Advances in Applied Sociology, 2023, 13, 422-440
https://www.scirp.org/journal/aasoci
ISSN Online: 2165-4336
ISSN Print: 2165-4328

Dynamic Simulation Study on Evolution Law and Intervention Strategy of Public Opinion Information of Major Public Health Events

Shuo Liu[1], Yang Li[2*]

[1]School of Economics and Management, Beijing Institute of Graphic Communication, Beijing, China
[2]School of Economics and Management, Beijing Institute of Petrochemical Technology, Beijing, China
Email: *liushuo621@163.com

How to cite this paper: Liu, S., & Li, Y. (2023). Dynamic Simulation Study on Evolution Law and Intervention Strategy of Public Opinion Information of Major Public Health Events. *Advances in Applied Sociology, 13,* 422-440.
https://doi.org/10.4236/aasoci.2023.135026

Received: April 27, 2023
Accepted: May 27, 2023
Published: May 30, 2023

Abstract

Compared with the traditional media era, the network information production and dissemination mode in the new media era has undergone essential changes. Especially after the outbreak of major public health events of public concern, a variety of public opinion information spread together, and the evolution law of network public opinion becomes more complex, which easily leads to the outbreak of a public opinion crisis. Therefore, it is of great significance to master the evolution law of public opinion information about major public health events and scientifically intervene and guide public opinion for event handling and maintaining social stability, and it is also a crucial part of the field of public management at present. Based on SEIR infectious disease model, this paper analyzed the dynamic characteristics of dissemination of network public opinion information and built a simulation model using the dynamic simulation method on the NetLogo simulation platform to simulate the evolution law of network public opinion of major public health events, analyzed the expected effect of public opinion intervention and public opinion guidance strategies, and put forward a more scientific idea of public opinion intervention and public opinion guidance.

Keywords

Dynamic Simulation, Evolution Law, Intervention Strategy, Public Opinion Information, Public Opinion Guidance, Major Public Health Events

1. Introduction

Public health events refer to events that have occurred or may occur and cause

*Corresponding author.

or may cause great losses to public health. According to the causes and nature of events, public health events can be divided into major infectious diseases, major food poisoning and occupational poisoning, major environmental pollution accidents, natural disasters, mass unexplained diseases, biochemical nuclear radiation and other events (Zhang, 2019). With the rapid development of the human economy and society, major infectious diseases and major public health incidents of group diseases of unknown origin occur from time to time, which have brought adverse effects on normal economic and social development and attracted wide attention from all walks of life and the public. In recent years, the most typical major infectious diseases and major public health events of group diseases of unknown origin are the global pandemic events of COVID-19. At the end of 2019, an unexplained respiratory disease broke out and spread rapidly, which was later confirmed to be caused by Novel Coronavirus. On March 11, 2020, the World Health Organization thought that the Novel Coronavirus infection could be called a global pandemic. By 2023, the "COVID-19 pandemic", which had lasted for three years, had not yet ended. During the duration of this major public health event, public opinion information related to the pandemic situation is constantly emerging. Supported by convenient network information production and dissemination technology in the new media era, public opinion information directly affects the rational cognition and behavior of the public, and even induces group irrational behavior, which aggravates the risk of social stability. Thus, public opinion intervention and public opinion guidance of major public health events in the new media era is of great significance for event handling and maintaining social stability. In the new media era, the production and dissemination of network media information are very similar to the spread of infectious diseases in the real world. Based on SEIR infectious disease model, this paper analyzed the dynamic characteristics of network public opinion information dissemination, added realistic elements to build a dynamic simulation model of two kinds of public opinion information dissemination evolution on the NetLogo simulation platform, analyzed different types of public opinion situations and expected effects of intervention strategies, and put forward more reliable ideas for network public opinion intervention and public opinion guidance.

2. Literature Review

The early theory of "opinion leader" believed that the public would be influenced by the opinion leaders' opinions and behaviors on a certain event, and would even change their own cognitive and behavioral patterns because of the opinion leaders' words and deeds, so that by guiding the opinion leaders or by government departments becoming opinion leaders themselves, it could effectively and correctly guide the public opinion (Katz & Lazarsfeld, 1955). In order to achieve the correct guidance of public opinion, government departments need to firstly grasp the initiative of information release, and secondly make timely and continuous information announcement, and at the same time ensure the truthfulness and comprehensiveness of public information (Regester & Larkin, 2005).

In the face of the current open and complex public opinion environment, the government should focus on improving the initiative and timeliness of news release, analyzing public opinion, ensuring effective release, transitioning from the "propagandist" to the "communicator", making good use of new media communication platforms, strengthening system construction, and improving crisis awareness (Li & Niu, 2023). The application of network big data technology provides pre-response and intervention technical support for public opinion early warning, and the construction of network public opinion early warning mechanism, the establishment of network public opinion management mechanism, the improvement of guidance and cultivation mechanism for disseminators and receivers, the improvement of network public opinion legal system and accountability mechanism, and the optimization of co-management mechanism of network public opinion will effectively avoid the occurrence of public opinion crisis of public emergencies (Peng, Chen, & Yi, 2022). Visualization technology provides a more intuitive display of the evolution of public opinion in public emergencies, and the use of data collection technology, combined with sentiment analysis and text processing methods, to monitor and analyze public opinion information and monitor changes in emotional fluctuations in the process of public opinion, can better assist government decision-making (Zhao et al, 2021). Mathematical model construction and simulation research on public opinion dissemination can better grasp the laws of public opinion evolution and the expected effects of public opinion intervention and public opinion guidance (Liu & He, 2019).

