Journal of Contemporary Eastern Asia Vol. 18, No. 1: 189-216
DOI: 10.17477/jcea.2019.18.1.189

Risk Communication on Social Media during the Sewol Ferry Disaster

Minsun Song [1], Kyujin Jung [2], Jiyoung Ydun Kim [3] and Han Woo Park [4]

The frequent occurrence of overwhelming disasters necessitates risk communication systems capable of operating effectively in disaster contexts. Few studies have examined risk communication networks during disasters through social networking services (SNS). This study therefore investigates the patterns of risk communication by comparing Korean and international networks based on the social amplification of risk communication in the context of the Sewol ferry disaster (SFD). In addition, differences in language use and patterns between Korean and international contexts are identified through a semantic analysis using KrKwick, NodeXL, and UCINET. The SFD refers to the sinking of the ferry while carrying 476 people, mostly secondary school students. The results for interpersonal risk communication reveal that the structure of the Korean risk communication network differed from that of the international

[1] Minsun Song is assistant professor in Department of Political Science at Valdosta State University. Her research has been published in Public Administration Review, Urban Affairs Review, Quality and Quantity, and the Journal of Homeland Security and Emergency Management. Her research focuses on issues related to emergency management, collaborative networks, and local governance. E-mail: msong@valdosta.edu

[2] Kyujin Jung is assistant professor in the Department of Public Administration and the Graduate School of Governance at Sungkyunkwan University in Korea. He has performed grant research projects funded by the National Science Foundation, IBM Center for the Business of Government, and Seoul Institute to investigate interorganizational collaboration. His research has appeared in Public Administration Review, Urban Affairs Review, Government Information Quarterly, and Quality and Quantity. His research interests include interorganizational arrangements, social network analysis, and issues related to emergency management. E-mail: kjung1@skku.edu

[3] Jiyoung Ydun Kim is a doctoral candidate in the School of Communication and Culture, Datalab, Aarhus University (AU), Denmark. Her Jiyoung Ydun Kim's PhD project is in "*AI in Digital Sociology*". Her PhD project on gender gap in Facebook groups is a part of AU DATALAB at the Centre for Advanced Visualization and Interaction (CAVI). E-mail: Jiyoung@cc.au.dk wonderflyb@gmail.com

[4] Han Woo Park is a Professor in the Dept. of Media & Communication, Interdisciplinary Program of Digital Convergence Business, and Director of Cyber Emotions Research Institute at YeungNam University, South Korea. He was a pioneer in network science of open and big data in the early 2000s (often called *Webometrics*) when he used to work for Royal Netherlands Academy and lead the World Class University project. He has published more than 100 articles in *SSCI* Journals. Several publications were included in top 10 list of downloads and citations. He has been co-awarded the best paper in EPI-SCImago in 2016 and included in the list of core-candidates of the Derek de Solla Price Memorial Medal in 2017 and 2019. E-mail: hanpark@ynu.ac.kr (corresponding author)

network. The Korean network was more fragmented, and its clustering was more sparsely knitted based on the impact and physical proximity of the disaster. Semantic networks imply that the physical distance from the disaster affected the content of risk communication, as well as the network pattern.

Keywords: Risk Communication, Twitter, Facebook, Sewol Ferry Disaster, Webometrics

Introduction

Despite technological advances, potential risks remain and cannot be detected completely. In addition, the intensity of disasters has seemed to strengthen as a result of global climate change. That is, potential risk factors are widespread, unpredictable and serious. Their complete prevention is virtually impossible, but alertness must be maintained. Regardless of whether a disaster is man-made or natural, initial responses and information sharing remain crucial, and media technologies enable disasters to be addressed quickly and efficiently by transmitting timely and accurate information to the public (Yates & Paquette, 2011; Jung, No, & Kim, 2014). Since the creation of Twitter, a 140-character messaging tool for social networking service (SNS), in 2006, the speed of information diffusion has accelerated across Twitter users. Similarly, Facebook has contributed to social interactions for information diffusion through "Friending," which refers to adding people to the inventory of friends (Boyd, 2006).

The frequent occurrence of overwhelming disasters has emphasized the importance of risk communication in disaster contexts. Risk communication refers to a process in which social, psychological, and cultural messages are transmitted, disseminated, or exchanged through risk signals (Rosa, 2003; Kasperson et al., 1988; Pidgeon, Kasperson, & Slovic, 2003). Regarding efficient communication among people, the social amplification of risk can help predict the behavior of social groups, individual responses, and structural movements in institutions (Kasperson et al., 1988). Public sharing of information on risk factors can help foster a resilient community and facilitate active responses, thereby enabling people to take their initial action. People's ignorance or unawareness of risk sometimes leads to extreme outcomes directly related to casualties and property loss.

Real-time SNS (e.g., Twitter and Facebook) can facilitate the diffusion of risk information, but the pattern of interactions between Twitter users may vary. In addition, Facebook links online communities to offline relationships through "Friending" and promotes mutual interactions based on shared interests regardless of the geographic distance. Few studies have examined risk communication networks during disasters through SNSs although the networks have a potential to give social pressure or wishes to responders for better response and risk communication might include diverse messages such as condolence, request of any countermeasures, and/or providing crucial information. Risk communication networks can be considered a type of social capital for enhancing emergency relief efforts (Cole & Fellows, 2008). Based on the social amplification of risk framework, this study examines the pattern of risk communication by comparing Korean and international networks. Depending on the seriousness of a critical issue and the physical and

emotional distance, the pattern of risk communication may vary. The social context of risk generates different patterns of information diffusion (Chung, 2011), and therefore an actor playing an intermediary role in a risk communication network can be detected by analyzing the structure of each network. Therefore, the present study identifies the differences in language use and patterns between Korean and international networks through a semantic analysis based on the assumption that language usage reflects attitudes toward a given situation.

The rest of this paper is organized as follows: the social amplification of risk framework is first reviewed, and then Twitter and Facebook are discussed as SNS tools. Next, the research design is discussed, followed by the data collection procedure using UCINET 6.0, NodeXL, and KrKwic for a network analysis. Finally, the results are presented, followed by the discussion and conclusions.

The Sewol Ferry Disaster and Its Recovery

Despite a fog delay for two and a half hours, the Sewol ferry, carrying 476 people on board, was finally ready to depart at 9 p.m. KST (Korea Standard Time) on April 15, 2014, for Jeju Island. The ferry set sail along the Incheon-Jeju route, but capsized only 25 km off the southwestern seashore. The voyage deviated from the regular route to reach the destination on time, and as it made a sudden 45-degree starboard turn near Gwanmae Island, JeollaNamdo, at 8:49 a.m. on April 16, the ferry began to tilt severely and the passengers heard a loud banging sound.

The initial distress signal to the Jeju VTS (Vessel Traffic Service) was officially issued by the Sewol ferry at 8:55 a.m., although the first rescue call by a Danwon High School student was made to the Jeonnam Fire Service (911) at 8:52 a.m. The Jindo VTS established contact with the Sewol ferry only at 9:07 a.m. to verify the capsizing and the ferry's rescue request. According to records of contact with the VTS, the onboard announcement tragically kept instructing passengers to stay inside. At 9:10 a.m. the Coast Guard Headquarters began operating, and Sewol crew members were asked about the evacuation possibility. However, the reply was “impossible” based on the fact that the ferry was already tilted more than 50 degrees to port at 9:17 a.m. The Jindo VTS ordered the captain to prepare for evacuation by deploying lifeboats, but the reply at 9:23 a.m. was that they were out of order.

The Jindo VTS stated that it did not have enough situational information and asked the captain to decide whether to issue evacuation orders immediately. At 9:28 a.m., the ferry was already tilted about 60 degrees to port, and the Coast Guard helicopters and vessels started to arrive. In addition, the Jindo VTS requested nearby fishing boats and commercial vessels to help in the rescue operation. After 9:38 a.m., the radio communication signal from the ferry was lost, and it was later determined that the captain and some crew members abandoned the ferry in violation of the law. They were even the first to be rescued by the Coast Guard.

It was not until the Sewol ferry tilted over 90 degrees to port that the first evacuation announcement was made, and only about 172 people were able to escape. At 10:30 a.m., the Sewol ferry finally capsized. Then it submerged in an hour, with only the bow remaining exposed. By 11:18 a.m., the bow also submerged, with only some part of the hull remaining above the water. The Ministry of Ocean and Fisheries (MOF) operated its own core response team at 9:40 a.m., and the Ministry of Security and Public Administration (MOSPA) installed an emergency operation team at 9:45 a.m. The first formal briefing was held by MOSPA at 10:00 a.m. The report on the number of people on board kept changing, and the Navy and the Coast Guard announced that they had entered three cabins but found no passengers. It was determined later that they could not get inside the cabin.

