A webometric network analysis of electronic word of mouth (eWOM) characteristics and machine learning approach to consumer comments during a crisis

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Abstract

This study explores the effectiveness of crisis response strategies for public response and perception in the context of social media by examining a case about the *Samsung Galaxy Note 7* product recall crisis. First, the study investigated the response strategies *Samsung* used on *Facebook* through the lens of situational crisis communication theory (SCCT). Next, we applied a webometric network analysis and exponential random graph models (ERGM) to analyze the relationship between the crisis response strategies and the dynamics of electronic word of mouth (eWOM) behaviors. Then, we performed topic modeling and semantic network analysis to examine the public perceptions of and responses to *Samsung*'s crisis communication strategies based on public comments. *Samsung* used silence, information, and rectification strategies. More participants and comments were generated and stronger ties were found in the eWOM networks for matched responses than for silence. Public responses and perceptions toward the silence and the late adoption of an information strategy were primarily negative and resulted in complaints about poor customer service, whereas positive responses –expressing brand royalty and forgiveness– increased via the rectification strategy. Methodological triangulation in this study offers evidence-based lessons on how to systemically monitor stakeholders' reactions and manage consumer complaints in order to repair a corporation's damaged reputation after a crisis.

Keywords

Webometrics; Situational crisis communication theory; Topic modeling; Machine learning; Network analysis; Semantic network; Exponential random graph model; Electronic word of mouth; eWOM; Crisis communication; *Samsung Galaxy Note 7*.

1. Introduction

Building a brand's reputation takes a long time, but an accident can hurt a brand's equity very quickly. Brands can restore their damaged reputation through successful crisis management. Crisis management failure puts brands at more risk and leads to sales losses (**Zhang**; **Veijalainen**; **Kotkov**, 2016). During *Malaysia Airlines' MH370* crisis, for instance, slow and ineffective reaction infuriated customers and generated negative publicity (**Rauhala**, 2015).

During and after an organizational crisis, stakeholders use social media to learn about the crisis and spread information about it (**Pang**; **Hassan**; **Chong**, 2014). The crisis management literature is increasingly examining stakeholders' electro-

nic word of mouth (eWOM) communication about crises in order to understand public perceptions of and reactions to crises and corporate communication (**Byrd**, 2012; **Chen**; **Hong**; **Li**, 2017; **Zhang** *et al.*, 2016). Despite their importance, few studies have examined the effectiveness of crisis response strategies for managing public responses in the context of social media (**Ki**; **Nekmat**, 2014). In particular, little is known about the process and communicative characteristics of eWOM behaviors in reaction to corporate crisis response strategies. Previous studies have shown that interaction levels between users and public responses to corporate crisis communication are important components of crisis management (**Ki**; **Nekmat**, 2014). Interactions between stakeholders embedded in social networks can influence the diffusion and facilitation of crises (**Jung**; **Park**; **Wu**; **Park**, 2015). They can also increase public support for brands **(Ki**; **Nekmat**, 2014). Managers need to understand the eWOM diffusion process, such as the factors driving information behavior, in order to intervene in and influence consumers' eWOM effectively in crisis situations (**Ford**; **Redwood**, 2005). Moreover, detecting public perceptions of post-crisis communication is valuable for evaluating the effects of crisis response strategies in repairing reputation damage (**Liu**; **Austin**; **Jin**, 2011).

Given all the above, this study applies situational crisis communication theory (SCCT) to assess the effectiveness of crisis response strategies in managing public perceptions of and reactions to a brand and crisis situations using the case of a *Samsung* product recall crisis (**Coombs**, 2006a). First, we study the crisis response strategies *Samsung* employed on *Facebook* after the recall crisis using the SCCT model. Next, we use a webometric network analysis and exponential random graph models to investigate the relationship between the crisis response strategies and the dynamics of eWOM behavior. Then, we employ two text-mining approaches, topic modeling and semantic network analysis, to examine the public responses to the crisis strategies. Topic modeling of public comments allows us to identify how the public perceives the crisis responses, while semantic network analysis further investigates the findings to make sense of the relationships between key crisis-related issues.

This study extends the utility of the SCCT model by using it to analyze the mechanism and characteristics of eWOM behaviors and public responses to organizational crisis communication strategies. The findings offer practical guidelines for future response strategies on social media designed to repair organizational damage after a crisis. The mixed analytical approaches adopted in this study demonstrate how to evaluate the impacts of crisis response strategies on public responses by tracking a large number of unstructured textual data from different angles.

2. Crisis response strategies

A crisis is an unanticipated event that threatens an organization's reputation, products, or services (**Fearn-Banks**, 1996). Crises can result in negative WOM among the public and threaten relationships with stakeholders (**Coombs**, 2007). Post-crisis communication strategies help organizations repair reputational damage, reduce negative behavioral intentions, and prevent further reputational damage (**Benoit**, 1997; **Coombs**, 2006b). Communication and management studies have analyzed crisis communication models and the theoretical framework of crisis communication strategies. **Benoit** (1997) identified three image-restoration approaches: denial, evasion of responsibility, and reducing offensiveness. However, this model tells us little about when and how to employ these strategies in different crisis situations.

The SCCT model is one of the most widely applied theories of crisis communication. It provides a useful framework by which public relations practitioners can understand appropriate crisis response strategies and anticipate how stakeholders will react to different types of crises by assessing levels of responsibility attribution (**Coombs**, 2007). The theory recommends that crisis response proceed in three stages: 1) instructing information, 2) adjusting information, and 3) reputation repair. In the "instructing information" stage, the firm offers instructions about what caused the crisis and how the public can physically protect themselves (**Coombs**, 2006a). In the "adjusting information" stage, the firm informs the public about how to psychologically cope with any threats related to the crisis. Organizations are advised to use these two information-giving strategies before they select the reputation-repair options.

