International Journal for Housing Science and Its Applications
Publish August 10, 2025. Volume 46, Issue 4 Pages 1530-1546

https://doi.org/10.70517/ijhsa464137

# Research on the Mechanism of Juvenile Crime Propagation in Multi-Layer Networks and Graded Control Strategies

**Da'na Han[1,*] and Jie Chen[2]**
[1] College of Political Science and Law, Zhoukou Normal University, Zhoukou, Henan, 466001, China
[2] College of Foreign Languages, Zhoukou Normal University, Zhoukou, Henan, 466001, China
Corresponding authors: (e-mail: 20131065@zknu.Edu.cn).

**Abstract** Based on complex network theory, this paper constructs a multilayer network model containing online and offline interactions for simulating the dissemination process of juvenile criminal behavior. The SEIR model is introduced to deeply explore the topology of the multilayer network and the coupling relationship between the nodes, and the event propagation mechanism on the multilayer network is designed to establish the information propagation control model of juvenile delinquent behavior, and quantitatively analyze the influencing factors of the positive and negative propagation. The results show that the model in this paper is very effective in identifying key nodes in suppressing information dissemination. The simulation results of the dissemination of juvenile criminal behavior under the multilayer network model of online-offline interaction are highly consistent with the distribution trend of real data. In addition, the model in this paper can accurately simulate the dissemination trend of juvenile criminal behavior events in the case; in the process of dissemination of the events, it can be used to guide the government and the media to speak out on multiple social platforms at the same time and strengthen the joint control and prevention, thus effectively controlling and preventing the dissemination of juvenile criminal behavior events.

**Index Terms** Complex network, multilayer network model, SEIR model, juvenile delinquency, dissemination mechanism

## I. Introduction

With the rapid development and change of society, the problem of juvenile delinquency is becoming more and more prominent, which has aroused widespread concern in all walks of life, and juvenile delinquency is not only a manifestation of individual misbehavior, but also a reflection of social problems [1]-[3].

The psychological phenomenon of juvenile delinquency is a complex and multidimensional topic, which involves multiple factors such as physiological, psychological, social and environmental factors, in order to better understand and prevent juvenile delinquency, we need to analyze in depth the psychological motivation behind it [4]-[7]. The psychological development of minors is not yet mature, and their cognitive, emotional and behavioral control abilities are still in the developmental stage, which leads to the fact that they often have difficulty in making rational and correct decisions when facing frustration, conflict and temptation [8]-[10]. At the same time, their self-consciousness and values are also in the process of formation, and they are easily influenced by external adverse factors, thus deviating from the normal track, while family and society are important factors affecting juvenile delinquency [11]-[13]. The disharmony of the family environment, the inappropriate parenting style, and the lack of family function may all lead to the psychological problems of minors [14], [15]. For example, family factors such as parental overindulgence or neglect, domestic violence, and parental divorce are important triggers of minors' criminal psychology [16], [17]. And the bad customs of society, cultural dregs, and the chaos of network environment may have a negative impact on the psychology and behavior of minors [18], [19]. For example, the spread of violence, pornography and other undesirable information may lead minors to develop wrong values and behavioral patterns [20], [21]. Although juvenile delinquency is illegal and immoral behavior, but as a minor still enjoys a certain degree of "criminal protection", so in the juvenile delinquency, the dissemination of criminal behavior will inevitably cause secondary damage to the person concerned, in the dissemination of juvenile delinquency to take into account the minors' personal privacy security The problem, so as to realize the protection of minors [22]-[25].

Literature [26] examined the impact of social media on juvenile criminal behavior, and concluded that false information, cyber bullying and privacy invasion have serious negative impacts on minors, increasing the possibility of their involvement in criminal activities, and put forward effective governance recommendations to prevent and reduce juvenile crime. Literature [27] discusses the characteristics of juvenile delinquency and factors affecting juvenile delinquency, and proposes countermeasures to prevent juvenile delinquency with a view to reducing

juvenile delinquency and contributing to the purification of juvenile delinquency. Literature [28] analyzed the influence of parents on juvenile delinquency, emphasized that parental factors do not have a direct impact on juvenile delinquency but play a mediating role, and made evidence-based recommendations to modify implicated parenting factors. Literature [29] aimed at identifying the causes of underage crime by pointing out the social, personality, school and economic influences through a survey and proposing appropriate coping strategies to prevent and control the rising crime rate. Literature [30] describes juvenile delinquency and identifies two types of offenders, recidivist and juvenile delinquents, the former being those who exhibit antisocial behavior during childhood that continues into adulthood, and the latter exhibiting certain mental illnesses, substance abuse, and economic problems. Literature [31] conducts a critical review of juvenile delinquency and analyzes the factors that influence their delinquency and control, specifically in terms of ethnicity, class, and gender. Literature [32] discusses the issue of underage crime and justice, noting the growing concern about underage crime and highlighting the current state of unstable, inadequate, and unprofessional legal frameworks in various countries, comparing the efforts made by the UK and other high-income countries around the world with regard to underage crime. Literature [33] explored trends, factors, and interventions related to juvenile delinquency based on the current state of juvenile delinquency in the U.S. It analyzed the individual, family, and environmental risk and protective factors for juvenile delinquency and described the factors and trends related to juvenile delinquency that are intended to support effective prevention. The above study comprehensively explores the current situation of juvenile delinquency and the factors affecting it, reveals that juvenile delinquency is on the rise, its influencing factors are diversified, and based on this, proposes appropriate intervention strategies.

This paper provides an introduction to the theory and technology related to complex networks, which lays the foundation for analyzing the transmission characteristics of juvenile delinquency and the psychological characteristics of network users. Three contagion models describing different evolutionary processes are introduced in detail and analyzed for their applicability, and the $SEIR$ model is selected as the research method for the evolutionary mechanism of juvenile criminal behavior. Based on the multilayer network theory, we studied the model of public opinion dissemination on the two-layer network under the interaction of online network and real network, and explored the dissemination mechanism of juvenile delinquent behavior on the two-layer social network. On this basis, the speed parameter is introduced into the positive and negative propagation model to analyze the characteristics of the propagation of juvenile delinquency. Finally, the accuracy of the model is verified through simulation experiments, and targeted control strategies for the propagation of juvenile delinquent behaviors are proposed using actual cases.

## II. Mathematical Modeling of Propagation Mechanism under Multilayer Network Structure

### *II. A. Complex networks*

Complex networks, are networks with some or all of the properties in self-organization, self-similarity, attractors, small worlds, and scale-free. A closed and uniformly mixed group of $N$ individuals is generally regarded as a social network, where the individuals are the nodes of the network, and the links between the individuals are called the edges of the network, which can be obtained as an undirected graph $G(V,E)$, where the set of nodes is $V=\{1,2,\cdots,N\}$ and the set of edges is $E=\{(i,j)\,|\,i,j\in V\}$.

#### II. A. 1) Key technologies for complex networks

The structural characteristics of complex networks can be measured by many statistical features, such as degree, degree distribution, average path length, aggregation coefficient, etc. In the following, we focus on several statistical features commonly used in this paper:

(1) Degree and degree distribution

Degree indicates the number of neighboring nodes of a node, in general, the larger the degree of a node, the more important it is. And the average value of the degrees of all nodes in the network is called the average degree $\langle k\rangle$, denoted as:

$$\langle k\rangle=\frac{1}{N}\sum_{i=1}^{N}k_i \tag{1}$$

where, $N$ denotes the number of nodes and $k_i$ denotes the degree of node $i$.

(2) Average path length

In complex networks, the distance between two nodes indicates the number of edges contained in the shortest path between these two nodes. And the average path length of the network is defined as the average value of the

distance between all pairs of nodes, which indicates the average degree of separation between nodes in the network, and can be expressed by the formula:

$$L = \frac{2}{N(N-2)} \sum_{i=1}^{N} \sum_{j=i+1}^{N} d_{ij} \tag{2}$$

where, $N$ denotes the number of nodes and $d_{ij}$ denotes the distance between nodes $i, j$.