One day later, on April 17, to integrate the function of the MOSPA, the MOF, and the Coast Guard, the Central Disaster and Safety Countermeasures Headquarters (CDSCH) were installed as the control tower at the site of the accident. The ferry sank completely at 12:35 p.m. on April 18, 2014. On the following day, the joint rescue team finally succeeded in entering a passenger compartment at 11:40 p.m. and recovered three corpses. In addition, the national government declared Jindo and Ansan special disaster zones on April 20.

The death toll kept rising, but no more survivors were rescued after April 16. As time went by, families lost all hope of survival, and their waiting shifted from rescuing missing people to finding corpses. In addition, they were heartbroken by the sluggish and passive response from the government and questioned the failure of initial response (Jung, Song, & Park, 2018). On April 18, representatives of the victims' families issued a public statement and appealed to the public for any help in rescuing missing people. In particular, seven days after the Sewol disaster on April 22, parents of surviving *Danwon* High School students appealed for the government to make more effort rescuing than fact finding. They emphasized that children and families were in cold water, waiting for their rescue. In this regard, the current study examines the role of risk communication of disaster relief on social media from the Sewol disaster case.

Theoretical Considerations

Social amplification of risk

Social contexts such as cultural thoughts and national traits generally shape the pattern of information flow (Park, Baek, & Cha, 2014; Park et al., 2013). In addition, risk communication behavior, including that on online platforms, reflects a comprehensive context (e.g., social, institutional, and economic backgrounds). Risk communication has played an increasingly important role in helping people acquire crucial information during and even after disasters and in mitigating losses and social conflicts. The social amplification of risk framework addresses relationships between social entities (e.g., opinion leaders) and risk communication behavior (Renn, 2011). Depending on the social context, risk communication can be either amplified or attenuated, and the pattern of information diffusion may vary.

According to Kasperson et al. (1988), people perceive "risk" and thus learn from others and diverse media platforms with respect to information mechanisms of social amplification. As a key agent of social amplification, information flow has been highlighted. Information attributes influencing the social amplification of risk include volume, disputes, dramatization, channels, informal communication networks, and symbolic connotations. A large volume of risk-related information and dramatization can serve as an amplifier. Debates among diverse actors increase public uncertainty, and risks perceived by the public are often the likely outcome. The previous perspective on channels may be different from the present one. More specifically, social media are prevalent, which facilitates media convergence. In addition, personalized media platforms such as Twitter and Facebook have played a key role in the social amplification of risk, and the diffusion of shared information is likely to be triggered with a symbolic term.

A disaster can be understood as a consecutive process instead of a disconnected one. That is, recovery is an extension of the outcome of the response to a disaster. In the recovery of normalcy, diverse issues such as political and social conflicts, economic aid, and community rehabilitation arise. Along with the perspective of seeing an ongoing disaster, the pattern of information sharing is shaped differently by key actors on social media. In the same vein, key actors as a social amplifier of risk communication may rapidly change some aspect of information delivery (Binder et al. 2011; Jung & Park 2014), and this pattern may drive a vigorous discussion on a specific issue, facilitating risk perceptions. In the process of resolving a problem, risk communication evolves in a dynamic manner. This study applies the risk amplification of the risk framework to the Sewol ferry disaster and examines the role of actors who disseminated relevant information on the disaster through social media platforms.

Social amplification of risk framework (SARF) provides a conceptual mechanism to understand how different patterns of information dissemination or distribution are shaped (Sheppard, Janoske, & Liu, 2012). Rogers et al. (2007) state that social contexts relevant to risk management can magnify or shrink the risk communication of the public that posited by SARF. Also, according to Kim and Grunig (2011), action or behavior for risk communication is determined by incident detect, constraint recognition, and involvement level. Each public are differently motivated to utilize social media for engagement in risk communication, leading to different network patterns depending on social groups (Aldoory & Sha, 2007). The publics under a different social context are expected to form the different structure of risk communication on social media.

Risk communication networks on Twitter and Facebook

Twitter and Facebook in emergency contexts.

Studies of Twitter and Facebook are rapidly emerging (Kim, Park, & Rho, 2013; van de Velder, Meijer, & Homburg, 2014; Jung & Park, 2014). In terms of Twitter networks, early studies focused more on the general features of the whole Twitter network and patterns of its growth

(Java et al 2007; Krishnamurthy, Gill, & Arlitt ,2008), and previous studies of Facebook focused on interactions between undergraduate students, presenting the level of social capital (Ellison, Steinfield, & Lampe, 2007; Steinfield, Ellision, & Lampe, 2008; Valenzuela, Park & Kee, 2009; Ellison, Steinfield, & Lampe, 2011). More recent studies have investigated social interactions on Twitter (Huberman, Romero, and Wu, 2008; Hughes & Palen, 2009) and examined the features of the hybrid media platform on Facebook, as well as the principle of social capital in a structural dimension (Lin & Lu, 2011). In emergency contexts, Twitter and Facebook have been seriously considered in risk communication (Hagar, 2009; Hughes et al., 2008; IFRC, 2013; The Social Engagement Team at National Headquarters, 2012) to address technological and social issues in emergency situations.

With respect to the analysis of Twitter networks in emergency contexts, Subrahmanyam et al. (2008) found that the adoption of new information through technologies such as Twitter and Facebook facilitated responses and relief efforts by displaced victims (e.g., victims of Hurricane Katrina). Their use may continue even after the disaster and help victims reestablish a sense of community (Shklovski et al., 2008; Hughes & Palen, 2009). According to the perspective of directive stakeholders who experience a disaster, potential victims in unseen future disasters may view specific disasters differently based on community and individual attributes. Their risk perceptions and understanding of disasters in different social contexts may vary. In this regard, this study examines different patterns of risk communication on Twitter and Facebook by analyzing risk perceptions of the Sewol disaster to provide a better understanding of features of risk communication on social media platforms in two Twitterverses with different socio-cultural backgrounds.

Structural patterns reflected by social connectivity in the Twitterverse and the Facebook-verse.

Users who retweet and/or are retweeted are more likely to be opinion leaders (Jung, No, & Kim, 2014; Meza & Park, 2016; Xu, et al., 2014). Twitter networks are associated with social connectivity, and this study analyzes connections between diverse users by using the keyword "Sewol." As detailed later, to compare the pattern of connectivity related to risk communication across countries, the keyword "Sewol" in English is considered instead of "세월호" (Sewol ferry in Korean). In addition, to identify users' identity, the study examines those more likely to be retweeted. Identifying opinion leaders through SNS such as Twitter and Facebook in a disaster is meaningful because it helps understand the risk communication mechanism. Opinion leaders with quick response through SNS in emergency management contexts are regarded as a hub in terms of information flows and demands for instant countermeasures in disasters; this research tentatively investigates the potential of SNS applicability for disaster response and relief by comparing the patterns of risk communication in the different contexts of Korean and international networks.

Social connectivity is grounded in users' position in Twitter networks. As a tool of social interactions and information sharing, Twitter allows "followings," which refer to users following other users to acquire information offered by them. The action of "following" facilitates the

diffusion of specific information related to retweets. Following broadens the pool of audiences and helps users be exposed to more information (Takhteyev, Gruzd,

& Wellman, 2012). Therefore, the pattern of Twitter networks is likely to influence others' thoughts or attitudes and may facilitate or hinder information flow relying the context in which individuals interact with one another. In this regard, the following research question is proposed:

> *RQ 1-1: How does the structure of risk communication on Twitter differ between Korean and international networks?*

Facebook (2009) defines a profile page as a "public profile that enables you to share your business and products with Facebook users" (McCorkindale, 2010). In particular, fan pages are active trust-building channels in that they facilitate mutual interactions in information and opinion sharing, leading to an increase in social ties with others (Powell, 2009; Park & Lim, 2014). Interactions on Facebook are based on offline relationships, and its online property extends the level of social connectivity. Fan pages offer a media platform for posting issues and information, and therefore individuals share their perspectives on social issues through fan pages. These pages often play a role in disseminating brand value.