According to SCCT, the first step in reputation repair is to determine the crisis situation by evaluating the level of perceived crisis responsibility (**Coombs**, 2007). These levels are divided into three "clusters." In the "victim" cluster, the organization is considered to be a victim of the crisis, and stakeholders thus attribute the weakest level of crisis responsibility to the organization. In the "accidental" cluster, the crisis is viewed as unintentional, and a minimal level of crisis responsibility is attributed to the organization. In the "preventable cluster," the organization is considered to have triggered the crisis intentionally, and stakeholders attribute the greatest level of crisis responsibility to it (**Coombs**, 2007). The response strategies suggested by SCCT range along a defensive–accommodative continuum, wherein higher levels of crisis responsibility need a more accommodative response strategy (**Coombs**; **Holladay**, 2007). Whereas low-accommodation strategies show minimum concern for victims, high-accommodation strategies focus on the victims heavily. **Coombs** (2009) suggests four response options: deny, diminish, rebuild, or reinforce. The "deny" response is a defensive strategy involving denial, attacking the accuser, and scapegoating. The "diminish" response is a moderate accommodation strategy that includes making excuses and providing justifications. The "rebuild" response is a high-accommodation strategy that involves offering compensation, apologies, and rectification and explains the corrective action the organization will take to prevent future crises. The "reinforce" response is a high-accommodation strategy that includes "bolstering," which reminds the public of the organization's past good works; and "ingratiation," which praises the organization's stakeholders.

The literature on crisis communication has rarely considered silence as a response strategy option within the framework of SCCT or image restoration theory (**Benoit**, 1997; **Coombs**, 2006a). However, silence can be categorized as a low-accommodation strategy. Silence itself is a tactical method used by practitioners to handle a crisis; organizations often choose to remain silent during a crisis (**Dimitrov**, 2015).

3. Crisis management using social media

Social media is an increasingly important component of crisis management. Addressing crises successfully requires that organizations provide information in a timely manner and communicate strategically with stakeholders (**Benoit**, 1997; **Coombs**, 2007). In emergencies, social media is an effective communication toolkit for public relations practitioners to use to not only distribute messages but also manage relationships with stakeholders (**Jung** *et al.*, 2015). When catastrophic events occur, leading corporations utilize social media outlets such as *Facebook*, *Twitter*, *YouTube*, and *LinkedIn* to manage the crisis (**Ki**; **Nekmat**, 2014).

Organizations' social media use is a double-edged sword. While insensitive posts can hurt their reputation, appropriate responses can help practitioners manage a crisis (**Kraft**, 2016). For example, *Microsoft* tested its artificial intelligence chatbot *Tay* on *Twitter* in 2016. It was designed to repeat others' statements while engaging in conversations. Within a day, *Tay* began to appear racist, as some of its responses were inappropriate because *Microsoft* failed to filter out racist labels and expletives (**Hunt**, 2016; **Kraft**, 2016). Although *Microsoft* apologized for *Tay*'s speaking style and released a revised version after fixing the bug, *Tay* continued to tweet in a way that questioned the brand's control over the technology (**Hunt**, 2016). A successful lesson can be taken from *Toyota*'s recall crisis. *Toyota* faced product problems due to claims of sudden and unintended acceleration issues with *Lexus* vehicles in 2019. *Toyota* quickly responded to the crisis via both traditional media and social media. In particular, they engaged with stakeholders and their fans using authentic and reciprocal communication that resulted in an increase in favorable *Facebook* comments (**Byrd**, 2012).

Although these cases imply that social media is an efficient crisis management toolkit for monitoring potential issues and stakeholder responses, very few empirical studies have conducted to scrutinize how major organizations utilize social media for crisis management (**Byrd**, 2012; **Ki**; **Netman**, 2014). To fill this gap, this study examines corporate crisis response strategies on social media based on SCCT by studying the case of *Samsung*'s *Galaxy Note 7* recall crisis. The following research question is addressed:

> RQ1: What post-crisis response strategies did *Samsung* employ on *Facebook* to deal with the *Galaxy Note 7* recall crisis?

4. WOM communication on social media during crisis

Communication by WOM is defined as communication or information exchange between individuals about organizations, brands, products, or services (**Sahelices-Pinto**; **Rodrigues-Santos**, 2014). Social media are used by consumers as a convenient conversation channel for sharing positive or negative experiences with brands, and a growing number of individuals are participating in eWOM communication (**Lee**; **Song**, 2010). As eWOM influences brand attitudes and purchase intentions, organizations must understand it in order to effectively manage these conversations and promote their brands and products (**Hambrick**; **Pegoraro**, 2014).

The literature on public relations focuses on the capacity of WOM, the contagion process, and the role of opinion leaders in product promotion and purchase decisions, and little eWOM research has been done in the crisis context (e.g., **Chakravarty**; **Hambrick**; **Pegoraro**, 2014; **Liu**; **Mazumdar**, 2010). Organizations can benefit from understanding eWOM behavior and primary information sources in a positive context. Research on eWOM can also allow corporations facing a crisis to identify the critical information that can "go viral," which will help them repair any crisis-related damage they may have suffered (**Hambrick**; **Pegoraro**, 2014).

The literature on reputation management has highlighted the role of interactivity in effective communication on social media. Research on message diffusion and reception in public relations emphasizes the importance of "contingent interactivity," which refers to interdependent messaging (**Kelleher**, 2015). According to Lee and **Park** (2013), contingent interactivity is related to favorable organizational reputation and positive relationship outcomes. Though social media communication is based on social embeddedness, studies have narrowly focused on interactivity by considering only the communication between corporations and consumers (**Chen** *et al.*, 2017), ignoring the interaction between customers. In the context of crisis communication, it is even more important to recognize that eWOM in crisis situations is complex and unpredictable. Various types of agents intervene in interactions to propagate and comprehend the available crisis-related information (**Jung** *et al.*, 2015). As social media users are more likely to rely on peer-to-peer communication in crisis situations, it is important to explore the information exchange activities that occur among the public (**Cho**; **Jung**; **Park**, 2013). Consumers' engagement levels and the interactivity between users are important components of crisis communication. Interestingly, higher levels of interactivity between customers on social networks can facilitate an ongoing crisis situation or trigger a new crisis, but they can also lead to positive outcomes, such as support for brands (**Ki**; **Nekmat**, 2014). The findings discussed above imply that, along with interactivity between organization and customers, the extent and pattern of interactivity between stakeholders should be considered to reflect the nature of eWOM behaviors in crisis communication.

