycle stages. It is a quantitative expression of the relevance of dialogue questions. In this paper, the cosine similarity method is used to calculate the relevance between topics in the adjacent life cycle. The calculation formula is as follows.

$$\text{similarity}(T_{1i}, T_{2j}) = \cos(\theta) = \frac{\sum_i^n \omega_{1k} \omega_{2k}}{\sqrt{\sum_i^n \omega_{1k}^2 \sum_i^n \omega_{2k}^2}} \tag{2}$$

$T_{1i}$  and  $T_{2j}$  represent two different topics,  $\omega_{1k}$  and  $\omega_{2k}$  are the keywords under two corresponding topics  $\omega$  frequency of occurrence. The larger the calculated value, the higher the similarity between the two topics. By setting the threshold, if the similarity value of the two topics is greater than the threshold, the two topics are considered related. For example, calculating the correlation between the topic T1\_0 in the first outbreak stage and the topic T2\_1 in the first fluctuation stage. First, print out the subject words and their probabilities under T1\_0 and T2\_1 topics, and then print out the Words\_Subject probability distribution, calculate the cosine similarity value of T1\_0 and T2\_1 through Formula (2). The calculation core code is shown in Figure 3 below. The code uses the cosine\_similarity function under the Python open-source code package sklearn.

```
cos = np.zeros(shape=(len(left_topics), len(right_topics)))
for i in left_topics:
    for j in right_topics:
        cos[i, j]=cosine_similarity(tt1[:, i].reshape(1, -1), tt2[:, j].reshape(1, -1))

cos=pd.DataFrame(cos, index=range(len(left_topics)), columns=range(len(right_topics)))
cos.to_excel("Cosine similarity.xlsx", index=True)
```

**Figure 3.** Core computing code.

## 4. Experimental Process

### 4.1. Data Collection and Preprocessing

In this paper, we analyze the data with the “Jiang Ge case”, a hot social event, as the research object. The case took place in November 2016, and the place of occurrence was located in Tokyo, Japan. Before the case, Liu Xin, a close friend of Chinese female student Jiang Ge, was still frequently harassed by her boyfriend Chen Shifeng after her breakup, so Jiang Ge kindly invited Liu Xin to live with her. On the night of November 3, Jiang Ge was killed in front of her apartment by Chen Shifeng, who had ambushed her while she was entering the apartment with Liu Xin. Liu Xin ignored Jiang Ge’s pleas for help, hiding in Jiang Ge’s room and locking the door behind him so that Jiang Ge could not enter. The murderer fled the crime scene after killing Jiang Ge. The case was heard in Tokyo in December 2017.

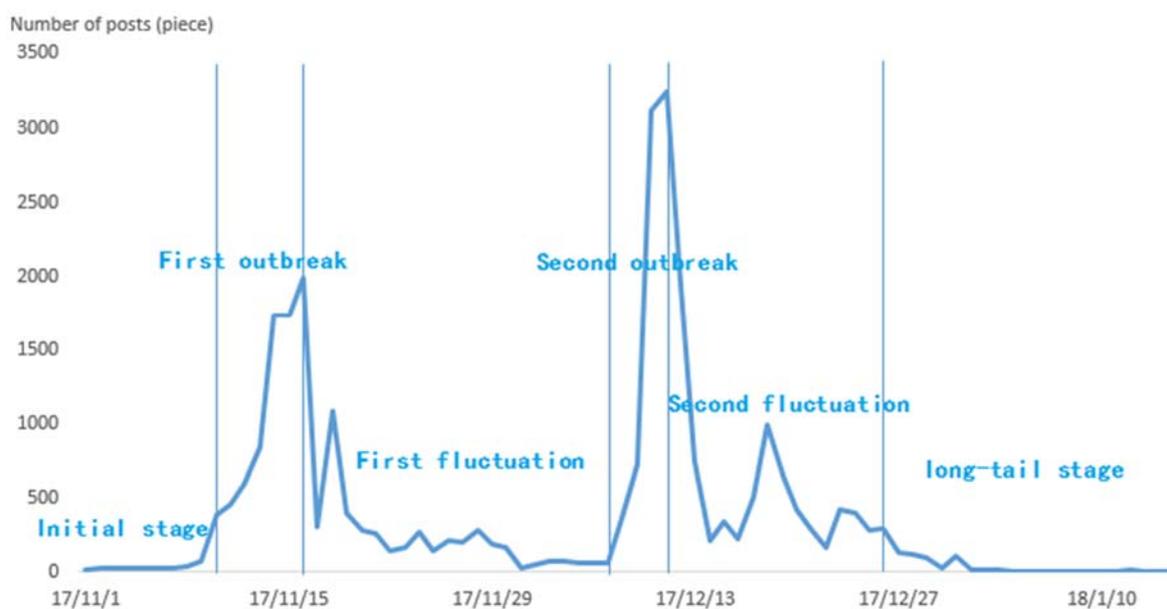
We selected the period from 1 November 2017, to 31 January 2018, to collect microblog data related to this case. Python programming script was used to collect the keywords “Jiang Ge, Jiang Qiulian, Liu Xin and Chen Shifeng”, and 28,572 valid data were obtained for this topic analysis after deleting useless microblogs, removing duplicates and removing irrelevant data.

