Hindawi
Scientific Programming
Volume 2022, Article ID 5902445, 16 pages
https://doi.org/10.1155/2022/5902445

Research Article

Simulation Model on Network Public Opinion Communication Model of Major Public Health Emergency and Management System Design

Lei Li,[1,2] **Yujue Wan**,[1,2] **D. Plewczynski**,[3] **and Mei Zhi**[1,2]

[1]*College of Safety Science and Engineering, Xi'an University of Science and Technology, Xi'an 710054, China*
[2]*Key Laboratory of Western Mines and Hazard Prevention, Ministry of Education of China, Xi'an 710054, China*
[3]*University of Warsaw, 02097 Warsaw, Poland*

Correspondence should be addressed to Lei Li; lilei_safety@xust.edu.cn

Received 26 April 2022; Revised 11 May 2022; Accepted 20 May 2022; Published 20 June 2022

Academic Editor: Lianhui Li

In order to identify the communication law of network public opinion in major public health emergency, a multifactor communication model based on multiagent modeling is proposed. Based on the SEIR model and NetLogo simulation analysis, the model integrates a variety of network public opinion communication characteristics and extends the existing single network public opinion communication model. Based on these studies, a network public opinion communication management system is designed and developed with Python tools. Case analysis and simulation results show that this model can better simulate the evolution trend of network public opinion communication in major public health emergency; the key communication channels of public opinion play an important role in the evolution of network public opinion, which can control and guide the network public opinion of major public health emergency from the three communication influencing factors of total number, initial number, and communication cycle. Communication cycle refers to the number of days in the process of network public opinion dissemination of major public health emergencies.

1. Introduction

At present, the number of netizens in my country accounts for 73.7% of the total population, and the Internet penetration rate exceeds 73% [1]. With the popularization and development of smart mobile terminals and mobile communication technologies, rich and diverse social media platforms have become netizens for information sharing and a gathering place for expressing opinions and emotional exchanges. When public health emergencies occur, public opinion on the Internet also arises, and it may bring serious negative effects. From the 2003 "SARS" virus to the H5N1 virus in 2005, the H1N1 flu in 2009, the H7N9 virus in 2013, and the new coronary pneumonia to today, the derivative accidents caused by public opinion brought about the incidents, reflecting the sudden public emergency in the context of the rapid development of the Internet. The importance of timely response to and disposal of public opinion on the Internet of health incidents is obvious.

In 2020, there was a large-scale outbreak of COVID-19 pneumonia in China. According to Baidu data, the average daily search frequency of the keyword "COVID-19 pneumonia" reached 300,000 times. As the enthusiasm of netizens gradually rises, there have been more than 700 million participations in public opinion discussions on the "COVID-19 pneumonia" on Internet platforms. In the context of public health emergencies, the facts have been focused, magnified, and distorted due to the failure of online public opinion to study and respond in time. At present, scholars' research on online public opinion on emergencies mainly focuses on natural disasters, major cases, and social hot spots. There are relatively few studies on Internet public opinion in the context of public health emergencies [2–6]. The analysis process of the functional resonance analysis method (FRAM) is applied to China's safety supervision

system to classify and evaluate government safety supervision functions [7] and explain the measures taken to reduce risks in the face of the current public health emergency COVID-19 outbreak [8]. After the outbreak of the epidemic, a large number of studies on treatment and response measures were quickly generated for the global pandemic of COVID-19 [9].

Based on this, how to understand and grasp the characteristics, laws, and development trends of public opinion communication of public health emergencies will help the regulatory authorities to study and judge the development trends of public opinions and take active and effective response measures in a timely manner, so as to improve the response to sudden public health emergencies, so as to improve the ability to deal with the network public opinion of major public health emergencies.

Therefore, taking the "COVID-19 pneumonia" as an example to visualize the spread of online public opinion in the context of public health emergencies, through intuitive and vivid data and images to analyze the trend and law of communication public opinion on public health emergencies, it can effectively reflect the law and characteristics of the spread of public opinion on the Internet of public health emergencies. In a quantitative way, the key nodes in the "COVID-19 pneumonia" online public opinion communication network were visually identified and analyzed, and suggestions for the management, control, and guidance of the online public opinion communication of public health emergencies were put forward.

2. Theoretical Basis

2.1. Simulation Platform

2.1.1. Gephi Visualization. Gephi provides for processing any network data that can be represented as nodes and edges and will be presented in the form of graphics images, such as data representing social relationships, information nodes, biology, ecology, physics, and other networks [10–13]. Gephi can not only process large-scale network data sets but also support mainstream network scientific algorithms. It can not only perform statistical analysis on network attributes at the node level but also use different layout algorithms to visualize the network, and it can also simulate dynamic network analysis.

2.1.2. NetLogo Simulation Platform. NetLogo is a multiagent modeling and simulation software, which is used for modeling and simulation of complex systems changing with time. NetLogo was developed by the Center for Connected Learning and Computer-Based Modeling (CCL) of Northwestern University. NetLogo simulation can provide a simple, convenient, and powerful computer tool for scientific research in various fields. Logo language is used to control and coordinate multiple disciplines to meet the needs of studying multidisciplinary laws. The simulation process is shown in Figure 1.

2.2. Online Public Opinion on Public Health Emergencies. In recent years, many public health emergencies have occurred all over the world. In order to efficiently and reasonably respond to public opinion on public health emergencies, scholars have combined public health incidents to obtain data through Twitter and Facebook and use model construction, empirical analysis, and other methods to carry out related research. Barbara Reynolds believes that public opinion on public health emergencies should be divided into a summary evaluation stage, a calming stage, a crisis stage, a precrisis stage, and an initial stage [14]. Wang et al. summarized the characteristics of online public opinion communication of public health emergencies through case analysis [15]. Haihong et al. proposed a multichannel and multicore model to study the development of online public opinion under public health emergencies [16]. Gaspar et al. believe that different types and stages of crisis response will be different, and the comments made by netizens do not fully represent their attitude [17]. Gomide et al. believe that the development trend of public health emergencies can be monitored through relevant public opinion information on the Twitter platform [18]. Pei et al. believe that, by monitoring the news media on the Weibo platform, it is possible to predict the spread of public health event news and identify early warning signals [19]. Signorini et al. believe that analyzing the content of Twitter users' posts can provide a basis for timely intervention in the development of public opinion on public health emergencies [20, 21]. The Center for Disease Control and Prevention of the University of Chicago and NORC conducted a network survey of state, regional, and local health departments and concluded that public health emergency preparedness and response to the cooperation of state and local health departments are the key links.

However, most domestic scholars in China choose Baidu Index and Weibo as data sources to conduct research from the perspectives of dividing communication stages, analyzing communication characteristics, and studying communication influencing factors. The "Regulations on Public Health Emergencies and Emergency Responses" believe that public health emergencies refer to infectious disease outbreaks and unexplained mass epidemics, major food poisoning, and occupational poisoning that occur suddenly and cause or may cause major losses to the public health and other public emergencies that endanger public health [22]. Cao and Lu believe that it has the three characteristics of emotional expression of netizens' opinions, diversified communication subjects, and self-interested media [23]. Teng believes that provinces with more netizens and higher levels of economic development have a higher degree of public opinion attention on public health emergencies [24]. An Lu et al. constructed a topic evolution model for various stakeholders of public health emergencies at different life cycle stages [25]. Lin et al. established a model of factors affecting the spread of public opinion in public health emergencies [26]. Zhou made an overview and analysis of the information problems exposed at each stage of the development of the new crown pneumonia epidemic and put forward countermeasures and suggestions from the perspective of the construction of emergency information management system [27].

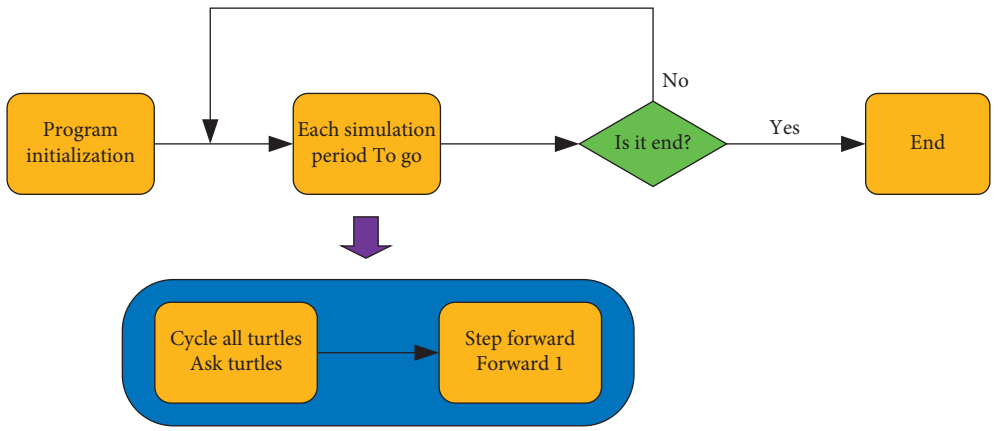

Figure 1: Simulation process.