We argue that to fully grasp the process and effects of message diffusion and reception effects in crisis management it is necessary to investigate the characteristics of social networking beyond the dimension of interactivity between users. Network indicators such as density, the extent of centralization in message production and reception, clustering effects, and the degree of mutual ties are important for measuring the dynamics of social networking among users (**Byrd**, 2012; **Jung** *et al.*, 2015). Adopting the social network perspective, this study offers a novel analytical approach to exploring the dynamics of eWOM behavior in crisis communication by addressing the following research questions:

> RQ2: How do crisis response strategies relate to the structural characteristics of the eWOM network, such as network size, centralization in message production and reception, reciprocity, and tie strength?
>
> RQ3: How do corporate crisis response strategies influence contingent interactivity between *Facebook* users?

An extensive literature shows the adverse outcomes of negative eWOM on brand reputation (**Chakravarty** *et al.*, 2010). Thus, companies are motivated to monitor, gauge, and control negative eWOM (**Pfeffer**; **Zorbach**; **Carley**, 2014). The successful monitoring of negative eWOM from customers results in improved customer relationships and brand evaluation (**Lee**; **Song**, 2010). Social media provides crisis response and reputation management teams with opportunities to improve their understanding of stakeholder interests, positions, and sentiments in real time, which is fundamental for developing future management strategies (**Ki**; **Nekmat**, 2014; **Pfeffer** *et al.*, 2014).

A growing but still limited number of studies have investigated the valence or themes in eWOM communication as outcomes of public responses to corporate communication strategies. Public comments on organizations' social media profiles or conversations between individuals about a crisis can be used to evaluate consumer perceptions and attitudes toward the brand in crisis situations and gauge the effectiveness of corporate response strategies (**Zhang** *et al.*, 2016). For instance, effective response strategies result in positive eWOM (**Byrd**, 2012; **Chen** *et al.*, 2017). It can be assumed that ineffective crisis management can lead to increased concern and hostile comments about an organization. The literature discussed above suggests that in order to assess the effectiveness of crisis response strategies eWOM needs to be investigated in conjunction with management strategies. Thus, the following research question is posed:

> RQ4: How do public perceptions and reactions toward the brand change over time in accordance with the crisis response strategies used on *Facebook*?

Figure 1 summarizes the study's research design based on our four research questions.

5. Background: *Samsung Galaxy Note 7* recall crisis

On August 19, *Samsung Electronics* launched a major product, the *Galaxy Note 7* smartphone. On August 24, 2016, an image featuring an exploded *Galaxy Note 7* smartphone was posted on an online community in South Korea (*BBC*, 2016a). This post spread globally across social media platforms. Several days later, other customers reported overheating issues and claimed online that *Galaxy Note 7* batteries had exploded during charging. *Samsung* received 92 reports from *Note 7* customers around the world about the battery overheating problem, which had resulted in burns and related property damage (**Samuelson**, 2016). *Samsung* announced a product recall and replacement for the smartphones on September 2, 2016 (*Samsung*, 2016). However, more than 100 incidents occurred after new batteries were used

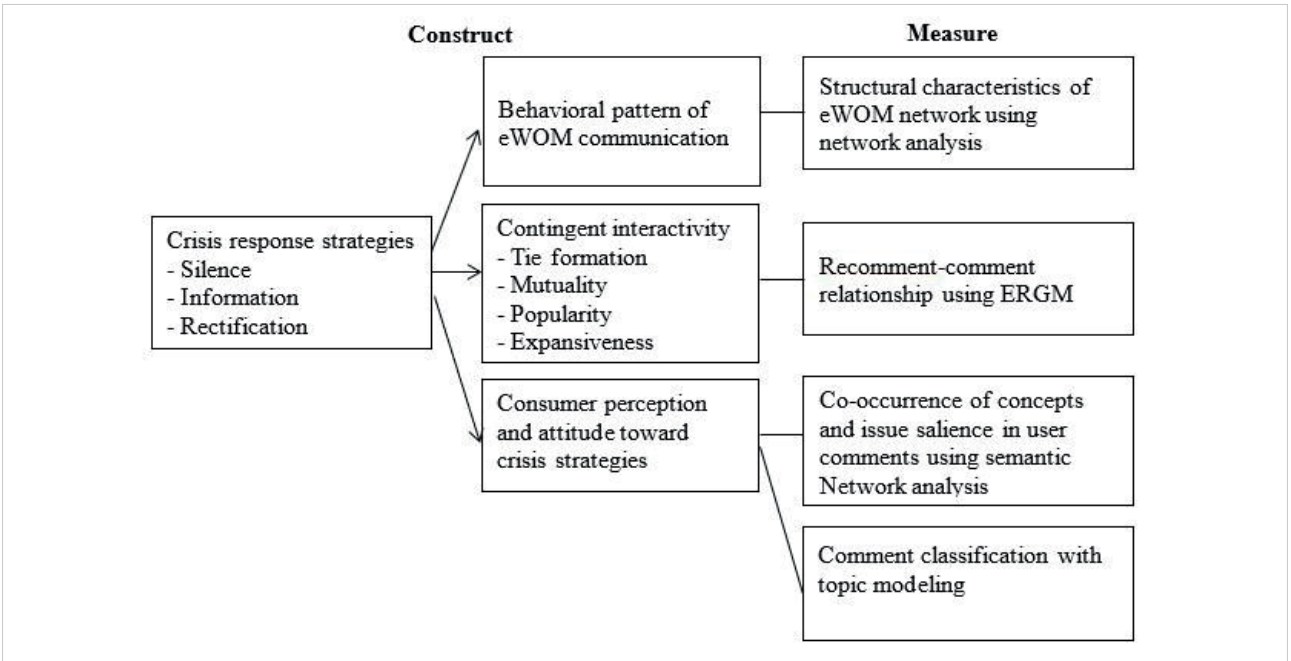


Figure 1. Research design

(**Samuelson**, 2016). On October 10, 2016, *Samsung* stopped the replacement initiative and discontinued production of the product (*BBC*, 2016). As a result, *Samsung* had to recall more than 2.5 million of the devices across 10 national markets and after 500,000 replacements had been sold in the United States alone. The recall cost was estimated at $5.3 billion (**López**, 2017). This crisis caused significant financial losses and reputational damage to the brand, particularly as *Samsung* faced the same issue twice –in the initial sales and with the replacement devices (*BBC*, 2016b). The cause of the incident had been attributed to the company's fast internal innovation process (**Yun**; **Jeon**; **Park**; **Zhao**, 2018). *Samsung* utilized social media to manage their damaged reputation. This case offers an opportunity to evaluate how a large corporation employed social media as a crisis-management tool and how that drove eWOM behaviors and public responses to the brand and its crisis communication.