Based on an analysis of co-commenters, social ties with others bound in the issue of the Sewol ferry disaster are considered in this study. Despite web-based interactions, Facebook has a distinct property of starting with individuals known in offline relationships. Therefore, a majority of individuals are not trying to meet strangers on SNS (Ellison, Steinfield, & Lampe, 2011). Nevertheless, acquainted friendships or relationships have the strength to maintain frequent and regular communication, and through the comment tool, ties between individuals remain dense. That is, diverse groups with which one interacts can overlap through fan pages, and one's interactions with others can help transmit shared information. In terms of the range of physical interactions, Korean and international contexts may provide different ways to transmit information to groups sharing common interests. In this regard, the following research question is proposed:

> *RQ1-2: How does the structure of risk communication on Facebook based on co-commenters differ between Korean and international networks?*

> *RQ 2: How do the intermediary roles of brokers and information starters differ between Korean and international networks[5]?*

[5] International networks are defined as outer networks beyond Korean networks that are structured based upon Korean language. Simply put, international networks are generated by English term "Sewol" instead of "세월호 (Sewol ferry in Korean)" that covers broader users who understand and/or speak English.

Research Design

Data.

Twitter.

To examine the interaction pattern of citizens' risk communication on Twitter in domestic and international social media networks during the Sewol ferry disaster, the analysis used NodeXL, a useful tool for estimating network structures regarding interactions between diverse actors on Twitter. In extracting data on followers on Twitter, NodeXL enables a test of hypothesized patterns of risk communication between Twitter users. Through this collection method, Twitter data relevant to the Sewol ferry disaster were collected on April 20, 2014.

The time point considered in this analysis was one day (20th April), although emergency management actors were still responding to it. Twitter data were collected using two keywords "Sewol" and "세월호" for both international and Korean networks. The term "Sewol" was chosen as a representative word for the accident. The data was collected based upon the contents with the term and hastag Sewol (#Sewol). Also, the terminology of "세월호" (Sewol ferry in Korean) provides the ferry accident information that can cover the type of the incident. Data collection was based on a daily snapshot in two contexts (Korea and the world) on April 20. To minimize any data collection bias derived from time differences between these two contexts, data were collected at the same time on April 20. This data set based on only one time point may be limited in showing the overall pattern of changes in risk communication but still can provide insights by comparing different structures of risk communication depending on the language-based context. The collected data included 2164 Twitter users[6] whose Tweets contained "Sewol" or "세월호" or who followed Tweets as followers. More specifically, retweet data collection was primarily based on reply and/or mention networks instead of following networks.

Facebook.

The most popular Facebook fan pages in both English and Korean (in terms of members) related to the Sewol ferry disaster were selected by using two keywords "Sewol" and "세월호" (Sewol ferry in Korean): the "Sewol Ferry Accident Memorial" on the international fan page and "세월호 침몰사건 상황실 [Sewol Ferry Disaster Control Center in Korean]" on the Korean fan page. Data were collected for the first five days by using NodeXL. On the first day of the disaster (April 16), all of Korea was shocked by the tragedy, and people started to deliver information and share emotions with other users through Facebook fan pages. The first five days until April 21 were considered to examine the pattern of interactive communication with respect to the initial response. The accident drew attention from both Koreans and people across the world. The examined fan pages in both contexts were chosen based on the largest numbers of members,

[6] The number of Twitter users were 2164, the maximum number of data that can be collected from NodeXL in one time point.

likes, and visitors. The international network contained 64 posts and the Korean network 241. The network pattern was analyzed using co-commenters, and a semantic analysis was conducted to identify differences in content for the same issue.

The size difference between the two data exists but this study focuses more on the content and the patterns of networks instead of simple comparison between the two. Moreover, it is natural that the size of the two shows disparity because the geographical distance from the disasters brings the different level of interest or concerns (Takhteyev, Gruzd, & Wellman, 2012). Differently put, relying on the physical distance from the incident affect the property of network pattern and/or the context of risk communication.

Methods.

The analysis used the social network analysis method to identify the interaction structure of risk communication on Twitter during one day (20th April) and Facebook during the first five days (16th -21th April) of the response to the Sewol ferry disaster. The different data collection periods between Facebook and Twitter were considered due to the different characteristics of the two social networking services. The way of sharing information on Twitter differs from that on Facebook. The first one is more of an open network, whereas the latter is an information-sharing platform based on networks of friends. Diffusion of communication is less powerful on Facebook due to its more closed network nature. Twitter has its own retweet function, which accelerates information diffusion. The webometrics method was used to analyze actors' relationships presented by statements from Twitter users. More specifically, relationships between actors were captured based on both keywords mentioned by actors and replies or responses to them by others, including retweets. For Facebook, a network analysis of co-commenters was conducted based on two representative fan pages.

Two network levels were considered: structural and individual. For the structural level, the analysis focused on describing the whole network (i.e., a global network) incorporating a set of vertices, unique edges, edges with duplicates, self-roofs, connected components, single-vertex connected components, maximum vertices in a connected component, maximum edges in a connected component, the maximum geodesic distance (i.e., the diameter), and graph density. At the individual level analysis, betweenness centrality measure was considered in order to identify who takes a bridging role spanning the networks for transmitting the information.

In the visualization of Sewol disaster communication networks, UCINET 6.0 (Borgatti et al. 2002) and NodeXL (Hansen et al., 2010; Meier, 2016; Smith, 2015) were used to analyze network indicators and capture risk communication clusters to reflect the characteristics of the network structure. The spring-embedding algorithm was used to identify clusters. Specifically, the networks were clustered using the Fruchterman-Reingold algorithm (Fruchterman & Reingold, 1991) by considering the strength of the relationship between two nodes. Cluster groups were generated by classifying Twitter and Facebook users to provide a better

understanding of risk communication. A network cluster consisted of similar actors closely connected to one another and was distinct from other clusters.

At the level of individual networks, betweenness centrality captures the level of social connectivity and indicates the penetrating property along the geodesic path between two actors that otherwise may not be connected with each other (Borgatti et al., 2009). It spans two different clusters, leading to the shortest path to connect others together (Freeman, 1979). In this study, betweenness centrality was used to capture online communication relationships between Twitter users and co-commenter relationships on Facebook fan pages in both Korean and international sphere:

Betweenness centrality: $$C_B(n_i) = \sum_{j<k} g_{jk}(n_i) / g_{jk}$$

A semantic analysis of Twitter and Facebook data was conducted to investigate differences in content and linguistic use patterns of Korean and international networks (Cho et al., 2012; Jung & Park, 2015). After the terms in the top 20-30% were extracted using KrKwic (Korean Key Word in Context) to classify large-scale text and analyze word frequency in the messages, the frequency of the most frequent terms was examined based on the co-occurrence of "word" × "word". Single-mode matrices were used to capture degree centrality, and the overall pattern of semantic networks was visualized using UCINET 6.0-NetDraw (Borgatti et al., 2002).

Results

Results for Twitter.

Table 1 summarizes the macro network indices for Twitter-based risk communication. There were 2,164 vertices, and the number of unique edges was the same as that of total edges (2,065), which indicate a fragmented network. In addition, in terms of different indicators of connected components, the maximum number of vertices was 625 and that of edges was 741. The maximum geodesic distance was 20, and the graph density was .0004. The overall network was loosely connected, although its absolute value provides no accurate insights.

Table 1

Overall Graph Metrics for Twitter Networks

Graph metric	**Value**
Graph type	Directed
Vertices	2164
Unique edges	2065
Edges with duplicates	0
Total edges	2065
Self-loops	200
Reciprocated vertex pair ratio	0
Reciprocated edge ratio	0
Connected components	455
Single-vertex connected components	179
Maximum vertices in a connected component	625
Maximum edges in a connected component	741
Maximum geodesic distance (diameter)	20
Average geodesic distance	6.899175
Graph density	.000398442
Modularity	.895739

To visualize clustering networks, diverse subgroups were generated. Among the cluster subgroups, group 1 (G1) was the international risk communication network, and group 2 (G2) was the Korean risk communication network. Their patterns of risk communication were distinct (see Figure 1). G1 formed a traditional broadcasting network structure with the eye of a typhoon as a generator of communication. This type of network structure on Twitter is generally triggered by prominent actors such as media outlets and pundits. On the other hand, G2 was clustered based on issues and tended to be a brand cluster. This type of network typically forms around a hot issue to attract the public's attention, but its network structure has little connectivity with other users.