Call the Jieba toolkit for word segmentation on the collected data, add words related to the event such as “Jiang GE”, “Jiang Qiulian”, “Jiang Mu” (This word refers to Jiang GE’s mother), “Chen Shifeng”, “Liu Xin” into the user-defined dictionary, and add meaningless words and symbols such as “view” and “picture” into the stop list to remove the stop words and obtain a text corpus for topic analysis. In order to improve the accuracy of the model, the custom dictionaries and deactivation tables were expanded several times based on the obtained corpus results, and then the expanded custom dictionaries and deactivation tables were used to split and deactivate the text corpus, and the process was repeated until satisfactory preprocessing results were obtained.

### 4.2. Event Life Cycle Division

The obtained 28,572 microblog texts are drawn in chronological order to obtain time distribution characteristics, as shown in Figure 4. It can be seen that the spread of public opinion in the collected stage presents the characteristics of “double peaks”. Public opinion is divided into the initial stage (1 November 2017, to 8 November 2017), the first outbreak stage (9 November 2017, to 16 November 2017), the first fluctuation stage (17 November

2017, to 7 December 2017), the second outbreak stage (8 December 2017, to 11 December 2017), the second fluctuation stage (12 December 2017, to 26 December 2017) and the long-tail stage (27 December 2017, to 31 January 2018). In the first public opinion outbreak cycle, Liu Xin avoided meeting with Jiang's mother. Jiang's mother made Liu Xin and her family photos and information public on the Internet to force Liu Xin out. A total of 294 days after Jiang GE was killed, the media facilitated the first meeting between the two people, and netizens condemned and abused Liu Xin on a large scale. The second peak occurred when the Jiangge trial began in Japan, and the majority of netizens and media paid high attention to the trial site and results, which triggered the growth of public opinion for the second time.



**Figure 4.** Distribution of daily microblogs in the first collection time span.

## 5. Results and Discussion

The LDA model is used to mine and classify the topic of text corpus in different periods. Since the number of effective blogs collected in the initial stage is small, the analysis of the initial stage is omitted in the subsequent analysis. One can figure out the number of topics corresponding to the lowest confusion value in the corresponding period by calculating and drawing the line graph of topic confusion degree of texts in each period. Finally, the number of theme clusters  $k_1$  in the first outbreak stage was set as eight, the number of theme clusters  $K_2$  in the first wave stage was set as three, the number of theme clusters  $K_3$  in the second outbreak stage was set as four, the number of theme clusters  $K_4$  in the second wave stage was set as eight, and the number of theme clusters  $K_5$  in the long-tail stage was set as four. The hyperparameters  $\alpha$  and  $\beta$  were set to  $50/k$  and  $0.01$ , and the number of iterations was 1000. The top 20 topic words with the highest probability of occurrence under each theme were displayed for analysis.

### 5.1. Focus Distribution of Stakeholders

First of all, let us take a look at the distribution of topics of most concern to various stakeholders. Each user has their own political position [27], and certainly their own position of interest, so the direction of concern about an issue is bound to be different. The five categories of topic focus that different stakeholders paid the most attention to in Jiang Ge's case are counted separately and plotted in Figure 5. The numbers before the underline represent the life cycle stages (1: the first outbreak stage; 2: the first fluctuation stage; 3: the second outbreak stage; 4: the second fluctuation stage; 5: the long-tail stage), and the numbers after representing different topics in the corresponding life cycle. Combined with

the subject words and text corpus, the topic content is summarized, as shown in Table 2. From the topic content, the topic can be divided into two types: Based on the case itself (case comments, latest progress of the case, details of the case) and based on the parties (paying attention to the words and deeds of the parties).