Public opinion on public health emergencies is a form of public opinion on the Internet. On the basis of the scholars dividing the law of the spread of public opinion on the network of emergencies into three, four, or five stages [28, 29], based on the life cycle theory, six rules that conform to the law of spread of public opinion on the Internet of public health emergencies are proposed.

2.3. Influencing Factors of Network Public Opinion Communication

2.3.1. The Total Number of People Involved in Communication. The complexity of the network environment also makes it an influencing variable of public opinion communication. It is reflected not only in the process of personal information exchange but also in the process of emotional communication. Public opinion information communication is usually the product of emotional processing of most people in different cognitive stages. It represents the thoughts and attitudes of Internet users and has a strong cohesion to the related Internet users. Even if people together do not know each other, they may be involved in huge public opinion discussions. These pieces of unconfirmed public opinion information will spread on the network, and gradually spreading, more and more people will spread. Therefore, in the process of network public opinion communication, the more the total number of people involved, the faster the speed of public opinion information communication; the less the total number of people involved, the slower the speed of public opinion information communication. When the total number of people involved in the communication is less, the difficulty of information communication will be greater, so it is difficult to disseminate information. It is believed that public opinion information will not be disseminated, so public opinion will be controlled. Therefore, the total number of people involved in the communication is an important factor affecting the communication of network public opinion.

2.3.2. Number of Initial Spreaders. With the rapid development of network, network public opinion will produce a lot of public opinion information. Due to the diversity of content in the network environment, in the incubation period of public opinion, the initial communicators publish text, pictures, videos, and other pieces of related content through various social platforms, which will promote the rapid communication of public opinion information and be known by other Internet users. Therefore, the initial communicators of these pieces of public opinion information have strong communication, and in order to attract the attention to increase their own flow or click rate, they will continue to disseminate public opinion information related to major public health emergencies. Therefore, the number of initial communicators of public opinion information will have a certain impact on the process of public opinion communication.

2.3.3. Transmission Cycle. Public opinion communication cycle will also affect major public health emergency network public opinion communication. In the same space, the longer the cycle of public opinion communication, the wider the scope of its communication and the more the Internet users involved in the communication. In a long communication cycle, the heat of public opinion will grow higher and higher over time, and the development of public opinion will be difficult to control. Internet users can browse the news through the network social platform, quickly understand the relevant hot topics of public opinion according to forwarding and comments, and join the network public opinion dissemination. At this time, the network public opinion information will spread rapidly. This kind of communication phenomenon will greatly accelerate the scope of public opinion communication and at the same time make the cycle of public opinion survival in the network longer, resulting in greater difficulty in the control of public opinion.

2.4. SEIR Model. The SEIR model divides the total population into the following four categories: susceptibles, denoted as $S(t)$, indicating the number of people who are not infected but may be infected by virus at t time; exposed, denoted as $E(t)$, meaning the number of people who have been lurked after being infected at t; infectives, denoted as

$I(t)$, indicating the number of people who have been infected and become patients with infectious force at time t; recovered, denoted as $R(t)$, meaning the number of people who have recovered from the infected at t moment. If the total population is $P(t)$, then $P(t) = S(t) + I(t) + R(t)$ SEIR differential equation is

$$\begin{cases} \dfrac{\mathrm{d}S}{\mathrm{d}t} = -\left(\dfrac{r\beta IS}{N}\right), \\ \dfrac{\mathrm{d}E}{\mathrm{d}t} = \left(\dfrac{r\beta IS}{N}\right) - \alpha E, \\ \dfrac{\mathrm{d}I}{\mathrm{d}t} = \alpha E - \gamma I, \\ \dfrac{\mathrm{d}R}{\mathrm{d}t} = \gamma I. \end{cases} \tag{1}$$

In the above equation, α corresponds to the infection probability, β corresponds to the probability that the latent person is converted to an infected person, γ corresponds to the cure probability, and r is the number of people in contact.

The equation essentially reflects the changes of the number of unit time changes of susceptible $S(t)$ latent $E(t)$, infected $I(t)$, and rehabilitation $R(t)$ with time t, and they will affect each other.

3. Law of Network Public Opinion Communication Rules of Major Public Health Emergency

Taking the network public opinion of major public health emergency as the research object and taking "epidemic situation of new corona pneumonia in Wuhan City" as an example, the Gephi visualization tool and case analysis method are used for empirical research.

3.1. Review of Event Development. On December 30, 2019, influenza and related diseases were continuously monitored in Wuhan City, Hubei Province, China. Multiple viral pneumonia cases were found, and all were diagnosed as pneumonia cases with novel coronavirus infection. Since viral pneumonia was found in Wuhan in 2019, it was temporarily named "COVID-19" by the World Health Organization on January 12, 2020. The outbreak was released by WHO as a new coronavirus pneumonia epidemic for major public health emergency of international concern. Later, the Director-General of the World Health Organization, Thadsey, announced that the new coronavirus had become a global pandemic. Table 1 is the review of the epidemic development of "epidemic situation of new corona pneumonia in Wuhan City."

3.2. Data Source and Processing. Weibo has 212 million monthly active users and is the mainstream platform of China's social networking platform. This paper uses Sina Weibo as the data source and the development of online public opinion on the "COVID-19 pneumonia" epidemic as the research object. So far, according to the Baidu Index, Chinese netizens have participated in more than 800,000 daily discussions on public health emergencies, with an average spread of 5,238 items per hour. The daily search volume of high-frequency words such as "infectious disease," "resumption of work," "pneumonia," and "prevention and control" related to this public health emergency reached a total of 4.5 million times. It can be seen from this that the public health emergency of the new type of coronavirus pneumonia has caused great concern among Chinese netizens.

Quantitative analysis is carried out by dividing the important time period of the network communication of this public health emergency, identifying core nodes, and using Gephi to visually analyze the law of communication. Select the number of forwarding data posted by key bloggers on Weibo from December 31, 2019, to March 1, 2020. In the communication of online public opinion information, the higher the number of fans, the greater the influence. Therefore, the key bloggers are identified based on the number of fans, and the Weibo account with the highest number of fans participating in this public health emergency is selected as the key channel for this public opinion communication. Take 5–8 Weibo accounts as the research objects in each communication stage, search for relevant Weibo information according to important time periods and time sequence, and count all the reposts of each Weibo. As of March 1, 2020, a total of 66,000 Weibo accounts with varying degrees of influence, a total of 761,333 original Weibos on the topic of "COVID-19 pneumonia," and a total of 7,429,838 original Weibo forwarding data on key Weibo accounts have been obtained.Finally, organize the sample data table shown in Table 2. Due to the large amount of data collected in the experiment, after categorizing and counting the data, the Gephi tool is used for visual analysis, and the Gephi tool is used for visual analysis. During the drawing process, the "YifanHu" process is used for layout, and "ForceAtlas2" is used for focus.

3.3. Data Results and Discussion

3.3.1. Division of the Law of Communication Public Opinion on Public Health Emergencies on the Internet. According to the public opinion development process of "COVID-19 pneumonia" in public health emergencies, the forwarding volume of Weibo accounts in key channels of Weibo was selected as the data source, and the development trend of public opinion transmission of "COVID-19 pneumonia" was drawn in units of important time periods, as shown in Figure 1. On the whole, the public opinion of the public health emergency showed obvious stage characteristics, based on the life cycle theory combined with the time span of the public opinion of the public health emergency, the peak point, and many scholars in the early stage. On the basis of the stage division of public opinion, the redivision is in line with the current law of communication public opinion on

Table 1: Review of the development of the "COVID-19 pneumonia" epidemic.

Important time period (point)	Event content (situation)
2019.12.31–2020.01.15	On December 31, 2019, an unofficial network circulated a report that "patients with unexplained pneumonia were found"; on December 31, the Wuhan Health and Health Commission notified for the first time that "27 cases were confirmed, but the cause was not clear." On January 9, the official confirmation, the pathogen was identified as the "COVID-19."
2020.01.16–2020.01.26	The China centers for disease control and prevention were upgraded to the first-level emergency response (the highest level); subsequently, 30 provinces initiated the first-level response to major public health emergencies; Wuhan City was closed on January 23.
2020.01.27–2020.02.03	Various localities have successively issued notices on strengthening the standardized management of communities during the epidemic prevention and control period; there are too many suspected and confirmed patients, and Fangcang shelter hospitals and Huoshenshan hospitals have been established to treat patients. The WHO has listed the novel coronavirus epidemic as a public health emergency of international concern.
2020.02.04–2020.02.15	On the 11th, the World Health Organization officially named the pneumonia caused by the COVID-19 as COVID-19; Mi Feng, a spokesperson for the National Health Commission, said that, as of the 15th, the proportion of severe cases in Hubei and other provinces in the country has dropped significantly.
2020.02.16–2020.02.23	The epidemic situation in China has gradually improved, and countries outside Japan, South Korea, the United States, Italy, and other countries have begun to break out of COVID-19 pneumonia, causing domestic netizens to discuss again.
2020.02.24–2020.03.01	The new crown pneumonia epidemic has been under control, and China has lowered the emergency response level of the new crown pneumonia epidemic.

public health emergencies; that is, it is divided into six stages of latent, fermentation, outbreak, relief, repetition, and decline, as shown in Figure 2, and is verified through the "COVID-19 pneumonia" analysis.