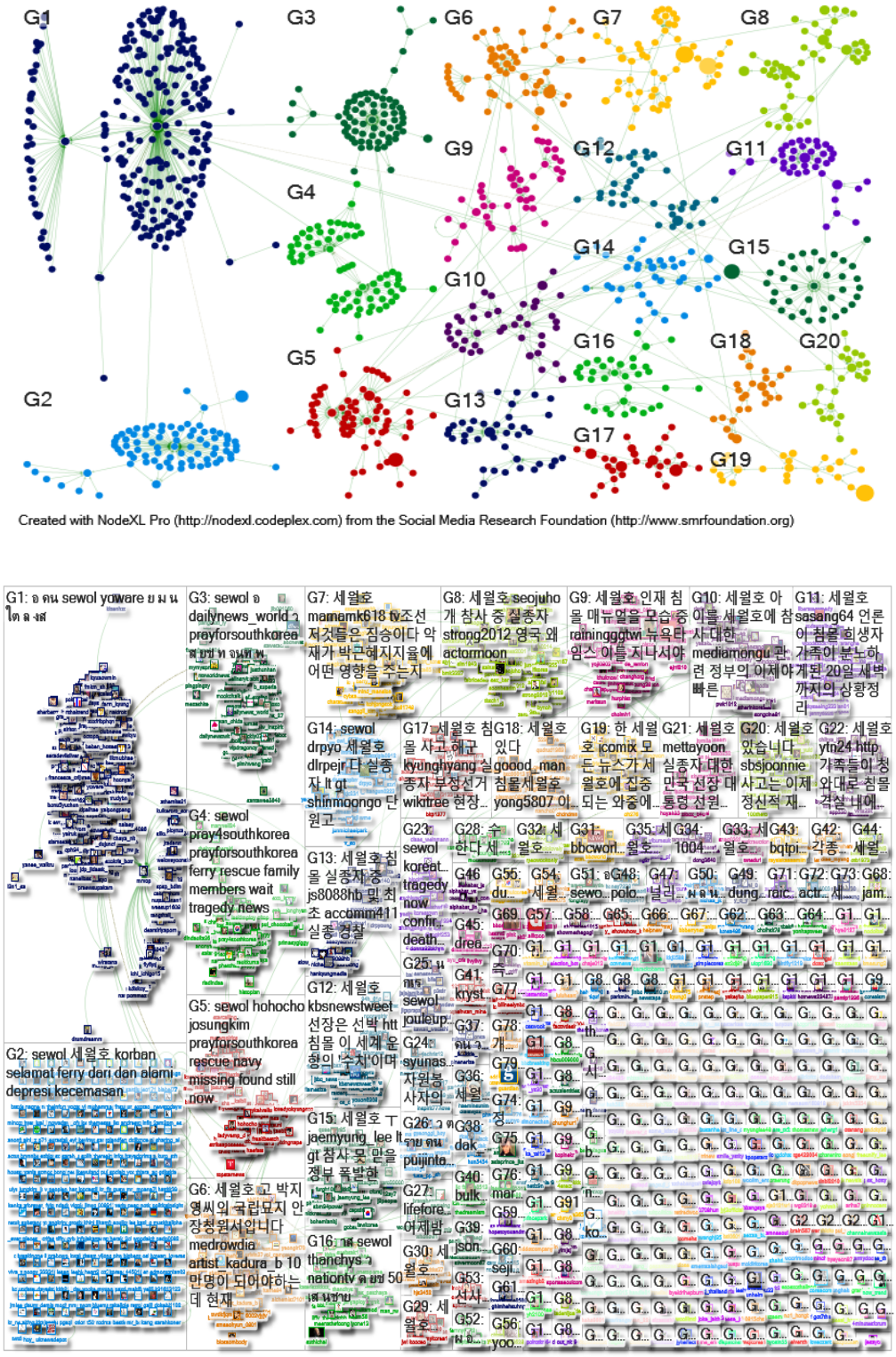

Figure 1. Visualization of the whole Twitter network

For social connectivity based on an analysis of Twitter networks, there was striking connectivity between Twitter users in the international network. In Figure 1, G1 showed two big clusters based on the topic of the Sewol ferry disaster. As a conversation starter, the user ID "yoware" from Thailand was positioned at the center of a big cluster. However, the user ID "mrvop" from Thailand acted as a broker connecting groups in the Sewol disaster conversation. Unlike the international communication network, the Korean risk communication network was loosely structured. As shown in G2, the connectivity between Twitter users was weaker because the Sewol ferry disaster was a national issue in Korea. Its conversation through Twitter was not limited to small groups of specific users.

Results for Facebook.

Table 2 summarizes the macro network indices comparing Korean and international networks with respect to Facebook-based risk communication. The international network contained 93 vertices and the Korean network 5,459. The number of unique edges was less than that of total edges, implying that both networks had duplicate edges, although quite fragmented. The Korean network (duplication rate: 1%) was more fragmented than the international one (4%). In addition, for different indicators of connected components, the maximum number of vertices was 91 in the international network and 5,435 in the Korean network. The maximum number of edges was 902 in the international network and 1,033,656 in the Korean network. The maximum geodesic distance was 6 in the international network and 4 in the Korean network. The graph density was.2069 in the international network and .0689 in the Korean network. The overall comparison of the two networks indicates some differences, although the absolute values provide no accurate insights.

Table 2

Comparison of Overall Graph Metrics for Korean and International Co-Commenter Networks

Graph metric	**Value**	
	International networks	Korean networks
Graph type	Undirected	Undirected
Vertices	93	5459
Unique edges	870	1019295
Edges with duplicates	33	14385
Total edges	903	1033680
Connected components	2	16

Single-vertex connected components	0	11
Maximum vertices in a connected component	91	5435
Maximum edges in a connected component	902	1033656
Maximum geodesic distance (diameter)	6	4
Average geodesic distance	2.057936	2.031442
Graph density	.20687237	.068874936
Modularity	.431296	.354565

The two networks were visually distinct. Facebook users developed a venue for the "Sewol" issue and commented on the disaster. The Korean co-commenter network was relatively loose, and the network of co-commenter subcommunities was more fragmented in the Korean network.