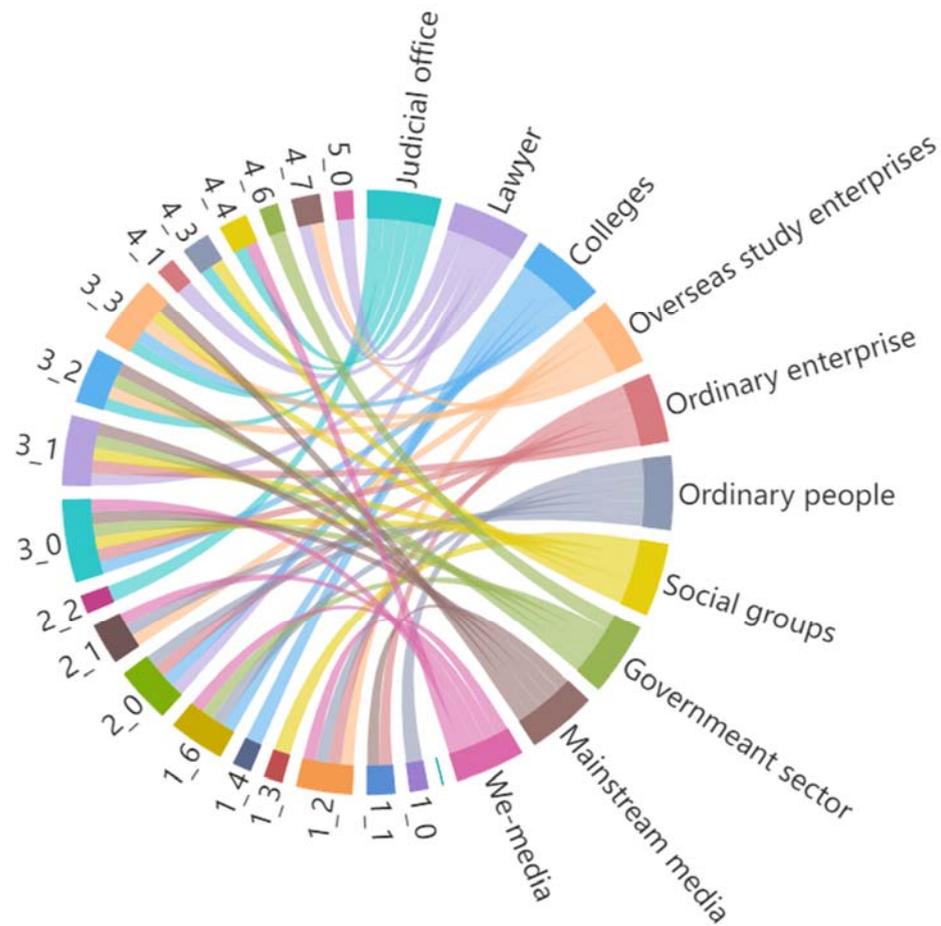


Figure 5. Distribution of topics with the highest interest of stakeholders.

Table 2. Summary of topics with the highest attention from different stakeholders.

1_0	Discussion on human nature in Jiang GE’s case.	3_0	On the eve of the trial, Jiang’s mother went to Jiang GE’s living apartment to worship.
1_1	Jiang Qiulian went to Japan to launch a signature petition for sentencing the murderer to death.	3_1	Jiang Qiulian held a media meeting and said that her biggest appeal was to sentence the murderer to death.
1_2	Express sympathy and support for Jiang’s mother and condemn Liu Xin’s words and deeds.	3_2	Jiang Qiulian said that after the end of the criminal case, she filed a civil lawsuit against the murderer.
1_3	Netizens launched human flesh on Liu Xin, and an old man lay innocent with a gun.	3_3	Jiang’s mother asked her friends to help record the details.
1_4	Chen Shifeng admitted the murder, and Jiang Qiulian’s lawyer said she would work hard to sentence the murderer to death.	4_1	The defense lawyer said Liu Xin locked the door and the police presented Liu Xin’s alarm recording.
1_6	Media interview with Jiang Qiulian and Liu Xin.	4_4	Jiang GE’s conversation with Jiang’s mother before she was killed.
2_0	Reflections on the social problems extended by the case.	4_6	The prosecution offered a 20-year sentence.
2_1	Attention and comments on Liu Xin’s words and deeds, I hope Liu Xin will testify in court.	4_7	Discussing the death penalty, Jiang Qiulian said she would go to court with the murderer and Liu Xin.
2_2	Efforts made before the trial to sentence the murderer to death.	5_0	Analysis of legal issues in cases.

The judicial organs, government departments, mainstream media, and lawyers pay attention to the topic essentially based on the case. The judicial organs and government departments mainly pay attention to the follow-up broadcasting of the case. For example, they pay attention to Jiang’s mother’s going to Japan to collect people’s signatures one

month before the trial (topic 1\_1), Jiang's mother held a media meeting one day before the trial (topic 3\_1) and asked friends on the scene to help record the details of the trial (3\_3). During the court trial, Jiang Mu testified as a witness (topic 4\_4), Chen Shifeng and his lawyer made a statement on the course of the crime (topic 4\_1) and brought a civil lawsuit against the murderer (3\_2) after the end of the criminal case. Lawyers also pay attention to the progress of the case, but the difference is that they pay more attention to the trial site: they make professional legal interpretations and analyses of the statement of the murderer to the case, the prosecution's accusation of premeditated murder (topic 4\_1) and the legal issues of the case (topic 5\_0), to help netizens gain a clearer and thorough understanding of the trial results. From the analysis of the case, it extends the thinking of whether public opinion can "kidnap" the dialectical relationship between justice, morality, and Law (topic 2\_0). Mainstream media have certain preferences in reporting events [28]. Our experimental results also show that the mainstream media paid more attention to the topics under the second outbreak stage, focusing on the media meeting held by Jiang Mu before the trial. Social groups and the mainstream media have similar concerns, and social groups have noted the violence caused by the case and the harm done to innocent elderly people (topic 1\_3). Due to the nature of students as their main objects, universities and overseas study institutions not only paid attention to the information and progress of Jiang GE's case (3\_2, 3\_3, 4\_7), but also paid attention to the extended topics of parents' safety of children and family education (2\_0) and their sympathy for Jiang's mother who lost her daughter (1\_2). Ordinary people and we-media, with individuals as the unit, mainly focus on the human feelings and moral issues reflected behind the case, and most of them are emotional expressions.