According to the current research results, in order to achieve public opinion guidance, government departments need to grasp the initiative to become public opinion leaders and release event information in a timely, comprehensive, truthful and continuous manner; meanwhile, the application of new technologies and methods has become an important support for public opinion monitoring and public opinion guidance.

3. SEIR Transmission Dynamics Model

SEIR model was originally used to study the spread and evolution of Infectious diseases in the real world. The model includes four types of subjects, namely Susceptible (S), Exposed (E), Infectious (I) and Recovered (R).

S. The people who is lack of immunity, have no infection with diseases, and have risk of infection after contact with infectious infected persons;

E. Having been exposed to infectious infected persons, they are not yet contagious, and such groups may be transformed into infected persons or directly into immunized persons;

I. Refers to people who are contagious after being infected, which can spread the disease to susceptible people and transform susceptible people into the exposed;

R. People who have immunity and will not be infected by the same disease in a short time. R can be divided into two types, one is a group with immunity after recovery; the other is a group of "natural" immune people who have antibodies and will not be infected when they come into contact with I.

The dissemination evolution of public opinion information in the online world is very similar to the subject and subject transformation path of this model. Public opinion information is similar to infectious diseases in the real world. The infected person is the subject I who pays attention to and spreads public opinion information and will spread public opinion information to other people. After contacting I, S has a certain probability to transform into E.

E will have two choices after obtaining public opinion information. If it is interested in public opinion information and spreads it, it will be transformed into an I; if it is not interested in or believes in public opinion information, it will be transformed into an R who will not pay attention to or spread public opinion information.

I has the ability to disseminate public opinion information, but after deeply understanding the real situation of public opinion information through public opinion guidance, it has a certain probability of being transformed into an R who is not interested in public opinion information and does not disseminate it. Then the path of public opinion information dissemination and subject transformation based on the SEIR model in the online media world is shown in Figure 1, where α represents the transformation probability from S to E, β represents the transformation probability from E to I, δ represents the transformation probability from E to R, and γ represents the transformation probability from I to R.

The dissemination and evolution of public opinion information in the network are on a continuous basis, the state of the subject is dynamically changing, and the number of corresponding types of people is also dynamically changing. This process can be expressed by a differential equation of propagation dynamics, as shown in Equations (1)-(4).

$$\frac{\mathrm{d}S(t)}{\mathrm{d}t} = -\alpha S(t) I(t) \tag{1}$$

Equation (1) indicates the change in the number of S exposed to public opinion information at each moment, and S has a probability of being transformed into E by I who spreads public opinion information.

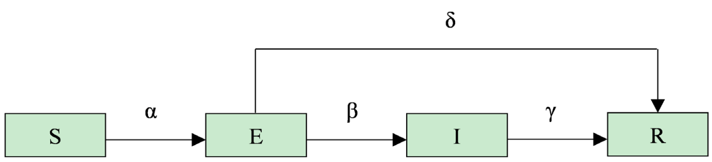

Figure 1. The path of network public opinion information dissemination and subject transformation.

$$\frac{\mathrm{d}E(t)}{\mathrm{d}t} = \alpha S(t)I(t) - (\beta + \delta)E(t) \tag{2}$$

Equation (2) indicates the number change of E who has not yet determined whether to pay attention to and disseminate public opinion information at each moment. The change of the number consists of two parts, the first part is transformed from Equation (1), and the second part is that β probability is transformed into I who pays attention to and disseminates public opinion information, and δ probability is transformed into R who does not pay attention to and disseminates public opinion information.

$$\frac{\mathrm{d}I(t)}{\mathrm{d}t} = \beta E(t) - \gamma I(t) \tag{3}$$

Equation (3) indicates the change in the number of I who has the ability to spread public opinion information at each moment. The change of the number consists of two parts, the first part is transformed from Equation (2), and the second part is transformed from γ probability to R who no longer pays attention to and does not spread public opinion information.

$$\frac{\mathrm{d}R(t)}{\mathrm{d}t} = \delta E(t) + \gamma I(t) \tag{4}$$

Equation (4) indicates that the number change of R who no longer pays attention to spreading public opinion information at each moment. The change of the number consists of two parts, the first part is transformed from Equation (2), and the second part is transformed from Equation (3).

In addition, assuming that the total number of subjects involved in the model remains unchanged, the changes in the total number of subjects and the number at each moment are shown in Equations (5) and (6).

$$N = S + E + I + R \tag{5}$$

$$\frac{\mathrm{d}N}{\mathrm{d}t} = 0 \tag{6}$$

SEIR transmission dynamics model clearly describes the relationship between the dynamic characteristics of network public opinion information dissemination evolution and subject transformation, and the model has strong rigor. This model describes the evolution characteristics of network dissemination of single public opinion information after major public health events. In fact, during the occurrence and development of major public health events, there are usually complex situations in which multiple public opinions emerge at the same time, and its transmission dynamics characteristics will be more complex. Taking the co-dissemination of two kinds of network public opinion information as an example, the path of public opinion information dissemination and subject transformation is shown in **Figure 2**.

