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USER-GENERATED CONTENT (UGC) ENCOUNTERED ENTERPRISE-GENERATED CONTENT (EGC): QUANTIFYING THE IMPACT OF EGC ON THE PROPAGATION OF NEGATIVE UGC

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Abstract

The impact of user-generated content (UGC), especially negative UGC on enterprises is well recognized. From the perspective of enterprises, different strategies of enterprise-generated content (EGC) have also been adapted to response to the unexpected UGC, but few studies have investigated the influence of such strategies on the UGC propagation. This research examines which strategy on the negative UGC propagation is optimal by proposing EGC-UGC interaction model. It aims to understand the interaction between UGC and EGC in the context of the social network. Using a simulation analysis method to measure the effect of such EGC factors as the first time of issuing EGC, EGC quantity and interactive frequency on the UGC propagation, the study finds that interactive frequency is the most key factor in defending against negative UGC propagation. This research further explores the effect of different strategy combination referring those three factors on the two types of negative UGC propagation based on deviation distance. The results present two optimal strategies for the two types of negative UGC propagation, respectively. Overall, these findings offer some unique implication for UGC management, information diffusion model of competitive information coexisting.

Keywords: User-generated content, Enterprise-generated content, Strategy combination, Deviation distance

1 INTRODUCTION

With the rapid development of Internet technology, particularly the emergence of Web 2.0 such as BBS, blog, microblog and social network services, people is not only exchanging information online but also expressing their ideas by virtue of user-generated contents (UGC) (Reilly 2007, Ozmutlu 2006). The amount of UGC available is already voluminous, and it continues to grow on a daily basis (Huang et al. 2010). UGC is not regulated by top-down rules, leaving users free to decide what to write about (topics), how to write (writing style), and when to write (publishing time). Since UGC is produced without supervision, standards and conventions, the effect of UGC, especially the extreme negative UGC on an enterprise is uncertain (Liao et al. 2003). Here, extreme negative UGC is one kind of negative UGC for an enterprise, which is unexpected, has a high possibility to cause extensive social influence, and is complex for dealing with.

Nestlé, the world's biggest food manufacturer, had to face the tough criticism storm from social media in the year 2010. On March 17 2010, environmental group Greenpeace launched a "Have a break; have a Kit Kat" video on YouTube attacking on Nestlé's Kit Kat brand. Greenpeace had found that Nestlé was sourcing palm oil from Sinar Mas, an Indonesian supplier that it claimed was acting unsustainably. The video led to Nestlé being attached on social networking sites such as Facebook and YouTube. Hundreds of thousands of people watched the grisly video, members of the public posted angry messages on Nestlé's Facebook page, anti-Nestlé campaign groups such as Baby Milk Action and Nestlé Critics took up the cause.

Nestlé attempted to use censorship to refrain the negative UGC. Nestlé's initial response was to force the video's withdrawal from YouTube, citing copyright. After the video was withdrawn from YouTube, it continued to spread on the social media. The antipathy soon gained expression in mainstream media around the world. By attempting to censor, Nestlé appeared hostile and sarcastic toward consumers and the brand image was badly damaged (Magee 2010).

The situation we described above does not just happen in the food industry. Actually, that is a common phenomenon and problem across many industries (e.g., services and manufacturing). As more enterprises realize the power of extreme negative UGC, it is reasonable that enterprises should interpose the propagation of extreme UGC through publish their own enterprise-generated content (EGC). But, what is the right way for enterprises to publish EGC? This is the practice issue we want to answer in this paper.

Extreme negative UGC can continue to grow exponentially without participation from the enterprise and completely outside of the enterprise's control, but there is a difficult balance to utilize the respond strategy due to the style of EGC and the time of response to different negative UGC (Thomas et al. 2012). Hence, it is worthwhile to identify the dynamic interaction mechanism between extreme negative UGC and EGC and offer optimal EGC strategies to restrain the propagation of the extreme negative UGC. This is the scientific motivations of this research.

To our knowledge, little of current study involves extreme negative UGC, not to mention the quantitative optimal strategy for enterprise to do decision. Thus, the most contribution of this paper lies in proposing the optimal EGC strategies for enterprise dealing with the extreme negative UGC, based on modelling the extreme negative UGC's propagation.

This paper is arranged as follows. Section 2 describes related work. Section 3 provides UGC propagation model considering EGC. Section 4 explores the equilibrium solution of our UGC propagation model. Section 5 presents EGC publishing strategies based on the parameter analysis of UGC propagation model. In Section 6, we provide management strategies to deal with UGC. The limitation and the directions for future research are put forward in the last.

2 LITERATURE REVIEW

Our work attempts to simultaneously address the negative UGC propagation under the context of EGC and the strategies for enterprises' responding to UGC. We review two relevant streams of literature: one is on the strategic manipulation of UGC and the other one is on the information diffusion.

2.1 Studies on Managerial Strategies to Negative UGC

Previous research examined how enterprises respond to negative incident and crisis in general. The impression management literature presents five response strategies that enterprises may adapt: confession, excuse, justification, denial and silence. Denial and confession, considered the two extremes of the response, have most often been studied. Similar to the way enterprises react to crisis, two typical reactions to consumer criticism in social media are observed. One is to fend off accusations, deny the flaw, and try to protect the brand image while the other one is to admit a possible defect and apologize.

Emelia Howell et al. (2012) unpacked options for enterprises dealing with unexpected negative UGC. Case studies and a conceptual model identifying possible strategies (delay, respond, partner, legal action, and censorship) for enterprises dealing with negative UGC attacks were presented. Xia (2013) examined the effects of enterprises' response to consumer criticism in social media and found that a vulnerable response leads to more positive behavioural consequences without damaging product quality perceptions than a defensive response. Gu and Ye (2013) measured the impact of management responses on customer satisfaction using data from a major online travel agency in China and found that online management responses are highly effective among low satisfaction consumers but have limited influence on other consumers.

To sum up, the studies on the response to consumer criticism can be concluded in two perspectives: generalizing response strategies conceptually and analysing the effect of enterprises' response to consumer opinion on consumer satisfaction and enterprises' brand image. Moreover, research suggests that proactive responses are more effective in building consumer-brand relationships (Xia 2013).