Subsequently, we analyzed the differences in stakeholder attention to inputs at different life cycle stages. Through the five topics that stakeholders pay the most attention to, we can summarize the difference in the attention of stakeholders in different stages of public opinion. As shown in Figure 6, the color of the rectangle represents different life cycle stages, and the longer the length of the rectangle indicates the greater attention to the topic under the corresponding life cycle stage. As can be seen from the figure, except for lawyers, the topics in the late long-tail stage have not become important concerns of the remaining nine categories of stakeholders. Lawyers focus on Topic 5\_0 at this stage: Analysis of the legal problems such as the appearance and effectiveness of Liu Xin's testimony in the trial, the defense made by Chen Shifeng's lawyer in the trial, the failure of witnesses to appear in court and the refusal of lawyers to apply for evidence collection in connection with the Hangzhou nanny arson case. Enterprises studying abroad and we-media have focused on public opinion topics in the first and second outbreak and fluctuation stages, and showed long-term and continuous attention and participation over the whole life cycle of public opinion. Universities and ordinary enterprises have focused on the topics before the trial in Japan in the stage of the first outbreak, the first fluctuation, and the second outbreak. The judiciary and government departments have focused on three stages in the whole life cycle. The judiciary department has focused on the topics in the first outbreak, the first fluctuation, and the second fluctuation; Government departments have focused on the topics in the first outbreak, the second outbreak, and the second fluctuation stage, among which the topics in the second outbreak were the most concerned, which also reflected the rapid and immediate response of government departments to public opinion. Ordinary people, social groups, and mainstream media all have focused on two stages. Ordinary people focus on the first outbreak and the first fluctuation stage and pay great attention to topics that very easily stimulate emotion, such as the contradiction and entanglement between Jiang's mother and Liu Xin. Social groups and mainstream media focus on the same stage, both for the first outbreak stage and the second outbreak stage.

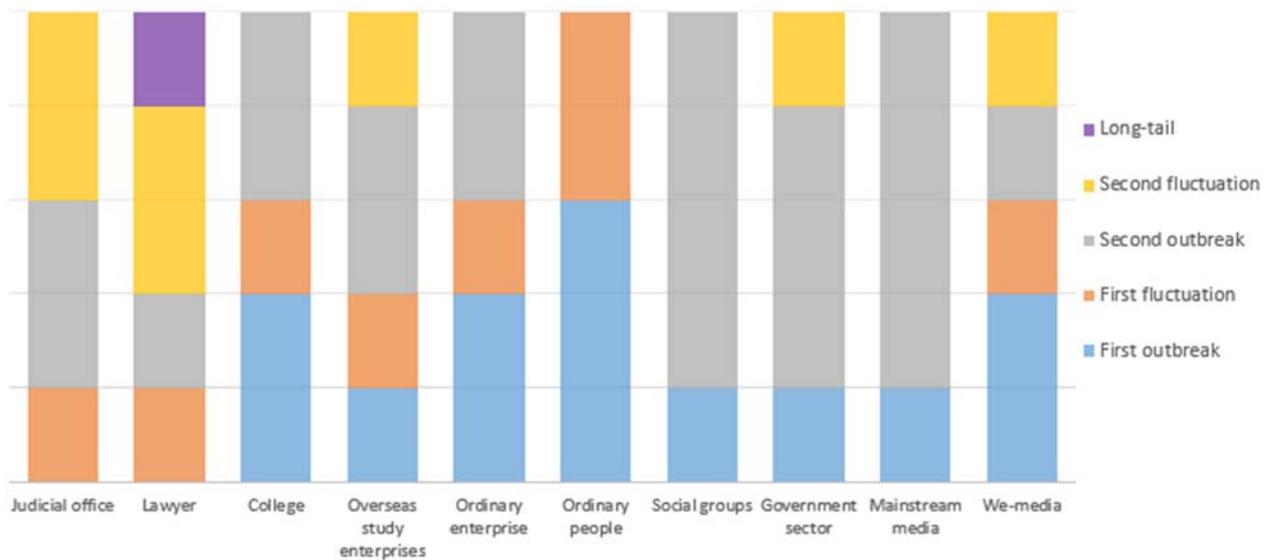


Figure 6. Periodic distribution diagram of the five types of topic points with the highest attention of different stakeholders.

5.2. Analysis of the Evolution of Stakeholder Focus

5.2.1. Focus on Topic Content Evolution

The topics of concern of each stakeholder under different life cycle stages of public opinion are represented visually, as shown in Figure 7. The topics based on the case are filled in green and the topics based on the parties are filled in orange. From the perspective of content evolution, it is analyzed as follows:

	First outbreak	First fluctuation	Second outbreak	Second fluctuation	Long-tail stage
Judicial office	1_7Legal issues in cases and trial by public opinion	2_2Before the court's session, Jiang Qiulian made efforts to sentence the murderer to death	3_3Jiang Qiulian, please listen in and record the details of the case	4_3Latest progress of case trial	5_1Discuss the different death penalty systems in China and Japan
Mainstream media	1_1Jiang Qiulian went to Japan to launch a petition to sentence the murderer to death	2_2Before the court's session, Jiang Qiulian made efforts to sentence the murderer to death	3_2Jiang Mu said she would bring a civil lawsuit against the murderer	4_7Discussion on the imposition of death penalty	5_1Discuss the different death penalty systems in China and Japan
Government sector	1_7Legal issues in cases and trial by public opinion	2_2Before the court's session, Jiang Qiulian made efforts to sentence the murderer to death	3_0Jiang Qiulian goes to Jiangge apartment to worship	4_6The court pronounced the sentence, the prosecution gave sentencing opinions	5_1Discuss the different death penalty systems in China and Japan
College	1_6Jiang Qiulian and Liu Xin met and interviewed	2_0Reflections on Jiang GE's case	3_3Jiang Qiulian, please listen in and record the details of the case	4_7Discussion on the imposition of death penalty	
Overseas study enterprises	1_2Express emotional and action support to Jiang Mu	2_1Pay attention to Liu Xin's words and deeds and hope him to testify in court	3_2Jiang Mu said she would bring a civil lawsuit against the murderer	4_7Discussion on the imposition of death penalty	5_1Discuss the different death penalty systems in China and Japan
Social groups	1_3Netizens carried out human flesh on Liu Xin, an old man suffered innocently	2_2Before the court's session, Jiang Qiulian made efforts to sentence the murderer to death	3_1Jiang held a media meeting to try to sentence the murderer to death	4_3Latest progress of case trial	5_1Discuss the different death penalty systems in China and Japan
Lawyer	1_6Jiang Qiulian and Liu Xin met and interviewed	2_0Reflections on Jiang GE's case	3_1Jiang held a media meeting to try to sentence the murderer to death	4_7Discussion on the imposition of death penalty	5_0Discussion on Liu Xinting's testimony and subsequent words and deeds
Ordinary people	1_2Express emotional and action support to Jiang Mu	2_1Pay attention to Liu Xin's words and deeds and hope him to testify in court	3_3Jiang Qiulian, please listen in and record the details of the case	4_4Discuss the words and deeds of the parties and the outcome of the trial	5_3Condemnation and abuse of Liu Xin's words and deeds
We-media	1_6Jiang Qiulian and Liu Xin met and interviewed	2_0Reflections on Jiang GE's case	3_0Jiang Qiulian goes to Jiangge apartment to worship	4_4Discuss the words and deeds of the parties and the outcome of the trial	5_0Discussion on Liu Xinting's testimony and subsequent words and deeds
Ordinary enterprise	1_2Express emotional and action support to Jiang Mu	2_0Reflections on Jiang GE's case	3_0Jiang Qiulian goes to Jiangge apartment to worship	4_4Discuss the words and deeds of the parties and the outcome of the trial	5_0Discussion on Liu Xinting's testimony and subsequent words and deeds

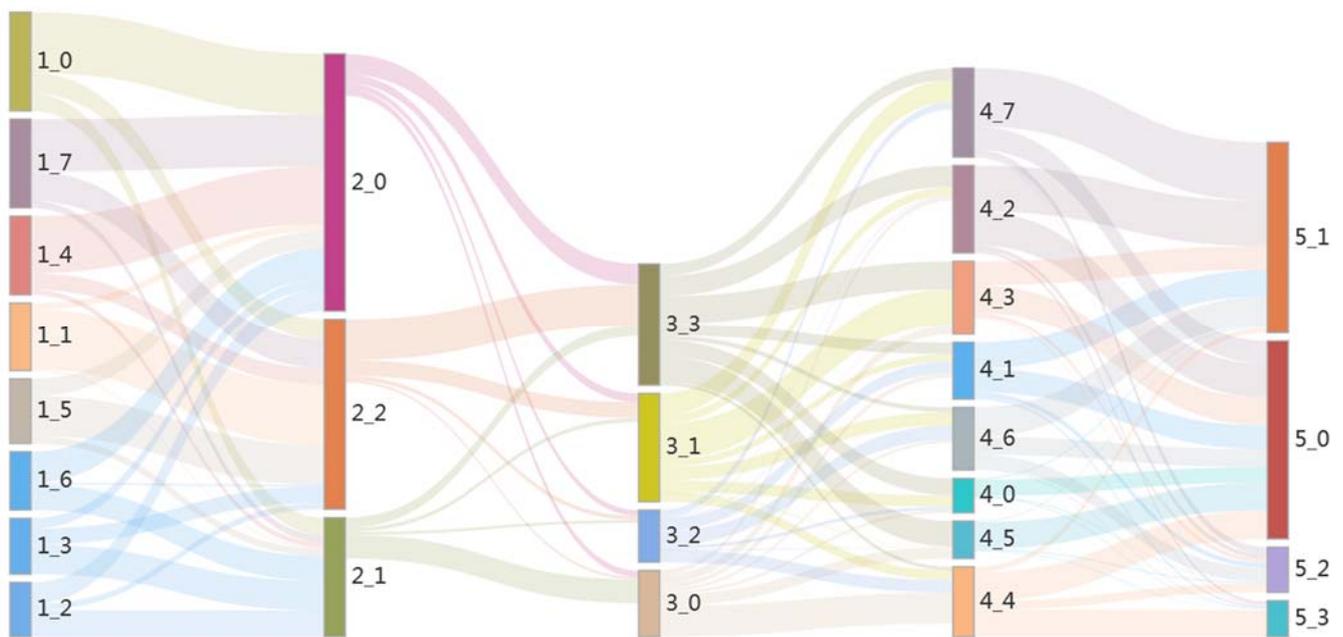
Figure 7. Evolution chart of stakeholder focus content.