When two kinds of online public opinion information are transmitted together, in addition to the single chain transmission and subject transformation path shown in **Figure 1**, it may also involve the mutual transformation of two kinds

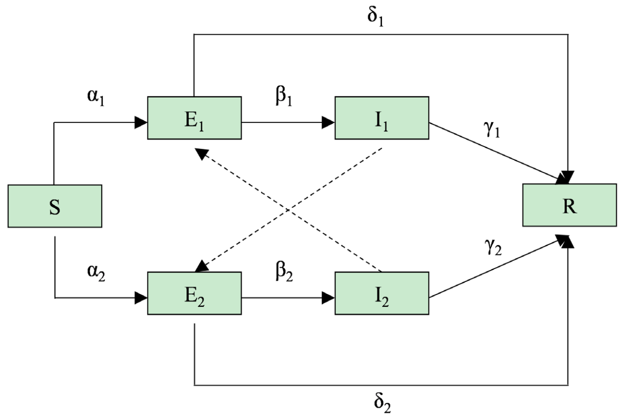

Figure 2. The path of network public opinion information dissemination and subject transformation involved two kinds of public opinion information.

of public opinion information, that is, the disseminator I_1 of public opinion information 1 will have a certain probability of being transformed into E_2 or even the disseminator I_2 of public opinion information 2. Accordingly, the disseminator I_2 of public opinion information 2 will be transformed into E1 or even the disseminator I_1 of public opinion information 1 with a certain probability, and the complexity of the public opinion information dissemination system is greatly improved, so it will be very difficult to describe and analyze it by using strict mathematical models.

From the above theoretical model analysis, we can see that the transmission process of network public opinion has the characteristics of continuity, dynamics and complexity, and the realistic network public opinion environment is more complex. The transmission and evolution of public opinion information among subjects is accompanied by strong randomness, which accords with the characteristics of complex systems, and dynamic simulation research method may be adopted to carry out simulation research closer to the actual situation.

4. Dynamic Simulation Research of SEIR Public Opinion Dissemination Model

4.1. Dynamic Simulation

With the rapid development of computer technology, building virtual models of the real world in a computer environment for simulation research has been widely used in engineering, physics, meteorology and other natural science fields. With the continuous maturity and perfection of system theory, simulation technology has been gradually applied to the study of complex systems such as sociology and economics. Compared with traditional normative research, simulation research has the advantages of low cost, short cycle, and strong openness, and is very suitable for studying systems with high complexity and long evolution cycle in reality, such as social systems and economic systems.

First, the research cost is low. The cost of building systems or system models in the real environment of the real world, such as engineering systems, is very high, and the construction cycle is long. Some systems, such as complex socio-economic systems and astronomical systems, cannot even build realistic models, so it is difficult to conduct related research. In the computer environment, as long as the sampling of the real system is the theoretical model, the simulation model can be constructed by programming language or suitable simulation tool software, which greatly reduces the system research cost. At the same time, by adjusting the functional modules and parameters of the simulation model, the model can adapt to the research of other similar problems, which makes the simulation model universal and further reduces the system research cost.

Second, the research cycle is short. With the powerful computing power of computers, simulation research can greatly shorten the research cycle. The evolution process of complex systems in the real world, such as socio-economic systems, is very long, and the effects of some policy measures may take several years or even longer to appear. Therefore, it is difficult to accurately predict the system evolution process and policy effects by using traditional normative research methods. In the computer environment, the evolution process of the system and the expected effect of the policy can be simulated only in a short time, and the comparative study of the evolution path of the system under different policy backgrounds can be carried out to determine more scientific policy measures and make the simulation model have the function of policy laboratory.

Third, it is open. The system simulation model constructed in a computer environment has high openness and freedom and can add more abundant realistic elements on the basis of the theoretical model. Meanwhile, it may embody random factors ignored by the theoretical model and variables that are not easy to be accurately described in the simulation model, which makes the simulation model closer to the realistic system on the basis of the theoretical model, ensures more reliable research conclusions and more scientific countermeasures and suggestions.

In a word, the dynamic simulation research method not only has the rigor of theoretical analysis but also features close-to-reality authenticity. In addition, it has the characteristics of low research cost, short research cycle, and strong openness, which is very suitable for the research of complex systems and plays the role of "policy laboratory".

4.2. NetLogo Network Public Opinion Information Dissemination Simulation Model Construction

NetLogo is a programmable modeling environment developed by the Center for Connected Learning and Computer-Based Modeling (CCL) of Northwestern University, which is used to simulate natural and social phenomena. It is a multi-Agent-based modeling tool, especially suitable for complex systems evolving with time. NetLogo is user-friendly and has low requirements for user programming technology. At the same time, it provides a rich model base and friendly visual interface, and even non-professional programmers can get started quickly. These characteristics make this simulation tool widely used in various industries. At the same time, NetLogo has a high application upper limit, and can support the construction of large and complex systems. However, if we want to build a large-scale and high-complexity simulation model, we need professional system science theoretical model guidance and programming technical support.

NetLogo simulation model provides three types of agents, namely turtles, patches, and observers. Turtle is used to simulate the active subjects in the real world, such as people, vehicles, animals and so on; patches are used to simulate environmental subjects and elements in the real world, such as roads and buildings; the observer is a functional subject that controls the construction and operation of the simulation model, and observes the state of subject and system evolution.

In this paper, we built a virtual network environment in the NetLogo simulation environment and used patches to simulate the composition of the network world, and turtle to simulate the subject facing public opinion information in each access network, so as to dynamically simulate SEIR public opinion dissemination model and observe the system evolution process and the change of subject state. In order to make the simulation model closer to the real situation of network public opinion information dissemination of major public health events, this simulation model is based on the following four hypotheses.

Hypothesis 1: All subjects in the network can become disseminators of public opinion information. If they come into contact with I who has the ability to disseminate public opinion information, the subjects may become E who pays attention to public opinion information and spreads it;

Hypothesis 2: Through public opinion intervention and public opinion guidance, I who pays attention to and disseminates public opinion information will be transformed into a recovered person who no longer pays attention to and disseminates public opinion information. The recovered person is an R with antibodies and will not be re-infected to become E and I;

Hypothesis 3: The number of subjects in the network remains unchanged, that is, during the research period, subjects will not exit the network, and no new network users will access the network;

Hypothesis 4: There are two kinds of public opinion information in the network, and the disseminators of different public opinion information, that is, different Is, will not transform into each other.