6. Methods

6.1. Data collection

The primary unit of analysis is public comments to wall posts on *Samsung Global*'s *Facebook* fan page that appeared from August 24, 2016, when the first picture of the *Galaxy Note 7* burning incident was posted online, to January 22, 2017. A total of 2,240 comments generated by 1,839 unique users were collected using *NodeXL*, an API-based network analysis tool and analyzed.

6.2. Qualitative analysis of crisis communication strategies

We qualitatively examined the crisis response strategies *Samsung* employed in press conferences, press releases, and social media from August 24, 2016, right after the incident, to January 22, 2017. The post crisis strategies were determined, in accordance with the updated code book by adding "silence", as shown in Table 1 (**Dimitrov**, 2015; **Holladay**, 2012).

Table 1. Crisis communication strategies

Crisis response strategies	Explanations
Silence	Provide no response about the crisis
Information giving strategies	
Instructing information	Informs people about what to do to protect themselves physically and financially
Adjusting information	Tells detailed information about a crisis to help people cope psychologically with the crisis; explains action an organization takes to prevent a recurrence; shows compassion or express regret about the crisis
Reputation repair strategies	
Deny	
Attack the accuser	Argues the existence of the crisis
Scapegoat	Blames a person or groups outside of the organization for causing a crisis
Suffering	Says the organization is the victim of the crisis
Diminish	
Excuse	Attempts to minimize responsibility by denying the organization's intention to trigger the crisis
Deny volition	Attempts to minimize responsibility by arguing inability to control an incident that caused the crisis
Justification	Attempts to minimize the damage of the crisis
Rebuild	
Compensation	Offers compensation, money, or other gifts to victims
Apology	Acknowledges full responsibility for the crisis
Repentance	Asks for forgiveness
Rectification	Tells what action is being done to prevent reoccurrence in the future
Reinforce	
Bolstering	Reminds about past good works the organization did
Transcendence	Locates crisis in a larger, more desirable context
Ingratiation	Praises stakeholders for their help

Source: **Holladay** (2012); **Dimitrov** (2015)

6.3. Topic modeling

To model the major themes appearing in the large body of 2,240 public comments, we applied topic modeling using Latent Dirichlet Allocation (LDA). Topic modeling is an unsupervised machine learning technique that determines salient themes in a corpus (**Diesner** *et al.*, 2015). We used Jana Diesner's program *ConText* (**Diesner** *et al.*, 2015). This method produces two outputs: (1) word clusters (topics) with an estimated probability of a topic, representing a given corpus; and (2) the probabilistic weights of each word in a topic, indicating the strength of its association with the topic.

6.4. Semantic network analysis

In addition to topic modeling, we also employed a semantic network analysis to further examine public perceptions and attitudes to *Samsung*'s response strategies expressed in the comments. Semantic network analysis is a meaning-centered network technique used to determine shared meanings and interpretations among network actors based on word associations in texts (**Park**; **Park**; **Lim**; **Park**, 2016; **Park**, 2019). *NodeXL* was employed to generate co-occurrence matrices of top 100 word-pairs and visualizations.

6.5. A webometric network analysis

Social network analysis was conducted to investigate the structural characteristics of eWOM communication and the patterns of interaction between users embedded in the networks (**Barnett**; **Park**, 2014). *UCInet* was used to compute descriptive statistics for networks, such as network size, number of links, average geodesic distance, number of clusters, out-degree and in-degree centralization, and reciprocity. *NodeXL* was used for network visualization. In addition, a bootstrap technique with 500 samples was used to compare network density.

6.6. Exponential random graph model

Contingent interactivity was operationalized in terms of whether a user replied to another user's comment about the organization's post. This study explored the influence of crisis strategies on contingent interactivity by comparing the structural pattern of commenting behaviors corresponding to crisis strategies using exponential random graph models. Three recomment–comment networks in response to crisis strategies were constructed wherein, if user *i* recommented on a comment made by user *j*, then *i* was considered connected to *j*. We used the *Statnet* package in *R* to analyze the comment networks (**Handcock** *et al.*, 2008). The exponential random graph model (ERGM) technique produces approximate maximum likelihood estimates (MLEs) and simulates random networks from an ERGM given network data. It also allows us to test the goodness-of-fit of the specified model (**Hunter**; **Goodreau**; **Handcock**, 2008). Analogous to logistic regression, ERGM models determine the processes that influence link creation in the observed network (**Peng**; **Liu**; **Wu**; **Liu**, 2016). It estimates the probability of tie formation dependent upon the structural features of a network or the characteristics of network members (**Handcock** *et al.*, 2008). The expression for the ERGM can be written as

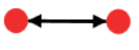
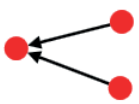
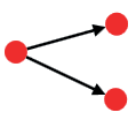
$$P_{\theta 0}(\mathrm{Y}=\mathrm{y}) = exp\left({\theta_0}^{\top}\mathrm{g(y)}\right)/\kappa(\theta)$$

where $\vartheta_0 \in R^p$ is a vector of fixed parameters, Y is a random network on nodes, y is the observed network, g(y) is a p-vector of statistics on network y, which comes from network set γ, and (θ) is a normalizing constant (**Hunter**; **Goodreau**; **Handcock**, 2013):

$$\kappa(\theta) = \sum_{z\in\gamma} \exp\{{\theta_0}^{\top} > \mathrm{g(z)}\}$$

We investigated the four forms of contingent interactivity in each network. (a) Tie formation: a user recommends on another user's comment on *Samsung*; (b) mutuality: a user replies to another user who comments on the user; (c) popularity effect: popular users become more popular in terms of receiving comments from others; and (d) expansiveness effect: active commentators tend to reply to other users. The structural configurations that represent the contingent interactivity are illustrated in Table 2.