From the perspective of the content of the topic of concern, the evolution types of the topic of concern of stakeholders with the evolution of the life cycle can be divided into four

categories: the whole process is based on the case, the focus of attention evolves from the parties to the case itself, the focus of attention evolves from the parties to the case and then returns to the attention of the parties, and the focus of attention evolves from the case to the parties and then returns to the case itself. Stakeholders under corresponding categories: Judiciary and mainstream media; Study abroad groups and enterprises; Lawyers, ordinary people, We-media and ordinary enterprises; Government sector. Due to the serious nature of the three types of stakeholders, the judiciary, government departments, and mainstream media, the focus of attention in the life cycle of public opinion is based on the objective perspective of the case: the focus of mainstream media focuses on the latest progress and situation of the case under different life cycles; in addition to paying attention to the progress of the case, the judicial organs and government departments paid attention to the legal issues in the case at the first outbreak and the long-tail stage. For example, in the first outbreak stage, when the legal facts of the case were unknown, they paid attention to the abuse and moral condemnation of the survivor Liu Xin's evasion and inaction by the public opinion, guiding the reflection on the dialectical relationship between judicial trial and moral trial, and emphasized the balance between public opinion discussion and public opinion trial. In the long-tail stage, all three types of stakeholders paid attention to the sentencing of the death penalty, including the trial scene of the death penalty, the different attitudes of China and Japan towards the death penalty, and whether Chinese law can hold the murderer accountable. Among the three types of stakeholders whose evolution model belongs to the second category, universities, and enterprises studying abroad focused on the parties Jiang Qiulian and Liu Xin in the early stage, focusing on their interview contents and meeting details, as well as the origin of their grievances in recent years. In the early stage, social groups focused on the derivative events caused by netizens' human flesh behavior against Liu Xin: an old man in Qingdao was attacked innocently and called for a return to rationality. Under the second outbreak stage, with the trial of the case, the facts gradually became clear, and the concerns of the three types of stakeholders evolved into the concerns of the case. The four types of stakeholders under the third focus content evolution model focused on the parties under this public opinion life cycle. The concerns of ordinary people focused on Jiang's mother and Liu Xin, made more subjective remarks, expressed sympathy and support for Jiang's mother's experience, and expressed strong condemnation of the words and deeds of the beneficiary Liu Xin. Although we-media also focused on Jiang Mu and Liu Xin in the first outbreak stage, they were different from the expression of emotional views of ordinary people. They paid attention to the interview contents and meeting details of Jiang Mu and Liu Xin, and their views were more objective. In the first fluctuation stage, attention was paid to the social problems caused by the case. With the hearing of the case in Japan, we have paid attention to the self-statement of the murderer, the loopholes in Liu Xin's testimony, and the judgment results. It can be seen that this focus of attention of we-media is controversial and easy to trigger public discussion. Compared with the focus of mainstream media on the restoration of the truth of the event, we-media mostly involves the focus on emotional tendency, which regulates public attitude and emotion [29] in line with their purpose to improve their account traffic and attention. Although the concerns of lawyers evolved from the parties to the case and then returned to the parties, it can be seen from the figure that their concerns about the parties and cases are relatively average and show no obvious tendency.

### 5.2.2. Focus on Topic Form Evolution

Calculate the cosine similarity of topics in adjacent life cycle stages, and draw the focus evolution path diagram according to the calculated data results, as shown in Figure 8. The vertical line represents the topic of focus. The similarity between topics is represented by connecting lines. The thicker the line, the higher the similarity between them. Finally, the threshold is selected through multiple experiments.



**Figure 8.** The evolution path of topics under different public opinion life cycles.

When analyzing the topic relevance of various stakeholders, it is found that the focus of attention in the second outbreak stage of the whole public opinion life cycle is relatively special. The topic focus at this stage is similar to a cut-off point. Basically, themes that are not related to the themes of their adjacent previous and later phases appear in this phase. The topics in the front and back stages are either related or not related to them, and the topic points in the front and back stages are related to each other. Compared with the text corpus in the second fluctuation stage, in this stage of public opinion, Jiang Ge’s case will be heard in Japan, and Jiang’s mother travelled to Japan to initiate a signature petition to prepare for the hearing. In the first outbreak and first fluctuation stage before this stage, the specific occurrence process and legal facts of the case are not clear, and the topic of public opinion mainly focuses on Jiang Qiulian and Liu Xin. After this stage, in the second fluctuation and long-tail stage, the murderer entered the public’s attention and began to focus on the discussion, and the topic also focused on the trial. It can be seen that public opinion in the second outbreak stage can indeed be used as the topic dividing point of public opinion in different stages, which also proves that our calculation results of topic relevance are relatively good.

The evolution forms of the topic focus of various stakeholders changing with the life cycle of public opinion can be divided into three types. The first is that the focus of attention is interrelated. The stakeholders in this model include judicial organs, social organizations, and universities (colleges). Most of the three types of stakeholders focus on cases, and the related topics indicate that the three types of stakeholders have a topic center of gravity throughout the life cycle of public opinion, and the focus has always been around this center of gravity. The second category is that in the second outbreak stage, the theme is disconnected from the theme of its previous stage, but re-associated with the theme of its subsequent second fluctuation stage and long-tail stage. Stakeholders with the evolution form of such concerns include lawyers, ordinary enterprises, and we-media. In the second outbreak stage, we-media and ordinary enterprises focused on Topic 3\_0: the behavior of Jiang’s mother in Jiang Ge’s apartment after she travelled to Japan. The focus of this topic is based on the words and deeds of the party concerned, thus it is not related to the focus of the previous stage based on the case. After this stage, the topics in the second fluctuation stage and the long-tail stage are based on the parties again, and the concerns are related to each other. After the restoration of facts of the case in court, the focus in the later stage is continuously directed at the parties, and most of them express strong