However, firstly, although enterprises' response is regarded as good practice in handling consumer criticism, no research has examined the impact of using these tactics on the propagation of such UGC. No matter the strategy chosen, enterprises hope not only to minimize the negativity but also to turn the negative UGC into a positive outcome (e.g., improving an enterprise' brand image). Secondly, enterprises' response should refer to evaluate the negativity, publicity of the UGC and determine the time of publishing information and information quantity. But there is no study has quantified these factors. Lastly, it seems that most of the current research mainly focus on response to consumer review on third-party reviewer, but less theoretical studies consider how to response to unexpected UGC in social network such as Facebook and Microblog. In the age of social media, any UGC can attract the attention of hundreds and thousands of existing and potential consumers, and may take enterprises into crisis. These limitations stimulate us to explore how to design optimal strategy to dealing with the negative UGC.

2.2 Studies on Modelling Information Propagation

We briefly review related work in information propagation which has become an active research area. Most works focus on the topology of the social graph, trying to model the propagation process, maximize the spread of information in a minimal effort by finding the most influential modes, and maximize purchases induced by viral marketing and social recommendation networks, or model temporal dynamics of information spread. Modelling the propagation process and dynamics of information diffusion are related to our research.

Sudbury (2004) has applied the classical epidemiological model to understand the information propagation. One modification they make is adding temporary immunity to nodes, which means that cured ones can be reinfected. Nguyen and Shinoda (2007) have also used the same models with an in-depth exploration of the average number of newly infected network items. The models they use, however, lack such a state in which nodes have accepted the information but they can be infected by the other opposite opinion. Starnini et al. (2012) and Moreno (2004) have studied the information propagation in a special network by using the mean-field method. They incorporate the network topology into their model to make it more precise.

While the studies of information diffusion in earlier literature, there are some crucial distinctions between this study and prior work. First, the literature on product diffusion distinguishes between well-informed early adopters and late ones, wherein early adopters learn by doing while late ones from observing others. In contrast, we posit that the influence of EGC in the negative UGC propagation, and the learning pattern of all users is the same. Second, the original studies considered the interaction networks as static entities and only existing single information. This static view of interaction hides however the fact that the adoption probabilities are time-varying and the interaction between two competitive information. In addition, those studies do not discuss how different strategies influence the spread trend of the information. These limitations interested this research to how to offer an interaction model of two competitive information propagation as well as which strategy will bring to the information propagation under control.

3 THE MODEL

3.1 Contents Generated by Users and Enterprises

There are two contents from users (user-generated content, i.e., *UGC*) and enterprises (enterprise-generated content, i.e., *EGC*) respectively.

UGC is also called user created contents (UCC) and some other similar terms. Until now, there is still no widely accepted definition for UGC. There are some subtle differences among these terms. The main difference lies in three points. The first one is that professional should be included in or excluded from "user"; the second one is that only totally new original contents can be seen as "contents" of UGC or some other contents (such as releasing existing contents) should also be "contents" of UGC; the third difference involves contents sharing scale. Some scholars hold that UGC should be published by the user in a larger scale publicly, while others think UGC can include those shared in a selected group with a limited influence.

In this paper, we integrate some of the previous scholars and organizations opinions. "User" means "digital common" rather than web publishers (Guo 2009, Shim and Lee, 2009, Tsur and Rappoport 2012); In terms of the nature of content, all kinds of content are possibly created/modified/aggregated/published/rated/recommended by a user have been considered (IDATE, 2007/2008). Importantly, all UGC are publicly distributed (Oum and Han, 2011).

For UGC, there exists a bias with the real truth (hereafter ***deviation distance***) which can be perceived by enterprises, and some users may question this information but it is not easily discoverable by other users before UGC appears. A UGC is described by its intrinsic and time-invariant characteristics such as product/service quality, price and sentiment. We thus represent the intrinsic characteristics of a UGC using a vector $\boldsymbol{c_U}$, and simultaneously using a vector $\boldsymbol{c_R}$ denoting intrinsic characteristics of the real information. Thus, deviation distance is measured as

$$d_{UR} = dis(\boldsymbol{c_U}, \boldsymbol{c_R})$$

Where $\boldsymbol{c_U}$ and $\boldsymbol{c_R}$ are the respective characteristic vector of UGC and real information, dis(.) is a distance function, and $\boldsymbol{d_{UR}} > 0$. $\boldsymbol{d_{UR}}$ measures bias of UGC. Hence, the higher the value of $\boldsymbol{d_{UR}}$ is, the less information similarity between UGC and real information is. For enterprises, the deviation distance usually has a threshold. When $0 < \boldsymbol{d_{UR}} < \theta$, they view UGC as a normal case. Otherwise, they consider the UGC as a risky one and will make a response to it.

Relative to UGC, EGC refers to the Internet contents produced by an enterprise officially and publicly on social media.

This paper shows the propagation of opinion derived from UGC/EGC in four cases based on the opinion sponsor and the sponsor' positive or negative sentiment on enterprises. See Figure 1 for the description of cases about opinion propagation.

Case 1: The opinion is initiated by Internet users (i.e., UGC) and this UGC has a negative effect on enterprises.

Case 2: The opinion is initiated by Internet users (i.e., UGC) and this UGC has a positive effect on enterprise.

Case 3: The opinion is initiated by enterprise (i.e., EGC), and most of the Internet users generate positive UGC towards this EGC subsequently.

Case 4: The opinion is initiated by enterprise (i.e., EGC), and most of the Internet users generate negative UGC towards this EGC subsequently.

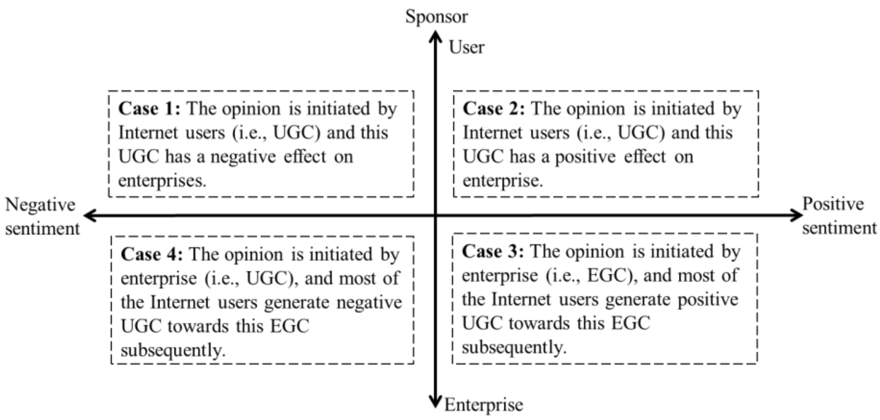

Figure 1.four cases of opinion propagation

For case 1, according to the aforementioned four principles of opinion propagation, the mechanisms of opinion propagation can be divided into the following four stages.