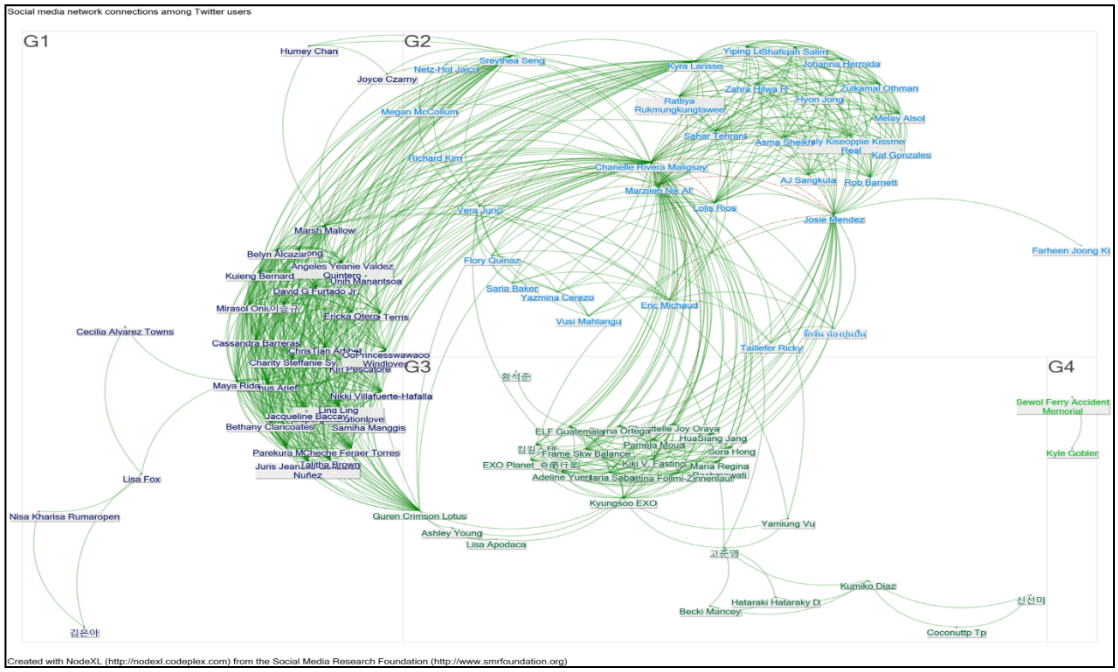

Figure 2. Visualization of the international network on Facebook

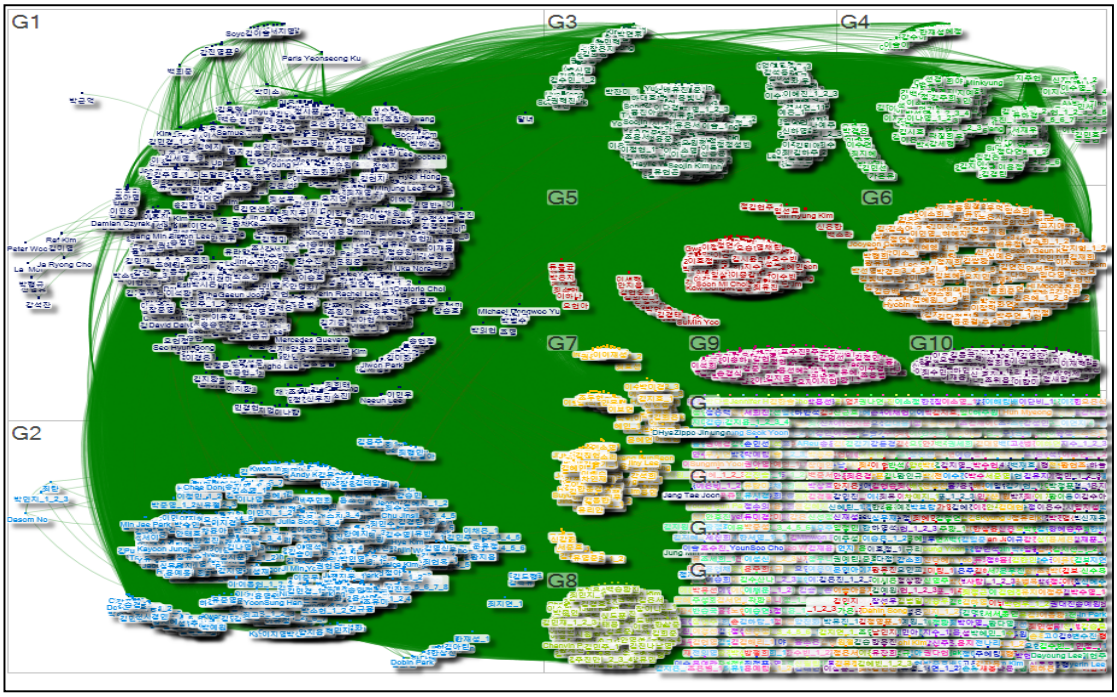

Figure 3. Visualization of the Korean network on Facebook

Results of a semantic network analysis.

For comparing the Korean and International risk communication on Facebook, it was decided to use a minimum number of stop words, such as “in”, “the”, “a” and “and”, since there is no single list of universal stop words used by all natural language process analyses. Furthermore, our research revealed an important difference between the Korean network and the International network in the use of words such as “I”, “people”, “you” or “we”. The Korean network does not use these words, but rather combines them into the word “all”. Before the difference in semantic analysis results for the Facebook-verse was evaluated, the difference in the percentage of terms used in the two networks was analyzed. Table 3 shows the most frequent terms in the international network. Among 622 terms, 32 belonged to the top 40%. Most terms were related mainly to prayers or demonstrative pronouns. Table 4 shows frequent terms in the Korean network. Among 48,661 terms, 32 belonged to the top 20%. This network included terms referring to actions such as mourning, praying, asking for the rescue, and requesting countermeasures.

In Figures 4 and 5 show the international semantic network and the Korean semantic network on Facebook, respectively. The sizes of the vertices represent the frequency of words, and the links show co-occurrence between the words. Networks are visualized with a spring-embedded layout

to layout the positions of the vertices in a way that minimized the sum of the forces in the network. The Korean network has a much larger number of vertices, and there is a substantial difference in the number of terms. Despite the four highest frequency words, such as "consoling the soul (1,561)" and "pray (1,531)", the word "all" was connected with most of the links in the Korean network. The word "all" has a significant structural position in the network, despite its relatively low frequency of 10th place (145). An interesting difference between the two networks is the location and use of "I" and "all", which served as the key words in the international and Korean networks, respectively. Koreans use the subject "all" related not only to mourning and praying but also requesting a quick response to the disaster in combination with words such as "now", "in a hurry", "doing action", "how to deal with" and "please disseminate". The use of "we" represents the collective culture in the social media, according to Park et al. (2011).

Table 3

Frequent Terms (top 40%) in the International Network

	Term	Frequency	Cumulative %
1	I	25	4.95
2	AMEN	24	9.70
3	#PRAYFORSOUTHKOREA	11	11.88
4	GOD	11	14.06
5	MY	10	16.04
6	YOU	8	17.62
7	FOR	7	19.01
8	PRAY	7	20.40
9	SOUTH	7	21.78
10	THEM	7	23.17
11	HERO	6	24.36
12	KOREA	6	25.54
13	KOREAN	6	26.73
14	WE	6	27.92
15	FOREVER	5	28.91
16	HEART	5	29.90
17	BEAUTIFUL	4	30.69

18	FERRY	4	31.49
19	PRAYER	4	32.28
20	SHE	4	33.07
21	ANGEL	3	33.66
22	HERE	3	34.26
23	HOPE	3	34.85
24	LOVE	3	35.45
25	MANY	3	36.04
26	MIRACLE	3	36.63
27	NO	3	37.23
28	PEACE	3	37.82
29	PEOPLE	3	38.42
30	PRAYING	3	39.01
31	REST	3	39.60
32	RIP	3	40.20

Table 4

Frequent Terms (top 20%) in the Korean Network

	Term	Frequency	Cumulative %
1	Consoling the soul	1561	3.21
2	The deceased	1531	6.35
3	Pray	1531	9.50
4	Respectfully	1389	12.35
5	Please	308	12.99
6	More	261	13.52
7	Now	212	13.96
8	Really	195	14.36
9	Seriously	151	14.67
10	All	145	14.97

11	Quickly	134	15.24
12	Present	125	15.50
13	ㅠㅠ(crying emoticon)	122	15.75
14	Definitely	118	15.99
15	Why	117	16.23
16	Doing	109	16.46
17	Number	107	16.68
18	Very	102	16.89
19	Ship	102	17.10
20	How to deal with	100	17.30
21	Ferry's	98	17.50
22	Existent	92	17.69
23	Ah!	85	17.87
24	Inner	79	18.03
25	Doing action	76	18.19
26	Rescue	75	18.34
27	This message	75	18.50
28	How	74	18.65
29	Staying	72	18.80
30	Please disseminate	72	18.94
31	In a hurry	71	19.09
32	There is	71	19.24

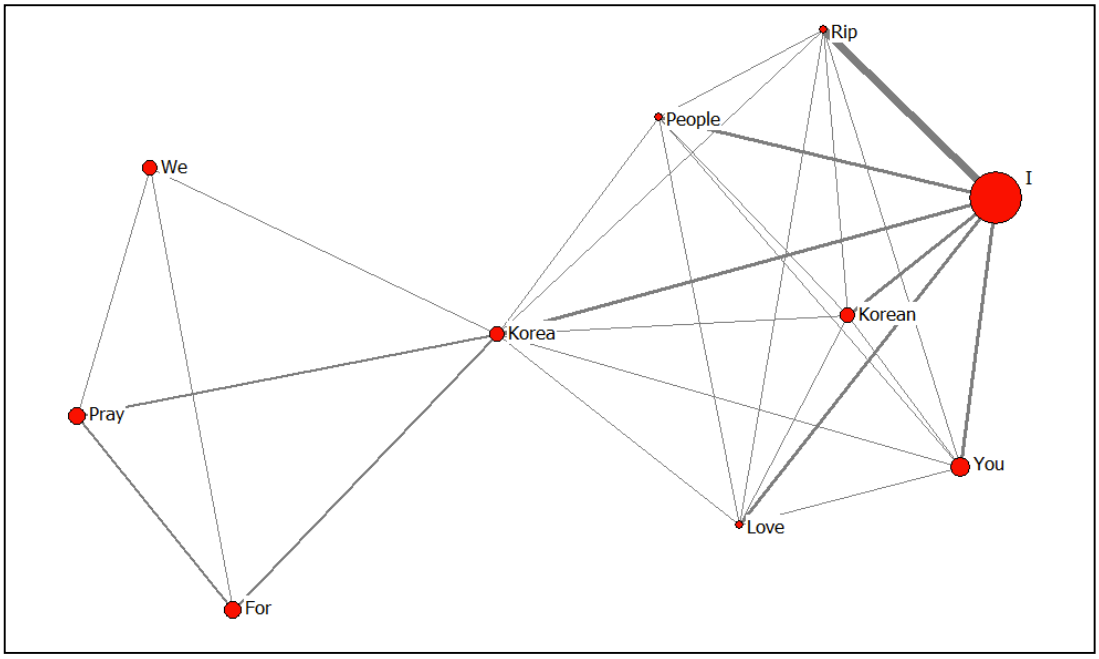

Figure 4. Semantic analysis of Facebook (international network)

