A New Information Transmission Model of Product Quality and Safety Based on Government Intervention

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***Abstract*—The paper takes the web information of product quality safety as research object. Aiming at its transmission characteristic at social network, information transmission model based on government intervention is presented. Meanwhile, the influence of information transmission with government intervention is analyzed. Lastly we adopted BA network to build human relation model, used MATLAB tool to simulate the model. The results show that the proposed model is effective and feasible.**

***Index Terms*—Web information, product quality safety, information transmission model, government intervention**

I. Introduction

Product quality and safety closely links the national economy and people's livelihood, and it is not only a consumer attention priority, is also the focus of public opinion and governments. With the development of Web technology, the social media appears, such as the blog, the Microblog, BBS, content community, information transmission mode is more and more diversified and complicated. Web has gradually become the important platform of product quality and safety of information release, evolution and public opinion monitoring. The most effective way to interpose and guide network public can well communicate with the public timely. Domestic and foreign scholars have done extensive research on this problem, and achieved achievements. Glik (2007) argued that the characteristics of public emergency, the type and release form of information, information, the recipient's property were the critical factors which determined whether the public would take protective action[1]. Sarafidis (2007) carried on a further research on network public transmission in network community, furthermore proposed scientific warnings and effective intervention strategies[2]. Wei et al. (2005) designed public opinion monitoring system based on meta search engine[3]. Cao et al. (2007) put forward that information monitoring and early warning in emergencies of public events, crisis resource management theory and technology, cognitive and decision-making behavior of public emergency problem were the important scientific problem in the study of the crisis of public emergency management[4]. Chen et al. (2008, 2010), according to the basic characteristics of the small-world network, built up a complex network model of public crisis information dissemination, they adjusted the network evolution by changing special parameters, and put forward an intervention mode of public crisis information dissemination[5,6]. Camelia et al. (2012) carried on a further research on how to perform compensation and make intervention methods after the occurrence of public opinion[7]. Liu et al. (2012), combined the present management situation of China food safety risk information with realistic foundation, proposed network public opinion monitoring and intervening workflow, technical system and intervention measure of food safety in our country[8]. Lu (2012) carried on risk analysis on quality safety of livestock and poultry and proposed related countermeasures. Furthermore, several researches have studied the impact of spatial geographic factors and social network topology structure on the public opinion formation[9]. Combined with complex networks and infectious disease dynamics theory, Zhang et al. (2011) constructed information dissemination model based on a social online network that analyzed node degree and the impact of dissemination mechanism[10]. Through partial features of spatial location and small-world, Luo et al. (2012) used the Ising model and a scale-free network to study how the space factors, the network factors, and

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related parameters affect the formation of public opinion[11]. Jalili (2013) used the complex network to analyze the social power and public opinion formation and further conducted a simulation experiment with small-world and scale-free networks[12]. On the basis of the previous research, this paper attempts to build evolution model of product quality and safety incidents with government intervention. The remainder of the paper is organized as follows. Status transition diagram of information transmission model is discussed in Section 2. The mathematical formulation for the transmission model based on with government intervention is presented in Section 3. Computational results are analyzed and discussed in Section 4. Section 5 concludes the paper.

II. Status Transition Diagram Of Information Transmission Model

In the information transmission model based on government intervention, we setup two kinds of information W (event information) and G (government information) according to the reality. These two kinds of information are transmitted in the same crowd and network. In general, after the event has occurred and been transmitted to a certain inform scale, government will deliver the official information of event by pre-built public platform like micro-letter account. At this moment, government information and previous consumer products quality safety information are both transmitted in the network. The differences between government information and previous event information are:

(1) At the point of time, government information is later than event information. At the beginning of transmission large number of people pay attention to the event.

(2) The reliability of government information is higher. People prefer to believe in information delivered by the government department for the description related to the same event.

(3) After government department deliver the information, the event will evolve from a kind of non-standard and informal rumor into an authorized and normalized event. The audience's inform will and transmission will to event information will increase. The event will be paid more attention.