Table 2. Structural configurations in ERGM

Parameter	Graphic	Network effect	Explanation
Arc		Tie formation	Propensity to form a tie between two actors
Reciprocity		Mutuality	Propensity for mutual ties between two actors
2-in-star		Popularity	Propensity for a tie to be directed to an actor who is already active as a tie target
2-out-star		Expansiveness	Propensity to send information to two distinct actors

Sources: **Lusher** and **Ackland** (2011); **Gondal** and **McLean** (2013)

The ERGM models were generated based on the results of the network characteristics. A Markov chain Monte Carlo for maximum likelihood estimation was used to simulate random networks and the model fit.

7. Results

7.1. *Samsung*'s crisis response strategies

The *Samsung* case represents an accidental crisis because the organizational action was not intentional. However, considering the severe reputational damage the crisis triggered, it should be treated as a preventable cluster, in which stakeholders might attribute high responsibility to the organization (**Coombs**, 2006b). Regarding RQ1, this study explored what post-crisis response strategies *Samsung* employed in dealing with the *Galaxy Note 7* recall crisis from August 24, 2016 to January 22, 2017. *Samsung* employed a silence strategy as the first step. They provided no responses about the crisis while posting promotional content about their other products on *Facebook*. According to the SCCT model, this was an inappropriate response for any type of crisis (**Coombs**; **Holladay**, 2015). After two months of silence, *Samsung* responded by combining the instructing and adjusting information strategies on October 13, 2016. They instructed customers about how to protect themselves from the overheating issue by suggesting turning off the phones and seeking consultation at local purchase or customer service centers. They also expressed concern about customers' safety and offered information about the inspections they were performing; this was an attempt to help customers handle the crisis psychologically (**Coombs**, 2007). This response was in line with the SCCT model's guideline for the initial reaction, although it was too late. Next, they used a rectification strategy on January 22, 2017, by telling customers about the actions they were taking to improve the product's quality, safety, and technology and prevent a reoccurrence of the crisis. This was an optimal response to the preventable cluster (**Coombs**, 2006a).

7.2. Structural characteristics of eWOM networks corresponding to crisis response strategies

To address RQ2 we first compared the structural characteristics of the eWOM comment networks generated across the three response strategies. Table 3 summarizes the descriptive statistics for the eWOM networks in response to each crisis strategy.

Table 3. Network descriptive statistics

Network measures	Silence	Information	Rectification
Network size	118	975	749
Number of unique links	111	1,051	767
Number of duplicated links	14	203	94
Number of total links	125	1,254	861
Average geodesic distance	2.02	2.31	2.29
Number of clusters	4	5	39
Out-degree centralization	0.0085	0.0172	0.0039
In-degree centralization	0.9573	0.9846	0.8528

The networks suggest that the flow of eWOM in all the comment networks took the form of highly centralized hub-and-spoke models. This means that a small number of users received most of the user comments. This high in-degree centralization may be attributable to the nature of the networks that included the focal node, *Samsung*. The average geodesic distances in the three networks are relatively small (2.02, 2.31, and 2.29, respectively), suggesting that the shortest possible route from one user to any other user is only around 2 steps.

When the brand offered no response to the crisis (i.e., silence strategy), 118 users generated 125 comments on *Samsung*'s nine posts that provided promotion or information regarding their other products. Among these, four replies were from users to other users. Four clusters were found in the comment network. The largest cluster was composed of ties between *Samsung* and stakeholders, suggesting that users tended to respond directly to *Samsung* rather than converse with other stakeholders. The majority of the influential users, those with high in-degrees, were current customers who mocked *Samsung*'s new product. They expressed doubts about *Samsung*'s product quality by reminding them of the explosion issue and complained about the unsatisfactory recall service for the *Note 7*.

After *Samsung* used an information strategy on *Facebook*, the network size sharply increased. A total of 975 users produced 1,254 comments. Communication between stakeholders also became more active in response to the information strategy. A total of 370 of 1,254 ties were replies to other users' comments. Five clusters were found, and the largest group embodied ties between *Samsung* and stakeholders. The comment network in response to the information strategy was extremely centralized: The top twenty influential users received nearly one-third of all comments from other users –either current *Note 7* users or other *Galaxy* phone users. Influencer commenters shared their negative experiences, complaining about poor customer service and the safety issue caused by the explosion.

When *Samsung* employed the rectification strategy, a total of 749 users generated 861 comments on the brand's post. Among them, 190 comments were recommendations to other users. The number of sub-groups increased sharply over that found for the silence and information strategies: 49 groups who were highly interconnected to each other were generated. As in the information network, the rectification network shows that the top influencers received the most comments from other users. They were also active in creating comments and consisted of current *Note 7* or other *Galaxy*

phone customers. *Samsung* rarely commented back to the public comments, which confirms that corporations use a *Facebook* as an information dissemination tool, rather than a communication tool (**Zeler**; **Capriotti**, 2019)

Next, network densities were compared to determine how the crisis response strategies related to the aggregate level of connectedness between users. Density refers to the average strength of ties for valued networks. As shown in Table 4, the result indicates that the average tie strength was statistically stronger for the information strategy than for the rectification ($p < .001$) and the silence strategies ($p < .001$). Users were also more likely to comment on *Samsung* or other users in response to the rectification strategy than to the silence strategy ($p < .001$).

Table 4. Comparison of network densities across crisis response strategies using bootstrapping

Crisis response strategies	Density (standard deviation)	Information	Rectification
Silence	0.018 (0.325)	- 47.565**	- 0.064**
Information	47.583 (81.074)	-	- 0.060**
Rectification	0.082 (3.004)	-	-

**Significant at $p < 0.01$; number of samples = 500

7.3. Influence of crisis response strategies on contingent interactivity

RQ3 addresses the influence of crisis response strategies on the pattern of contingent interaction between users. This study explored four forms of contingent interactivity –tie formation, mutuality, popularity effect, and expansiveness effect– in each network. We generated three symmetric matrices (user by user) based on comment–recomment relationships. We first computed descriptive statistics of the four parameters to determine what to include in the ERGM models. As no two-out-star was found in the information network, it was not included in the ERGM analysis.