Stage I: UGC active stage. Abrupt enterprise disaster can frequently lead to negative eruption of UGC. Under this condition, the enterprise always needs some time to investigate, take evidences, check the original of the incidents, clear the responsibilities and scheme for the announcement for the incidents. At the same time, according to the negativity effect, the public often keep a highly attention on crisis event. Under the condition, if they could not receive an entire response from the enterprise, they often decode the crisis event by themselves by means of speculation. According to the fraction of selection or probability optimal principle, the Internet users are more likely to accept the opinion which is easier to acquire, and then spread it. The conditions above lead the UGC action to be very active, UGC volume to be larger gradually and to spread rapidly. Under this condition, the speculations of Internet users are always harmful to enterprise. The enterprise endures great public opinion pressure.

Stage II: EGC issue stage. With the acquisition of the truths of the event and timely announcements of EGC to the public, Internet users begin to contact with the topics published by enterprise. While due to the first impression comes first principle, same type credit principle and negativity effect principle, the EGC can seldom receive recognition in the first instance. With the gradual spread of EGC, it may spur another high tide of UGC propagation on the contrary.

Stage III: EGC and UGC confrontation stage. After the enterprise fully finds out the truths of the event and draws up the solutions for crisis public relationship information communication, the enterprise will use all kinds of media resources (include social media and traditional media) to publish the crisis events' truths and disposition results to minimize the negative effect from UGC as quick as possible. Especially to utilize the strong information radiation effect of traditional mass media, the enterprise can change the public opinion direction by largely increasing the quantity of EGC in a very short time. Then, the probability of Internet users browsing EGC is raised highly. After a period of time, EGC present all-around surge and show head-to-head situation with UGC.

Stage IV: EGC dominant stage. Since the generating objects of UGC are large numbers of autonomous and unorganized ordinary Internet users, the opinions' consistency, actions' persistence and events' objectiveness are usually very poor. While the object of EGC is enterprise, its topics are generated by careful determination, its issue actions are fully planned, and the aim of EGC is straightforward: eliminating the negative effect of UGC at the largest degree by persistent and all-around EGC distribution. Therefore, with the distribution of enterprise's persistent EGC and under the driving of fraction of selection or probability optimal principle, more users begin prone to accept EGC topics and consequently avoid the Internet users to make hard choice from various different topics. Finally, EGC topics become dominant and continually transmit with small amount of UGC on social media until no scrutiny.

3.2 User Groups and States

Before constructing the model, we assume that the main source of UGC is Microblog (such as Sina microblog or Tencent weibo) where users post UGC about their experiences with the products or services of the enterprises. Other users read these opinions and form perceptions about the enterprises' products/services. Based on these perceptions, they may resend the UGC. Enterprises can try to affect user perceptions by posting EGC on the same platform.

There are an enterprise ($creator_E$) and a user ($creator_U$) who is creators of EGC and UGC, respectively. After that, we divide the users on Microblog into two categories. The first is the ones who have not contacted with the relative topics, assigned with identifier A; the second is the ones who have contacted with relative topics, assigned with identifier B. Divide the second category again according to whether they will accept and then transmit the information. 1) Identify the users who accept UGC as B1 and users who accept EGC topic as B2 and users who hold neutral attitude as B3. 2) Identify users who both accept and transmit UGC as U11, and identify users who accept but not transmit UGC as U12 and users who both accept and transmit EGC as E11and identify users who do not transmit EGC topic as E12. As the users of identifier A, B3, U12, E12 do not have much influence on the opinion transmission, so in order to avoid complexity to establish the model, we unify these users as one category, which is identified as N0. In this way, we can get the classification of users in the UGC opinion propagation process as is shown in Figure 2.

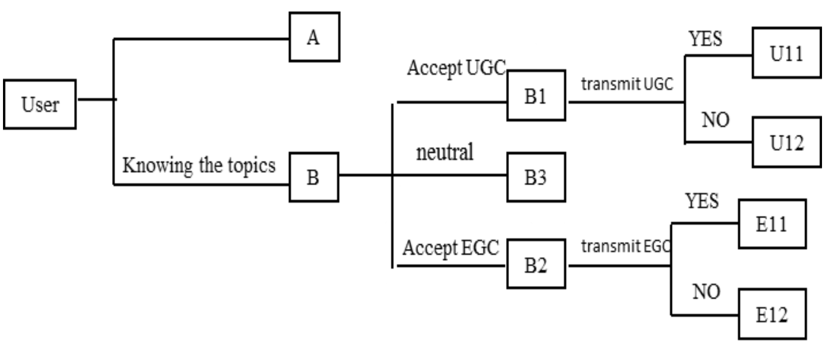

Figure 2. The users' categories of topic propagation model

Furthermore, we take the users into three states: one browsing information and susceptible state (S_0), one browsing and retransmitting UGC state (S_U) and one browsing and retransmitting EGC state (S_E). First, $creator_E$ and $creator_U$ send out their generated content reviewing one of the products/services, respectively. In line with the aforementioned discussion of UGC opinion propagation (Case 1), we assume that $creator_U$ posts created content before enterprise publish related information and are only motivated by a desire to share their experiences with others, an assumption that is consistent with most word-of-mouth studies. Thus, $creator_U$ posts truthful information about the enterprises' products/services. Nevertheless, the review has inevitably included the poster's sentiment, and then it exist positive or negative bias which other users do not observe. Here, the enterprise does not actively engage in user discussions and simply monitoring online user behavior. G_U in this case is the segment of acceptors who retransmit the content from $creator_U$ and not its source. After this, the enterprise is aware of the review of its own products/services and publishes unbiased information to ensure the online word of mouth in good momentum. Afterwards, browsing the information online including UGC and EGC, the users make an inference on the products/services taking account that some of the information may be biased. We constrain these users with S_0 to retransmitting only one opinion at a time, but she can change prior opinion next time.