Aiming at the characteristics of government information transmission, we assume that (1) Audience won't query the government information and won't be in panic after receiving the government information. They can adjust their solutions according to the authenticity of the event. (2) Previous information and government information transmission won't disturb each other after government department delivers the information. Figure 1 shows the information transmission model based on government intervention based on above assumptions.

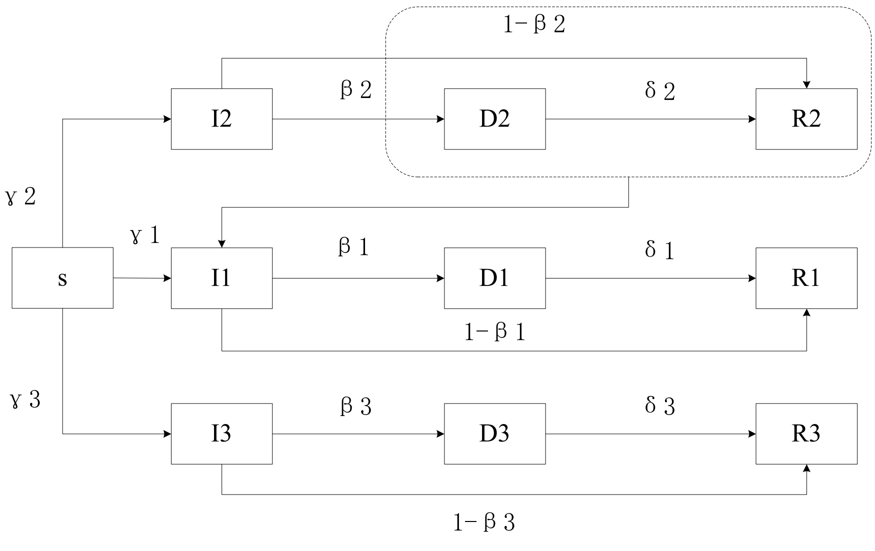

Figure 1 Status transition diagram of information transmission model based on government intervention

III. Construction The Information Transmission Model

A. Basic Parameters

T indicates the time start of government intervening transmission process. N indicates total number of nodes in the network, which represents the scale of the network. K represents the average in-degree of all the nodes in the network, like the number of users by whom the individual is in attention. k_g is the number of nodes which attention government information, thus the out-degree of government information node. P indicates the probability of the node getting information from connectionless node, like a node acquires information a friend's friend.

P_g indicates the probability of government information is informed by the node. Before government delivers the information, $P_g = 0$. After government delivers the information,

$$P_g = k_g/N + P(1-k_g/N) + (k/N + (1-k/N)P(D_1(t-1)+D_3(t-1)))$$

It includes probability of node acquires information from node which delivers government information $k_g/N + P(1-k_g/N)$ and probability of node acquires information from node which knows government information.

$$(k/N + (1-k/N)P(D_1(t-1)+D_3(t-1))).$$

Seen from the latter equation, probability of node acquires information from node which knows government information will increase when the number of nodes D_1 and D_3 which know and transmit information increases. The reason is that the increasing number of informed and transmitted nodes in the network leads that nodes are easier to contract informed and contracted nodes.

$\beta_i (i=1,2,3)$ indicates the transmission will of insiders, which means the probability of insiders transmit the scanned consumer products quality safety We information or government information to friends. After becoming an insider, the individual will make a decision whether transmitting information to friends. The decision is influenced by the user's character and behavior by one side. By the other side it's influenced by earnings (like satisfaction of drawing attention) and time cost acquired by transmitting the information. This model concerns the difference of insider's transmission will to different information, which means that the wills of insider's transmitting information W and G are not equal. β_1, β_2 and β_3 respectively represent the wills to transmit information W and G, information W and information G. In general, β_3 is bigger than β_2 because when government speech occurs in the network, public have clear discrimination to consumer products information and prefer to transmitting the verified information by the authority. Meanwhile government speech can be received by many kinds of media. Repeated receiving the same information can enhance the memory and both will increase the transmission factor of information.