Table 5 summarizes the ERGM results. The negative, significant coefficient of Arc in the silence network suggests that users were unlikely to recommend on the comments of others ($p < .001$). The goodness-of-fit (GOF) test suggests a fitted model.

Table 5. Results of ERGM on influence of response strategies for contingent interactivity

Contingent interactivity		Silence		Information		Rectification	
Construct	Parameter	Estimate	SE	Estimate	SE	Estimate	SE
Tie formation	Arc	-2.5649***	0.5991	-6.281***	1.107	-7.0279***	0.5156
Popularity	2-in-star	NA	NA	1.007***	0.057	0.2061	0.3648
Expansiveness	2-out-star	NA	NA	NA	NA	0.1954	0.3803
	AIC	23.21				1895	
	BIC	25.35				1920	

Note: *** $p < .001$

Similarly, users responding to the information strategy were unlikely to recomment on others' comments ($p < .001$). Interestingly, however, the popularity effect occurs at greater-than-chance levels ($p < .001$). Although the information network does not suggest a good fit for the model statistics, it satisfied the GOF based on other key statistics, including in-degree and out-degree centrality, edgewise shared partners, and minimum geodesic distance. Like other networks, the comment network for the rectification strategy also shows an unlikelihood of recommenting. The popularity and expansiveness effects were not significant. Out of the four GOF statistics, minimum geodesic distance and edgewise shared partner showed a good fit.

7.4. Consumer perceptions of crisis response strategies

Regarding RQ4, concerning differences in public perceptions and reactions toward *Samsung* and its crisis communication strategies, we performed topic modeling using an LDA algorithm to explore the entire corpus of comments made in *Samsung*'s posts addressing the crisis. The topic modeling indicates five main topics, represented by seven words. The importance of each topic was calculated in terms of weight. For the silence strategy (see Table 6), all five topics were hostile.

Table 6. Major topics in response to silence strategy

Topic name	Importance	Words
1. Delayed replacement process and poor customer service	3.15	Note, *Samsung*, phone, call, time, customer, device
2. Sadness for the delayed status process	1.57	lady's, sad, countries, gear, stopped, status, process
3. Skepticism for new product release & request for solution	1.42	Message, release, days, purchase, globally, lied, immediately
4. Customer's right & compensation	1.38	*Galaxy*, *Samsung*'s, temporary, sell, you, buyers, purchased
5 Criticism on *Samsung*'s wrong PR	1.36	Customers, money, millions, water, date, information, wrongs

The most popular topic comprised complaints about delayed replacement and poor customer service, followed by related concerns and sadness regarding the status update. Other topics include expressions of skepticism about new product releases, requests for a solution to the battery problem, statements about customer rights, and requests for compensation. Interestingly, users also criticized *Samsung*'s ineffective public relations.

When *Samsung* provided instructing and adjusting information about how they would protect customers from the battery overheating issue, the four of five topics still comprised negative responses (see Table 7).

Table 7. Major topics in response to information strategy

Topic name	Importance	Words
1. Delayed responses on recall, Request to replacement of 7 edge	2.63	*Samsung*, note, phone, edge, back, galaxy, service
2. Unfair replacement options in *Samsung Egypt*	1.27	Offer, Egypt, oct, official, thing, model, blow
3. Blame about refund process	1.135	Level, videos, batch, glad, amazon, credit, sucked
4. Software update issue	1.129	Collect, half, worth, found, updated, understand, mentioned
5. Positive sentiment on *Samsung*'s efforts to resolve the problems	1.11	Check, complaint, resolver, carrier, respect, resolved, promise

The major topics concerned *Samsung*'s delayed recall, requests to have the product replaced with the *7 Edge* (another smartphone model), complaints about unfair replacement options in Egypt, complaints about the refund process, and software update issues. Interestingly, the least important topic concerned positive sentiments about the firm's efforts to resolve the problem.

Stakeholders raised different issues after *Samsung* employed the rectification strategy (see Table 8).

Table 8. Major topics in response to rectification strategy

Topic name	Importance	Words
1. Concern on battery	2.77	*Samsung*, note, phone, battery, galaxy, edge, problem
2. Comparison with *Apple*	1.43	Where, absurd, half, apple, ppl, bye, coz
3. Blame on CEO office/Quality	1.30	Cases, office, attendant, ceo, phone, heats, money
4. Praising quality of *Samsung* products, concern on explosion	1.30	Point, says, metal, system, burn, navigation, station
5. Comparison with *Apple*, over heating issue	1.30	Heating, telephone, waste, crapple, days, value, tiny

While the most critical topic was still concern about the battery problem and through users still blamed the firm's CEO for the poor quality of the product, two topics were related to positive feedback in comparison with its competitor Apple and Apple's iPhone. One of the topics consisted of a mixed response –praising the quality of *Samsung*'s products while expressing worries about the explosion issue.

Semantic network analysis investigates public perceptions based on the co-occurrence of words, which represents users' shared concepts and a common understanding of a situation (**Shapiro**; **Park**, 2015). As visualized in Figure 2, the most salient word pair for the silence strategy is "note-7" (123), followed by "Galaxy-Note" (16), and "customer-service" (11).