The main parameters and explanations of the simulation model constructed according to the SEIR theoretical model are shown in **Table 1**. The parameters can be divided into the simulation environment, public opinion information, and public opinion intervention according to their functions and meanings. The simulation model has a high degree of freedom in parameter setting, which can simulate richer scenes. For example, different public opinion information parameters represent different intensity characteristics of public opinion information, and different public opinion intervention parameters represent different

Table 1. Main parameters and explanations of SEIR public opinion dissemination model based on NetLogo.

Parameter	Type	Meaning	Explanation
netizens	Simulation environment	Number of access network subjects	Number of people accessing network media, with the initial value being set to 1000
activity-range	Simulation environment	Range of subject activities	Moving range of subjects in NetLogo two-dimensional space
initial-infectious-num1	Public opinion information	Number of initial infections 1	Initial number of netizens who pay attention to and disseminate public opinion information 1
initial-infectious-num2	Public opinion information	Number of initial infections 2	Initial number of netizens who pay attention to and disseminate public opinion information 2
infection-rate1	Public opinion information	Infection rate 1	The probability that S will be transformed into a potential disseminator, namely E_1, after contacting I_1 who spreads public opinion information 1, that is, α_1 in Figure 2
infection-rate2	Public opinion information	Infection rate 2	The probability that S will be transformed into a potential disseminator, namely E_2, after contacting I_2 who spreads public opinion information 2, that is, α_2 in Figure 2
transform-rate	Public opinion information	Transform rate	The probability that E_1 and E_2 are transformed into I_1 and I_2 who pay attention to and spread public opinion information, that is, β_1 and β_2 in Figure 2. Assuming that the transform rate of the two public opinion information is the same
recovery-rate	Public opinion information	Recovery rate	The probability that I_1 and I_2 are transformed into recovered people, namely R, who no longer pays attention to spreading public opinion information, that is, γ_1 and γ_2 in Figure 2. Assuming that the recovery rate of the two kinds of public opinion information is set to be the same
immunization-rate	Public opinion information	Immunization rate	The probability that the potential disseminators of public opinion information, namely E_1 and E_2, are directly transformed into R who no longer pays attention to spreading public opinion information, that is, δ_1 and δ_2 in Figure 2. Assuming that the immunization rates of the two public opinions are set to be the same
latent-time	Public opinion information	Latent period	Time when E transforms into I who pays attention to and spreads public opinion information
opinion-guidance-range	Public opinion intervention	Range of public opinion guidance	Coverage of intervention and public opinion guidance for access network subjects
opinion-guidance-response-time	Public opinion intervention	Response time	Response time of public opinion guidance to the agent accessing the network, that is, the timeliness of public opinion intervention and public opinion guidance
opinion-guidance-rate	Public opinion intervention	Guiding effect of public opinion	The success rate of public opinion intervention and public opinion guidance

types of public opinion intervention and public opinion guidance strategies.

The core process of the simulation model is public opinion intervention and public opinion guidance, which includes two functions. Function 1: Intervene and guide I who pays attention to and disseminates public opinion information, so that it can be transformed into a recovered person who does not pay attention to and disseminates public opinion information and become an R with immunity to public opinion information; Function 2: Guide the E, who is potentially concerned about spreading public opinion information, so that it can be directly transformed into an R.

The simulation model of the NetLogo environment based on the SEIR public opinion dissemination model is shown in **Figure 3**.

The left side of **Figure 3** is the control area, which includes two buttons: model setup and go, and also includes a series of simulation model parameter setting slider for setting the model parameters shown in **Table 1**. In the middle of **Figure 2**, there is a two-dimensional space with a black background with the regional center as the origin and the horizontal and vertical coordinates (−50, 50). It is a virtual world provided by NetLogo to carry the agents and subjects, in which the small square is the agents accessing the network to face public opinion information, and each main body will move in this space. There are six states of the subject, which are set as follows: 0 for S-green, 1 for E_1-yellow, 2 for I_1-red, 3 for R-blue, 4 for E_2-purple and 5 for I_2-pink.The right side of **Figure 2** is the result output area, which is used to show the changes in parameters that researchers are interested in. In this model, we mainly observed the evolution law of public opinion information dissemination and the changes in various types of subject states under the public opinion guidance strategy. Six "monitors" are set up to show the proportional changes in S, E_1 and E_2, I_1 and I_2 and R in each simulation cycle and a "graph" is also set up to show the changes in the number of six types of subjects with the operation of the simulation model.

4.3. Simulation Experiments

In this paper, we carried out four simulation experiments through parameter setting, namely, Two kinds of public opinion information with no competitive relationship without implementing public opinion intervention measures; Two

