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How the discussion on a contested technology in Twitter changes: Semantic network analysis of tweets about cryptocurrency and blockchain technology

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How the discussion on a contested technology in Twitter changes

: Semantic network analysis of tweets about cryptocurrency and blockchain technology

Scholars have asserted that emerging technological innovations are socially constructed by diverse social actors with different interests on technologies in the matter (Funtowicz & Ravetz, 1993; MacKanzie & Wajcman, 1999; Taebi & Kadak, 2010). Recently, social media offer these stakeholders an agora in which they can present opinion and information about technological innovations (Brossard & Scheufele, 2013; Runge et al., 2013). Their beliefs widespread on social media produce public discourse that contributes to the diffusion and the institutionalization of certain value within them (Demirhana & Çakır-Demirhan, 2015). These stakeholder dynamics are often influenced by the institutional context such as the legal or political practices of government agencies that try to incorporate divergent stakes into the social decision-making process of adopting emerging technologies for society (Correljé & Groenewegen, 2009).

Governments encounter uncertainty about the consequence of their policies when such policies deal with social issues involving high complexity and diverse social actors. In this case, publicizing the information about the general direction of policies may enable administrators to observe the climate of public opinion regarding the issue (Kim, 2004). Previous research has conceptualized this leak of news information as a ‘pseudo-event’ that happens in diverse forms such as press conference or informal meeting (Boorstin, 1992). When a pseudo-event is accompanied with information about the direction and details of government policies regarding social issues involving diverse social actors, it might have significant resonance in the stakeholders and in turn, exert the influence on public discourse about the issue.

The recent increase in social controversy over emerging technologies has made democratization in science and technology into an important agenda (Lidskog, 2008). This situation has motivated individuals to proactively respond to the legal or political practices regarding the regulation or support of new technologies and discuss the future direction of policies on the issue. Considering this, investigating public discourse about technological innovations and its changes according to the government’s release of relevant information would help government agencies to democratize the process of planning policies about science and technological development. However, there has been no attempt to study the impact of government pseudo-events on public discourse about contested technologies. Previous studies have investigated the public discourse regarding scientific or technological issues (Hopke, & Simis, 2017; Kim, Ham, Kim, & Choi, 2017;

Kim & Kim, 2015; Runge et al., 2013), but most have focused on simply describing public discourse itself. In addition, previous research about pseudo-events (Clarke, 2003; Kim, 2014) has focused on journalists' reporting on them and ignored the impact of pseudo-events on the public perception of the issue.

The most prevalent technological issue in Korea these days is cryptocurrency and blockchain technology. The Korean Bitcoin market accounted for 37.95% of worldwide Bitcoin trade volume in 2017 (Choi, 2017.10.11), and Bitcoin was once traded at a premium about 23% over international rates in Korea (Cho, Yuji and Kim, 2017.12.7). As the concern over the nationwide cryptocurrency frenzy increased, distinct government departments made different comments about regulating cryptocurrency transactions in January 2018. In a press meeting, the Ministry of Justice announced that the bill was prepared to shut down domestic cryptocurrency exchanges, while after few hours, the Korean Presidential Office made a repudiation by saying that the proposal made by the Minister of Justice needed consultation among related ministries (Bae, 2018.1.12). After 4 days, the Office for Government Policy Coordination held a press conference and announced its plan to introduce real-name transaction system and supporting the research and development of blockchain technology (Han, 2018.1.15). These series of government announcements intensified public debate over cryptocurrency and blockchain technology, and Twitter served as a public sphere online in which diverse social actors formed public discourse about the issue and disseminated it using Twitter's retweet function.

The goal of this study was to examine the impact of government pseudo-events on changes in public discourse about contested technologies. To be specific, this study focused on the changes in public discourse on Twitter about cryptocurrency and blockchain technology according to the different government agencies' announcements about regulating domestic cryptocurrency transactions. The time and dates of three different comments made by distinct government departments (the Korean Ministry of Justice, the Presidential Office and the Office for Government Policy Coordination) were used as the criteria for collecting tweets and dividing them into the three groups. The nouns appearing in the tweets were extracted and the three-word co-occurrence matrix per group was constructed. Using these matrixes, semantic networks were drawn to perform convergent correlation (CONCOR) analysis that enables the detection of discourse about the issue.

Literature Review

The social shaping of contested technologies

Scientific or technological innovations once were thought to be independent of any social influences: in this perspective, the society itself had been considered as the consequence of technological changes (Bimber, 1990; White, 2005). This technological deterministic view, for example, is still observed in some of the contemporary nanoscience supporters' argument that nanotechnology makes progress with its own internal logic and brings significant change in the world (Mody, 2004). In opposition to this, scholars argued that social structure and its factors such as public demand or social groups' interests have impact on the trajectory of technological development (Law & Bijker, 1994; MacKenzie & Wajcman, 1999). For example, previous research explained that large electronic and power companies' investment in and the support of electronic refrigerators in 1920s contributed to its market dominance over gas refrigerators with superior performance than electronic ones (Cowan, 1999).