subjective views. When the facts of the case in the second outbreak stage are not clear, the lawyers focus on the parties (topic 1\_6) and the general thinking caused by the cases such as women's self-protection, the role of public opinion in the judicial trial, and whether Liu Xin is guilty (topic 2\_0). After the case was opened in Japan, the legal facts were clear, and the lawyers focused on the interrelated contents of the trial. The third type of evolution mode is the disconnection of topic relevance in the second outbreak stage. At the same time, it is different from the second type of mode and is also irrelevant to the topic in the later stage. Taking the topic of the second outbreak stage as the cut-off point, the topic before and after the two public opinion life cycles are interrelated. The stakeholders under this mode include government departments, mainstream media, enterprises studying abroad, and ordinary people. Government departments in the first outbreak and the first fluctuation of the topic based on the case are related to each other, the second outbreak stage of the topic briefly developed to the concern of the parties, after the case opened, the concern of the topic changed to the case. The ordinary people and government departments are just the opposite. The demarcation topic is based on the case itself, which is not related to the topic based on the parties in the previous and subsequent stages. Mainstream media and overseas study companies have been focusing on the same issues since the second outbreak. Although the boundary topic 3\_2 and the topics of concern in the subsequent public opinion stage were both based on the case, the content of topic 3\_2 was that Jiang Ge's mother travelled to Japan and held a media meeting before the trial, so it was not related to the topics related to the trial of the case in the second fluctuation stage.

### 5.3. Comparison of Topic Concerns and Evolution Models of Various Stakeholders

The topic focus of the judiciary is entirely focused on the case: the case comment (topic 1\_7), the latest progress of the case (topic 2\_2, topic 3\_3; topic 4\_3), and the case comment (topic 5\_1). In addition, the topics of concern are related to the topics of concern in the next stage, which reflects the presence of the focus of topic concern over the whole life cycle of public opinion. In the first outbreak stage when the murder of Jiang Ge, a female student studying in Japan, caused a great deal of attention from the masses, the judiciary focused on the issue of criminal jurisdiction in this case, and promptly publicized the issue of jurisdiction over extraterritorial criminal cases to the general public. attribution of jurisdiction in criminal cases outside the country. The long-tail phase of Japanese law carries a sentence of 20 years in prison for the killer, which has sparked complaints from netizens that it is unfair for the killer not to receive the death penalty. The judicial organs also carried out legal publicity to the public from the perspective of the different judgment values of death penalty in China and Japan, and guided them to view the case from a legal perspective, which played an effective positive guiding role for emotional public opinion. The progress of the case and the details of exposure at the same time are also given varying degrees of attention. The focus of social groups is also basically on the case. As the registered non-profit group, the speeches of social groups are serious and official. Therefore, their focus also stays at the case level, focusing on objective speeches. At the same time, social groups have noticed the surge and loss of control of public opinion and the accidental injury caused to innocent people, which reflects the concern of social groups for humanistic care. Compared with the judicial organs, its focus on legal publicity is lower.

Government departments and mainstream media also focus on the case itself, and the topics in the second outbreak stage are related to those in the previous and subsequent stages, but the focus on the topic content is slightly different. The topic evolution track of government departments is case comment (topic 1\_7), latest progress of the case (topic 2\_2), parties (topic 3\_0), latest progress of the case (topic 4\_6) and finally back to case comment (topic 5\_1). While the mainstream media focus on the latest development of the case (Topic 1\_1; Topic 2\_2; Topic 3\_2), comments on the case (topic 4\_7; Topic 5\_1), the two are different in the first outbreak stage. Compared with the mainstream media's function of releasing case information, the government pays more attention to the legal analysis of the case and is committed to guiding the public.

Colleges and universities focus on the parties (topic 1\_6), case comments (topic 2\_0), the latest progress of the case (topic 3\_3), and case comments (topic 4\_7). They first pay attention to the relationship and disputes between Jiang Mu and Liu Xin, and then connect with Zhang Yingying's case in the first fluctuation stage, emphasizing college students' self-protection and considerations about human nature. When entering the second outbreak period, the case was tried in Japan. At that time, attention was paid to Jiang Mu's request to record the details of the trial and testify in court. In the second fluctuation stage, while discussing the death penalty, colleges and universities also put forward the thinking of how parents can pass on traditional virtues to children and guide children to pay attention to their own life safety. As a study abroad enterprise that also has more "contacts" with parents and students, due to the safety of overseas students involved in the case, parents may be worried about the safety of their children's study abroad and refrain from the idea of studying abroad. Therefore, study abroad companies have a stake in this event. Their concerns are the parties (topic 1\_2; topic 2\_1), the latest progress of the case (topic 3\_2), and case comments (topic 4\_7; topic 5\_1). During the first outbreak of public opinion, they paid attention to the discomfort and hardship of Jiang's mother raising Jiang GE alone, and called for action to be taken for her to survive tenaciously. Later, they paid attention to Liu Xin's words and deeds and hoped that she would testify in court. The emotional support of enterprises studying abroad for Jiang Mu is consistent with the general emotional tendency of the public at this stage of the case. It is worth noting that enterprises studying abroad also noticed the resentment of Chinese netizens that the murderer was not sentenced to death. In the long-tail stage, they paid attention to the interpretation of the case by Japanese Asahi television, showing the different values of the two countries on the death penalty. They interacted with netizens to dispel their doubts and help them improve their understanding of Japanese justice, reduce their resistance to Japan, and avoid domestic parents from giving up their plans to study abroad for their children, which would be affected. It is conceivable that this concern reflects the interesting pursuit of overseas study enterprises.