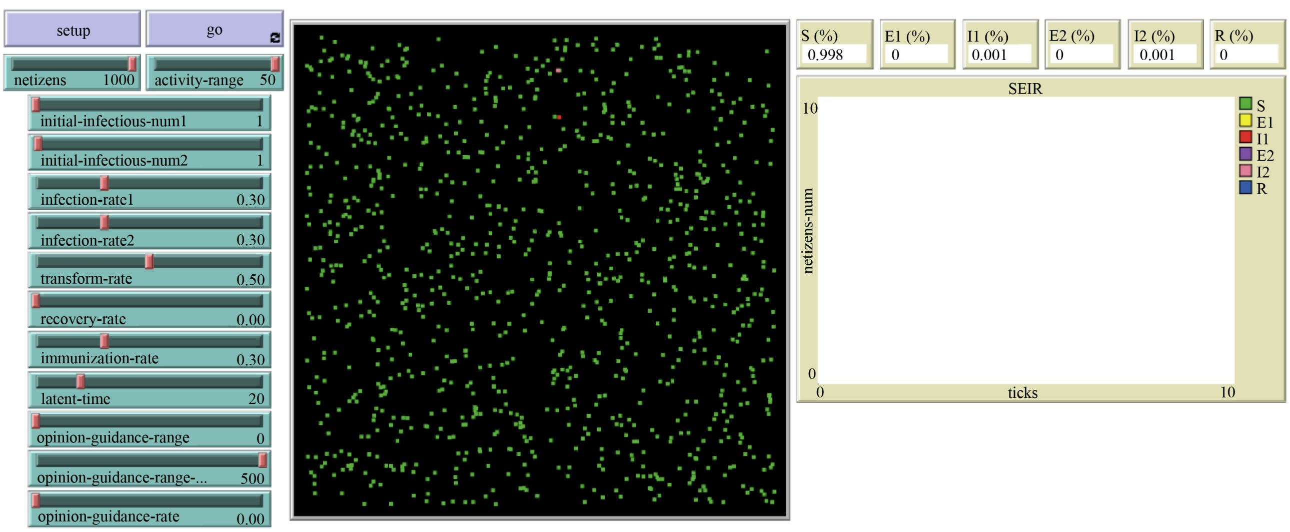

Figure 3. SEIR public opinion dissemination simulation model based on NetLogo.

kinds of public opinion information with certain competitive relationships without implementing public opinion intervention measures; Implementing general public opinion intervention and public opinion guidance situation; Implementing strong public opinion intervention and public opinion guidance situation to simulate the evolution law of network public opinion information dissemination and subject state changes in different states.

Experiment 1: Two kinds of public opinion information with no competitive relationship without implementing public opinion intervention measures

The parameter settings of the situation where there is no competition between the two kinds of public opinion information and no public opinion intervention measures are shown in Table 2.

Parameters of the simulation environment. Assume that the number of network subjects is netizens = 1000. As public opinion information is always generated and disseminated from one network subject, the initial number of concerned disseminators of public opinion information 1 and public opinion information 2 is set to be initial-infectious-num1 = 1 and initial-infectious-num2 = 1. The activity range of the subject is activity-range = 50, that is, the subject can move arbitrarily in the two-dimensional space provided by NetLogo with the center as the origin and the horizontal and vertical coordinates (−50, 50), indicating that public opinion information can break through the spatial boundaries and spread arbitrarily.

Parameters of public opinion information. When there is no competitive relationship between the two kinds of public opinion information, it can be considered that the corresponding parameters of these two kinds of public opinion

Table 2. Parameters of two kinds of public opinion information with no competitive relationship without implementing public opinion intervention measures.

Parameter	Value
netizens	1000
activity-range	50
initial-infectious-num1	1
initial-infectious-num2	1
infection-rate1	0.3
infection-rate2	0.3
transform-rate	0.5
recovery-rate	0
immunization-rate	0.3
latent-time	20
opinion-guidance-range	0
opinion-guidance-response-time	500
opinion-guidance-rate	0

information are the same, that isinfection-rate1 = infection-rate2 = 0.3; transform-rate = 0.5; recovery-rate = 0; immunization-rate = 0.3; latent-time = 20.

Parameters of public opinion intervention. Under the situation that public opinion intervention and public opinion guidance measures are not implemented, the parameter is set as opinion-guidance-range = 0, and the meaning of this parameter is that the range of implementing public opinion intervention and public opinion guidance is 0, that is, no intervention and guidance are carried out for any network subject; opinion-guidance-response-time = 500, which means that the response time to public opinion information is the maximum value of 500 set by the model, that is, it does not respond to public opinion information in time; opinion-guidance-rate = 0.00, which means that the success rate of public opinion intervention and public opinion guidance is 0, and public opinion intervention and public opinion guidance will not cause the subject state transition.

When the simulation model is run, the changing trend of subject state proportion and quantity is shown in **Figure 4**. Because the public pays great attention to major public health events, the network public opinion related to the events spreads very rapidly. When faced with two kinds of public opinion

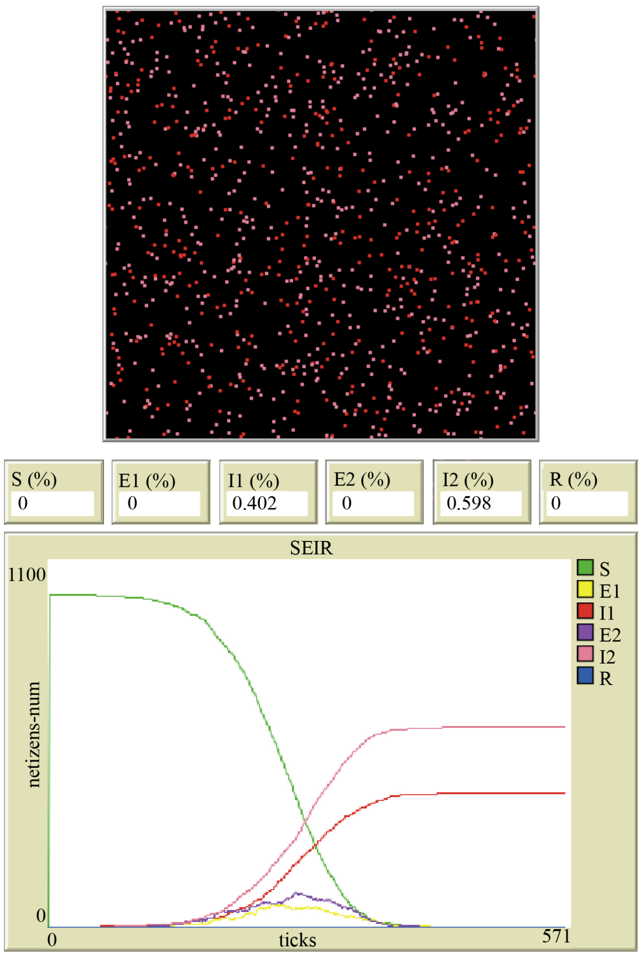

Figure 4. Simulation results of two kinds of public opinion information with no competitive relationship without implementing public opinion intervention measures.

information with the same characteristics and no competitive relationship, the number of I_1 and I_2 who pay attention to the dissemination of public opinion information continues to rise rapidly and reaches a stable state after 400 simulation cycles.