(3) Aggregation factor

In complex networks, the aggregation factor of a node represents the ratio of the number of edges connected between the neighboring nodes of a node to the maximum possible number of edges connected between the neighboring nodes of this node. The aggregation factor of node $i$ is expressed as:

$$C_i = \frac{2M_i}{k_i(k_i-1)} \tag{3}$$

where, $k_i$ denotes the degree of node $i$ and $M_i$ denotes the number of edges connected between the neighboring nodes of node $i$. Then the aggregation factor of the network can be expressed as:

$$C = \frac{1}{N} \sum_{i=1}^{N} C_i \tag{4}$$

where $N$ denotes the number of nodes of the network and $C_i$ denotes the aggregation factor of node $i$.

**II. A. 2) Complex network models**

Social networks are often the vehicle through which incidents of juvenile delinquency spread, and there are many complex social networks on the web. We describe these networks in detail below.

(1) ER stochastic network

ER model is usually used to simulate and study various networks in the display world, etc. The randomness of this model is reflected in the way edges are generated between nodes.

(2) Small-world networks

Many networks in the real world also have small-world properties, and many empirical graphs also show the influence of small worlds, including social networks, Wikipedia, and so on. Small world networks are also known as WS small world networks. It has properties such as tight neighborhood connectivity, randomness connectivity, short path length and high aggregation factor.

(3) Scale-free networks

Partially real social network is a power law distribution structure of the network, that is, with the majority of nodes with small degree and a few nodes with large degree, similar to the BA scale-free network. The specific generation process of BA scale-free network is as follows:

(a) At the initial moment, there is $m_0$ node in the network, and a new node $j$ is introduced each time, connected to $m$ already existing nodes, where $m \le m_0$.

(b) The probability $p$ that a new node $j$ is connected to an old node $i$ is related to the degree $k_i$ of the old node $i$, which is expressed as:

$$p = \frac{k_i}{\sum_j k_j} \tag{5}$$

**II. A. 3) Multilayer networks**

(1) Definition of multilayer network [34]

A multilayer network containing $M$ layer can be represented as $G = (A, O)$ where $A = \{G_\alpha \mid \alpha \in \{1, \cdots, M\}\}$ is a set of directed or undirected graphs, weighted or unweighted $G_\alpha = (V_\alpha, E_\alpha), V_a = \{1, 2, \cdots, N\}$ represents the set of nodes of the network at layer $\alpha$, $E_\alpha = \{(i, j) \mid i, j \in V\}$ the set of edges of the network at layer $\alpha$. $O = \{E_{\alpha\beta} \subseteq V_\alpha \times V_\beta \mid \alpha, \beta \in \{1, \cdots, M\}, \alpha \ne \beta\}$ is the set of interconnected edges between nodes of different layers $G_\alpha$ and $G_\beta$. The elements of $E_\alpha$ are called intra-layer connected edges and each $E_{\alpha\beta}(\alpha \ne \beta)$ is called inter-layer connected edge.

(2) Basic statistical characteristics of multilayer networks

Degree of a node of a multilayer network: the degree of a node $i \in V$ of a multilayer network $G=(A,O)$ is defined as: $k_i=(k_i^{[1]},\cdots,k_i^{[M]})$, where $k_i^{[a]}$ denotes the degree $k_i^{[\alpha]}=\sum_j a_{ij}^{[\alpha]}$ of node $i$ in layer $\alpha$. The overlap degree of node $i$ denotes the sum of the node's degree values in each layer and is defined as $o_i=\sum_{\alpha=1}^{M} k_i^{[\alpha]}$.

Overlap of multilayer network: overlap between two layers $\alpha$ and $\beta$ of a multilayer network $O^{\alpha\beta}$ is defined as the total number of edges between layers $\alpha$ and $\beta$: $O^{\alpha}\beta=\sum_{i<j} a_{ij}^{\alpha}a_{ij}^{\beta}$, here $\alpha\neq\beta$. The local overlap $o_i^{\alpha\beta}$ between the two layers $\alpha$ and $\beta$ of a multilayer network is defined as the total number $o_i^{\alpha\beta}=\sum_j =1^N a_{ij}^{\alpha}a_{ij}^{\beta}$ of neighboring nodes of node $i$ in layer $\alpha$ and layer $\beta$.

Degree correlation in multilayer networks: each node $i=1,2,\ldots,N$ of a multilayer network has a degree $k_i^{[\alpha]}$ at each layer of the network $\alpha=1,2,\cdots,M$ and the degrees of the same node in different layers are correlated. There are methods to assess the degree correlation between layer $\alpha$ and layer $\beta$:

Complete characterization of matrices: construct a matrix $P(k^{\alpha},k^{\beta})=\frac{N(k^{\alpha},k^{\beta})}{N}$, where $N(k^{\alpha},k^{\beta})$ denotes the total number of nodes that satisfy a degree of $k^{\alpha}$ in layer $\alpha$ and a degree of $k^{\beta}$ in layer $\beta$.

The average degree of a layer depends on the degree of the nodes in the layer: there is also a coarser degree dependence measure of $\overline{k^{\alpha}}(k^{\beta})$, where the average degree of the nodes in a layer depends on the degree of the corresponding nodes in the layer:

$\overline{k^{\alpha}}(k^{\beta})=\sum_{k^{\alpha}} k^{\alpha}P(k^{\alpha}\mid k^{\beta})=\frac{\sum_{k^{\alpha}} k^{\alpha}P(k^{\alpha},k^{\beta})}{\sum_{k^{\alpha}} P(k^{\alpha},k^{\beta})}$, if the function does not depend on $k^{\beta}$, the degrees in the two layers are uncorrelated. If this function increases with $k^{\beta}$, the degrees of the nodes in the two layers of the network are positively correlated.

Pearson's correlation coefficient: the degree correlation of Pearson's correlation coefficient is defined as: $r_{\alpha\beta}=\frac{\langle k_i^{[\alpha]}k_i^{[\beta]}\rangle-\langle k_i^{[\alpha]}\rangle\langle k_i^{[\beta]}\rangle}{\sigma_{\alpha}\sigma_{\beta}}$ where $\sigma_{\alpha}\sigma_{\beta}=\sqrt{\langle k_i^{[\alpha]}k_i^{[\beta]}\rangle-\langle k_i^{[\alpha]}\rangle^2}$.

(3) Interlayer connectivity modes for two-layer networks

There are generally three types of inter-layer connection modes for bilayer networks:

① Inter-layer same-matching connection, i.e., all nodes of the first and second layer networks are respectively sorted in ascending order according to the degree to generate two sequences, and then two nodes of different network layers at the same position in the sequences are connected to realize the one-to-one connection of nodes between the two network layers.

② Inter-layer heterogeneous connection, the opposite of homogeneous connection, i.e., the first layer of network nodes according to the degree of the ascending order, the second layer of network nodes according to the degree of the descending order, the same two sequences are generated, and then two nodes in different network layers at the same position in the sequence are connected to achieve one-to-one connection between nodes of the two layers of the network.

③ Inter-layer random connection, the first layer network nodes and the second layer network nodes are connected randomly and constitute a one-to-one connection pattern of the two layer network nodes.

### *II. B.Infectious disease models*

#### II. B. 1) The SI model

As one of the earliest models of infectious disease modeling, the SI model has only two states of nodes with relatively simple node states that can be used to describe the spread of infectious diseases, where S denotes the uninfected, i.e., the healthy, and I denotes the disease-infected. This indicates that the SI model can only describe the spreading process of infectious diseases that cannot be cured. Similarly, the model can also describe the process of information dissemination, in which network users are classified into two states: unknowns and disseminators. In describing the information dissemination process, the propagation principle can be expressed as:

$$S(i)+I(j)\xrightarrow{\lambda}I(i)+I(j) \tag{6}$$

where, $\lambda$ denotes the propagation probability in the process of information dissemination, which is the probability that the propagator of the information will disseminate the information when it comes into contact with other people, and expresses the degree of people's desire to share the information with others.

When node $i$ is in an unknown state, and it is associated with the nodes around the state of $j$, the node will have a probability of $\lambda$ to transform from unknown to disseminator, and in the next moment the node will become a disseminator, while the state of node $j$ will not change again.