Table 2: Sample data table of information communication of "COVID-19 pneumonia" Weibo during important time periods.

Period	Number of participating Weibo accounts	Number of original Weibos	Select the number of Weibo accounts	Weibo forwarding volume
2019.12.31–2020.01.15	6743	7186	7	172393
2020.01.16–2020.01.26	90183	152291	6	714913
2020.01.27–2020.02.03	100995	160421	7	2215159
2020.02.04–2020.02.15	122761	180074	5	1665850
2020.02.16–2020.02.23	106618	153423	7	1827211
2020.02.24–2020.03.01	76723	107938	8	834312

3.3.2. Visualized Analysis of the Law of Communication Public Opinion on the Internet of Public Health Emergencies. On the basis of the above-mentioned classification of public opinion transmission rules of public health emergencies, Gephi is used to visually analyze the "COVID-19 pneumonia."

During the incubation period of the first stage, the public is still in a state of understanding public health emergencies from unknown to understanding, and public opinion on the Internet has never occurred until it gradually ferments. At this time, public opinion begins to spread for the first time. After the unidentified pneumonia incident occurred in Wuhan, it can be seen from Figure 3(a) that it was reported as "Headline News," "People's Daily," "CCTV News," "CCS Open Class," "People's Daily Online," "Xinhua Viewpoint," Weibo accounts headed by "Xinhuanet" which are used as key communication channels, the communication network developed by using this as a core node is relatively sparse, and its influence at this stage is still relatively small.

In the second phase of the fermentation period, after the epidemic was identified as "COVID-19 pneumonia," as shown in Figure 3(b), it was reported as "CCTV News," "Headline News," "People's Daily," and "Beijing New." A large number of fans with scattered core nodes, led by Weibo accounts such as "Central Securities Public Courses" and "People's Daily Online," gradually received information. At this time, these Weibo accounts played a key role in attracting the attention of netizens and promoting the development of public opinion.

During the third stage of the outbreak, due to the initial transmission of Chinese netizens through the key communication channels of the previous stage, more netizens have learned about the occurrence of this public health emergency. At this time, the Weibo accounts of these key communication channels are playing a role. They have a great influence. As shown in Figure 3(c), the core nodes, such as "micro-blog secretary," "micro-blog administrator," "CCTV news," "People's Daily," "headline news," "Xinhua viewpoint," and "He Jiong," are rapidly expanding the

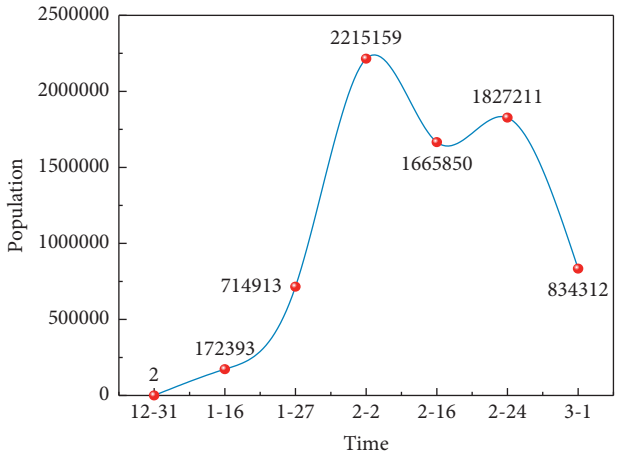

Figure 2: The communication trend of public opinion on the Weibo network of "COVID-19 pneumonia."

network of public opinion communication. The density of the network of the above core nodes is very high, and the number of microblog forwarding and fans increases sharply, resulting in the highest point of network public opinion in this major public health emergency. These key communication channels have exerted a huge influence and a wide range of influence at this stage, pushing the public opinion development of the "COVID-19 pneumonia" public health emergency to the climax.

In the remission period of the fourth stage, in view of the serious public opinion impact caused by the public health emergency "COVID-19 pneumonia," government departments have spoken out and conducted timely public opinion control, which reversed the perception of netizens. At this time, under the influence of these key communication channels, the development trend of online public opinion gradually stabilized. It can be seen from Figure 3(d) that the scope of the communication network composed of core nodes headed by "People's Daily," "Headline News," "CCTV News," "Xinhua Viewpoint," and "people's Daily Online" has gradually decreased, and the density of the communication network has also been reduced. Gradually decreasing, the public opinion of the "COVID-19 pneumonia" public health emergency at this stage has entered a stable period of remission.

In the fifth stage of the repetitive period, after the development of the previous stage, the development of public opinion should have stabilized. Due to the large number of rumors appearing and communication, under the influence of some key channel Weibo accounts, a large number of core nodes are connected. Fans are gradually increasing as secondary nodes, and the communication network is gradually becoming denser. Netizens' attention to this public health emergency has risen again. As shown in Figure 3(e), this stage is based on "People's Daily," "Headline News," "CCTV News," "Xinhua Viewpoint," and "People's Daily." The key communication channels led by "He Jiong" and "Ang Mi" have caused public opinion to show a trend of small climax.

In the sixth phase of the recession period, the heat for this public health emergency has been reduced to a relatively low level through the remission period. Therefore, the online public opinion of the "COVID-19 pneumonia" is about to enter recession and even die out. At this stage of the epidemic, as the epidemic was basically controlled, the panic of netizens was gradually eliminated, making public opinion tend to decline. Figure 3(f) shows that the microblogs are headed by "CCTV News," "People's Daily," "Headline News," "Xinhua Viewpoint," "People's Daily Online," "Xinhuanet," "Yao Chen," and "China News Weekly." As the core node of the blog account, the spread of public opinion has become smaller, and the density of the spread network has been significantly reduced. The public health emergency "COVID-19 pneumonia" network public opinion has entered a period of decline.

Based on Gephi visualization, it analyzes in detail the communication characteristics and rules of each stage of the public opinion communication network composed of some accounts of the key communication channels of Weibo as the core nodes and the amount of fan reposting as the secondary nodes and analyzes these key communication through visual graphics as shown in Figure 3. The role of channels in each stage of the process of public opinion communication is an empirical study of the proposed public opinion communication law of public health emergencies.

4. Construction of Network Public Opinion Communication Model of Major Public Health Emergency

4.1. Model Construction

4.1.1. SEIR Epidemic Model Hypothesis. When public opinion occurs, most Internet users (except witnesses) do not know about public opinion information, but they will soon obtain relevant information from various channels and make judgments on information. This paper will receive public opinion information that is easy to produce risk perception of Internet users called easy communicators; Internet users who receive public opinion information but are still suspicious of judgment and have not spread it are called carriers; when the perceived risk of public opinion information exceeds its own tolerance, the communication of public opinion information is called the communicator; otherwise the carrier state is maintained. Disseminators become immune under the influence of external factors such as truth or government intervention. With the continuous disclosure of the truth or the continuous emergence of rumors, immune people are affected by the evolution of public opinion and herd mentality and may be reintegrated into the communication of public opinion and become easy communicators.

Considering the complexity and uncertainty of public opinion communication after major public health emergency, the audience classification in the model is expanded and adjusted according to the interaction rules. The SEIR model is assumed as follows.