The agent I_1 who pays attention to and disseminates public opinion information 1 accounts for 40.2%, and the agent I_2 who pays attention to and disseminates public opinion information 2 accounts for 59.8%. The number of S who did not pay attention to and disseminate public opinion information at the beginning of the period continues to drop rapidly to 0, that is, the two kinds of public opinion information with the same characteristics quickly "captured" all agents and subjects. At the same time, the proportion of I_1 and I_2 is not completely consistent.

From the experimental results, it can be seen that in the absence of public opinion intervention measures, public opinion information floods the network, which will form irrational consensus and then induce group irrational behavior in reality, thus causing social instability and bringing a negative impact on the handling of major public health events.

Experiment 2: Two kinds of public opinion information with certain competitive relationships without implementing public opinion intervention measures

When there is a certain competitive relationship between the two kinds of public opinion information, strong public opinion information has stronger dissemination power and is more easily concerned and disseminated by the subject. The competitive relationship of public opinion information can be reflected by adjusting the infection rate parameter of public opinion information in the model, and the infection rate of public opinion information 2 is set to infection-rate2 = 0.5 to indicate that public opinion information 2 is stronger than public opinion information 1, and other parameters remain unchanged. The specific parameter settings are shown in **Table 3**.

When the simulation model is run, the changing trend of subject state proportion and quantity is shown in **Figure 5**. The changing trend of the proportion of each subject is very close to the result of Experiment 1. The number of I_1 and I_2 who pay attention to spreading public opinion information continues to rise rapidly and reaches a stable state after 400 simulation cycles. The agent I_1 who pays attention to and spreads public opinion information 1 accounts for 22.9%, and the main body I_2 who pays attention to and spreads public opinion information 2 accounts for 77.1%. It can be seen that strong public opinion information will eventually occupy the main position of public opinion, and public opinion information about major public health events will flood the network.

Experiment 3: Implementing general public opinion intervention and public opinion guidance situation

By adjusting the parameters of public opinion intervention in the simulation model, the situation of public opinion intervention and public opinion guidance is reflected.

Table 3. Parameters of two kinds of public opinion information with certain competitive relationships without implementing public opinion intervention measures.

Parameter	Value
netizens	1000
activity-range	50
initial-infectious-num1	1
initial-infectious-num2	1
infection-rate1	0.3
infection-rate2	0.5
transform-rate	0.5
recovery-rate	0
immunization-rate	0.3
latent-time	20
opinion-guidance-range	0
opinion-guidance-response-time	500
opinion-guidance-rate	0

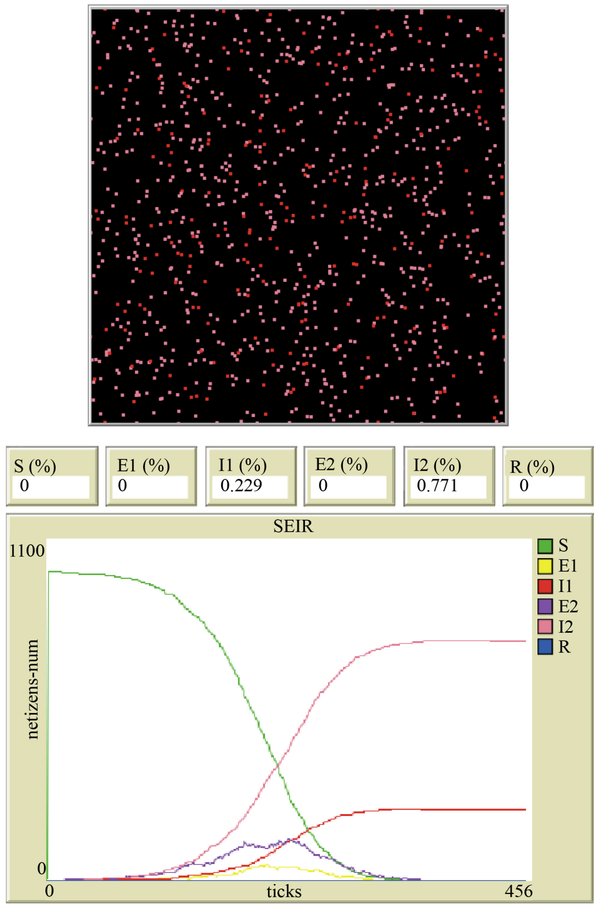

Figure 5. Simulation results of two kinds of public opinion information with certain competitive relationships without implementing public opinion intervention measures.

The parameter of public opinion intervention is set to opinion-guidance-range = 1000, which indicates that there is no space restriction in the network, and public opinion intervention and public opinion guidance can face all subjects; opinion-guidance-response-time = 200, which indicates that the response time of public opinion information is shortened to 200; opinion-guidance-rate = 0.2, and the success rate of public opinion intervention and public opinion guidance is 0.2, that is, public opinion guidance can transform infected persons with public opinion information into recovered persons (R) with a probability of 20%. Other parameters follow the parameter settings of Experiment 2, and the specific parameter settings are shown in **Table 4**.