The number of users in the group who are in the state of unknown and propagator at moment $t$ is labeled by $s(t)$ and $i(t)$ respectively as a proportion of all users in the network. Therefore, at moment $t$, the probability that an individual in the group contacts a node in the propagation state is $i(t)$, and at this time, when the unknown comes into contact with the propagator, it will become a propagator with a probability of $\lambda i(t)$. The differential equation for the transfer of the unknown to the propagation state in the information dissemination process is:

$$\begin{cases} \dfrac{ds(t)}{dt}=-\lambda s(t)i(t) \\ \dfrac{di(t)}{dt}=\lambda s(t)i(t) \\ S(t)+I(t)=1 \end{cases} \tag{7}$$

**II. B. 2) SIR models**

The SIR model divides the population in the barn into three categories: S is the population of susceptible individuals who are in close contact with infected individuals or infectious agents and have a high likelihood of being infected; I is the population of infected individuals who have an infectious disease of their own and who carry the infectious agent; and R is the population of emigrants who have been quarantined or cured of an infectious disease and have gained immunity.

The SIR model has a constant population of N in the silo at all times, and the number of people in each of the three categories at moment $t$ is $s(t),i(t)$ and $r(t)$. The SIR model is built on the following three assumptions: (1) the silo is considered to be static, with no entries or exits of people, and the total number of people in the system is a constant: (2) it is assumed that an infected person has the ability to infect the unknowns, and the number of people an infected person is able to infect is proportional to the number of susceptible people inside the silo, and the infectivity factor is proportional to the number of infected people inside the silo. infected persons is proportional to the number of infected persons in the compartment, the coefficient of contagion is $\lambda$, so that the number of persons transmitted by an infected person in $t$ a unit of time is $\lambda s(t)i(t)$, and (3) the number of immunized persons is proportional to the number of infected persons at this point in time under $t$ time intervals, the coefficient of healing is $\beta$, and the number of removals is $\beta i(t)$. The differential equation for this is:

$$\begin{cases} \dfrac{ds(t)}{dt}=-\lambda s(t)i(t) \\ \dfrac{di(t)}{dt}=\lambda s(t)i(t)-\beta i(t) \\ \dfrac{dr(t)}{dt}=\beta i(t) \\ S(t)+I(t)+R(t)=1 \end{cases} \tag{8}$$

**II. B. 3) SEIR models**

The SEIR model [35] assumes that the unknown does not rapidly change to a propagated state upon contact with a propagator, but rather undergoes a period of time before evolving into a propagated state. Therefore, a new state E (latent state) is introduced based on the traditional SIR model. The differential equation for the evolution of the SEIR meter state is:

$$\begin{cases} \dfrac{ds(t)}{dt} = -\lambda s(t)i(t) \\ \dfrac{ds(t)}{dt} = \lambda s(t)i(t) - \beta i(t) \\ \dfrac{ds(t)}{dt} = \lambda s(t)i(t) - \beta i(t) \\ \dfrac{ds(t)}{dt} = \beta i(t) \\ S(t) + I(t) + R(t) = 1 \end{cases} \tag{9}$$

Among the three contagion models mentioned above, for the characteristics of network users in the evolution process of juvenile criminal behavior events, four states of users who are uninformed about the juvenile criminal behavior events, those who are informed but do not have propagation behaviors, those who are informed and propagate the juvenile criminal behavior events in the network, and those who are informed and do not propagate them in the network will appear in the two-micro coupling network. Therefore, in order to be closer to the process of dissemination of juvenile criminal behavior events in the real network, SEIR is chosen as the basic dissemination model of this paper.

### *II. C.Model of the spread of juvenile delinquent behavior in a multilayer network structure*

#### II. C. 1) Multi-layer network modeling for online and offline interactions

The model of the dissemination of juvenile delinquent behavior events on the multi-layer social network studied in this paper contains the physical contact network layer A (also known as the offline network) and the virtual social network layer B (also known as the online network).

(1) Online social network layer construction

The physical contact network portrays interpersonal social relationships in the real world, where nodes represent real people and connected edges represent interpersonal relationships.

(2) Physical contact network layer construction

The virtual social network reflects the virtual social relationships generated by people with the help of social platforms, in which nodes represent online users and edges represent friend relationships.

(3) Construction of inter-layer interaction relationship

The offline network corresponds to the nodes in the online network, i.e. an offline individual corresponds to an online user. In the existing studies on the propagation dynamics of multilayer networks, it is usually assumed that the states of the corresponding nodes in the online and offline networks are identical. In fact, on the one hand, because offline individuals can not access the Internet or can not access the Internet in time, there are some offline communication individuals who can not or even will not disseminate information about juvenile delinquent behavior events on online social platforms; on the other hand, due to forgetfulness and other factors, a part of the online communication users do not disseminate juvenile delinquent behavior events offline. Therefore, this paper will study the dissemination model of juvenile delinquent behavior under the situation that the corresponding node states of online and offline are not exactly the same.

#### II. C. 2) Design of event propagation mechanisms on multilayer networks

The model divides the subjects of the incident of criminal behavior of minors into two categories: the transmitters (denoted S) and the non-transmitters (denoted I). Consider the following practical points:

(1) When an individual who has not disseminated a juvenile criminal behavior incident comes into contact with a disseminator of a juvenile criminal behavior incident in a physical contact network or a social network, then the individual who has not disseminated the situation becomes a disseminator of a juvenile criminal behavior incident with a certain probability.

(2) Individuals who transmit juvenile delinquent behavior have already transmitted juvenile delinquent behavior, so these individuals may not transmit juvenile delinquent behavior again.

(3) Offline juvenile delinquency transmitters will not transmit juvenile delinquency offline because they have already transmitted juvenile delinquency online.

Based on the above three facts, the following assumptions can be made: through the contact with offline communicators, the probability that the non-communicator $i$ in the physical layer becomes a communicator is $\lambda_A$; through the contact with online communicators, the probability that the non-communicator $i$ in the virtual layer becomes a communicator is $\lambda_n$; the probability that the offline and online communicators become non-communicators are recorded as $\beta_A$ and $\beta_B$, respectively; $\lambda_{AB}$ and $\lambda_{BA}$ denote the behavioral choices of the

individual, $\lambda_{AB}$ denotes the probability that the individual communicates offline instead of offline; $\lambda_{RA}$ denotes the probability that an individual spreads online and, instead of spreading online, then spreads offline.

For the sake of presentation, $S_{A(B)}$ denotes the disseminator of juvenile delinquent behavior on layer $A(B)$, and $I_{A(B)}$ denotes the person who did not disseminate juvenile delinquent behavior on layer $A(B)$. Based on the above analysis, the status of the subjects of juvenile delinquent behavior events on the two-tier social network can be divided into four categories:

$S_AS_B$ indicates that the subject of the juvenile criminal behavior incident is in the transmitting state of engagement on both network layers;

$S_AI_B$ indicates that the subject of a minor criminal behavior event is transmitting a minor criminal behavior event on the physical contact layer, but not on the virtual social layer;

$I_AS_B$ indicates that the subject of the minor criminal behavior event does not propagate the minor criminal behavior event on the physical contact layer, but does propagate the minor criminal behavior event on the virtual social layer;

$I_AI_B$ indicates that the subject of the engagement is in an undisseminated state in both the physical contact layer and the virtual socialization layer.

Therefore, the state transfer expression for the subject of the minor criminal behavior incident on the two-layer social network is as follows:

$$\begin{cases} I_AI_B + S_A \xrightarrow{\lambda_A} S_AI_B \\ I_AS_B + S_A \xrightarrow{\lambda_A} S_AS_B \\ I_AI_B + S_B \xrightarrow{\lambda_B} I_AS_B \\ S_AI_B + S_B \xrightarrow{\lambda_B} S_AS_B \\ I_AS_B \xrightarrow{\lambda_{BA}} S_AS_B \\ S_AI_B \xrightarrow{\lambda_{AB}} S_AS_B \end{cases} \tag{10}$$

Let the total number of nodes in the offline and online networks be $N^A$ and $N^B$, respectively; the number of propagators and non-propagators in the offline network layer A are denoted as $N_S^A$ and $N_I^A$, so $N^A = N_S^A + N_I^A$; the number of propagators and non-propagators in the online network layer B are denoted as $N_S^B$ and $N_I^B$, so $N^B = N_S^B + N_I^B$; and the total number of propagators and non-propagators in the two layers of the network are denoted as $N_S = N_S^A + N_S^B$ and $N_I = N_I^A + N_I^B$, respectively. Therefore, the dynamics of the number of propagators in the online and offline networks over time equation can be expressed as:

$$\begin{cases} \dfrac{dN_S^A}{dt} = (1-\lambda_{AB})[(1-\mu_A)N_S^A + \lambda_A N_I^A N_S^A] + \lambda_{BA}[(1-\mu_B)N_S^B + \lambda_B N_I^B N_S^B] - N_S^A \\ \dfrac{dN_S^B}{dt} = \lambda_{AB}[(1-\mu_A)N_S^A + \lambda_A N_I^A N_S^A] + (1-\lambda_{BA})[(1-\mu_B)N_S^B + \lambda_B N_I^B N_S^B] - N_S^B \end{cases} \tag{11}$$