This 'social shaping of technology' perspective explains public debate on contested technologies these days. Contested technologies refer to emerging technological innovations that involve social controversy over their impact on people or the propriety of regulating them (Hopke & Simis, 2017). They contain system uncertainty and high decision stakes that result in the complex and context-dependent problems within a society (Lidskog, 2008). Therefore, diverse stakeholders' values are traded off or prioritized during the social decision-making process on the development of contested technologies within society (Funtowicz & Ravetz, 1993; Taebi & Kadak, 2010).

Stakeholder dynamics regarding contested technologies take place within the institutional context comprised of formal and informal ones: the former includes laws or policies, while the latter incorporates tradition, customs or morality (Taebi, Correlié, Cuppen, Dignum, & Pesch, 2014). The formal institutions with coercive power often redesign themselves to accommodate distinct values, and these institutional changes bring significant ramification for the stakeholders (Correljé & Groenewegen, 2009). That is,

the stakeholders are encouraged to make response to the legal or political practices regarding the technology in the matter and discuss the future direction of those institutional changes, according to their stakes.

Social media

Internet has been used as the primary source of information about scientific or technological issues these days (National Science Board, 2018). Large proportion of information and people's expectation, concern and feeling about technological innovations is often shared on social media that refer to "web-based services that allow individuals to construct public profiles within a bounded system and traverse the list of connections with other users (Boyd & Ellison, 2007, p. 211)".

Social media interfaces with high level of interactivity offer both individuals and organizations opportunities to co-create or share information and opinions regarding social issues (Fellenor, Barnett, Potter, Urquhart, Mumford, & Quine, 2017). A social media message often embodies its composer's beliefs in certain social issue, and it spreads widely on the network online by gaining support from other social media users. This dissemination of perspectives via social media contributes to the diffusion and the institutionalization of certain value within the views, and consequently, generates discourse (Demirhana & Çakır-Demirhan, 2015). Discourse refers to language practice as social action that defines the relationship between social actors to constitute the social status of its subject and institutionalize certain beliefs by gaining public support on it (Kim, Ham, Kim, & Choi, 2017).

Thus, social media offer a networked public sphere online, in which diverse discourse regarding important social issues is generated, changed or disappeared on the network (Friedland, Hove, & Rojas, 2006). In this context, the diffusion of diverse perspectives regarding scientific or technological issue stimulates various social actors with stakes to participate in the public discussion on social media (Xin, Qianqian, Lucheng, & Zhou, 2017).

Pseudo-events

A public policy as formal institutional context of emerging social issues is rearranged or created by the administrators. In the process of determining the direction and details of their policies, they often make use of news media to estimate the public opinion about the issue and policies. That is, politicians or administrators can observe people's response to the policy by leaking the fragment of information about their policy plan deliberately to the journalists who make it into news (Kim, 2004).

Boorstin (1992) conceptualized this social practice into pseudo-events, that refer to various forms of activity such as press release, interview or press conference designed to make ideas or policies seem important and to become news. A pseudo-event does not happen by chance but is planted by someone who intentionally decide its time and place to facilitate publicization of the event. A pseudo-event tries to become "self-fulfilling prophecy (Boorstin, p. 34)" by telling what it wants to be. This success of a pseudo-event is determined by the amount of news article dealing with it, and its ambiguity motivates people to be interested in it.

Government policies constitute institutional context within which a technological innovation is defined and credited for their social value. Introduction of policies also offer the new technology the authorized channels that enable it to be applied to society. Thus, public discussion on an emerging technology is likely to be strongly influenced by pseudo-events publicizing information about government policies that regulate or support the technological innovation.

Research Questions

Previous literature has suggested that social actors with stakes participate in the social decision-making process regarding the acceptance of contested technologies. Social media, rising public sphere online, serves as the field of diverse public discourse generated from the diffusion of beliefs or views relevant to the technological issue. This public discussion on the issue is affected by alterations in institutional context such as the introduction of regulatory policies on technological innovations. The fragment of information about government policy plans is often released to the public in pseudo-

events in forms of press release, interview or press conference designed on purpose to be reported by news media.

Considering this, the following research question was proposed regarding the cryptocurrency and blockchain technology issue in Korea. The research question investigates the changes in the public discourse on social media about a contested technology, according to government agencies' publicizations of information about their policy plans for the technological innovation.

RQ. Is there any significant change in social media public discourse about a contested technology, according to the government's announcement of policy plans for the technology?

Method

This study focused on Twitter messages. Twitter is a “broadcast-like interactive and networked microblogging service with public and multicast characteristics (Murthy, 2013, p.16)”. About 500 million tweets sent by the average of 100 million active users in a day make Twitter a global public sphere on recent public issues (Aslam, 2018). Twitter users are highly sensitive to the contemporary issues: for example, daily Twitter traffics in Korea were positively correlated to the emergence of domestic social issues, such as the early presidential election or sensational torso murder case happened in Incheon in 2017 (Yonhap News, 2017.11.26).

The analysis of this study consisted of two steps. First, the tweets that fulfilled the given conditions were retrieved and grouped into three datasets according to their composed time and date. Second, the dyadic-word co-occurrence matrixes per each dataset were constructed to draw the semantic networks and perform the convergent correlation (CONCOR) analysis.