3.3 Model of UGC Propagation

According to the topic propagation principles of social media and based on the four stages divided by topic propagation in case one, we propose some model assumption before establishing the UGC propagation model.

(1) We assume that Internet user groups don't regard enterprises as the same type except the enterprise's fans on social media. Based on same type credit principle, these users are prone to accept the information from the "same type" group, being affected by the opinions of the "same type" group and are more likely to trust the information from the "same type" group. The assumption means that the rate from state S_0 to S_U is higher than that from state S_0 to S_E in the former two stages.

(2) In our study, we assume that the UGC and EGC contents refer to the same crisis event on social media, while the topic propagation is only available to a certain social media. For the concision of analysis, external topic related with the enterprise is not concerned here.

Based on the above analysis on topic propagation mechanisms, we can conclude that EGC topic and UGC have different interaction rules in different topic propagation stages, which means that topic propagation rule is time variant. Initially, all users are in S_0-state. Once UGC/EGC come into the system, these users may change their states according to the rule as follows:

1) Assume social media user *i* and user *j* contact with each other. For the user *i* in state S_0, if the user *j* is in state S_U, he/she will then go into state S_E with the probability λ_1; if the user *j* is in state S_E, he/she will then go into state S_U with the probability δ_1.

2) If user *i* is in state S_E and user *j* is in state S_U, there are two possibilities: one is that user *j* is interrupted by topic information with probability δ_2 and goes into state S_U. The other one is that user *i* is impressed by enterprise topic information with probability λ_2 and goes into state S_E.

Figure 3 shows the three states and state transition in our proposed model. In the figure, each rectangle represents a state and the social media users who belong to this state. And the directed lines denote the potential transition paths from one state to others. The state S_E can decrease UGC propagation speed, and decrease the number of users resending UGC. In order to be advantageous for the description, we explain the notations used in this paper. See Table 1 for details.

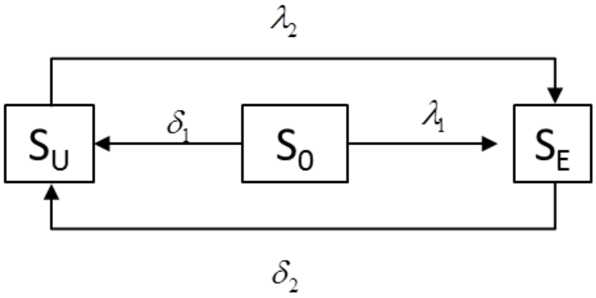

Figure 3. The states and state transitions in propagation of UGC

Variable type	Notation	Definition
State variable	$P_0(t)$	Proportion of users with state S_0 at time t (days)
	$P_U(t)$	Proportion of users with state S_U at time t (days)
	$P_E(t)$	Proportion of users with state S_E at time t (days)
Probability variable	λ_1	Transition probability of users from state S_0 to state S_E
	λ_2	Transition probability of users from state S_U to state S_E
	δ_1	Transition probability of users from state S_0 to state S_U
	δ_2	Transition probability of users from state S_E to state S_U
	TS	The degree of topic sensitivity
	TR	UGC reliability
UGC factor	*TP*	UGC publicity
	OL	Percentage of opinion leaders holding UGC and EGC opinion respectively
	π	Deviation distance
	ΔT	The first time of issuing EGC
EGC factor	*Fr*	Interactive frequency
	Q_E	EGC quantity

Table 1. Notations and definitions in this paper.

For better to understand the transitions among three states, we analogize the propagation of UGC to the epidemics. Actually through the observation and analysis of the propagation of UGC in our sample data, we found some helpful features for modelling the propagation. First, the UGC propagation mechanism on social media is indeed similar with the mechanism of the epidemics (Zhao, et al., 2009，Leskovec et al. 2007). Second the propagation trend of a UGC on social media is not up to only one individual or several individuals but up to the collective effort of many users just like the process of an epidemic. Because there are many factors to influence the propagation of a UGC and lead to the model complicated, it is reasonable that we construct the mean field equation model for predict UGC propagation on social media. Here we represent our model in a more formal manner. Based on the compartment model presented in Fig.4, our model can be formulated by a set of partial differential equation as follows:

$$\begin{cases} \frac{dP_0(t)}{dt} = -\delta_1 P_U(t) - \lambda_1 P_E(t), \\ \frac{dP_U(t)}{dt} = \delta_1 P_0(t) - \lambda_2 P_U(t) + \delta_2 P_E(t), \\ \frac{dP_E(t)}{dt} = \lambda_1 P_E(t) - \delta_2 P_E(t) - \lambda_2 [P_U(t) - m] P_U(t), \end{cases} \quad (1)$$

where λ_i and δ_i (i=1, 2) are the state transition probability of users with different states, m is the threshold of UGC propagation in which any UGC propagation goes if and only if the propagation number must be greater than the value according to the communication dynamics theory, and the three state variables satisfy P_0 (t)+P_E (t) +P_U (t)=1.

Since social media users' behaviour is affected by factors from both UGC and EGC (Avrahami, Hudson, 2006). Therefore, we will take those factors into the model parameters. Thus, in Model 1, the four state transition probability denoting the users of social media accepting topic opinion and transmitting it is defined as follows.

For constructing the transfer probability function included in the proposed model, we first define some critical variables as follows:

(1) Percentage of opinion leaders holding UGC and EGC opinion respectively: During the UGC propagation, opinion leaders mainly hold two types of opinions until the end of the stage 4. Define it as $OL=OL_U/OL_E$, in which OL_U and OL_E represent the number of opinion leaders holding UGC and EGC, respectively.

(2) The degree of topic sensitivity represents the probability to cause net-mediated public opinion be upsurge when unexpected emergencies happen. The strong topic sensitivity will make more users attend the UGC and then bring the high public opinion heat degree. The variable is defined and scaled by $TS \in [1,5]$.

(3) UGC publicity represents the degree of threat an event brings about to social value system and the scope of individual to be affected. If topic publicity is high, then the level is high. It can be defined by $TP \in [1,5]$.