Since $N_I = N_I^A + N_I^B$, so:

$$\begin{aligned} \frac{dN_S}{dt} &= (1-\mu_A)N_S^A + \lambda_A N_I^A N_S^A + (1-\mu_B)N_S^B + \lambda_B N_I^B N_S^B - N_S^A - N_S^B \\ &= \lambda_A N_I^A N_S^A + \lambda_B N_I^B N_S^B - \mu_A N_S^A - \mu_B N_S^B \\ &= (\lambda_A N_I^A - \mu_A)N_S^A + (\lambda_B N_I^B - \mu_B)N_S^B \end{aligned} \tag{12}$$

Since $N_S^A \approx N_I^A, N_S^B \approx N_I^B$, the above equation is linearized to:

$$\frac{dN_S}{dt} \approx (\lambda_A N^A - \mu_A)N_S^A + (\lambda_B N^B - \mu_B)N_S^B \tag{13}$$

And $N_S^A = N_S - N_S^B$, then:

$$\begin{aligned}\frac{dN_S}{dt} &= (\lambda_A N^A - \mu_A)(N_S - N_S^B) + (\lambda_B N^B - \mu_B)N_S^B \\ &= [(\lambda_A N^A - \mu_A)(1 - N_S^B / N_S) + (\lambda_B N^B - \mu_B)N_S^B / N_S]N_S \\ &= [(\lambda_A N^A - \mu_A)(1-f) + (\lambda_B N^B - \mu_B)f]N_S\end{aligned} \tag{14}$$

where $f = N_S^B / N_S$ denotes the proportion of propagators in the online network layer to the total number of propagators in the whole system and $0 < f < 1$.

The number of propagators is thus obtained as:

$$N_S(t) = N_S(0)e^{[(\lambda_A N^A - \mu_A)(1-f) + (\lambda_B N^B - \mu_B)f)]t} \tag{15}$$

Therefore, the proportion of disseminators is:

$$\rho_S(t) = \rho_S(0)e^{[(\lambda_A N^A - \mu_A)(1-f) + (\lambda_B N^B - \mu_B)f)]t} \tag{16}$$

In particular, the proportion of disseminators is when the dissemination and recovery rates are the same $\lambda_A = \lambda_B = \lambda, \mu_A = \mu_B = \mu$ for both online and offline:

$$\rho_S(t) = \rho_S(0)e^{[\lambda(N^A(1-f) + N^B f) - \mu]t} \tag{17}$$

Then, the propagation threshold on the two-layer network is $(\lambda / \mu)_c = \frac{1}{N^A(1-f) + N^B f}$.

If a single-layer ER network of the same size $N$ is used as the reference network, on which the propagation and recovery rates are $\lambda$ and $\mu$, respectively, the corresponding proportion of propagators on it is $\rho_S(t) \sim e^{(\lambda N - \mu)t}$. Therefore, the propagation threshold on the single-layer network is: $(\lambda / \mu)_c = \frac{1}{N}$.

Since this paper examines the general case where an offline individual registers for at most one online account, i.e., $N^B < N^A$, therefore, $N^A(1-f) + N^B f = (N^B - N^A)f + N^A > N^A$. and $0 < f < 1$, therefore, $(N^B - N^A)f + N^A < N^B$. So that yields:

$$N^A < N^A(1-f) + N^B f < N^B \tag{18}$$

So finally get:

$$\frac{1}{N^B} < \frac{1}{N^A(1-f) + N^B f} < \frac{1}{N^A} \tag{19}$$

### *II. D.Methods of controlling the spread of incidents of juvenile criminal behavior*

#### II. D. 1) Modeling the speed of information dissemination

The mathematical symbols and variables in the information dissemination speed model [36] are described below:

$f(v)$ -- growth rate of information dissemination speed, the

$\mu(t)$ -- positive propagation index.

$\varphi$ --constant, representing the magnitude of the effect of the positive propagation index on the speed of information dissemination, and

$\lambda(t)$ --negative propagation index.

$d$ --the number of information forwarding.

$v(t)$ --the amount of change in the amount of information forwarding from $t-1$ to $t$.

$v$ --the maximum value of the speed.

The complexity of information dissemination is such that there is a risk that information will be lost and that it will be interfered with by human behavior. At the same time, there is a wide variety of information on the Internet, which may overlap with other information in the process of information dissemination. Users have limited time and energy and cannot pay attention to all information. Therefore, when information receives attention from many people, the information propagation speed is accelerated, and more and more users will also push the process of information propagation.

The reason for introducing the speed parameter into the construction of the model is described in the problem description section, and the construction of the model will be specifically developed in the following. First of all, we draw on the analogous population growth model, and the formula of the model is expressed as follows:

$$f(v)=\varphi(1-\frac{v(t)}{v}) \tag{20}$$

Secondly, the model was constructed by considering both positive and negative propagation of information dissemination:

$$\frac{dv(t)}{dt}=\varphi(1-\frac{v(t)}{v})\mu(t)-\lambda(t)v(t) \tag{21}$$

Meanwhile, two extreme cases are considered in this paper, the first one, when the forward propagation index takes 0, $\mu(t)=0$ or the velocity takes the maximum value, $v(t)=v$. Substituting $\mu(t)=0, v(t)=v$ into Eq. (21) yields the following equation:

$$\frac{dv(t)}{dt}=-\lambda(t)v(t) \tag{22}$$

In the second case, and the forward propagation exponent is not 0, i.e., $\mu(t)\neq 0$, let:

$$\alpha=\varphi\frac{\mu(t)}{V}+\lambda(t) \tag{23}$$

$$\beta=\varphi\mu(t) \tag{24}$$

Substituting equations (23) and (24) into (21) gives the following equation:

$$\frac{dv(t)}{dt}=\beta-\alpha v(t) \tag{25}$$

We make $v(0)=v_{(0)}$ and compute:

$$v(t)=\frac{\beta}{\alpha}(1-e^{-\alpha t})+v_0e^{-\alpha t} \tag{26}$$

**II. D. 2) Modeling of Positive and Negative Propagation**

The symbols and variables in the positive and negative propagation models are described below:

$V_{(i)}$ - the maximum value of the velocity, the

$\mu(i)$ - the index of positive propagation, the

$\sigma_{ij}$ - the influence coefficient, representing the magnitude of the influence of message A on message B, the

$\lambda_{(i)}$ - the negative propagation index.

$\alpha$ - the value of the critical velocity of message A.

$\beta$ - critical velocity value of message B.

To simplify the procedure, we make the following assumptions:

① Make two types of information spread on the network platform, which are denoted as information A and information B. Information A and information B each have positive propagation index $\mu(i)$ and negative propagation index $\lambda_i$, where $\mu(i),\lambda(i)\in[0,1]$, and when $\mu(i)<\lambda(i)$, the information propagation fails, contrary to the reality of the actual situation.

② Because in the propagation process, the propagation speed of information can not be increased without limit, so there is a maximum speed $v_i$.

③ There are two cases of information propagation: positive propagation and negative propagation.