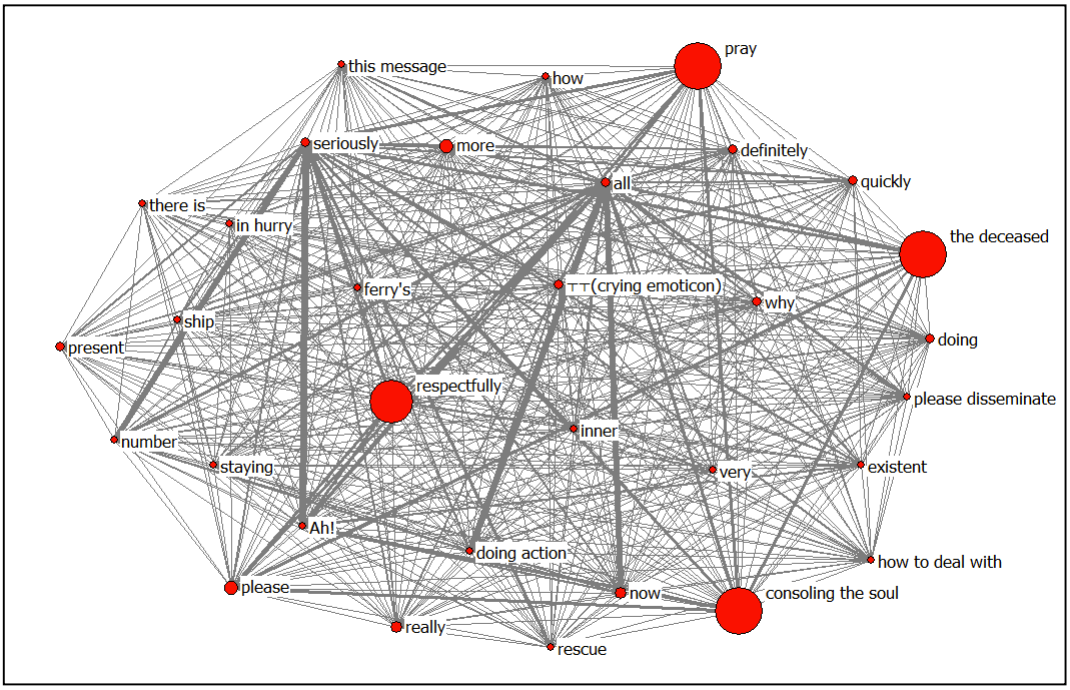

Figure 5. Semantic analysis of Facebook (Korean network Top 20%)

Another semantic network in the Twitter verse showed a pattern of language use. Terms in the international network were clustered based on frequent terms such as “Sewol,” whereas those in the Korean network had a more linear relationship, reflecting a scattered pattern but multilateral and diverse information sharing. In terms of word frequency, most terms in the top 10% (72 out of 53,561) were from Thailand and related to actors as transmitters of information in actor-based networks. English terms in the top 20% (303 out of 53,561) included “Sewol,” “family,” “disaster,” “ferry,” “missing,” “rescue,” and “pray.” Korean terms incorporated not only these words but also critical opinions about the government, emotional anger and grief, and problems of Korea's emergency management system.

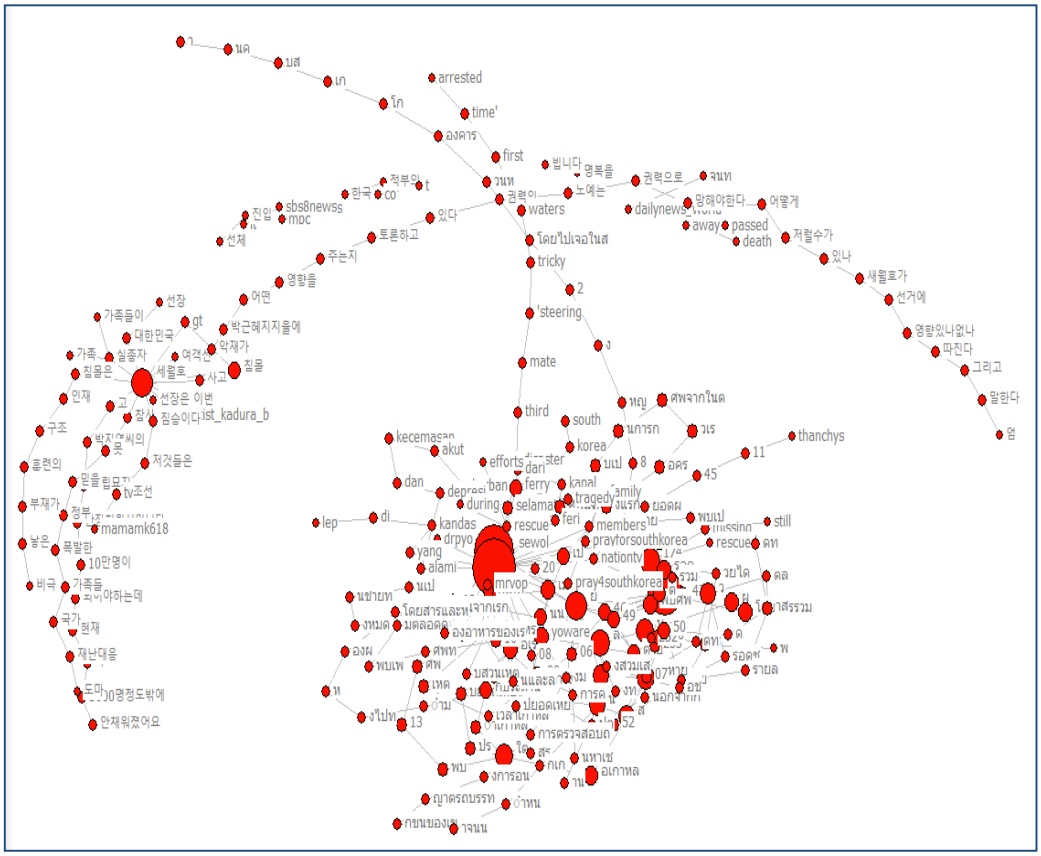

Figure 6. Semantic analysis of Twitter

Discussion

The structure of social risk communication on Twitter differed between the international and Korean networks. In terms of the Sewol ferry tragedy, the Korean Twitter network had more

issue-oriented clusters, whereas the international network had more actor-centered broadcasting clusters. The results show that Korean Twitter users were less likely to rely on key actors such as conversation starters. Structurally, the Korean network depended less on information brokers. In comparison to the international network, the Korean network was sparse and loosely coupled. This difference can be attributed to the impact of issues and the physical proximity to the disaster.

For the Facebook analysis, the co-commenter network was considered instead of the co-liker network. The co-liker network was vulnerable to some manipulation and hard to collect, but the co-commenter network was more active and responsive. The overall metrics of the co-commenters network were used to draw the following features (see Table 2). Not surprisingly, the Korean network had a larger number of vertices because of direct involvement in the accident. The physical distance from the disaster was related to the feature of less duplicated ties in the Korean network. In other words, the concern over the issue mushroomed across Korea, and more fragmented information groups were produced in the Korean network. Nevertheless, the co-commenters network of Korean fan pages was smaller in terms of the geodesic distance.

With respect to the semantic networks of Facebook fan pages, the Korean network incorporated deeper sorrow than the international network and even asked for actual countermeasures, as emphasized by the terms “how” and “rescue” in conjunction with expressions of condolence. In addition, the expression "rest in peace" was dominant in the international network, whereas mourning for families of victims, calling for quick countermeasures, and sharing sad emotions with one another were dominant in the Korean network.

The information flow itself through social networking services also facilitates to structure diverse patterns. Despite the content-building influence from other media, risk communication flows about emotional sympathy, or warning other stakeholders to take specific actions, are generated by human interactions though technical cyber tools.

Conclusions

The study explores the patterns of risk communication on Twitter and Facebook in the context of the Sewol ferry tragedy. Through social media, individuals started to share their feelings and perspectives, including information, with other SNS users. Based on the clustering of interpersonal risk communication networks in the Sewol ferry disaster, the results show that the structure of the Korean risk communication networks was different from that of the international network.

In terms of the social amplification of risk, social media can accelerate the speed of diffusion or the amount of information sharing. In particular, Twitter and Facebook, representative media tools today, have been frequently used for sharing risk information. The public's online conversation was followed by a wide range of audiences, and its dissemination enabled actors to

appeal for greater concern and alertness for the disaster beyond confined groups themselves (Smith, 2015).

Risk communication networks were vigorously generated, and the Korean and international networks differed in this respect. The international network had a center as a starter of the issue and a key user as a broker transmitting critical information. International opinions through Twitter spread from a hub relying on a specific broker ("mrvop"), while the Korean Twitter network structure was random and scattered with no center. This implies that the international network showed broadcasting patterns because it included more third-party spectators who saw the situation from a distance, although they were still interested in the accident. On the other hand, the whole public in Korea felt sorrow, as if everyone lost his or her family member. Every small issue related to the Sewol disaster drew the public's attention instead of specific information spreading from a key actor.