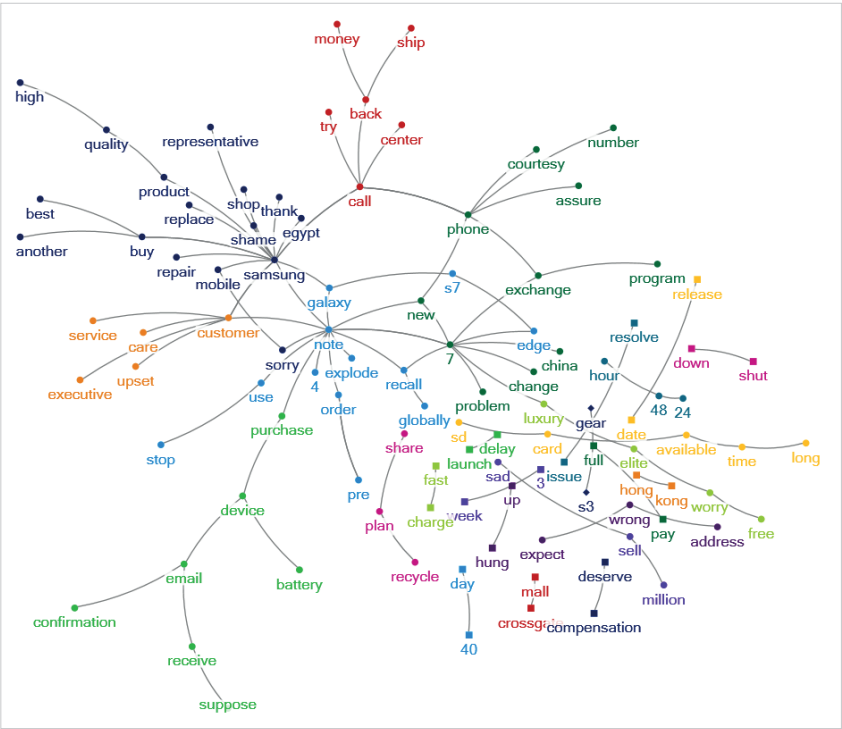


Figure 2. The semantic network of public comments in response to silence strategy.
Note. A node refers to a word. A tie between words shows the co-occurence of words. Node colors indicate the clusters.

Among the 25 clusters in the network, the major clusters indicate that users mocked *Samsung*'s mar-

keting for new product releases during the crisis, criticized the company for selling the *Note 7* in China and Egypt after the crisis, requested a solution of the *Note 7* explosion issue. They also asked for information on recall procedure of *Note 7* devices, complained about similar problems found in other products such as the *S7 Edge*, and complained about the delayed replacement in spite of *Samsung*'s 24-48 hours promise.

As Figure 3 shows, the most frequent word pair for the information strategy is "note-7" (400), followed by "s7-edge" (112), "*Samsung*-galaxy" (72), "galaxy-note" (56), and "customer-service" (54).

Word pairs about different smartphone models, such as "note-5" (50), "note-8" (44), "new-phone" (33), and "note-4" (29), appeared frequently as well. Among the 17 clusters in the network, the major ones reflected dissatisfaction and unhappiness about delayed replacements and customer relations, as well as disappointment with the brand. Some positive sentiments around brand royalty were also expressed, such as "love-note" (18), "best-phone" (10), and "love-Samsung" (8).

As illustrated in Figure 4, popular word pairs in the semantic network for the rectification strategy are related to users' experiences with the Note 7 and other smartphone models, such as "note-7" (88), "S7-edge" (47), "note-8" (42), and "note-4" (31), "galaxy-s7" (22), and "galaxy-s8" (14).

A total of 18 clusters were identified. The major cluster reflected positive sentiments toward *Samsung*'s work to solve the crisis and brand loyalty, as well as expectations about their other products (e.g., "love-note [6]," "looking-forward [9]" "fan-note [3]," "good-job [3]," "7-best [3], "well-done" [3], and "700-enginner" [3]. The comments still included criticisms about the irresponsibility of the firm's executives (e.g., "CEO-office" [6]) and suggestions on how to fix the problem (e.g., "remove-battery" [10] and "battery-life" [6]).

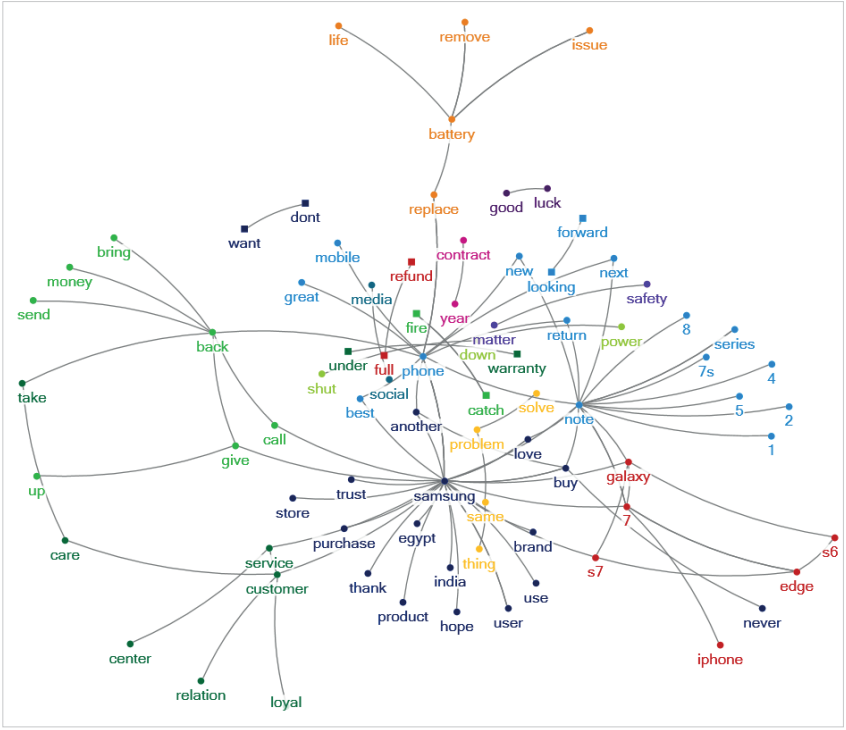


Figure 3. The semantic network of public comments in response to information strategy.
Note. A node refers to a word. A tie between words shows the co-occurence of words. Node colors indicate the clusters.