It can be obtained from hypothesis I and hypothesis II:

$$\begin{cases}\dfrac{dv_1(t)}{dt}=\mu_1v_1(1-\dfrac{v_1}{V_1})-\lambda_1v_1\\ \dfrac{dv_2(t)}{dt}=\mu_2v_2(1-\dfrac{v_2}{V_2})-\lambda_2v_2\end{cases} \tag{27}$$

According to the above three assumptions, information A and information B will inevitably be affected by time, space and other resources in the process of dissemination, and the two pieces of information will always collide and friction, which is specifically manifested in the positive and negative dissemination of information. By introducing the influence coefficient $\sigma_{ij}$ into the above equation, it can be obtained:

$$\begin{cases} \dfrac{dv_1(t)}{dt} = \mu_1 v_1 (1 + \sigma_{21} \dfrac{\beta}{V_2} - \dfrac{v_1}{V_1} - \sigma_{21} \dfrac{|v_2 - \beta|^*}{V_2}) - \lambda_1 v_1 \\ \dfrac{dv_2(t)}{dt} = \mu_2 v_2 (1 + \sigma_{12} \dfrac{\beta}{V_1} - \dfrac{v_2}{V_2} - \sigma_{12} \dfrac{|v_1 - \alpha|^*}{V_1}) - \lambda_2 v_2 \end{cases} \tag{28}$$

We make $a = 1 - \lambda_1 \mu_1, b = 1 - \lambda_2 \mu_2$, which then yields:

$$\begin{cases} \dfrac{dv_1(t)}{dt} = \mu_1 v_1 (\alpha + \sigma_{21} \dfrac{\beta}{V_2} - \dfrac{v_1}{V_1} - \sigma_{21} \dfrac{|v_2 - \beta|^*}{V_2}) \\ \dfrac{dv_2(t)}{dt} = \mu_2 v_2 (b + \sigma_{12} \dfrac{\beta}{V_1} - \dfrac{v_2}{V_2} - \sigma_{12} \dfrac{|v_1 - \alpha|^*}{V_1}) \end{cases} \tag{29}$$

In the first equation of Eq. (29), we make $v_2 = 0$ to obtain $dV_1(t)/dt = \mu_1 v_1 (\alpha V_1 - v_1) V_1$, which indicates that there exists only information A propagating on the information platform.

When $0 < v_1 < \alpha, 0 < v_2 < \beta$, the above equation can be changed to the forward propagation model of information A and information B:

$$\begin{cases} \dfrac{dv_1(t)}{dt} = \mu_1 v_1 (\alpha + \sigma_{21} \dfrac{v_2}{V_2} - \dfrac{v_1}{V_1}) \\ \dfrac{dv_2(t)}{dt} = \mu_2 v_2 (\beta + \sigma_{12} \dfrac{v_1}{V_1} - \dfrac{v_2}{V_2}) \end{cases} \tag{30}$$

At $v_1 > \alpha, v_2 > \beta$, Eq. (29) can be changed into a negative propagation model for information A and information B:

$$\begin{cases} \dfrac{dv_1(t)}{dt} = \mu_1 v_1 (a + 2\sigma_{21} \dfrac{\beta}{V_2} - \dfrac{v_1}{V_1} - \sigma_{21} \dfrac{v_2}{V_2}) \\ \dfrac{dv_2(t)}{dt} = \mu_2 v_2 (b + 2\sigma_{12} \dfrac{\alpha}{V_1} - \dfrac{v_2}{V_2} - \sigma_{12} \dfrac{v_1}{V_1}) \end{cases} \tag{31}$$

## III. Analysis of the spread and control of juvenile delinquency

### *III. A. Analysis of the spread of juvenile delinquency on the Internet*

#### III. A. 1) Data sets and information dissemination models

In this paper, five real social networks, including Karatein, Dophins, Polbooks, Football, and NetScience, are empirically analyzed based on the multilayer network model of offline and online interactions using C language, respectively. The statistical properties of the real networks are shown in Table 1.

This experiment uses the classical SIR disease propagation model to evaluate the propagation ability of nodes, which assumes that the nodes in the network have three states: susceptible state S, infected state I, and immune state R. At each time step, nodes in the infected state propagate to their neighboring nodes with probability $\alpha$, while each infected node is cured or dies with probability $\gamma$.

Table 1: The statistical characteristics of the real network

| Network characteristics | Karatein | Dophins | Polbooks | Football | NetScience |
|---|---|---|---|---|---|
| Point | 31 | 65 | 105 | 119 | 1590 |
| Side | 71 | 165 | 438 | 605 | 2735 |
| Average degree | 4.669 | 5.702 | 8.268 | 11.69 | 3.532 |
| Network diameter | 11 | 7 | 4 | 6 | 15 |
| Clustering coefficient | 0.579 | 0.382 | 0.534 | 0.452 | 0.891 |
| Mean path length | 2.567 | 3.622 | 3.182 | 2.836 | 5.901 |

| | | | | | |
|---|---|---|---|---|---|
| Number of clubs | 5 | 7 | 6 | 10 | 401 |
| Number of connection subgraphs | 2 | 3 | 4 | 5 | 388 |

**III. A. 2) Comparative analysis of statistical characteristics of network structures**

In order to verify the influence of key nodes on information dissemination, this experiment uses a multilayer network model with online and offline interactions to identify the key nodes of five real networks, and isolates the identified key nodes in the top 5% of the rankings, i.e., removes the edges that are connected to these nodes, respectively. The changes in the statistical properties of the network structure are shown in Table 2, from which it can be seen that the average degree and clustering coefficients of the network have decreased and the average path length has increased. Analyzed from the perspective of information propagation, the decrease in clustering coefficient makes the network association less tight, and the information propagation threshold within the association will be reduced accordingly, while the increase in average path length makes it more difficult for information to propagate to other parts of the network. The effectiveness of the key nodes identified by the multilayer network model controlling online and offline interactions in suppressing information propagation is verified from the perspective of network statistical properties.

Table 2: Statistical characteristics of the network structure

| Key node | Network characteristics | Karatein | Dophins | Polbooks | Football | NetScience |
|---|---|---|---|---|---|---|
| Before you remove the key nodes | Average degree | 4.25 | 4.898 | 8.133 | 10.546 | 3.526 |
| | Clustering coefficient | 0.595 | 0.302 | 0.514 | 0.375 | 0.903 |
| | Mean path length | 2.108 | 3.133 | 2.867 | 2.359 | 5.732 |
| After the key nodes are removed | Average degree | 3.668 | 5.092 | 7.289 | 10.258 | 3.026 |
| | Clustering coefficient | 0.494 | 0.343 | 0.452 | 0.402 | 0.891 |
| | Mean path length | 2.377 | 3.279 | 3.295 | 2.359 | 6.209 |

***III. B. Simulation of the case of the dissemination of criminal behavior of minors***

In recent years, juvenile delinquency type incidents occur frequently, which have caused extremely bad reflections and serious panic emotions in the society.2024 December, the murder of junior high school students in Handan, Hebei Province, as one of the most difficult to control, has the characteristics of juvenile criminal behavior event dissemination such as fast dissemination, little controversy and media first. This section chooses this case to conduct a simulation study on the dissemination of juvenile delinquent behavior events, in order to provide a good strategy for effectively guiding and intervening in the juvenile delinquent behavior events of this case. By comprehensively combing and analyzing the incident, seven main messages, seven psychosocial types and seven mainstream views were obtained. The information of the murder case of junior high school student in Handan, Hebei Province is shown in Table 3.

Table 3: The information of middle school students in Handan, Hebei province

| Information and number | Psychology and number | Views and Numbers |
|---|---|---|
| A1: Middle school students in Handan, Hebei province | B1: Violent mania | C1: The lack of national safety education |
| A2: Locate the suspect and expose it | B2: Social anxiety | C2: False information |
| A3: Official message: it has nothing to do with terrorism | B3: Mainstream fatigue | C3: Call on vulnerable groups |
| A4: Weibo: the perpetrators are non-adults | B4: Guest mindset | C4: Non-adult protection is urgently needed |
| A5: Monitor the details of the crime | B5: Compassion | C5: Condemn crime strongly |
| A6: The police disclosed the crime first with the motive of bullying | B6: Indignant | C6: Question the social system |
| A7: Media reporting on the lives of the perpetrators | B7: Objective thinking | C7: Hail to save a hero |

By the above multilayer network construction method, the offline network with Noff=11000 is constructed, the connection probability of ER random network is p=0.451%, and the degree distribution of the offline network obtained by Goff is shown in Fig. 1. The online network with Non=4614 is constructed according to the latest national Internet user rate by CNNIC, and the number of new connected edges per node of the BA network growth model is 85, and the degree distribution of the online network obtained by Goff is shown in Fig. 2. Both simulation results accept the original hypothesis at 99% confidence level and pass the hypothesis test, which is reasonable.