Whereas the Facebook fan page analysis produced consistent results, the Korean network was more fragmented, and its clusters were more sparsely knitted. This can be attributed to either the gravity of the issue or cultural reflection, but it should be cautiously assumed that the form of the Korean sub-network in risk communication primarily mirrored a cultural feature because only one big issue could not generate everything in the whole network and the culture of individuals affected the means of communication (Gudykunst et al., 1996).

In terms of emotional distance reported in semantic analysis, users in the Korean network were likely to share their emotions, as if they were family members of the victims, and seriously and urgently called for rescue operations and direct countermeasures, but the content of the international network was more reserved, simply reflecting condolence. This implies that the physical distance from the disaster affected the content of risk communication as well as the pattern of the network (Park et al., 2013; Park, Baek, & Cha, 2014).

Implications.

A comparison of Korean and international communication networks provides important insights into the risk communication environment. This comparison implies that the relative differential of communication structures reflects the emotional distances between them, depending on the proximity of the disaster, although it does not directly explain the disparity between the communication structures of the two networks as a whole.

Regarding the worldwide news on the Sewol disaster, this tentative research illustrates the network patterns in two distinct contexts reflecting physical distances from the incident beyond a simple disparity of the networks in order to predict the applicability of SNS tools by citizens in disasters. The results of the comparative networks indicate that risk communication bounded in the incidental region through SNS can encourage countermeasures in disasters and citizens can provide or share crucial information in timely manner. These communication networks are not the same as the response networks formulated by responders, but rather act as a third party to observe the situation from afar, and the vulnerability of not being connected when the ties are broken decreases.

The risk communication networks can either amplify or attenuate the social conflicts or concerns about the incidents. The importance of public attention is critical to maintaining and sustaining government action. Vigorous discussion or sharing strong emotions with others can amplify the perception of risk, eventually enlightening the necessity of reforming the underlying system of emergency management after, or even during, the disaster. Indirect concerns can push the responders to take more responsibility such as blaming their ineffective countermeasures.

Despite worldwide news on the Sewol disaster, property of the risk communication networks was predicted to be different and understanding the structures of them is important in order to consider usefulness for potential response or recovery of disasters in general. Instead of listing each property of the networks, the comparison of them gives more understandable but distinguishable insights on practical usage of the networks.

Relatively, Korean Twitter networks are less coupled, reflecting more fragmented information groups and shorter physical proximity to the disaster and representing a brand cluster. The Korean networks on Facebook also indicate the loosely coupled information sharing among the users and their geodesic distance is smaller. Further, the Korean networks on Facebook imply that the contents of risk communication on the Sewol disaster include more active requests to responders beyond expression of grief or anger, and user-effort in domestic networks through information sharing on the disaster is more concrete and detailed. Also, the physical and emotional distances affect the level of activeness and the strength of the demands for the responders and the government to act. It does not imply that the effect of international networks can be overlooked, but its pressure to responders is still considerable as drawing worldwide concern in a specific disaster. Further, the networks reflect cultural propensity of language usage.

Limitations and future studies.

This study has three important limitations. First, the network analysis based on webometrics was egocentrically designed, and therefore may have missed actors who did not use the keyword "Sewol", even when they were involved in the risk communication network. According to Scott and Carrington (2011), missing ties caused by unreported ones may limit the capture of the whole risk communication network. Second, the analysis did not consider changes in the network pattern of risk communication, because only a snapshot of the network was taken, and this may have limited active insights into changes in its structure or the role of intermediary actors. Last but not least, the scale of the networks in our study might not be large enough to reinforce the argument made, but it still gives an insight on the possible risk communication for other disasters.

This study fills the gap between risk communications on disasters and usage of social networking service tools as identifying and comparing the structures of domestic and international networks in Sewol disaster case. Nevertheless, generalizability of the findings is not guaranteed, so further relevant case studies need to be done within diverse contexts. Our next step of future research

lines is applying this risk communication framework to other disaster contexts around us through SNS tools.

References

Aldoory, L. & Sha, B.L., (2007). The situational theory of publics: Practical applications, methodological challenges, and theoretical horizons In E. L. Toth (Ed.), *The future of excellence in public relations and communication management: Challenges for the next generation*, pp.339-355. Mahwah, NJ: Lawrence Erlbaum Associates.

Beck, U. (1992). *Risk society: Towards a new modernity*. Sage, London.

Binder, A. R., Scheufele, D. A., Brossard, D., & Gunther, A. C. (2011). Interpersonal amplification of risk? Citizen discussions and their impact on perceptions of risks and benefits of a biological research facility, *Risk analysis*, Vol. 31, No. 2, pp. 324-334.

Borgatti, S., Everett, M. G., & Freeman, L., (2002). *UCINET for Windows: Software for social network analysis*. Harvard, MA: Analytic Technologies.

Borgatti, S. P., Mehra, A., Brass, D. J., & Labianca, G. (2009). Network analysis in the social sciences, *Science*, Vol. 323 No. 5916, pp. 892-895.

Bourdieu, P. (1986). The forms of capital, In: Richardson JG (ed.) *Handbook of Theory And Research for the Sociology of Education*. New York: Greenwood, pp. 241–258.

Boyd, D. (2006). Friends, Friendsters, and MySpace Top 8: Writing community into being on social network sites, *First Monday,* Vol. 11, No. 12.

Cho, S. E., Choi, M., & Park, H. W. (2012). Government-civic group conflicts and communication strategy: A text analysis of TV debates on Korea's import of US beef. *Journal of Contemporary Eastern Asia*, *11*(1), 1-20.

Chung, I. J. (2011). Social amplification of risk in the Internet environment, *Risk Analysis*, Vol. 31, No. 12, pp. 1883-1896.

Cole, T. W., & Fellows, K. L. (2008). Risk communication failure: A case study of New Orleans and Hurricane Katrina, *Southern Communication Journal*, Vol. 73, No. 3, pp. 211-228.

Ellison, N. B., Steinfield, C., & Lampe, C. (2007). The benefits of Facebook ‘‘friends:” Social capital and college students’ use of online social network sites, *Journal of Computer-Mediated Communication*, Vol. 12, No. 4, pp. 1143–1168.

Ellison, N. B., Steinfield, C., & Lampe, C. (2011). Connection strategies: Social capital implications of Facebook-enabled communication practices, *New Media & Society*, 1461444810385389.

Freeman, L. C. (1979). Centrality in social networks conceptual clarification, *Social networks*, Vol. 1, No. 3, pp. 215-239.

Fruchterman, T.M.J., & Reingold, E.M. (1991). Graph drawing by force-directed placement software: practice and experience. 21(11). 1129-1164.

Gruzd, A., Wellman, B., & Takhteyev, Y. (2011). Imagining Twitter as an imagined community, *American Behavioral Scientist*, Vol. 55, No. 10, pp.1294-1318.

Gudykunst, W. B., Matsumoto, Y., Ting-Toomey, S. T. E. L. L. A., Nishida, T., Kim, K., & Heyman, S. (1996). The influence of cultural individualism-collectivism, self construals, and individual values on communication styles across cultures, *Human communication research*, Vol. *22,* No. 4, pp. 510-543.

Hagar, C. (2009). The Information and Social Needs of Cumbrian Farmers During the UK 2001 Foot and Mouth Disease Outbreak and the Role of Information and Communication Technologies, In Döring, M. & Nerlich, B. (Eds.), *The Socio-Cultural Impact of Foot and Mouth Disease in the UK in 2001: Experiences and Analyses*, Manchester University Press.

Hansen, D., Shneiderman, B., & Smith, M. A. (2010). *Analyzing social media networks with NodeXL: Insights from a connected world*. Morgan Kaufmann.

Huberman, B. A., Romero, D. M., & Wu, F. (2008). Social networks that matter: Twitter under the microscope, arXiv preprint arXiv:0812.1045.

Hughes, A. L., & Palen, L. (2009). Twitter adoption and use in mass convergence and emergency events, *International Journal of Emergency Management*, Vol. 6, No. 3, pp. 248-260.

Hughes, A. L., Palen, L., Sutton, J., Liu, S. B., & Vieweg, S. (2008). Sight-Seeing in Disaster: An Examination of On-Line Social Convergence, paper presented at the Information Systems for Crisis Response and Management Conference (ISCRAM).