$\eta_i (i=1,2,3)$ indicates inform will, which represents the attention degree of node itself to information. Similar with transmission will, we also consider the difference of inform will of different information. η_2 indicates the inform will of node to information W and η_3 indicates the inform will of node to information G.

In the process of information transmission, information will inevitably have a certain degree of missing, omitting, overstating or distorting without remaining unchanged impossibly. In order to simplify the model, we will not consider the cases of information missing, omitting, overstating or distorting.

B. Construction Model

In the information transmission model based on government intervention, basic status are divided into four classes, susceptibly infection status, thus non-informed and may be told (S, Suspected), infection status, thus informed (I), involved in transmission (D, Disseminating), informed but not transmit (including stopping transmission status) R (Resistant) four statuses. And status I, D and R respectively divide into three child statuses, corresponding to three cases:

(1) indicate the status of node which informs consumer products quality safety information W and government information G. It can be interpreted that information W is transmitted in the network and informed by a part of people. Afterwards these people are ultimately informed of the government information by the continuously attention to the event and government verification and clarification to the event.

(2) indicate the status of node which informs consumer products quality safety information W but doesn't inform government information G. Information W transmission in the network is informed by a part of people. However, they are not informed of the government information because government information transmission doesn't cover the whole network.

(3) ndicate the status of node which doesn't informs consumer products quality safety information W but informs government information G. Afterwards a part of people may inquire into the whole event.

The process of information transmission is divided into two stages:

(1) When there is no government information ( ), web information W will be transmitted according to model introduced in the first section. The information of status S may have two kinds of status changes (and). If it contracts transmission node and be interested in the information and reads the information, the node will transit from status S to status . If it doesn't contract transmission node and is non-informed, its statue will maintain status S. When nodes read the information and become informed (status), a part of nodes produce transmission will after become insiders and become informed and transmitted . The other part of nodes won't produce transmission will and become immune nodes and stopping transmitting .

(2) When government information transmits in the network ( ), all the nodes inform W (and) are anew in a non-informed and may be told status (S), which have a certain probability of contracting information G and deriving into status , as it's shown dotted in the figure. This transition is meaningful in reality. Government transmission can't ensure all the nodes in the network can receive. However, in the trust in the government, the nodes that receive the information will be panic to the previous event and grasp more official correct information and transmit to other nodes.

For the node which doesn't know information W, information W and G transmit in the network at the same time and each node will transit into one of the statuses corresponding to different probabilities . If the node contracts information W and informs information G, then its status will be transited from S into . If it only knows information G not information W, its status will be from S to . If the node neither informs G nor W, its status will be maintained S.

It's worth noting that for the nodes , and that only inform government information G and don't inform information W in the network, and according to the characteristics of public inquisition and detailed explanation of government information, the proper paper tacitly approves that the node inform the integrated information after informing information G. Therefore, it won't lead to the panic of the nodes.

According to status transition diagram of information transmission model with government intervention, we can get the following differential equations.

$$dS/dt = -\gamma_1(t)S(t) - \gamma_2(t)S(t) - \gamma_3(t)S(t) \quad (1)$$

$$\begin{cases} dI_1/dt = \gamma_1(t)S(t) + P_g(t)I_2 \\ dD_1/dt = \beta_1\, dI_1/dt - \delta_1 D_1(t) \\ dR_1/dt = (1-\beta_1)\, dI_1/dt + \delta_1 D_1(t) \end{cases} \quad (2)$$

$$\begin{cases} dI_2/dt = \gamma_2(t)S(t) - P_g(t)I_2 \\ dD_2/dt = \beta_2\, dI_2/dt - \delta_2 D_2(t) \\ dR_2/dt = (1-\beta_2)\, dI_2/dt + \delta_2 D_2(t) \end{cases} \quad (3)$$

$$\begin{cases} dI_3/dt = \gamma_3(t)P_g(t)S(t) \\ dD_3/dt = \beta_3\, dI_3/dt - \delta_3 D_3(t) \\ dR_3/dt = (1-\beta_3)\, dI_3/dt + \delta_3 D_3(t) \end{cases} \quad (4)$$