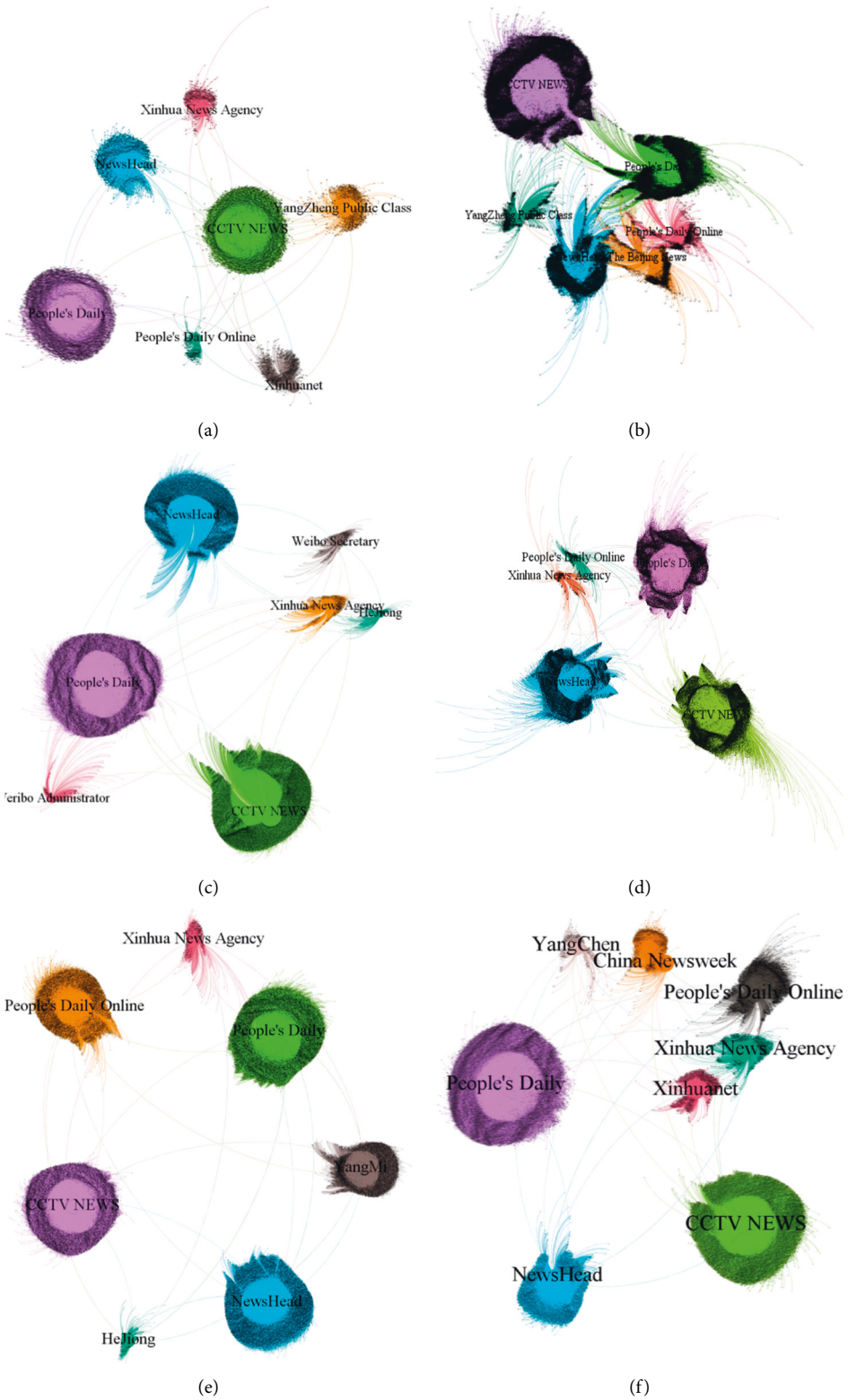

Figure 3: The law of the spread of public opinion on public health emergencies on the Internet. (a) Incubation period. (b) Fermentation period. (c) Outbreak period. (d) Remission period. (e) Recurrent period. (f) Decline period.

Hypothesis 1. Considering the long duration of major public health emergency and related information communication, the audience classification in the model is expanded, and the interaction rules are adjusted. The SEIR model is assumed as follows: the total number of people in the system remains unchanged during this period, and it is assumed to be 1. According to the spread of Internet users, the Internet users are divided into easy communicator S, latent E,

communicator I, and immune R. $S(t)$, $E(t)$, $I(t)$, and $R(t)$ are, respectively, used to represent the proportion of the four types of people in the total number at time t, which are denoted as S, E, I, and R and satisfy $S + E + I + R = 1$.

Hypothesis 2. Public opinion communication channels are not restricted, including online (network and media) channels and offline (interpersonal) channels.

Hypothesis 3. Each individual has several times of contact with information, but the transition rate between groups remains unchanged.

Hypothesis 4. In the whole communication region, only the behavior of the communicator will endanger the society, and the influence range of public opinion communication is positively correlated with the number of communicators.

4.1.2. Model Construction. According to the above infectious disease characteristics and assumptions of public opinion transmission after major public health emergency, an SEIR infectious disease model of public opinion transmission after major public health emergency is established, as shown in Figure 4.

SEIR differential equation is

$$\begin{cases} S_n = S_{n-1} - \dfrac{r\beta I_{n-1} S_{n-1}}{N}, \\ E_n = E_{n-1} + \dfrac{r\beta I_{n-1} S_{n-1}}{N} - \alpha E_{n-1}, \\ I_n = I_{n-1} + \alpha E_{n-1} - \gamma I_{n-1}, \\ R = nR_{n-1} + \gamma I_{n-1}. \end{cases} \tag{2}$$

In the formula, r is the person that every communicator can reach; α is the conversion rate from easy communicator to latent ones; β is the conversion rate from the latent person to the communicator; γ is the conversion rate from the transmitter to the immune.

4.1.3. Simulation Steps. The simulation software NetLogo is used to simulate the rumor communication model, observe the model trend diagram under different parameters, and analyze the influencing factors of public opinion communication, as shown in Figure 5.

The simulation steps are as follows: Step 1: initialize the parameters. Set a total number of initial communicators, transmission cycle, infection rate α, disease rate β, and cure rate γ. Step 2: click setup application parameters. Step 3: click Go, and then the model runs and continues to simulate. Step 4: observe the real-time curve. Record the "number-time" curve of vulnerable, latent, disseminator, and immune person. Step 5: end the simulation, data collation, and analysis. The simulated image changes in the simulation process are shown in Figure 6.

4.2. Analysis of Simulation Experiment

4.2.1. Factors Influencing Transmission

(1) The Total Number of People Involved in Communication. In general, it is believed that, in the same limited space, maintaining the same communication cycle, the more the people are, the faster the infection will be. In order to explore the influence of the total number of people involved in the communication of network public opinion in major public health emergency on information communication, we set the total number of people (population = 1000) as the control group and then set the total number of people (population = 2000, 3000, 4000) for the comparative study, so as to maintain the initial number of people and the communication cycle unchanged. The results are shown in Figure 7.

As shown in Figure 8, when $N = 1000$, the disseminator I approximates a horizontal line, which indicates that the number of disseminator I has not increased substantially in limited space, indicating that the number of public opinion disseminators is small, and controlling the development of public opinion is the best time. When $N = 4000$, disseminator I appeared at the earliest time, and this curve rose rapidly. This shows that the heat of public opinion in limited space has risen rapidly. When the relevant departments have not officially released confirmation news, most people have begun to spread information, and the scope of public opinion has begun to expand rapidly.

(2) Number of Initial Communicators. Similarly, in order to explore the influence of the number of initial communicators on the network public opinion communication of major public health emergency and to maintain the same total number of communicators involved and transmission cycle parameters, the number of the initial communicators is adjusted for simulation experiments. The results are shown in Figure 9.

(3) Transmission Cycle. Similarly, in order to explore the influence of communication cycle on the network public opinion communication of major public health emergency, the simulation experiments were carried out by adjusting the communication cycle to maintain the same parameters of the total number of people involved and the initial communicator. The results are shown in Figure 10.

4.2.2. Comparison between Real Cases and Simulation. After processing the data obtained by the crawler, the number of communicators in each stage of the real case is obtained. The number of communicators in the model simulation is the sum of the number of latent E and communicator I. After running NetLogo simulation software, the comparison between real case data and simulation results is shown in Figure 11.

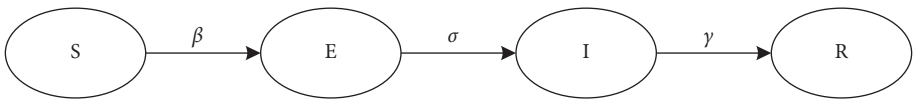

Figure 4: SEIR epidemic model of network public opinion transmission in major public health emergency.

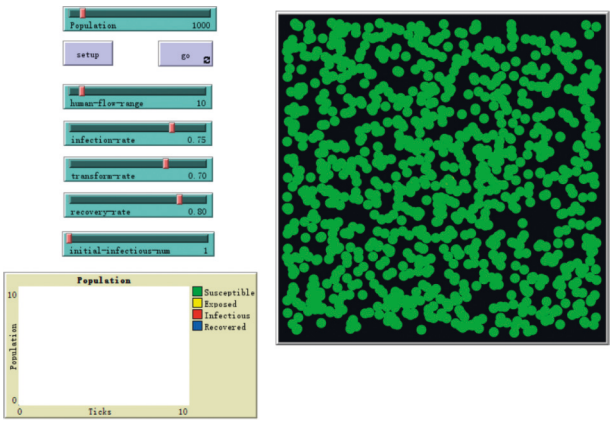

Figure 5: NetLogo simulation interface.