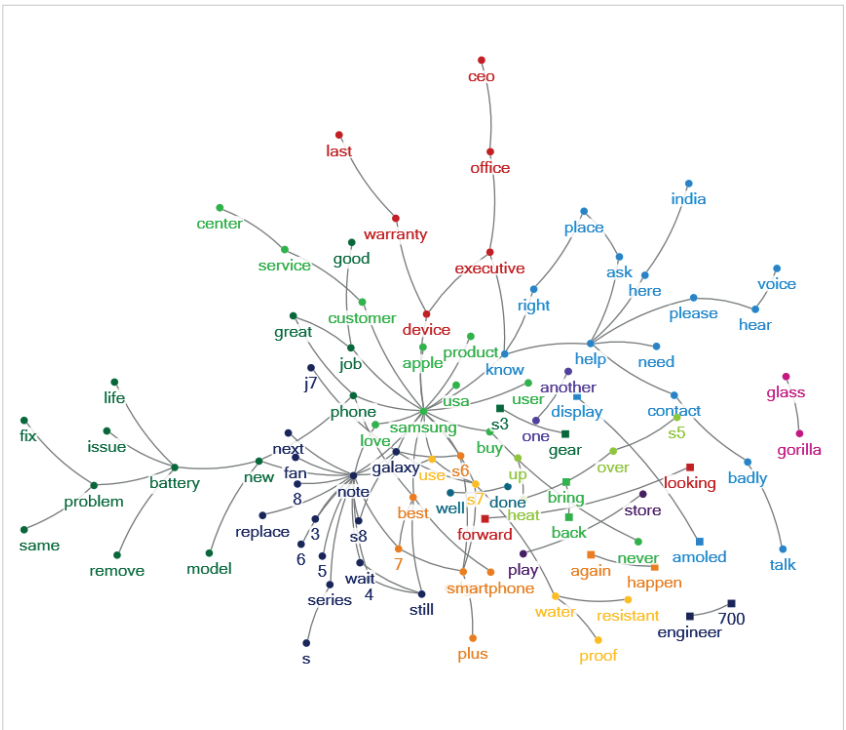


Figure 4. The semantic network of public comments in response to rectification strategy.
Note. A node refers to a word. A tie between words shows the co-occurence of words. Node colors indicate the clusters.

8. Discussion and conclusion

Using SCCT, this study assesses the effects of corporate crisis response strategies on public perceptions of and reactions to a brand and its crisis communication using the case of *Samsung*'s product recall crisis (**Coombs**, 2006a). The findings suggest that the response strategies *Samsung* employed in the preventable cluster were as follows: silence, a combina-

tion of instructional and adjusting information (base strategy), and rectification (rebuilding option). Although *Samsung* failed to choose appropriate responses in the initial stage, they eventually followed the guideline of the SCCT model, which recommends using rebuild options in the preventable cluster (**Coombs**, 2007).

The results of a network analysis showed that more participants and comments were generated and the average tie strength of the eWOM networks were stronger for matched responses (information and rectification) than for the silence option; thus, matched responses activated more responses to the brand and interactions between users. Interestingly, the information response sparked more commentators and stronger interactions between users than did the rectification response. This may have occurred because users were more interested in expressing their opinions and in discussing the information offered by *Samsung* about what caused the technical error and how to avoid the danger of potentially harmful products.

The eWOM networks in response to all the strategies displayed a power–law distribution in message reception, whereas comments were produced more evenly across a number of participants. We confirmed that a small number of skeptical and unsatisfied customers received most of the comments from others across all response strategies. In other words, negative opinions about the crisis went more viral and received more attention from others on social media. Considering that exposure to others' uncivil comments drives negative emotions and facilitates further uncivil discourse (**Ng**; **Song**; **Kwon**; **Huang**, 2020), crisis managers should address a consumer outcry on social media in a timely manner in order to prevent an adverse contagion effect.

The ERGM results showed no contingent interaction except for the popularity effect corresponding to the information response. This suggests that individuals were likely to visit corporate social media to request accountability from the organization and to communicate with it directly rather than interact with others. The significant popularity effect found in the network for the information strategy indicates that small number of central users tend to receive replies from others, indicating the importance of their opinions in prompting further discussions (**Wang**; **Cheliotis**, 2016). Thus, public relations practitioners should pay special attention to feedback from influential users when executing their information response.

The results of the topic modeling and semantic network analysis support the propositions of the SCCT model (**Coombs**, 2007; **Coombs**; **Holladay**, 2015). The silence strategy led to negative sentiment, complaints about their irresponsible customer relations, and requests for solutions from customers with defective products. The late adoption of a matched strategy generated primarily negative sentiments about the delayed response and ineffective crisis management, as well as some positive sentiment praising their efforts to solve the problem. These findings are consistent with the public relations principle that emphasizes early reactions to a crisis (**Benoit**, 1997; **Coombs**, 2007). In line with the SCCT model, a matched response (rectification) generated increased positive responses, such as brand loyalty and forgiveness for technical errors.

This study extends the scope of SCCT to include eWOM behaviors. It offers evidence-based lessons on how to systemically monitor stakeholders' reactions and effectively manage consumer concerns in order to repair a reputation damaged by a crisis. We demonstrated that combining network analysis and topic modeling are useful for describing the mechanism of eWOM behaviors and public perception based on a large body of texts. Methodological triangulation in this study helped us overcome the limits of conventional semi-automated text analysis, which may not be able to detect deeper meanings or contextual information. A qualitative examination of popular public responses was conducted as well. The study's results offer practical insights into crisis response strategies. This study highlights the importance of identifying influencer users and addressing their concerns before their voices expand and go viral. Moreover, silence should be avoided; instead, timely matched responses should be offered to shape positive perceptions after crises caused by technological errors or harmful products.

This study also has limitations. First, the study explored public comments on *Facebook*. Although, *Facebook* was the primary crisis communication channel of *Samsung* during the crisis, the results may not be generalizable. This is because important topics are discussed across different social media platforms (**Thelwall**; **Levitt**, 2020). Future studies need to use altmetric data sets that provide a wide range of resources such as mainstream media mentions, blog mentions, and social media mentions regarding corporate crisis events (**Ortega**, 2020). Thus, the results may not be generalizable. Future studies need to expand the scope of investigation. Second, the study did not capture any of the delayed effects of the response strategies that would have been likely. Future studies should also analyze how different types of stakeholders engage in eWOM in response to a crisis and how the sub-issues change over time in accordance with the organization's choice of response option.

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