where

$$\begin{cases} \gamma_1(t) = \eta_1 P_w P_g \\ \gamma_2(t) = \eta_2 P_w (1-P_g) \\ \gamma_3(t) = \eta_3 (1-P_w) P_g \end{cases} \quad (5)$$

$$P_g(t) = \begin{cases} 0, (t < T); \\ k_g/N + P(1-k_g/N) \\ +(k/N + (1-k/N)P(D_1(t-1) \\ +D_3(t-1))), (t \ge T) \end{cases} \quad (6)$$

$$P_w(t) = (k/N + P(1-k/N))(D_1(t-1) + D_2(t-1)) \quad (7)$$

For parameter $\gamma_i (i=1,2,3)$, it's made up of three parts.

(1) Inform will, represented by $\eta_i (i=1,2,3)$ and reflects the influence of individual to information transmission.

(2) Probability of contracting government information, which is represented by P_g and reflects the influence power of government deliver information platform. For example, public accounts, which have high public attention, have large influence and manifest the influence of government information to information transmission.

(3) Probability of individual contracts event information W, represented by P_w. This probability can be divided into two parts, probability of receiving information from direct connective nodes and probability of receiving information from non-direct connective nodes. It reflects the influence of network structure to information transmission.

IV. Case Studies

In order to verify the proposed model, in this section, we used MATLAB simulate experiments. At first, adopt scale-free model proposed by Barabasi and Albert which is more recognized at present and can reflect the high heterogeneity structure of interpersonal network in web environment. The basic data of the network are as follows: the total number of nodes is 1000, the average degree is 14.85, the most degree is 334, clustering coefficient is 0.0838189.

According to the degree distribution function of BA network:

$$P(k) = \frac{2k_0(k_0+1)}{k(k+1)(k+2)} \propto 2{k_0}^2 k^{-3}$$

The function in the above equation states that the degree in time t happens to be the probability distribution in time k, k_0 is the average degree, the degree distribution function can be approximately describe by power law function of power 3.

In order to analyze the government intervention for information transmission progress, the parameter settings are as follows:

$\beta_1 = \beta_2 = \beta_3 = 0.5$,
$\delta_1 = \delta_2 = \delta_3 = 0.1$,
$\eta_1 = \eta_2 = \eta_3 = 1$,
P=0,
S(1)= 9600,
D2(1)=300,
R2(1)=100,
I2(2)=400,
$D_1(1) = D_3(1) = R_1(1) = R_3(1) = I_1(1) = I_2(1) = 0$,
k_g=20,
$\gamma_1(1) = \gamma_3(1) = 0$,
T=70.

Figure 2 shows the variations of the amount of W information and G information with and without government intervention.

From figure 2 we can see that in the case of no government released information, the amount of W information in the network has no obvious increase after increased to a certain proportion, the amount of information Mean - W remain at a stable level. In the environment of government released information, the government released information will affect the amount of the original consumer product quality safety web information; its impact is shown in figure 17. Before the government releases information, W information propagates according to the existing situation, after the government releases information, the amount of W information will increase compared with no government released information, the acceleration of the amount of information largen obviously. The information released by government increased significantly for a period of time.

From the view of population proportion indicator X(t) that may produce panic, in the case of no government released information, X(t) rapidly rising, until reaches 1 (100%), under the government intervention, at the moment of releases information X(t) rapidly lowering, at the same time, with the increase of time the decrease speed of X(t) slow down. From the experimental results we can see that the participation of the government plays an important influence on information transmission in the network. Hence the government can release the official information in the network to reduce people's panic psychology about consumer goods quality security incident.