After the parameter setting is completed, the simulation model is run, and the changing trend of subject state proportion and quantity is shown in **Figure 6**. The results of public opinion intervention and public opinion guidance have changed greatly. The most obvious feature is that the proportion of I_1 and I_2 continues to rise at first, and after the intervention of public opinion intervention and public opinion guidance measures, the number and proportion of I drop rapidly. At the same time, the proportion of R who does not pay attention to public opinion information and does not disseminate public opinion information increases rapidly. After 2000 simulation cycles, it reaches a stable state. At this time, only 0.8% of I_1 are concerned about spreading public opinion information 1, 1.9% of I_2 are concerned about spreading public opinion information 2, and 97.3% of R are not concerned about spreading public opinion information. After the implementation of general public opinion intervention and public opinion guidance measures, the network public opinion environment of

Table 4. Parameters if implementing general public opinion intervention and public opinion guidance situation.

Parameter	Value
netizens	1000
activity-range	50
initial-infectious-num1	1
initial-infectious-num2	1
infection-rate1	0.3
infection-rate2	0.5
transform-rate	0.5
recovery-rate	1
immunization-rate	0.3
latent-time	20
opinion-guidance-range	1000
opinion-guidance-response-time	200
opinion-guidance-rate	0.2

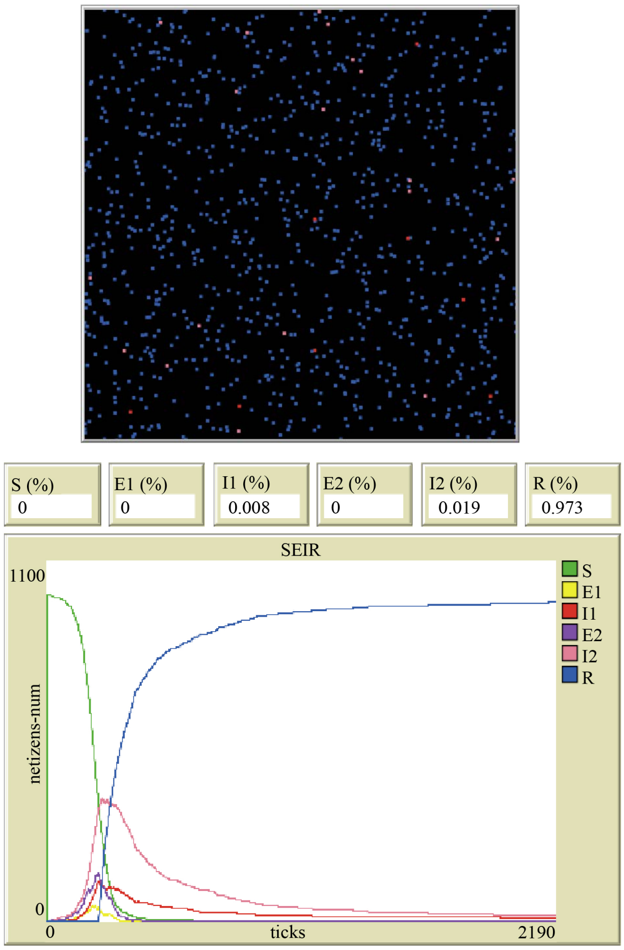

Figure 6. Simulation results of implementing general public opinion intervention and public opinion guidance situation.

major public health events has been obviously improved, public opinion information is rarely disseminated, and rational cognition of main groups is formed.

Experiment 4: Implementing strong public opinion intervention and public opinion guidance situation

The parameters of public opinion intervention are further adjusted, and the intensity of public opinion intervention and public opinion guidance is enhanced. The opinion-guidance-response-time is adjusted to100, that is, the response time of public opinion information is further shortened to 100, and the timeliness of public opinion intervention and public opinion guidance is improved; opinion-guidance-rate = 0.4, the success rate of public opinion intervention and public opinion guidance is increased to 0.4, the effect of public opinion guidance is improved, and I who pays attention to and disseminates public opinion information are transformed into recovered persons (R) as soon as possible, while other parameters remain unchanged. The specific parameter settings are shown in Table 5. After the parameter setting is completed, the simulation model is run, and the changing trend of the proportion and quantity of the main state is shown in Figure 7.

Table 5. Parameter of implementing strong public opinion intervention and public opinion guidance situation.

Parameter	Value
netizens	1000
activity-range	50
initial-infectious-num1	1
initial-infectious-num2	1
infection-rate1	0.3
infection-rate2	0.5
transform-rate	0.5
recovery-rate	1
immunization-rate	0.3
latent-time	20
opinion-guidance-range	1000
opinion-guidance-response-time	100
opinion-guidance-rate	0.4