(4) UGC reliability reflects the persuasive degree and amount of information the topic bring to the public. If the reliability level is low, it is difficult for the public to believe in the arguments. This variable is defined by $TR \in [1,5]$.

(5) The first time of issuing EGC ΔT refers to the interval time when enterprise firstly publishes some relative information after the UGC has occurred. The variable directly affects the initial value of accepting UGC. Its value can be set from1 to 3, in which the smaller the value is, the more timely enterprises response to the UGC.

(6) Interactive frequency Fr represents interactive amount between enterprise and Internet users via social media. For each stage of UGC propagation, the interactive frequency is not static. Through moderating the value of interactive frequency, the process of UGC propagation can be changed. We divide its value into low, mediate and high three levels which are scaled by discrete values from 1 to 3 respectively.

(7) EGC quantity Q_E is the measure on how much information contained in EGC. It presents that EGC can reduce the doubt of UGC to what extent. Therefore, the more EGC quantity is, the more users need and the shorter the propagation time of negative UGC will be. Because UGC related with enterprises often involves three dimensions which include quality and price of products/services, and evaluation in responding to the critical state according to Lasswell's communication theory, the EGC quantity can be measured based on three dimensions. If EGC contains some dimension, the value of the dimension is noted by 1, otherwise 0. EGC quantity is the addition of the three dimensions.

Next, we present some assumptions on the effects of the EGC quantity Q_E, the first time of issuing EGC ΔT and interactive frequency Fr on the state transition probability through the parametric analysis.

Next, we present some assumptions on the effects of the EGC quantity Q_E, the first time of issuing EGC ΔT and interactive frequency Fr on the state transition probability through the parametric analysis.

(i) Assume that the EGC quantity Q_E and interactive frequency Fr are fixed constants. The increase of the first time of issuing EGC ΔT will lead to the decrease of the state transition probability functions $\lambda_i(t)$. The state transition probability functions $\delta_i(t)$ show the opposite situation with this.

(ii) For the EGC quantity Q_E and interactive frequency Fr, there are two cases which distinguish the stages of UGC propagation to be considered. When it propagates in the EGC issue stage and topic confrontation stage, the transition probability functions $\lambda_i(t)$ increases as Q_E and Fr increase. When it propagates in EGC topic dominant stage, the transition probability functions $\lambda_i(t)$ decreases as Q_E and Fr increase. The transition probability functions $\delta_i(t)$ show the opposite situation with this.

(iii) For the coupling factor of the UGC. Because TF-derivative is greater than zero, the transition probability function $\delta_i(t)$ will increase as TF increases.

Therefore, for a special UGC, considering the four stages of UGC propagation we may assign the parameters with piecewise functions: $\delta_i(t)$ and $\lambda_i(t)$ (i=1,2). Thus, based on the above assumptions, we propose the transition probability functions of model (1) as follows:

$$\lambda_1(t) = \rho_{11}(\pi) \cdot TF + \rho_{12}(\pi) \cdot \Delta T - \rho_{13}(\pi, t) \cdot \frac{Fr}{OL} - \rho_{14}(\pi, t) \cdot \frac{Q_E}{OL}$$
$$\lambda_2(t) = -\rho_{13}(\pi, t) \cdot \frac{Fr}{OL} - \rho_{14}(\pi, t) \cdot \frac{Q_E}{OL}$$
$$\delta_1(t) = -\rho_{21}(\pi) \cdot TF - \rho_{22}(\pi) \cdot \Delta T + \rho_{23}(\pi, t) \cdot \frac{Fr}{OL} + \rho_{24}(\pi, t) \cdot \frac{Q_E}{OL},$$
$$\delta_2(t) = \rho_{23}(\pi, t) \cdot \frac{Fr}{OL} + \rho_{24}(\pi, t) \cdot \frac{Q_E}{OL}$$

where $\rho_{ij}(\pi)$ $(i = 1,2, j = 1,2)$ is the nonnegative parameter to adjust the weight of influence factors, and $TF = TS \cdot TP \cdot TR$ represents the coupling factor.

4 PARAMETER ANALYSIS OF MODEL

In the previous section, we have shown that the mechanism of UGC propagation and established the model of UGC propagation. In this section, we evaluate the performance of EGC factors in defending against UGC propagation by incorporating these factors into model through simulation to test whether they are able to delay and control the UGC propagation.

For this purpose, a pair of indicators is introduced to measure the spreading influence of UGC. The two are the peak values $\max(P_U(t))$ and $\max(P_E(t))$ representing the maximum ratio of the disseminator ever appeared in the whole spread process of topic, respectively. To some extent, these two indicators reflect the maximum disseminating coverage of UGC.

4.1 Parameter Analysis on the First Time of Issuing EGC ΔT

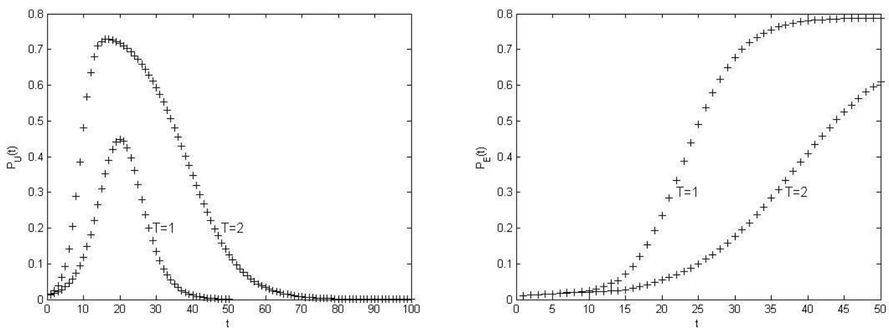

Figure 4. The effect of ΔT on the topic propagation from UGC and related EGC

According to the expression of the state transition probability, the probability becoming users with state S_U is monotonically increasing with the first time of issuing EGC ΔT. In order to verify the impact of the first time of issuing EGC on the topic propagation trend, we perform a simulation by keeping all other parameters unchanged, and analyse the propagation trends of the opinion information from UGC and related EGC topic.