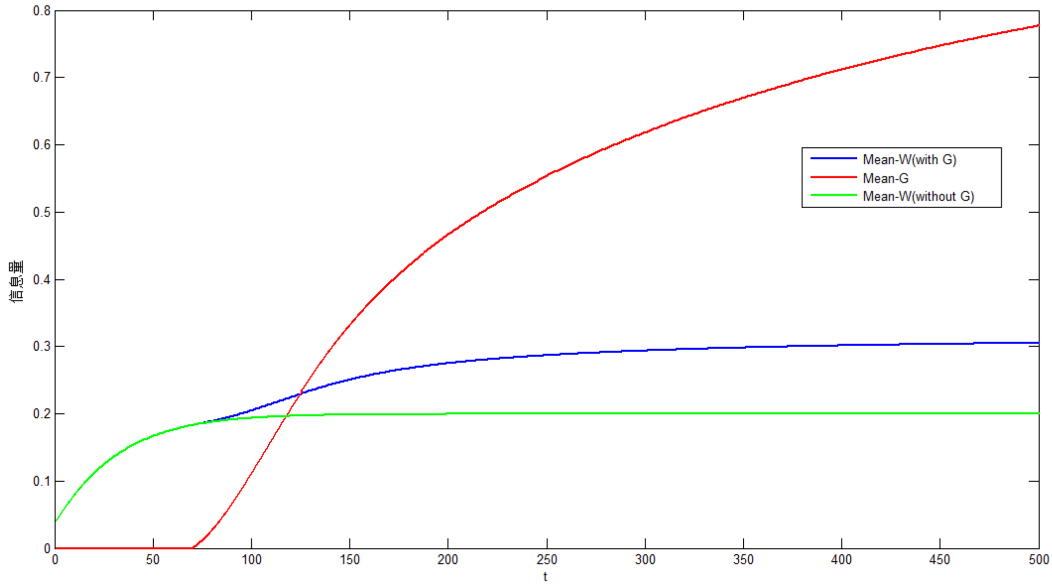

Figure 2 The variation of the amount of information with and without government intervention

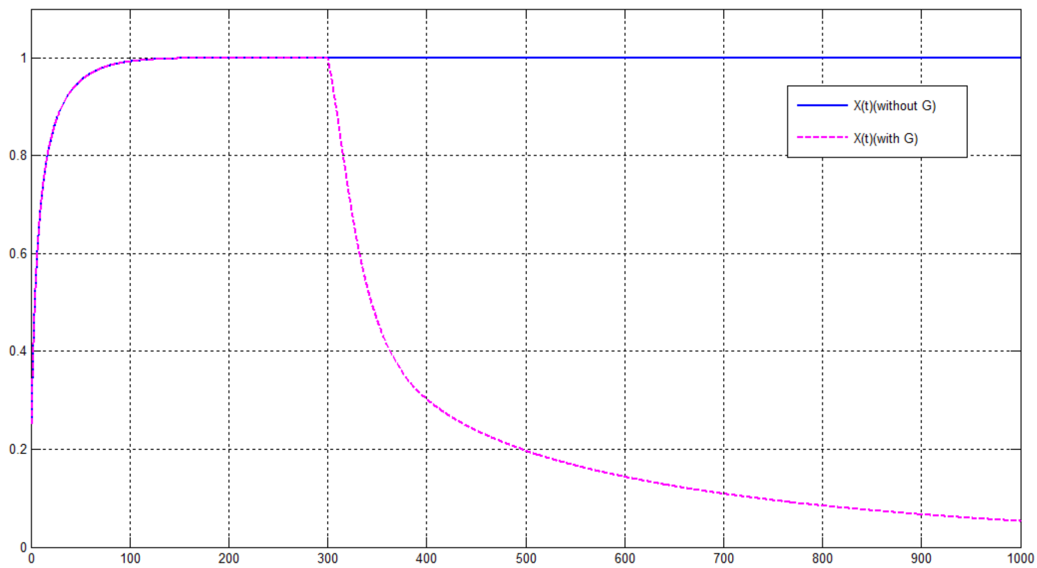

Figure 3 The effects to X with and without government intervention

V. CONCLUSION

In this study, we proposed information transmission model without government intervention aiming at the event information characteristic of consumer products quality safety. On this basis, we constructed information transmission model based on government intervention and analyzed the influence of information transmission with government intervention. Lastly we adopted BA network to build human relation model, use MATLAB tool to simulate the model. The experiment results showed the impacts of government information platform influence.

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