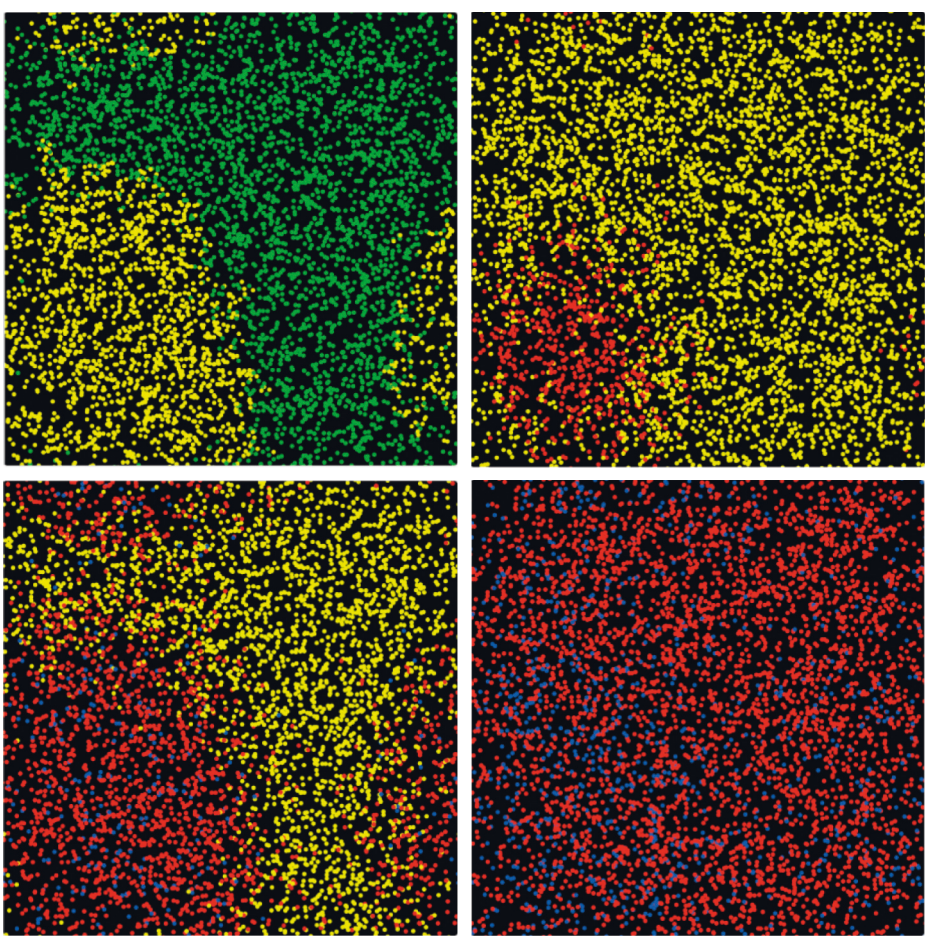

Figure 6: Simulation of image changes.

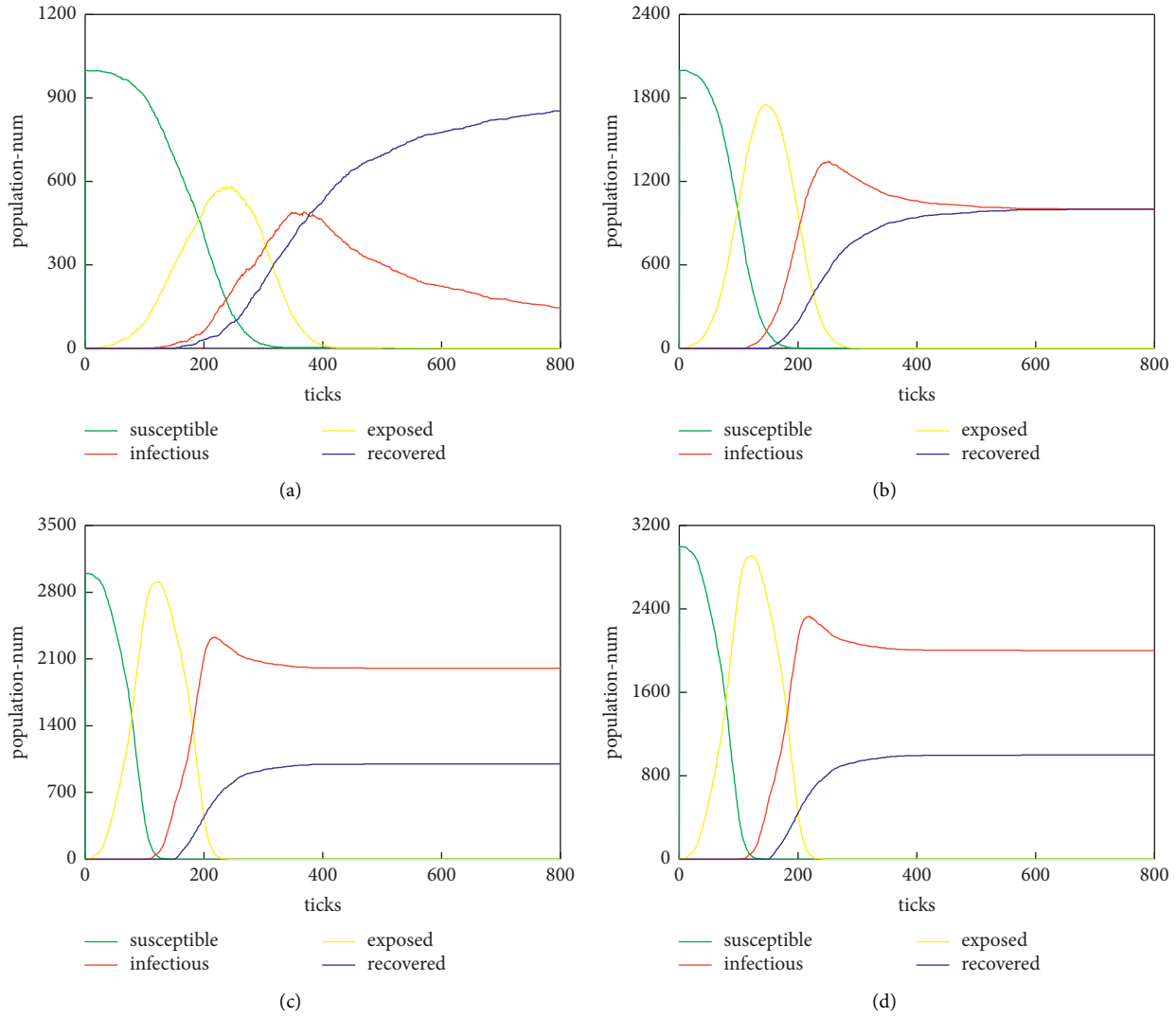

Figure 7: Impact of the total number of people involved in public opinion communication. (a) 1000. (b) 2000. (c) 3000. (d) 4000.

5. Network Public Opinion Communication Management System Design

The emergence of advanced information technology [30, 31] makes the design and development of network public opinion communication management system possible. Based on Python tools [32–35], the overall framework of the network public opinion communication management system is designed as shown in Figure 12.

5.1. Operation Process and System Architecture. Combined with the above research, we will design and implement the system. The modules of the system are divided into information collection module, public opinion content data preprocessing module, major public health emergency network public opinion monitoring module, and major public health emergency network public opinion evaluation module. The system operation logic diagram is shown in Figure 13.

The system architecture is shown in Figure 14.

As shown in Figure 14, the data collection layer adopts the theme crawler technology based on Python language and uses the third-party library Beautiful Soup and Urlib2 package to capture the data on the Weibo platform. The data storage layer adopts MySQL database to store the crawled data in the database. The algorithm execution layer uses Python's NumPy and JS language to bring the preprocessed data into the model established above and calculate the required results. The front-end display layer adopts HTML and CSS to realize the interaction of front-end pages, JS to realize the interaction function, AJAX technology to realize the data interaction with the server, and Ecarts to draw the front-end charts.

5.2. Development Environment. The development environment is as follows:

Experimental environment: Intel quad-core processor with 8G memory and 64-bit Windows 10 operating system.

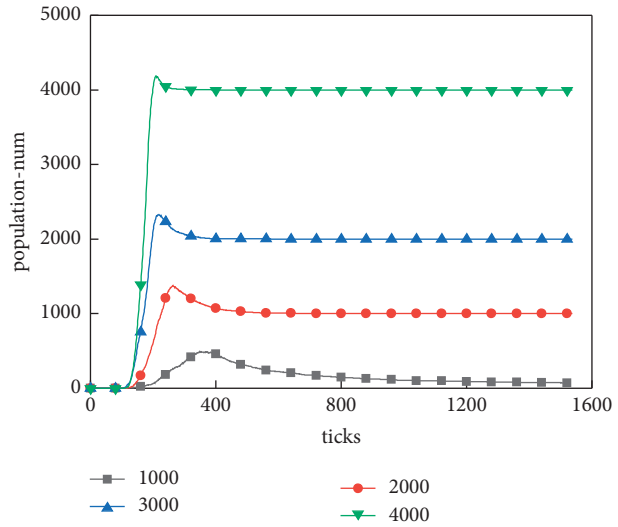

Figure 8: Changes in the I-curve of disseminator with different transmissions involving total numbers.