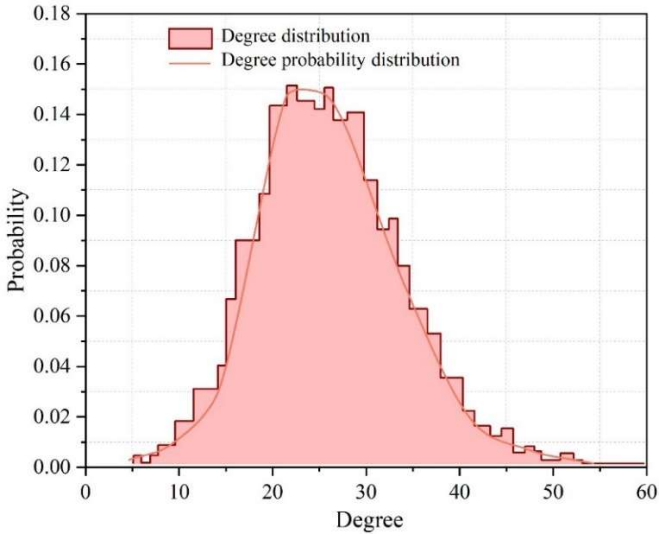


Figure 1: The degree distribution of the offline network of Goff

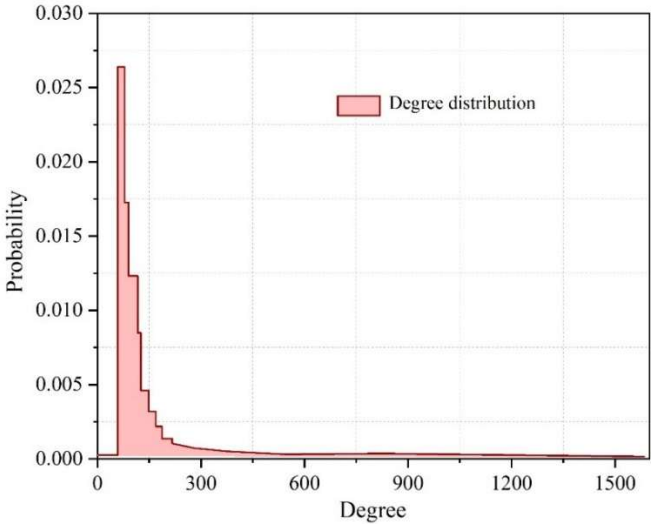


Figure 2: The online distribution of the Gon

**III. B. 1) Communication simulation**

At present, China is in a period of transition in its social development, and rapid changes in the social environment, social structure and social order, a serious imbalance in educational resources, and insufficient attention paid to the mental health of adolescents and young people have led to such phenomena as psychosocial imbalance in some groups of minors and the polarization of groups. The society is filled with all kinds of extreme psychology, as well as general indifference, making social pathology a prominent problem in the process of China's modernization and transformation.

Combined with the actual situation of the murder of the junior high school student in Handan, Hebei, the distribution of the number of people holding various views is shown in Figure 3. On the first day after the incident, the officials conducted forensic investigation on the information of the incident, and the readiness to recognize false information gradually decreased; on the second day, with the exposure of the details of the criminal's crime in the surveillance video, the number of people who strongly condemned the criminal act and the social system's punishment of the minors reached the highest level, and at the same time, after the media vigorously reported on the living environment of the perpetrator, the intensity of those who were concerned about the vulnerable groups and the lack of safety education became more and more popular. The fourth day honored the courageous and courageous people of the community. On the fourth day, after the conference honoring the courageous exposure of the real time, the viewpoints focusing on the mental health of the minors and the performance of the heroes who bravely exposed the dark side were the highest.

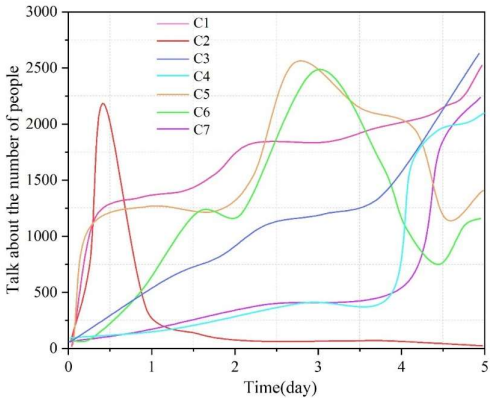


Figure 3: The distribution of various viewpoints

**III. B. 2) Validation of model validity**

This paper argues that the effectiveness of the model can be verified by inversion analysis of the real simulation scenario through real microblog data, and it is logically considered that different strategy scenarios are effective. Through the information mining platform for juvenile criminal conduct incidents, set up keywords "Hebei, minors, bullying" to collect microblog information; Through the visual analysis tool of Peking University's PKUVIS microblog, the data set of the murder of junior high school students in Handan, Hebei Province was obtained by taking the microblog information with the keyword "the victim of junior high school students in Handan, Hebei Province", and at the same time grabbing the retweet comment data of the microblog with a large number of retweeted comments.

The process of data processing is as follows: cleaning data, deleting duplicates, and obtaining a total of 5972 microblogging information. The text of the cleaned data is analyzed and categorized into the above seven views. The results were analyzed day by day and category by category, and the statistical distribution of the real viewpoints is shown in Fig. 4. Comparing the simulation chart and the real viewpoint statistics chart, the daily distribution trend of different viewpoints obtained from the analysis of real microblogging data is highly consistent with the simulation results, therefore, it can be considered that the multilayer network model of online and offline interactions is effective in the simulation of the dissemination of juvenile delinquent behavior events.

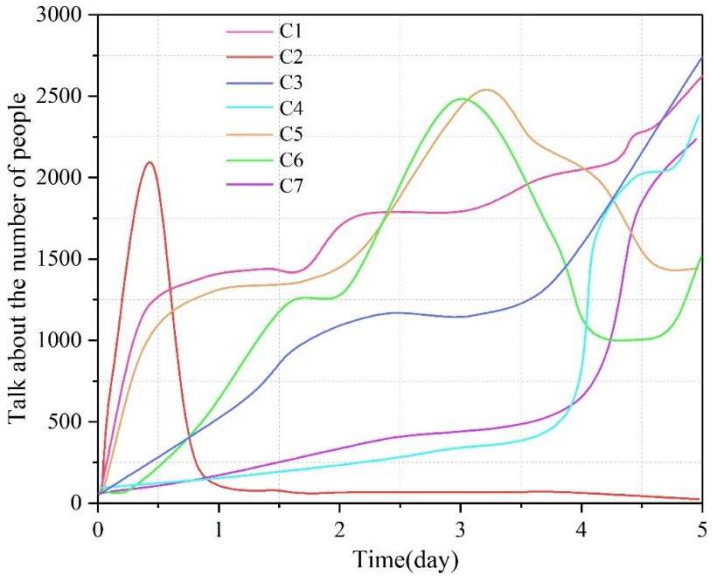


Figure 4: The results of the statistical distribution of real ideas

***III. C. Actual case studies of incident control of juvenile delinquent behavior***

In June 2024, a vicious case of school bullying occurred in Nanyang City, Henan Province. A minor girl, together with a number of people, committed insulting behaviors such as stripping, beating, and taking photos and videos of her classmates, and the video triggered public anger after spreading on the Internet. This paper takes this incident

as a case study to verify the validity of this paper's model, and examines the impact of various control measures on the dissemination of juvenile delinquent behavior incidents by setting up different scenarios.

**III. C. 1) Case Validation**

This paper uses WeChat and Weibo, a platform for analyzing incidents of juvenile delinquency, as a source of data. The number of messages generated on each platform per day for a total of 20 days from June 10 to 30, 2024 was selected as the number of infected persons by using the function of dissemination trend of sub-platforms in the platform. Set the total number of people on each platform as 30,000, 20,000 and 10,000 respectively, and standardize the data to get the relationship between the proportion of infected people under WeChat transmission, Weibo transmission and dual-platform transmission over time. Set the total number of users N0=16000 for the simulation experiment. The number of infected people at the initial moment is set to I1(0) = 100, I2(0) = 1000, I3(0) = 10000. Calibration experiments were conducted on the relevant parameters of the WeChat propagation model (WX), Weibo propagation model (WB), and dual-platform propagation model (B) in steps of 0.01.

The comparison of the simulation data of this paper's model (SEIR), the traditional model (SIR) and the case data is shown in Figure 5. As can be seen from the figure, the model of this paper can better simulate the evolution trend of the minor criminal behavior events in the case than the traditional model. Because the state of susceptible persons in microblogging and weibo layer is strictly synchronized, and the change in the number of susceptible persons can visualize the effect of media guidance and government intervention at the same time, the following section uses the optimal parameters of dual-platform propagation fitting as the experimental parameters, and takes the change in the number of susceptible persons in weibo layer as the index to carry out simulation experiments for controlling the criminal behavior of minors.