Ordinary enterprises are less involved in the interesting relationship in this case, so they speak freely, which can reflect their real thoughts on this event. The focus varies greatly with the stakeholders of the appeal, first focusing on the parties (topic 1\_2), then on the case comments (topic 2\_0), and then returning to the parties (topic 3\_0; topic 4\_4; topic 5\_0). For the parties concerned, the topics focused on Jiang Mu and Liu Xin, while the attention to the murderer Chen Shifeng was low. They generally condemned Liu Xin's ungrateful and selfish behavior and felt sad that her kindness was trampled on. Generally speaking, the concerns of ordinary enterprises closely follow the hot topics of public opinion in the current period and belong to a class of stakeholders that are easily guided.

Because of their professional and rich legal knowledge, lawyers pay more attention to the analysis of the legal direction in the case and pay attention to the deep-seated topics behind the phenomenon. The topics of concern are the parties (topic 1\_6), case comments (topic 2\_0), the latest progress of the case (topic 3\_1), case comments (topic 4\_7), and parties (topic 5\_0). In the first outbreak of public opinion and the first fluctuation cycle, the lawyers paid attention to the netizens for the murderer to make the public opinion trial of the death penalty, to the dialectical relationship between law and morality caused by Liu Xin's behavior, and women's self-protection issues. In the second wave and the long-tail stage, they gave professional interpretation of whether Liu Xin was at fault in the process of the crime that was reconstructed during the trial, strongly condemned Liu Xin's behavior of selling the privacy of Jiang Ge in the follow-up of the case, and supported and consoled the victim Jiang's mother. It can be seen that the focus of lawyers not only teaches law to the public, but also plays a positive guiding role in promoting traditional virtues and social justice.

At first, we-media paid attention to the origin of the feud between Liu Xin and Jiang's mother through the interview. In the first wave stage, we-media paid attention to the realistic problem of refraction of the case. In the second outbreak stage, as Jiang's mother travelled to Japan to prepare for the trial, we-media focused on the topic and changed back

to the parties, and continued to pay attention to the parties until the end. At the end of the long-tail phase, the trial came to an end and the murderer served his sentence. However, Liu Xin's comments concerning Jiang Ge's privacy on Weibo attracted the attention of we-media people. At this stage, the emotional tendency was more obvious and inflammatory, and they supported Jiang's mother and expressed their disgust and condemnation to Liu Xin. Ordinary people's attention to the parties is only the first outbreak stage, which is different from that of we-media. Ordinary people tend to express their emotions and action support for Jiang mu, and their emotional disclosure is more obvious and intense. Furthermore, they make improper remarks of personal attack such as "paying people to stab Liu Xin to death", which has aroused the forwarding and pursuit of quite a large number of ordinary people. Because the case touched the moral bottom-line and sensitive nerve in people's hearts, there was a wide range of moral condemnation. In addition, the topic focus of their attention is not related at each stage, it is found that the concerns and positions of ordinary people are easily changed, and it is likely to be used by people to detonate mass emotions and provoke public opinion wars.

## 6. Conclusions

This paper uses the LDA model to find and cluster the topics under different life cycle stages of hot social events, and visually presents the topic relevance degree under adjacent stages through cosine similarity calculation. Based on the thinking system of stakeholder theory and public opinion life cycle theory, this paper selects the Jiang Ge case, which has attracted extensive attention from the public, as an example to analyze the public opinion concerns of microblog users of hot social events. The main contributions are as follows:

① Through the extraction of topic words, this paper constructs the topic of concern and evolution model of 10 types of stakeholders in the public opinion participation of hot social events in the Jiang Ge case at different life cycle stages and analyzes the similarities and differences of topic concerns and evolution mode between them. The concerns of government departments, social groups, and judicial organs are mostly similar and concentrated, focusing on the progress and details of the case itself. As the corresponding functional departments, government departments and judicial organs have also played a positive role in guiding public opinion and popularizing the law in cases. The focus of universities and overseas study enterprises is also relatively concentrated. In addition to paying attention to the situation of the case, they also tended to express emotional support for Jiang's mother, who lost her beloved daughter, and paid attention to the parents' safety awareness training and family education issues reflected behind the case. Lawyers (institutions) focus on a large number of topics and a large degree of dispersion. As professionals, they focus on more profound topics and their speeches have greater influence. Compared with the above stakeholders, ordinary enterprises, ordinary people and "we-media" pay more attention to the parties concerned, with more subjective speeches and more scattered topics. ② In terms of evolutionary path analysis, from the perspective of evolutionary content, the topic evolution of stakeholders can be divided into four types according to the topic focus in each life cycle stage based on the case or the parties involved in the case, and the form of evolution can be divided into three types according to whether the topic is sustainable and relevant in the next stage.

Statistical analysis of different stakeholders' attention differences in different life cycle stages is helpful for relevant departments to provide secondary and targeted management of public opinion in different stages. The results of this study are helpful for relevant departments to gain a clearer understanding and comprehension of the public opinion concerns of different stakeholders in hot social events, and to formulate different public opinion supervision and guidance strategies for different stakeholders in different life cycle stages of public opinion.

In addition, this study also has some limitations. The empirical study of hot social events in this paper only selects the single case of the Jiang Ge case, and the applicability of stakeholders classified by other hot social events needs to be further compared and

verified. In the follow-up, we will compare, collect and analyze hot social events according to different types of events, and discuss the macro-classification of stakeholders of hot social events under the corresponding categories.

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