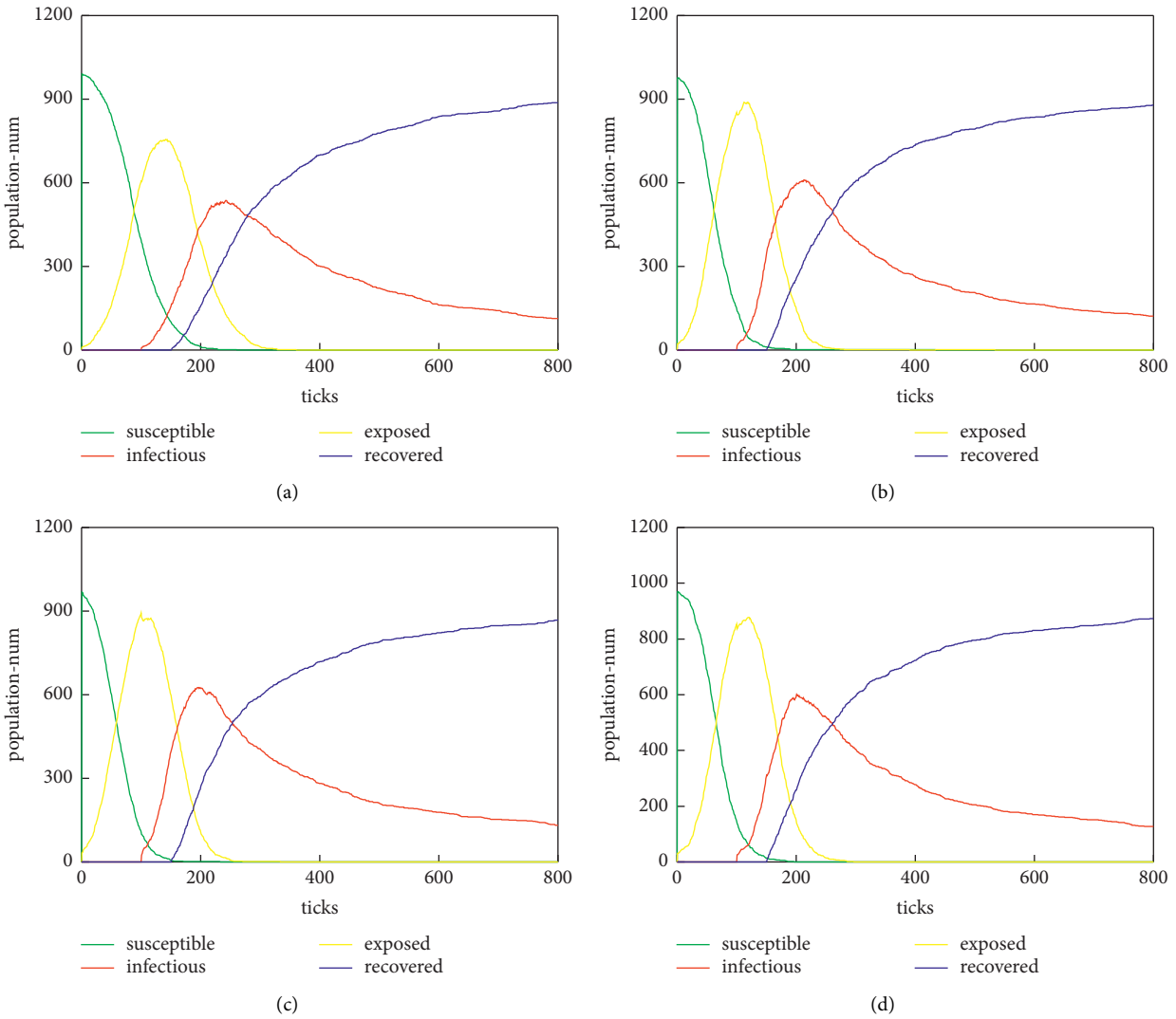

Figure 9: The impact of the initial number of communicators on public opinion communication. (a) 10. (b) 20. (c) 30. (d) 40.

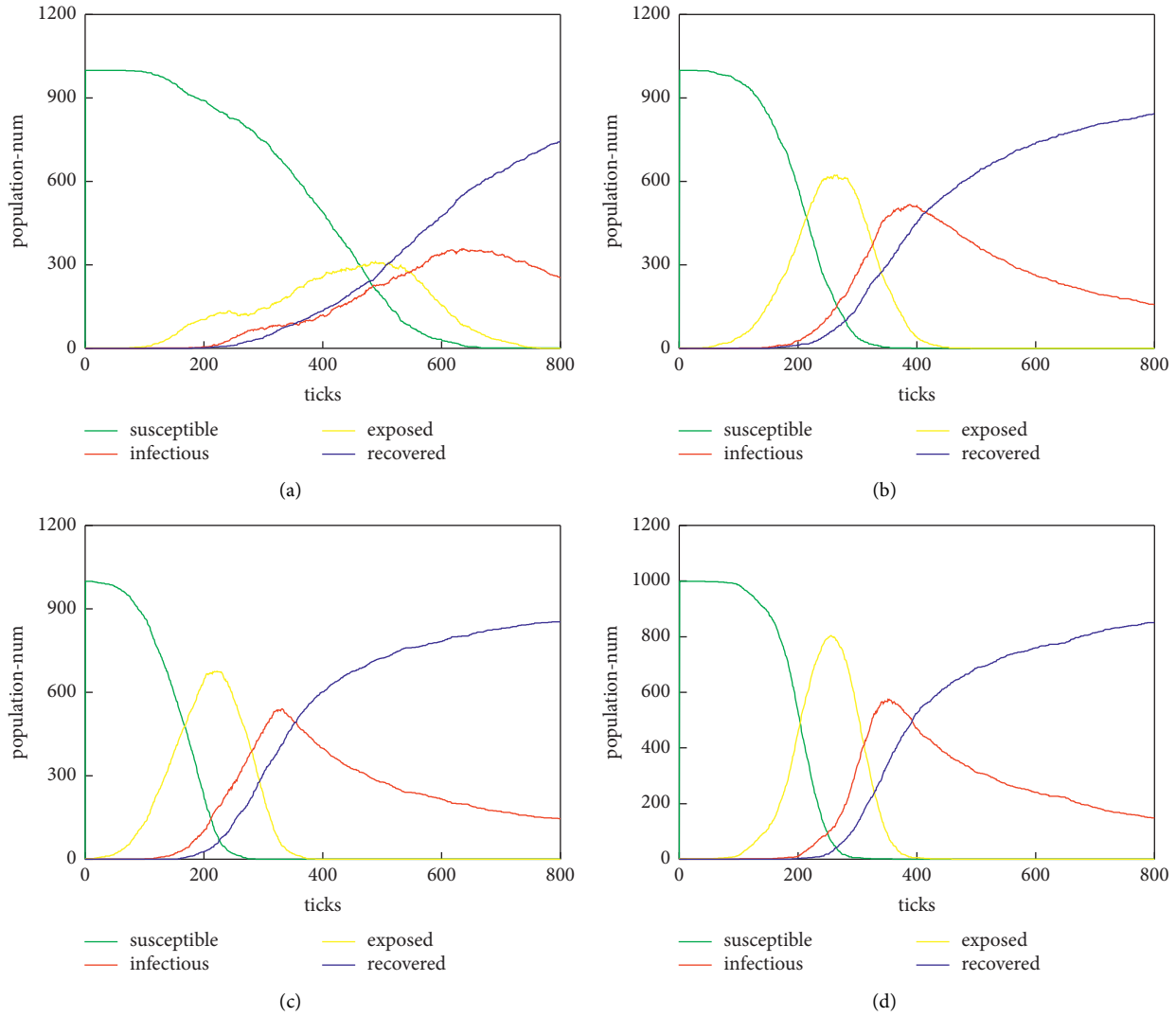

Figure 10: Influence of communication cycle on public opinion communication. (a) 5. (b) 10. (c) 15. (d) 20.