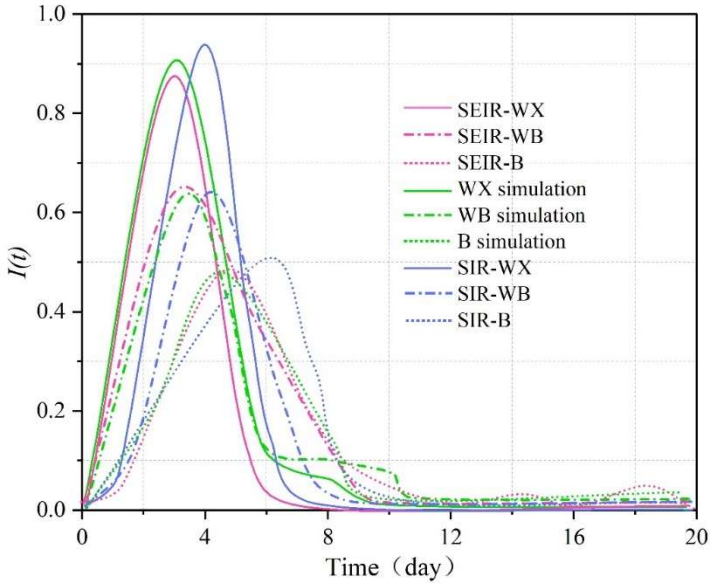


Figure 5: Different model simulation data compare with case data

**III. C. 2) Single/dual platform control comparison**

A comparative experiment was conducted to study the differences between media guidance and government control implemented on a single platform and simultaneous implementation on two platforms. Five scenarios are set up: Scenario 1, no juvenile criminal behavior event control is added; Scenario 2, media guidance is carried out at the WeChat layer; Scenario 3, media guidance is carried out at both the WeChat and microblog layers; Scenario 4, government intervention is carried out at WeChat only; and Scenario 5, government intervention is carried out at both the WeChat and microblog layers.

The simulation results of single/dual platform comparison are shown in Figure 6. Scenario 2 shows a significant decrease in the number of homeostatic susceptible persons and a shortening of the relaxation time of juvenile delinquent behavior, indicating that the media reports make netizens access to information faster and juvenile delinquent behavior accelerates; Scenario 2 is not as effective as Scenario 3, indicating that multi-platform media guidance is more effective than single-platform guidance; Scenario 4 shows a significant increase in the number of homeostatic susceptible persons and a shortening of the relaxation time of juvenile delinquent behavior. Scenario 4 has a significant increase in the number of steady state susceptible persons compared with scenario 1, and the

relaxation time of juvenile delinquent behavior events is shortened, which indicates that the government's intervention makes juvenile delinquent behavior events calm down quickly, so that some netizens do not have access to the information; Scenario 4 has a longer relaxation time than scenario 5, and the number of steady state susceptible persons is lower, which indicates that dual-platform control is more effective than single-platform control.

The simulation results suggest that media guidance should be voiced on multiple social platforms simultaneously in order to attract wider attention from netizens; government intervention should be strengthened by joint control and prevention, and multiple platforms should be started at the same time.

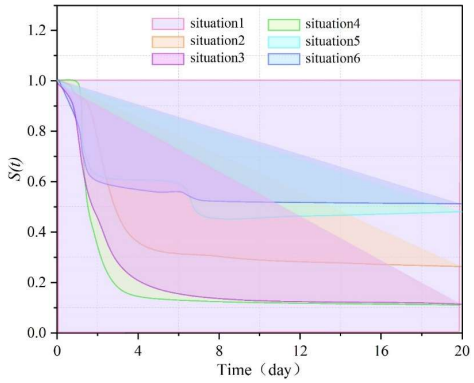


Figure 6: Single/dual platform comparison simulation results

**III. C. 3) Analysis of factors influencing media guidance**

The main influencing factors of media guidance include coverage intensity, guidance time, and number of media. Four guidance scenarios are set up: Scenario 1 is the basic scenario, with reporting intensity $sm = 0.7$, guidance threshold $I_0^G = 0.1$, and the number of media $N_c^M = 10$; Scenario 2 increases the reporting intensity, with $sm = 0.9$; Scenario 3 advances the guidance time, i.e., lowers the intervention threshold, with $I_0^G = 0.05$; and Scenario 4 increases the number of media, with $N_c^M = 20$.

The simulation results of media guidance influencing factors are shown in Figure 7. Scenario 2 shows a decrease in the number of homeostatic susceptibility compared with Scenario 1, which indicates that increasing the guidance intensity can make more netizens come into contact with the information; Scenario 3 shows a significant decrease in the relaxation time and the number of homeostatic susceptibility, which indicates that it is more effective for the media to intervene in the guidance at an earlier stage; Scenario 4 has the best effect among the four kinds of guidance, which indicates that it is easier to create a public opinion momentum by collaborating with a number of media to make a voice.

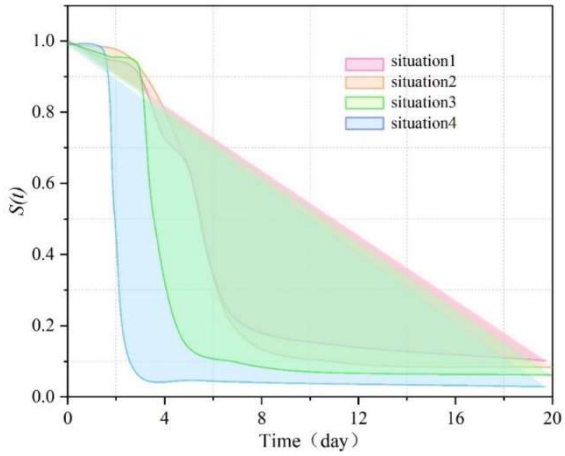


Figure 7: Simulation results of media guidance influence factors

**III. C. 4) Analysis of factors influencing government intervention**

The main influencing factors of government intervention include intervention scope, intervention intensity, intervention time, and tendency of cross-level dissemination. Five intervention scenarios are set up: Scenario

$\chi = 0.5$ is the base scenario, with intervention scope 1, intervention intensity $so = 0.7$, and control threshold $I_0^I = 0.15$; Scenario 2 expands the intervention scope, with $\chi = 0.7$; Scenario 3 increases the intervention intensity, with $so = 0.9$; Scenario 4 advances the intervention time, i.e., reduces the intervention threshold $I_0^I = 0.05$; and Scenario 5 reduces the flow of information between platforms, i.e., reduces the tendency of cross-layer dissemination, with $\varepsilon = 0.3$.

The simulation results of government intervention influencing factors are shown in Figure 8. Scenario 2 is shorter than scenario 1 evolutionary relaxation time of juvenile delinquent behavior events, and the number of steady state susceptible people is more, indicating that expanding the scope of intervention can make juvenile delinquent behavior events calm down as soon as possible, and the number of netizens who eventually did not come into contact with the information is correspondingly more; Scenario 3 has a greater intervention intensity than Scenario 1, and the evolutionary relaxation time of juvenile delinquent behavior events does not vary much, but it can increase the number of end-state susceptible people; Scenario 4 is the best effect Scenario 4 is the most effective, indicating that the control of juvenile delinquent behavior events should be intervened as early as possible to control juvenile delinquent behavior events in the incipient period, and the corresponding cost can be the lowest; Scenario 5 juvenile delinquent behavior events have a longer evolutionary time, but it can enhance the number of susceptible persons, indicating that the control of the cross-platform flow of information can be effective in the control of juvenile delinquent behavior events, but it takes a longer time.

The simulation results suggest that government intervention should increase sensitivity and intervene as early as possible, and at the same time, reducing the cross-platform interactive dissemination of information can effectively control juvenile delinquent behavior events.