International Federation of Red Cross Red Crescent Societies (IFRC) (2013). *World Disasters Report: Focus on technology and the future of humanitarian action*. American Red Cross, available at http://www.scribd.com/doc/176902958/World-Disasters-Report-Focus-on-technology-and-the-future-of-humanitarian-action

Java, A., Song, X., Finin, T., & Tseng, B. (2007). Why we twitter: understanding microblogging usage and communities, paper presented at the 9th WebKDD and 1st SNA-KDD 2007 workshop on Web mining and social network analysis. ACM. pp. 56-65.

Jung, K.Y., Song, M.S., & Park, H.W. (2018). Filling the Gap between Bureaucratic and Adaptive Approaches to Crisis Management: Lessons from the Sewol Ferry Sinking in South Korea. Quality & Quantity. 52(1), 277-294.

Jung, K. & Park, H. W. (2014). Citizens' Social Media Use and Homeland Security Information Policy: Some Evidences from Twitter Users during the 2013 North Korea Nuclear Test, *Government Information Quarterly*, Vol. 31, pp. 563-573, available at DOI: 10.1007/s11135-014-0092-x

Jung, K., No, W., & Kim, J. W. (2014). Who Leads Nonprofit Advocacy through Social Media? Some evidences from the Australian Marine Conservation Society's Twitter Networks. *Journal of Contemporary Eastern Asia* 13 (1): 69-81

Jung, K. & Park, H. W. (2015). A Semantic (TRIZ) Network Analysis of South Korea's Open Public Data Policy, *Government Information Quarterly*, Vol. 32, pp. 353–358, available at DOI: 10.1016/j.giq.2015.03.006

Jung, K. & Park, H. W. (2016). Tracing Interorganizational Information Networks during Emergency Responses: A Webometric Approach to the 2012 Gumi Chemical Spill. *Government Information Quarterly*, available at DOI: 10.1016/j.giq.2015.09.01

Kasperson, R. E., Renn, O., Slovic, P., Brown, H. S., Emel, J., Goble, R., & Ratick, S. (1988). The social amplification of risk: A conceptual framework, *Risk analysis*, Vol. 8, No. 2, pp. 177-187.

Kim, J.N. & Grunig, J.E., (2011). Problem solving and communicative action: A situational theory of problem solving. *Journal of Communication*, 61(1), pp.120-149.

Kim, S. K., Park, M. J., & Rho, J. J. (2013). Effect of the Government's Use of Social Media on the Reliability of the Government: Focus on Twitter, *Public Management Review*. Available at DOI:10.1080/14719037.2013.822530.
Krishnamurthy, B., Gill, P., & Arlitt, M. (2008, August). A few chirps about twitter. paper presented at the first workshop on Online social networks, ACM. pp. 19-24.
Lin, K., & Lu, H. (2011). Intention to continue using Facebook fan pages from the perspective of social capital theory, *Cyberpsychology, Behavior, and Social Networking*, Vol. 14, No. 10, pp. 565-570.
McCorkindale, T. (2010). Can you see the writing on my wall? A content analysis of the Fortune 50's Facebook social networking sites, *Public Relations Journal*, Vol. 4, No. 3, pp. 1-14.
Meier, H. (2016). Global Civil Society from Hyperlink Perspective: Exploring the Website Networks of International NGOs. *Journal of Contemporary Eastern Asia*, *15*(1). 64-77
Meza, X.V., & Park, H.W. (2016). Organic Products in Mexico and South Korea on Twitter. Journal of Business Ethics. 135. 587~603. DOI 10.1007/s10551-014-2345-y
Naaman, M., Boase, J., & Lai, C.H. (2010). Is it Really About Me? Message Content in Social Awareness Streams, paper presented at the 2010 ACM conference on Computer supported cooperative work, pp. 189-192.
Park, J., Baek, Y. M., & Cha, M. (2014). Cross-Cultural Comparison of Nonverbal Cues in Emoticons on Twitter: Evidence from Big Data Analysis, *Journal of Communication*, Vol. 64, No. 2, pp. 333–354.
Park, M., Cha, C., Cha, M. & Kweon, Y. (2013). Expression of depressive moods on Twitter, *Telecommunications Review*, Vol. 23, No. 3, pp. 304-316.
Park, S. J. & Lim, Y. S. (2014). Information Networks and Social Media Use in Public Diplomacy: a comparative analysis of South Korea and Japan, *Asian Journal of Communication*. Vol. 24, No. 1, pp. 79-98.
Procter & Gamble Facebook page. Retrieved on March 9, 2009, available at http://www.facebook.com/home.php?
Park, S. J., Lim, Y. S., Sams, S., Nam, S. M., & Park, H. W. (2011). Networked politics on Cyworld: The text and sentiment of Korean political profiles, *Social Science Computer Review*, Vol. 29, No. 3, pp. 288-299.
Pidgeon, N., Kasperson, R. E., & Slovic, P. (Eds.). (2003). *The social amplification of risk*. Cambridge University Press
Putnam, R. (2000). *Bowling Alone: The Collapse and Revival of American Community*. New York: Simon and Schuster.
Renn, O. (2011). The social amplification/attenuation of risk framework: application to climate change, *Wiley Interdisciplinary Reviews: Climate Change*, Vol. 2, No. 2, pp. 154-169.
Rosa, E. A. (2003). The logical structure of the social amplification of risk framework (SARF). Metatheoretical Foundations and Policy Implications. In: N. Pidgeon; R.E. Kasperson and P. Slovic (eds.): The social amplification of risk. Cambridge University Press: Cambridge, UK. pp. 47-49.
Rogers, M.B., Amlôt, R., Rubin, G.J., Wessely, S. & Krieger, K.. (2007). Mediating the social and psychological impacts of terrorist attacks: The role of risk perception and risk communication. *International Review of Psychiatry*, 19(3), pp.279-288.

Scott, J., & Carrington, P. J. (Eds.). (2011). *The SAGE handbook of social network analysis*. SAGE publications.

Shapiro, M. A. (2014, September/October). Establishing 'Green Regionalism': Environmental Technology Generation across East Asia and Beyond, *Journal of Contemporary Eastern Asia*, Vol. 14, No. 2, pp. 41-56.

Sheppard, B., Janoske, M., & Liu, B. (2012). Understanding risk communication theory: A guide for emergency managers and communicators, Report to *Human Factors/Behavioral Science*.

Shklovski, I., Burke, M., Kiesler, S., & Kraut, R. (2010). Technology adoption and use in the aftermath of Hurricane Katrina in New Orleans, *American Behavioral Scientist*, Vol. 53, No. 8, pp. 1228-1246.

Smith, M. (2015). Catalyzing social media scholarship with open tools and data. *Journal of Contemporary Eastern Asia*, 14 (2), 87-96

Smith, M. A., Shneiderman, B., Milic-Frayling, N., Mendes Rodrigues, E., Barash, V., Dunne, C., Capone, T, Perer, A., & Gleave, E. (2009, June). Analyzing (social media) networks with NodeXL, paper presented at the fourth international conference on Communities and technologies, ACM. pp. 255-264.

Steinfield, C., Ellison, N., & Lampe, C. (2008). Social capital, self-esteem, and use of online social network sites: A longitudinal analysis, *Journal of Applied Developmental Psychology,* Vol. 29, pp. 434–445.

Subrahmanyam, K., Reich, S., Waechter, N. & Espinoza, G. (2008). Online and offline social net- works: Use of social networking sites by emerging adults, *Journal of Applied Developmental Psychology,* Vol. 29, pp. 420–433.

Takhteyev, Y., Gruzd, A., & Wellman, B. (2012). Geography of Twitter networks. *Social networks*, Vol. 34, No. 1, pp. 73-81.

The Social Engagement Team at National Headquarters (2012). *Social Engagement Handbook Version 2.0*. American Red Cross, available at http://www.scribd.com/doc/92697012/Social-Engagement-Handbook-2-0

van de Velde, B., Meijer, A., & Homburg, V. (2014). Police message diffusion on Twitter: analysing the reach of social media communications, *Behaviour & Information Technology*, available at DOI:10.1080/0144929X.2014.942754

Valenzuela, S., Park, N., & Kee, K. (2009). Is there social capital in a social network site?: Facebook use and college students' life satisfaction, trust, and participation, *Journal of Computer-mediated Communication,* Vol. 14, pp. 875–901..,mn.

Xu, W. W., Sang, Y., Blasiola, S., & Park, H. W. (2014). Predicting Opinion Leaders in Twitter Activism Networks: The Case of the Wisconsin Recall Election. American Behavioral Scientist. 58(10), 1278-1293. DOI: 10.1177/0002764214527091

Yates, D., & Paquette, S. (2011). Emergency knowledge management and social media technologies: A case study of the 2010 Haitian earthquake. *International Journal of Information Management*, Vol. 31, No. 1, pp. 6-13.