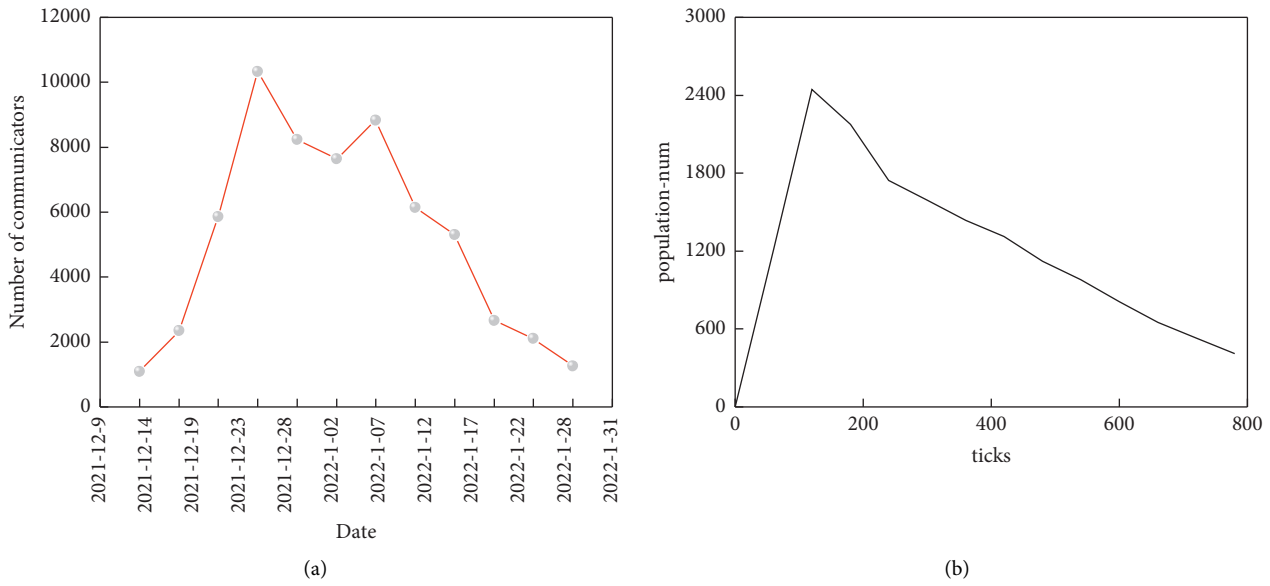

Figure 11: Comparison of real case data and model simulation data. (a) Trend of real case communicators. (b) Model simulation communicator trend.

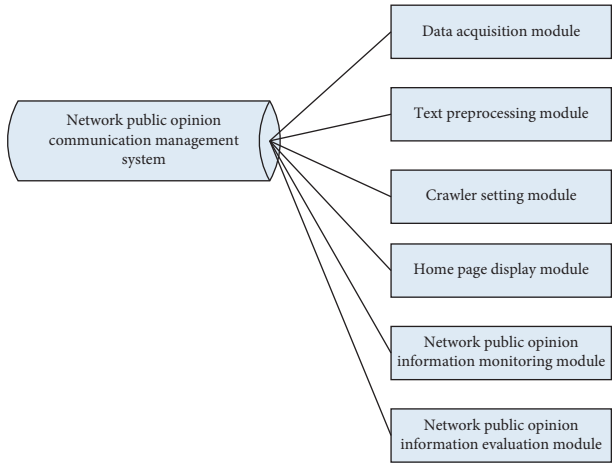

Figure 12: The overall framework of network public opinion communication management system.

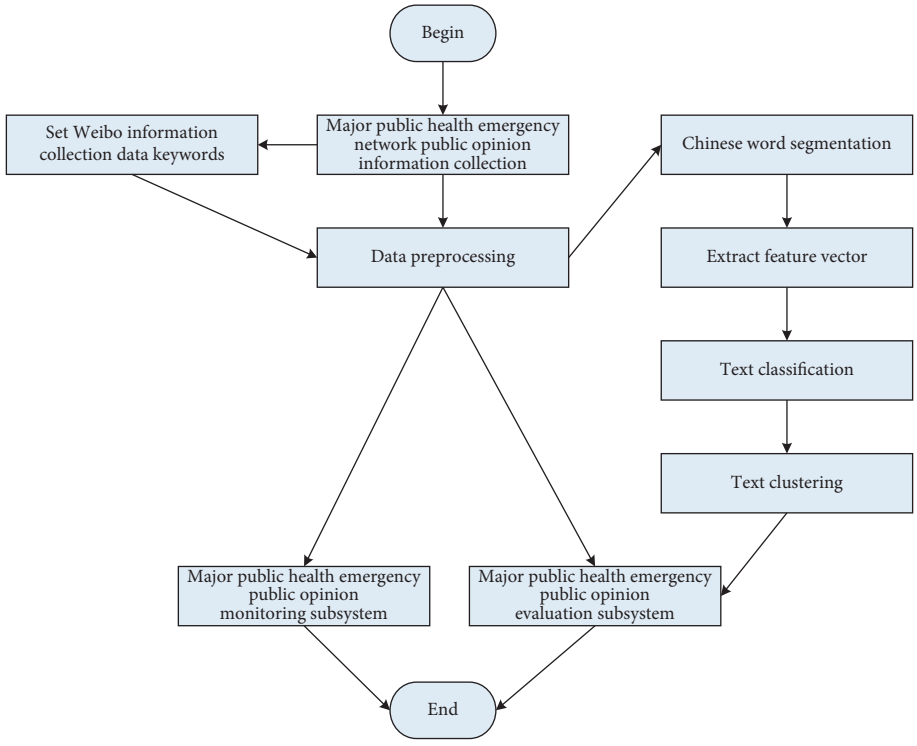

Figure 13: The system operation logic design.

Programming languages: Python, Java, HTML, CSS, and JavaScript.

Database: MySQL.

Development tools: PyCharm, Eclipse, and Sublime Text 3.

5.3. Database Design. For the data storage layer of the system, it is the design of the database. According to the above modeling analysis, crawled data, and preprocessed data, the database of the network public option communication management system is designed. The main data sheets are shown in Tables 3 and 4.

Table 3 is the crawler search major public health emergency history information table. Users can query and research the search history through this table.

After preprocessing the original data, the processed data is stored in the public opinion monitoring table after compiling the monitoring algorithm in the background. The public opinion monitoring table is shown in Table 4.

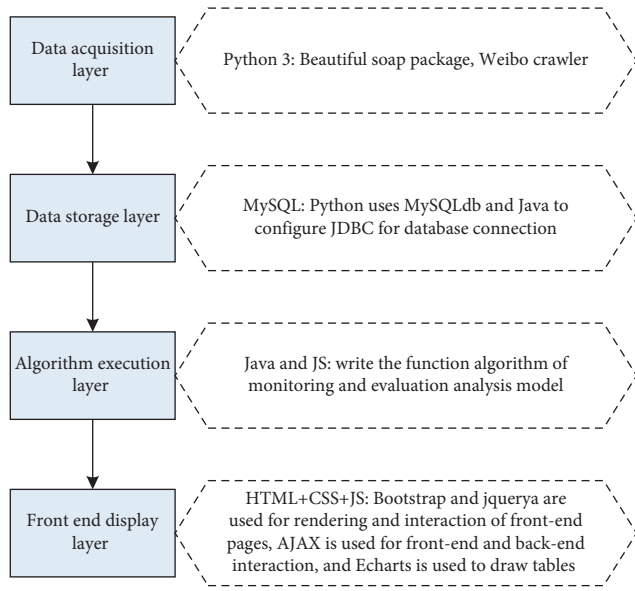

Figure 14: The system architecture design.

Table 3: The crawler search major public health emergency history information table.

Name	Type	Length	Decimal point	Nonempty	Remarks
ID	Int	11	0	Yes	Primary key identification
Topic	Varchar	50	0	No	Search topic
Count	Int	50	0	No	How many pieces of data did it crawl
Step	Int	50	0	No	Crawl interval
StartTime	Datetime	0	0	No	Start time
EndTime	Datetime	0	0	No	End time
CreateTime	Datetime	0	0	No	Record retrieval time

Table 4: The public opinion monitoring table.

Name	Type	Length	Decimal point	Nonempty	Remarks
ID	Int	11	0	Yes	Information ID
ParentID	Int	11	0	No	Original data sheet ID
TopicAtt	Float	50	0	No	Topic attention
TopicAttRate	Float	50	0	No	Change rate of topic attention
Topic	Varchar	200	0	No	Topic
StartTime	Datetime	0	0	No	Start time
EndTime	Datetime	0	0	No	End time

6. Conclusions and Suggestions

Taking "epidemic situation of new corona pneumonia in Wuhan City" as an example, using Gephi visual analysis, this paper makes an empirical study on the law of network public opinion transmission in line with the current major public health emergency. The specific conclusions are as follows:

(1) Put forward the law of network public opinion communication of major public health emergency. Based on the life cycle theory, taking the major public health emergency "COVID-19" as an example, and through Gephi visual analysis, the network public opinion communication law of major public health emergency is divided into six stages: latent, fermentation, outbreak, remission, recurrent, and decline. It provides a new idea for the regulatory authorities to grasp the development law of network public opinion of major public health emergency timely and accurately and judge the possible public opinion crisis.

(2) Construct a major public health emergency network public opinion communication model. Based on the SEIR model, taking the influencing factors of the network public opinion communication law of major public health emergency as the index, and through the NetLogo simulation, the results show that the total number of people involved in public opinion communication, the initial number of

people involved in public opinion communication, and the communication cycle are the three influencing factors of network public opinion, so as to construct the network public opinion communication law model of major public health emergency.