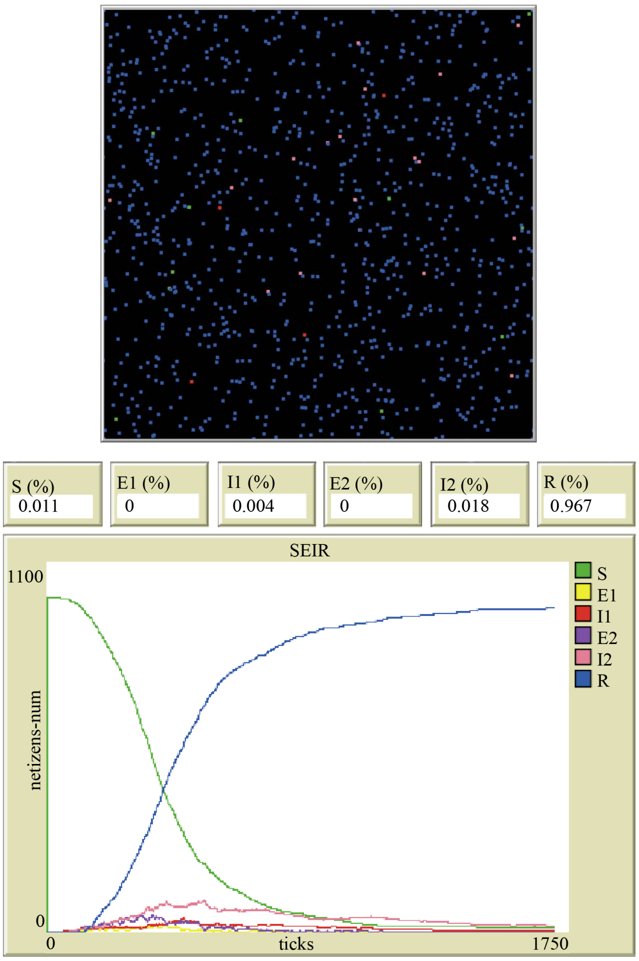

Figure 7. Simulation results of Implementing strong public opinion intervention and public opinion guidance situation.

The public opinion intervention and public opinion guidance are further strengthened. The rising speed and amplitude of the proportion of concerned disseminators I_1 and I_2 of public opinion information decrease obviously, while the proportion of R who does not pay attention to the dissemination continues to rise rapidly and reaches a stable state after 1700 simulation cycles. At this time, the proportion of I_1 who pays attention to the dissemination of public opinion information 1 is only 0.4%, the proportion of I_2 who pays attention to the dissemination of public opinion information 2 is only 1.8%, and the proportion of R who does not pay attention to the dissemination of public opinion information is 96.7%. After the implementation of public opinion intervention and public opinion guidance measures with faster response and better effect, rational public awareness of major public health events will be formed faster, and the public opinion environment of major public health events will be further improved.

5. Conclusion

By analyzing the dissemination mode of public opinion information related to major public health events in the real network environment in the new media era, it is found that its dissemination law is very similar to SEIR infectious disease model, and the transformation of the subject state can be described by a differential equation of transmission dynamics. The SEIR transmission dynamics model has a strong rigor for describing a single public opinion information situation, but when major public health events occur and develop, multiple public opinion information is usually transmitted at the same time, and there may be competitive relations among different public opinion information. The transformation of the subject state and the law of system evolution are extremely complex, so it is very difficult to analyze rigorously by using the transmission model. Therefore, the dynamic simulation method is introduced to simulate complex public opinion situations. A simulation model of public opinion dissemination with two kinds of public opinion information at the same time is constructed in the NetLogo simulation environment, and realistic factors and public opinion intervention measures are added in the form of parameters, simulation experiments, and comparative analysis of results are carried out. The results show that when public opinion events occur in major public health events, if intervention and guidance measures are not taken, public opinion information will soon flood the network, and the public will form cognitive consensus, which may induce group irrational behavior. Thus, public opinion intervention and public opinion guidance are necessary. For public opinion intervention and public opinion guidance measures, measures with a wide scope, strong timeliness and high success rate of guidance will greatly improve the network public opinion environment faced by major public health events and can gather the rational consensus of the public in a short time, thus providing strong support for event handling.

This study also provides new ideas for the design of public opinion intervention and public opinion guidance strategies for possible major public health events in the future, that is, the theoretical model → dynamic simulation model → simulation experiments → experiment results in comparison and analysis, so that the research conclusions are more reliable and the expected effects of countermeasure suggestions are more easily grasped. Major public health events are the kind of events that are most concerning to the public, with a wide influence range and long duration. Public opinions and rumors are constantly emerging and spreading, and the transformation and formation of network subject cognition are more complex and random. Therefore, it is necessary to add more realistic elements to the model, make the simulation model closer to the real situation, further enhance the reliability of research conclusions and the scientific nature of public opinion information intervention and guidance measures, maintain social stability, and create a favorable public opinion environment for the disposal of major public health events.

Acknowledgments

The paper is supported by the BIGC Project (Project No.: Eb202005).

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

Katz, E., & Lazarsfeld, P. F. (1955). *Personal Influence.* The Free Press.

Li, Q., L., & Niu, W., Q. (2023). Analysis of Government News Release Strategies in Public Emergencies. *Journal of Xinjiang Normal University (Edition of Philosophy and Social Sciences), 44,* 146-148. https://doi.org/10.14100/j.cnki.65-1039/g4.20230329.001

Liu, X. Y., & He, D. B. (2019). Study on Information Propagation Dynamics Model and Opinion Evolution Based on Public Emergencies. *Computer Science, 46,* 320-326.

Peng, Z. S., Chen, W. J., & Yi, L. (2022). Research on Network Public Opinion Governance of Public Emergencies Based on Text Mining. *Journal of University of South China (Social Science Edition), 23,* 49-56. https://doi.org/10.13967/j.cnki.nhxb.2022.0023

Regester, M., & Larkin, J. (2005). *Risk Issues and Crisis Management* (3rd ed.). Kogan Page/CIPR.

Zhang, X. L. (2019). *Research on Major Public Health Events in Contemporary China.* Southeast University Press.

Zhao, J., Dong, W. H., Shi, L. J., Kuang, Z. J., Bi, J. X., Wang, Z. Y., & Qiang, W. Q. (2021). Public Opinion Monitoring and Visual Analysis for Public Emergencies. *Journal of Jilin University (Information Science Edition), 39,* 712-719.