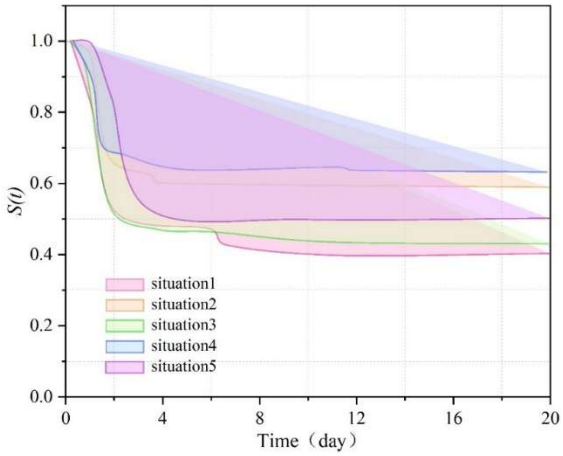


Figure 8: Government intervention impact factor simulation results

## IV. Conclusion

Based on the multilayer network theory, this study constructs a multilayer network model of online and offline interaction to reveal the propagation mechanism of juvenile delinquent behavior and provide scientific basis and decision support for preventing and controlling the propagation of juvenile delinquent behavior.

(1) This paper verifies the effectiveness of controlling the propagation model of this paper in identifying the key nodes in inhibiting the spread of information from the perspective of network statistical properties.

(2) The simulation results of the murder case of junior high school students in Handan, Hebei province show that the prediction results of this paper's method on the dissemination trend of juvenile delinquent behavior events are effective, and the distribution trend of different viewpoints obtained from the analysis of its real data is highly consistent with the simulation results.

(3) The results of the actual cases found that the model of this paper can better simulate the evolution trend of juvenile delinquent behavior events in the cases than the traditional model. In addition, in the dissemination of juvenile delinquent behavior, the media should guide the simultaneous voices in multiple social platforms to attract wider attention from netizens; government intervention should strengthen the joint control and prevention, intervene as early as possible, and effectively control juvenile delinquent behavior events by reducing the interactive dissemination of information across multiple platforms.

## References


[1] Rahman, M. T., & Mufti, M. (2021). Massification of youth religious studies to prevent juvenile delinquency in Bandung. HTS Teologiese Studies/Theological Studies, 77(4).

[2] Mpofu, P., & Machingauta, T. T. (2023). Dissecting probable indicators of juvenile delinquency among Gweru Urban adolescents in Zimbabwe. Interdisciplinary Journal of Sociality Studies, 3, 72-89.

[3] Salih, D. (2021). Phenomenology of Juvenile Delinquency. Journal of Management and Development Studies, 10(2), 24-41.

[4] Ashebir, K. (2018). Juvenile Delinquency and Its Subsequent Consequences. Available at SSRN 3864798.

[5] Mohammad, T., & Nooraini, I. (2021). Routine activity theory and juvenile delinquency: The roles of peers and family monitoring among Malaysian adolescents. Children and Youth Services Review, 121, 105795.

[6] Saxena, A. A. A., & Khom, N. M. (2019). CHAPTER-3 Juvenile Delinquency. GENDER ISSUES, 15.

[7] Riaduzzaman, M. (2017). Juvenile Delinquency and Justice System in Bangladesh: A Critical Analysis. BiLD Law Journal, 2(1), 125-144.

[8] Sagita, A. S. (2023). Analyzing the Public Perception of Brawl Phenomena Involving Juvenile Delinquency in Jakarta. IJESS International Journal of Education and Social Science, 4(2), 82-95.

[9] Kim, H. R. (2023). The current state and legal issues of online crimes related to children and adolescents. Journal of the Korean Academy of Child and Adolescent Psychiatry, 34(4), 222.

[10] Brady, C. M., & Peck, J. H. (2021). Office of juvenile justice and delinquency prevention. The Encyclopedia of Research Methods in Criminology and Criminal Justice, 2, 809-813.

[11] Sun, C. (2024). Summary Report on the Relationship between Juvenile Delinquency and Educational Environment. Social Sciences and Childhood, 5(1), 37-46.

[12] Hirschi, T. (2017). Causes and prevention of juvenile delinquency. In The Craft of Criminology (pp. 105-120). Routledge.

[13] Mbugua, M. (2016). An investigation of public perceptions of youth crime and juvenile delinquency in Embakasi Sub-county in Nairobi County, Kenya. context, 6, 14.

[14] Pardini, D. A., & Hawes, D. J. (2022). Evidence‐based Delinquency Prevention for Children Exhibiting Conduct Problems. Facilitating Desistance from Aggression and Crime: Theory, Research, and Strength‐Based Practice, 315-337.

[15] Delcea, C., Fabian, A. M., Radu, C. C., & Dumbravă, D. P. (2019). Juvenile delinquency within the forensic context. Romanian Journal of Legal Medicine, 27(4), 366-372.

[16] Mwangangi, R. K. (2019). The role of family in dealing with juvenile delinquency. Open Journal of Social Sciences, 7(03), 52.

[17] Rathinabalan, I., & Naaraayan, S. A. (2017). Effect of family factors on juvenile delinquency. International Journal of Contemporary Pediatrics, 4(6), 2079-2082.

[18] Nisar, M., Ullah, S., Ali, M., & Alam, S. (2015). Juvenile delinquency: The Influence of family, peer and economic factors on juvenile delinquents. Applied Science Reports, 9(1), 37-48.

[19] Khuda, K. E. (2019). Juvenile delinquency, Its causes and justice system in Bangladesh: A Critical Analysis. Journal of South Asian Studies, 7(3), 111-120.

[20] Abhishek, R., & Balamurugan, J. (2024). Impact of social factors responsible for Juvenile delinquency–A literature review. Journal of education and health promotion, 13(1), 102.

[21] Bobbio, A., Arbach, K., & Illescas, S. R. (2020). Juvenile delinquency risk factors: Individual, social, opportunity or all of these together?. International journal of law, crime and justice, 62, 100388.

[22] Bagheri, M., Moazami, S., Nejad, A. A., & Mansouri, S. M. (2022). Examining Social and Psychological Factors that Affect Juvenile Delinquency. Journal of Positive School Psychology, 6(7), 292-300.

[23] Susila, M. E., & Yonar, B. (2024). Protecting Children Rights through the Juvenile Criminal Justice System in Indonesia: Issues and Challenges. Jurnal Mercatoria, 17(1), 76-84.

[24] Valuiskov, N. V., Bondarenk, L. V., & Arutiunian, A. D. (2017). Juvenile crime: current state and dynamics. J. Pol. & L., 10, 225.

[25] Li, Z. (2024). Empirical Research on Juvenile Crime Prevention. Transactions on Comparative Education, 6(3), 43-49.

[26] Cai, Y. (2024). The Role of Social Media in Influencing Juvenile Delinquent Behavior. Communications in Humanities Research, 52, 1-8.

[27] Xu, J., & He, M. (2022). Prevention and Countermeasures of Juvenile Delinquency. Studies in Social Science & Humanities, 1(1), 101-104.

[28] Cicerali, L. K., & Cicerali, E. E. (2018). Parental influences on youth delinquency. Journal of criminal psychology, 8(2), 138-149.

[29] Rose, S., Ambreen, S., & Fayyaz, W. (2017). Contributing factors of juvenile delinquency among youth of Balochistan. Pakistan Journal of Criminology, 9(3), 165-179.

[30] Lucas, G. N. (2018). Juvenile delinquency. Sri Lanka journal of child health, 47(3).

[31] Bates, K. A., & Swan, R. S. (2020). Juvenile delinquency in a diverse society. Sage Publications.

[32] Young, S., Greer, B., & Church, R. (2017). Juvenile delinquency, welfare, justice and therapeutic interventions: a global perspective. BJPsych bulletin, 41(1), 21-29.

[33] Kennedy, T. D., Detullio, D., & Millen, D. H. (2020). Juvenile delinquency. Theory, Trends, Risk Factors and Interventions, Nova Southeastern University, Fort Lauderdale, USA.

[34] Dongliang Wang,Chuang Huang,Hao Pan,Yuan Sun,Jian Dai,Yanan Li & Zhenwen Ren. (2025). AMLCA: Additive multi-layer convolution-guided cross-attention network for visible and infrared image fusion. Pattern Recognition,163,111468-111468.

[35] Yang Fangfang & Zhang Zizhen. (2021). Hopf bifurcation analysis of SEIR-KS computer virus spreading model with two-delay. Results in Physics,24,

[36] Jan Haskovec. (2021). Well posedness and asymptotic consensus in the Hegselmann-Krause model with finite speed of information propagation. Proceedings of the American Mathematical Society,149(8),3425-3437.