When we change the first time of issuing EGC, Figure 4(a) represents different propagation speeds and maximum coverage of UGC propagation. The smaller the first time of issuing is, the slower the UGC propagates at the early stage, and the smaller the number of users with state S_U is. However, the process of EGC propagation is reverse. This is mainly due to the fact that the population with state S_U increases along with the delay of issuing EGC. At the initial stage of UGC propagation, the enterprise usually does not pay much more attention on the UGC information, and does not take any timely action to deal with it, making the users more likely to accept the opinion from which are similar to their owns. When shorting the first time of issuing, we can effectively take users with state S_0 into state S_E to some extent (See Figure 4(b)). However, a small ΔT can also decrease the speed of EGC propagation due to the fact that the hasty response and the quantity of EGC Q_E may be false positive effect on the UGC propagation. Thus when determining an appropriate the first time of issuing EGC ΔT to defend against negative UGC, enterprises should consider the coupling effect from the other factors.

4.2 *Parameter analysis on EGC quantity* Q_E

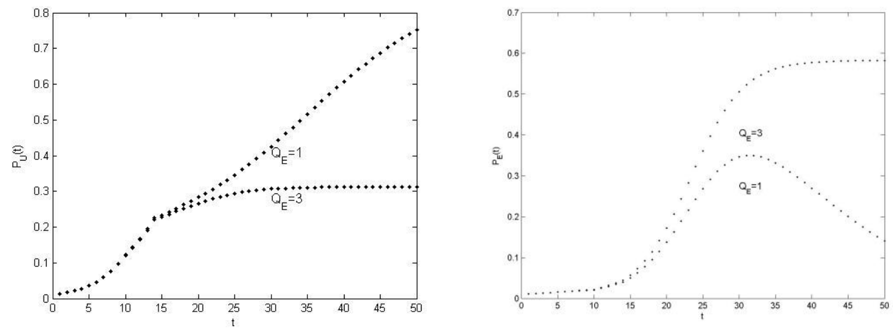

Figure 5. The effect of Q_E on the topic propagation from UGC and related EGC

EGC quantity is the measure on how much information contained in EGC. It presents that EGC can reduce the doubt of UGC to what extent. Figure 5(a) shows the effect of changing EGC quantity on UGC propagation. As expected, a larger EGC quantity results in decreasing the UGC propagation speed, lowing the total number of users with state S_U, and shortening the time at which population with state S_U reaches its peak . This is mainly due to the fact that the initial acceptance of UGC may reversely resend EGC and users with state S_0 are more likely to adopt EGC and repost it as EGC quantity increase in the EGC issue stage. Consequently, the propagation speed of the UGC opinion will become slower, and the coverage of UGC will be smaller.

Correspondingly, Figure 5(b) shows the effect of different EGC quantity on EGC influence. The propagation speed of EGC and the peak of EGC coverage are increased with the increase of EGC quantity. However, we can also observe that after the population of users with state S_E reaches its peak, the influence of EGC become weak rather than keeping increase or stable when EGC quantity is very low. Perhaps that is due to the fact that the information contained in EGC is too little to persuade users to accept opinion from enterprise. And then they will lose interest in resending such EGC.

4.3 *Parameter analysis on interactive frequency Fr*

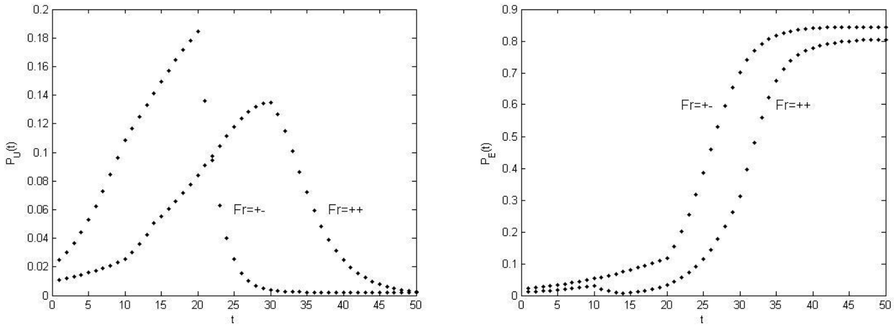

Figure 6. The effect of Fr on the topic propagation from UGC and related EGC

In order to show the effect of interactive frequency (which vary from low, mediate and high), we run the simulation after the EGC issuing stage and set interactive frequency with the same value (*Fr*=1) during the EGC issue stage and EGC and UGC confrontation stage. Therefore, we compare the effect of different interactive frequency in the EGC dominant stage on the UGC propagation. As it is shown in Figure 6(a), the interactive frequency plays an important role in controlling UGC propagation. However, it is apparent that a high interactive frequency results in prolonging the time at which UGC propagation dies out. Perhaps, most users are satisfied with EGC opinion information and accept the EGC opinion at the first few stages. As time goes on, the UGC and EGC topics are both controlled to a steady status and transition probability of users will not change again. However, if enterprise still keeps interactive frequency in high level, it can lead the users to generate new UGC which make the transfer probability increased in the model easily. It is because excessive information can cause Internet users generate excessive or negative mentality and behaviour response (Vasterman 2005). And then, they will turn to prefer accepting UGC from the "similar".

Figure 6(b) represents the effect of interactive frequency on the EGC influence. We can observe that the higher the interactive frequency is, the lower the final influence coverage of EGC is. The simulation result is consistent with that of Figure 5(a).

As was indicated in the previous section, it is critical to test which EGC factor plays the most important role in effect UGC propagation. This subsection is intended to present the sensitivity analysis to the first time of issuing EGC ΔT, EGC quantity Q_E and interactive frequency *Fr*, respectively. The effect of the signal factor on UGC propagation is calculated and shown in Table 2. It can be seen that, among these three parameters, the peak of UGC propagation maxP_U is most sensitive to the change in interactive frequency *Fr*. Indeed, an increase in *Fr* would yield a decrease of 62.31 percentage in the maximal population of users with state S_U maxP_U when a decrease of 30 percentage if Q_E is doubled. As opposed to this, ΔT has a proportional relationship with maxP_U; an increase in ΔT will bring about an increase in maxP_U with a 39.77 percentage of increase. This sensitivity analysis informs us that the interactive frequency is the most key factor for enterprises to deal with UGC propagation on social media. Therefore, it is strongly recommended that enterprise which facing unexpected UGC should supply promotional interaction with users with state S_U to influence the users' early perception and make them transfer to EGC acceptors. Besides, shortening the first time of issuing EGC and enhancing EGC quantity is also suggested.