(3) Key communication channels play an important role in the development trend of network public opinion in major public health emergency. Among them, "People's Daily," "Headline News," and "CCTV News" are the three Weibo accounts with the largest number of forwarding, the highest number of fans, and the greatest influence. The common users connected with the three Weibo opinion leaders as the core nodes have the widest range of public opinion communication and have played a huge influence in the process of network public opinion communication of major public health emergency. Therefore, in order to prevent the negative impact of network public opinion on major public health emergency, it is necessary to intervene in key food transmission channels timely and effectively.

Epidemic development is the key to the development of network public opinion in major public health emergency. It has been found that the infection and treatment of COVID-19 pneumonia are the core to promote network public opinion. We should pay attention to and choose the appropriate time to intervene and guide the key communication channels with high influence. Through the control of public opinion, we can change the interaction between these key communication channels and Internet users' forwarding and comments, stop the spread of negative public opinion in time, reduce the spread of rumors, and guide public opinion to the positive.

Data Availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Acknowledgments

This study was funded by the National Natural Science Foundation of China (52074214) and the Social Science Foundation of Shaanxi Province (2020M010). The authors sincerely thank the experts for their participation and valuable comments in the research process.

References

[1] Cnnic, "The 49th China Internet Report," *China Education Network*, vol. 2, no. 3, 2022.

[2] Y. Liu and H. Yang, "Network public opinion information monitoring platform for natural disaster events based on big data," *Disaster Science*, vol. 33, no. 4, pp. 13–17, 2018.

[3] C. Pan, "Huajuxiang. Internet public opinion survey based on workplace violence incidents suffered by nurses in a certain city of Jiangsu Province," *Medicine in Society*, vol. 29, no. 3, pp. 37–40, 2016.

[4] Y. Lan, "Construction of the security evaluation index system of network public opinion in emergencies," *Information Magazine*, vol. 30, no. 7, pp. 73–75, 2011.

[5] V. Santosh, N. Glen, H. Itai, and J. Yan, "Virtual Zika transmission after the first U.S.case: who said what and how it spread on Twitter," *American Journal of Infection Control*, vol. 46, pp. 549–557, 2018.

[6] A. Maria Popescu and M. Pennacchiotti, "Detecting controversial events from twitter," in *Proceedings of the 19th ACM International Conference on Information and Knowledge Management*, pp. 1873–1876, Association for Computing Machinery, NY,USA, October 2010.

[7] Y. Gao, Y. Fan, J. Wang, and D. Zhao, "Evaluation of Governmental Safety Regulatory Functions in Preventing Major Accidents in China," *Safety Science*, vol. 120, 2019.

[8] Y. Bruinen de Bruin, Anne-Sophie Lequarre, J. McCourt, C. Peter, and P. Filippo, "Initial Impacts of Global Risk Mitigation Measures Taken during the Combatting of the COVID-19 pandemic," *Safety Science*, vol. 128, 2020.

[9] H. Milad, C. J. Bliemer Michiel, G. Floris, and L. Jie, "The Scientific Literature on Coronaviruses, COVID-19 and its Associated Safety-Related Research Dimensions: A Scientometric Analysis and Scoping review," *Safety Science*, vol. 129, 2020.

[10] N. Aggrawal and A. Arora, "Visualization, Analysis and Structural Pattern Infusion of DBLP Co-authorship Network Using Gephi," in *Proceedings of the 2nd IEEE International Conference on Next Generation Computing Technologies (NGCT)*, Dehradun, India, October 2016.

[11] L. Li, B. Lei, and C. Mao, "Digital twin in smart manufacturing," *Journal of Industrial Information Integration*, vol. 26, no. 9, Article ID 100289, 2022.

[12] G. Sun, H. Z. Lv, and Z. Y. Guo, "Visualization analysis for business performance of Chinese listed companies based on Gephi," *CMC-computers materials & continua*, vol. 63, no. 2, pp. 959–977, 2020.

[13] L. Li, C. Mao, H. Sun, Y. Yuan, and B. Lei, "Digital twin driven green performance evaluation methodology of intelligent manufacturing: hybrid model based on fuzzy rough-sets AHP, multistage weight synthesis, and PROMETHEE II," *Complexity*, vol. 2020, no. 6, 24 pages, Article ID 3853925, 2020.

[14] B. Reynolds, *Crisis and Emergency Risk Communication: Pandemic Influenza*, pp. 109–154, Centers for Disease Control and Prevention, Atlanta, Georgia, 2006.

[15] J. Wang, M. Y. Guo, L. Zhang, L. Chen, and X Hou, "Research on dissemination rule of public opinion from SNA perspective: taking the vaccine safety event as an example," *Studies in Media and Communication*, no. 1, p. 42, 2017.

[16] E. Haihong, H. Yingxi, P. HaiPeng, Z. Wen, X. Siqi, and N. Peiqing, "Theme and sentiment analysis model of public opinion dissemination based on generative adversarial network," *Chaos, Solitons & Fractals*, vol. 121, pp. 160–167, 2019.

[17] R. Gaspar, C. Pedro, P. Panagiotopoulos, and B. Seibt, "Beyond positive or negative: qualitative sentiment analysis of social media reactions to unexpected stressful events," *Computers in Human Behavior*, vol. 56, pp. 179–191, 2016.

[18] J. Gomide, A. Veloso, M. Wagner et al., "Dengue Surveillance Based on A Computational Model of Spatio Temporal Locality of Twitter," in *Proceedings of the 3rd International Web Science Conference*, pp. 1–8, Association for Computing Machinery, NY,USA, June 2011.

[19] J. Pei, G. Yu, X. Tian, and M. Renee Donnelley, "A New Method for Early Detection of Mass Concern about public health issues," *Journal of Risk Research*, vol. 20, no. 4, pp. 516–532, 2017.

[20] A. Signorini, A. M. Segre, and M. Philip, "The use of twitter to track levels of disease activity and public concern in the U.S. During the influenza A H1N1 pandemic," *PLoS One*, vol. 6, no. 5, Article ID e19467, 2011.

[21] C. Chew and G. Eysenbach, "Pandemics in the age of twitter: content analysis of tweets during the 2009 H1N1 outbreak," *PLoS One*, vol. 5, no. 11, Article ID e14118, 2010.

[22] The State Council of the People's Republic of China, "Regulations on Public Health Emergencies," 2005, http://www.gov.cn/zwgk/2005-05/20/content_145.html.

[23] W. Cao and H. Lu, "The formation and guidance of public opinion in social media in the era of mobile internet—taking the WeChat dissemination of the "Shandong Vaccine Incident" as an example," *Southeast Communication*, vol. 6, pp. 56–58, 2016.

[24] W. Teng, "Research on the regional distribution of netizens' attention to public opinions on public health emergencies in public health," *Chinese Health Service Management*, vol. 32, no. 5, pp. 393–396, 2015.

[25] An Lu, T. Du, and G. Li, "etc. Stakeholders' concerns and evolutionary models of public health emergencies in social media," *Journal of Information*, vol. 37, no. 4, pp. 394–405, 2018.

[26] L. Wang, Ke Wang, and Wu Jiang, "The spread and evolution of public opinion on public health emergencies in social media: taking the vaccine incident in 2018 as an example," *Data Analysis and Knowledge Discovery*, vol. 3, no. 4, pp. 42–52, 2019.

[27] X. Zhou, "Research on emergency information management problems and countermeasures in the prevention and control of the new crown pneumonia epidemic," *Library and Information*, vol. 40, no. 1, pp. 51–57, 2020.

[28] S. H. Chaffee and M. J. Metzger, "The end of mass communication?" *Mass Communication & Society*, vol. 4, no. 4, pp. 365–379, 2001.

[29] R. Zeng, C. Wang, and Q. Chen, "Comparative research on the stages and models of network public opinion dissemination," *Journal of Information*, vol. 33, no. 5, pp. 119–124, 2014.

[30] L. Li and C. Mao, "Big data supported PSS evaluation decision in service-oriented manufacturing," *IEEE Access*, vol. 8, no. 99, pp. 154663–154670, 2020.

[31] L. Li, T. Qu, Y. Liu et al., "Sustainability assessment of intelligent manufacturing supported by digital twin," *IEEE Access*, vol. 8, pp. 174988–175008, 2020.

[32] Y. Fang, M. Xie, and C. Huang, "PBDT: Python Backdoor Detection Model Based on Combined Features," *Security and Communication Networks*, vol. 2021, Article ID 9923234, 2021.

[33] J. An, D. Peng, X. Zhou, J. Wu, and Zheng, "Penghua. Service-life study of polycarbonate outdoors using Python with incomplete data," *Modelling and Simulation in Engineering*, vol. 2020, Article ID 8909747, , 2020.

[34] V. Dolgopolovas, V. Dagiene, S. Minkevičius, and L. Sakalauskas, "Python for scientific computing education: modeling of queueing systems," *Scientific Programming*, vol. 22, no. 1, pp. 37–51, 2014.

[35] F. S. Bao, X. Liu, and C. Zhang, "PyEEG: An Open Source python Module for EEG/MEG Feature Extraction," *Computational Intelligence and Neuroscience*, vol. 2011, Article ID 406391, 2011.