	Double ΔT	Double Q_E	Double Fr
$\max(P_U(t))$	Increase by 39.77%	Reduce by 30%	Reduce by 62.31%

Table 2. Results of sensitivity analysis.

5 STRATEGY DEVELOPMENT AND ANALYSIS

Encouraged by our simulation results and considering the coupling effect of the three parameters (i.e., the first time of issuing EGC, EGC quantity and interactive frequency), we make the further analysis on which strategy is optimal to managing negative UGC with different deviate distance. The strategy set refers to the time of EGC, EGC quality and interactive frequency which are taken as decision variables.

Based on the four stages of the negative UGC propagation, we describe the strategy by $S = \{S_1, S_2, S_3, S_4\}$, in which S_i $(i = 1,2,3,4)$ denoting the i-th stage of the UGC propagation is a three-dimensional vector on the decision variables, i.e., the first time of issuing EGC, EGC quantity and interactive frequency. That is to say, $S_i = (\Delta T_i, Q_{Ei}, Fr_i)$. By choosing different values of the three factors in the four stages, the strategy set can be formed. In order to simplicity, we will take the values of three factors into discretization. Then, the detail of the strategy is given as follows.

In the UGC active stage, enterprises need to listen to the voice from UGC information and investigate the real truth of opinion events rather than immediately deny users' negative reviews. Considering the first time of issuing EGC as an important factor affecting the UGC propagation, ΔT is set as 1 representing enterprises for the first time to release information in response to UGC after understanding the actual situation in The EGC topic issue stage. ΔT denotes the interval between the time at which enterprise firstly publishes relative EGC and the time when the UGC occurred, thus, we take the strategy for the first time of issuing EGC as $\Delta T = (\Delta T_i) = (0, 1, 0, 0)$ in the simulation process.

Based on the definition of the EGC quantity and rule management of UGC, some enterprises response to all dimensions of UGC once only, and others answer to the each dimension one by one. Therefore, in order to simulate the UGC propagation trends simply, we take three in the second stage and zero in the other stages or one for the later three stages. The expression of EGC quantity is $Q_E = (Q_{Ei}) = (0, 3, 0, 0)$ or $(0, 1, 1, 1)$.

For interactive frequency, under the common circumstances, some people argues that it is optimal for keeping high interactive frequency while the excessive information generated by interactions can cause Internet users generate excessive or negative mentality and behaviour response (Vasterman2005). To ensure strategy integrity and avoid the negative effect of excessive interaction, we assume that the distribution of interactive frequency has two cases: one is uniformed and the value is set by mediate; the other is monotonically decreasing. Based on the two situations, we set medium degree of interactive frequency in the three stages and decreased values from the EGC topic issue stage to the EGC dominant stage, respectively, i.e., $Fr_i = (0,2,2,2)$ or $(0,3,2,1)$.

Therefore, in our paper, we list the possible strategies responding negative UGC for enterprises as follows:

	Strategy S				
	ΔT	Q_E		Fr	
The UGC active stage	0	0		0	
The EGC issue stage	1	3	1	2	3
The EGC and UGC confrontation stage	0	0	1	2	2
The EGC dominant	0	0	1	2	1

stage					

Table 3. *The description of strategy combination.*

Our results demonstrate that such EGC factors as the first time of issuing EGC, EGC quantity and interactive frequency significantly affect UGC propagation through EGC. Here, we make multiple factor analysis and generate insights into which strategy presented in Table 3 is optimal for controlling the negative UGC with deviation distance, respectively.

Case 1: For the negative UGC with the deviation distance $0 < \pi < \theta$

Based on the model (1) and strategy combination on the first time of issuing EGC, EGC quantity and interactive frequency shown in Table 3, we will obtain the optimal strategy for dealing with the negative UGC with the deviation distance $0 < \pi < \theta$.

Via the simulation, we show UGC propagation trend under different enterprise strategies in Figure 7. Compared with the four curves, we can find that:

Regardless of EGC quantity, monotonically decreasing sequence of interactive frequency will keep make the aggregate number of reposting UGC keep in a high level by 0.25 and more. However, mediate interactive frequency and EGC quantity of single dimension in each stage of UGC propagation can shorten the life cycle of UGC propagation. Hence, we conclude that strategy combination $S = \{(0,0,0), (1,1,2), (0,1,2), (0,1,2)\}$ is the most efficient ways to control the negative UGC with deviation distance $0 < \pi < \theta$.

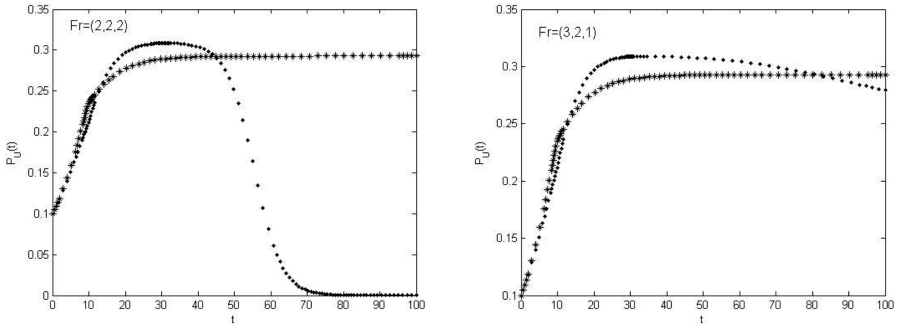

Figure 7. the effect of multiple factors on the UGC propagation with the deviation distance $0 < \pi < \theta$,-.- the group of the EGC quantityis (1,1,1);-*- the group of the EGC quantityis (3,0,0)

Case 2: For the negative UGC with the deviation distance $\pi > \theta$

In this section, we simulate to investigate the combined effect of these factors based on strategies in Table 3 for the negative UGC with the deviation distance $\pi > \theta$. The detail process is similar with case 1.

Its propagation trend via the simulation is presented in Figure 8. Fig.8(a) shows that how the strategies in which the interactive frequency is fixed for (0, 2, 2, 2) effect the negative UGC propagation by adjusting the values of the EGC quantity while Fig.8(b) shows the propagation trends under the condition the interactive frequency is fixed for (0,3,2,1). Through comparing the figures, For EGC quantity, the best strategy is (0, 3, 0, 0) which means to disclose the complete EGC information from the three dimensions in the EGC issue stage. Furthermore, we can see that choosing the values of the interactive frequency for (0, 2, 2, 2) will make the negative topic remain in a lower level. Hence, the best strategy for the negative with deviation distance $\pi > \theta$ is $S = \{(0,0,0), (1,3,2), (0,0,2), (0,0,2)\}$.

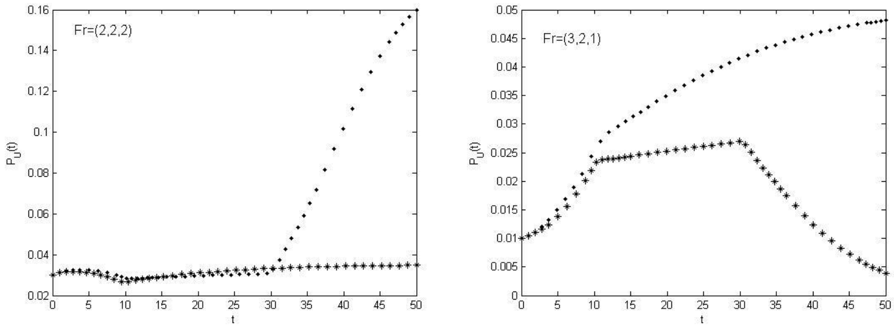

Figure 8. the effect of multiple factors on the UGC propagation with the deviation distance π>θ,-.- the group of the EGC quantityis (1,1,1);-*- the group of the EGC quantityis (3,0,0)

6 MANAGEMENT STRATEGIES OF ENTERPRISES FOR UGC

In general, in the environment of Web2.0, social media makes everyone to be information distributor and disseminator. Objective normal UGC public opinion expression and deliberately planned UGC public opinion control exist at the same time, enterprise management's boundary enlarged greatly, the complexity and the risk of enterprise management both increases greatly. Therefore, enterprise should release EGC more actively and get adept at making use of social media, listening to voice of Internet users in order to realize bilateral communication with them. This can attract more Internet users to take part in the discussion of EGC information, which can realize to restrain transmission of negative UGC with deviation distance $\pi \geq \theta$ and guide the negative UGC with deviation distance $0 < \pi < \theta$ to propagate rationally, thereby avoiding blind conformity effect. Its function mechanism is that adjusting the first time of issuing EGC, EGC quality and interactive frequency properly can increase the number of users in topic information propagation network, which are more likely to increase the probability of transforming the users who might accept negative UGC information into EGC information disseminators. Furthermore, the spread of negative UGC information will be under control and the EGC information transmission is barely disturbed. In conclusion, such method can realize the purpose of controlling negative UGC propagation.

From the perspective of whole life cycle management of the negative UGC propagation, we give the following suggestions for enterprises to manage it.

1) For the negative UGC, regardless of the deviation distance, interactive frequency is the most important for the UGC propagation, and then the first time of issuing EGC and the last factor is UGC quality. That is consistent with the users' need when facing the negative UGC information. They pay more attention to negative information than positive one and urge to know the response from the enterprise (Homer and Yoon, 1992).

2) For the negative UGC with deviation distance $0 < \pi < \theta$, the propagation of the UGC can be efficiently controlled by increasing the EGC quality step by step. As the EGC information increases, it can reduce the number of UGC opinion in turn to reduce the probability δ_i $(i = 1,2)$ which represent the transfers from users to UGC disseminators. Meanwhile, this strategy can increase the probability λ_i which represents the transfers from users to EGC disseminators via the high interactive frequency.

3) For the negative UGC with deviation distance $\pi \geq \theta$, the propagation of the UGC can be efficiently controlled by publishing the whole information from the three dimensions of the EGC quality. Perhaps such deviation distance of negative UGC is because of enterprises' products or service defects, it is better for responsible enterprises to response all review contents at very first time. Otherwise, it will fight with hopeless odds eventually. Once the real truth revealed, it will burst into violent negative UGC immediately which makes $\delta_i$increase rapidly. Finally, even if the enterprise increases interactive

frequency Fr to suppress negative impact from UGC, the UGC propagation will still spread towards the even worse direction for the enterprise.

7 IMPLICATIONS AND DIRECTIONS FOR FUTURE RESEARCH

The purpose of this study was to offer some strategies for enterprises dealing with negative UGC. This study tried to capture enterprise' decision variables and seek optimal strategies for the two cases of UGC propagation using a simulation analysis. Our work is listed below.

First, we showed the propagation of opinion derived from UGC/EGC in four cases based on the opinion sponsor and the sponsor' positive or negative sentiment on enterprises.

Second, we established the model of UGC propagation and evaluated the performance of EGC factors in defending against UGC propagation by incorporating these factors into model through simulation. The results revealed that the interactive frequency is the most key factor for enterprises to deal with UGC propagation.

Third, the strategy combination including the first time of issuing EGC, EGC was constructed and the optimal strategies for managing negative UGC with different deviate distance were determined, respectively.

This study also has important methodological implications. First, this study contributes to the understanding of the effects of enterprise-generated content on the negative UGC propagation. Second, it expands the analysis to model UGC diffusion considering factors including the first time of issuing EGC, EGC quantity and interactive frequency.

We hope that the UGC propagation principle–driven model and simulation results in this paper be of certain value for further research on information diffusion and put forward some helpful suggestion for enterprises to deal with UGC. Meanwhile, from the application point of view, enterprises may adopt these strategies for unexpected negative UGC.

Future research should confirm the existence of each strategy via survey data. Surveying a large sample of enterprises to see which strategies they have utilized and why they selected that strategy would be a useful extension of this study. It would also be interesting to see what variables might impact the choice of a particular strategy, such as enterprises size (i.e., small versus large), the particular industry (i.e., services versus manufacturing), or the corporate culture of the enterprises (i.e., open versus closed). Clearly, enterprises need to know more about how to deal with UGC and future research needs to continue to shed light on this complicated subject matter.

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