Data collection

In Korea, cryptocurrency is referred to by many different terms including ‘virtual money (*Gasangtongwha*)’, ‘virtual currency (*Gasangwhapye*)’, ‘cryptocurrency (*Amhowhapye*)’ because of the opposing views on whether cryptocurrency serves as the ‘encrypted’ ‘medium of exchange’. Therefore, these three terms and the word ‘blockchain (*Blokchaein*)’ were selected as the key identifying words representing the issue.

First, the online news articles reported in January 2018 and contained more than one of the key identifying words in their title were imported from BigKinds (<https://www.kinds.or.kr/>), the Korean online news searching system provided by the Korea Press Foundation. The researcher scanned the collected news articles ($n = 3,664$) and identified government agencies’ three important announcements on restricting domestic cryptocurrency transactions (see Table 1). Considering this, the data collection period was settled as seven days between January 10 and 16, 2018.

Table 1 here

Second, Sifter (<https://discovertext.com/sifter>), an online application for accessing historical tweets, was used to retrieve the tweets composed during the data collection period. The tweets written in Korean and included more than one of the key identifying words in their body text were retrieved. The data included the time and date of tweet creation, the body text, and the number of retweet a tweet received. Despite of their exhibition of the same body text, different users’ retweets of the same message were included in the data since they also reflected the important topography of the communications in Twitter (Priebe, 2018). After unnecessary and commercial tweets were deleted, the remaining tweets were grouped into the three datasets, according to the time and date of their creation (see Table 2).

Table 2 here

Semantic network analysis

This study applied semantic network analysis that has been used in previous research that investigated the discourse within large quantities of short and unstructured social

media messages (Kim & Kim, 2015; Kwon, Bang, Egnoto, & Raghav Rao, 2016; Xin et al., 2017). Since semantic network analysis is the branch of the network analysis, it converts a text into the network of words: That is, the words manually or automatically extracted from a text are the nodes, and their co-occurrences refer to the undirected and weighted links (Atteveldt, 2008). The co-occurrence of two words within a text is combined into a matrix, in which the words are listed in the first row and column and the numeric values in each cell indicate the frequencies of two words' co-occurrence (Kwon et al., 2016).

The unit of analysis in this study was a tweet. Since this study applied the semantic network analysis, the nodes and links of a semantic network had to be specified. The nodes were defined as the words (either the nouns or adjectives) of which appearing frequencies in a dataset were higher than a certain threshold value. To operationalize the links among the nodes, nodes that appeared in the same tweet were considered as implicitly linked. Therefore, the number of times any two nodes appeared in a tweet was calculated to measure the dyadic words' strength of association.

The words from each dataset were extracted by using Textom (<http://www.textom.co.kr/>), an online package for analyzing the large quantities of Korean text data. Most of its functions are based on Fulltext (<https://www.leydesdorff.net/software/fulltext/>), a data analysis software developed by L. Leydesdorff (Kim, 2018). In this process, the miss-spellings and wrong spaces within a word were manually adjusted, and the several words indicating the same object were unified into the same word. For example, several Korean words indicating *Moon Jae-in* (the Korean president) including '*Moon-Daetongryeong*' and '*Moon-Tongryung*' were manually converted into '*Moon Jae-in*'.

Not every word in the dataset was considered as the node of co-occurrence matrixes: Using the word-frequency lists generated from the package, the words of which appearing frequencies were less than certain cut-off values (See the footnotes of table 4, 5 and 6) were excluded. In addition, the words that commonly appear across all datasets (including key identifying words) were also ruled out, because they are less meaningful in detecting the difference in the semantic networks derived from distinct datasets (Kwon et al., 2016). Three Jaccard coefficient co-occurrence matrixes were generated based on the links between the nodes per dataset. By importing these matrixes to UCINET program, three

semantic networks were drawn and CONCOR analysis was performed per each network to identify the clusters of words that construct public discourse about the issue.

This study calculated each node's degree centrality and eigenvector centrality. In network analysis, centrality is endogenous variable that focuses on the structural attribute of a given node in a network (Wasserman & Faust, 1994). Degree centrality (DC) of a node is the number of nodes connected to the given node (Borgatti, 1995). Eigenvector centrality (EC), on the other hand, is based on the idea that "actors' status is determined by those with whom they are in contact" (Bonacich & Lloyd, 2001, p. 199). That is, a node is central if it forges relations with other nodes that are also in a central position. Previous research has asserted that the nodes with high DC can be considered as topical keywords representing the theme of the given cluster and that the topical keywords are surrounded by the words with high EC that contribute to the shaping of dominant discourse patterns within the cluster (Choi & Lecy, 2012; Kwon et al., 2016). Considering this, this study utilized each node's DC and EC values to interpret the clusters that exhibit distinct narratives about the issue.

Result

Table 3 shows the number of Twitter users, total tweets and retweets (the duplicates of original tweets) analyzed in this study. More than 78% of the total users ($n = 22,715$) composed tweets or retweets during the period of dataset 2. One of the most noticeable things was that the proportion of retweets jumped from 50% (dataset 1) to more than 85% (dataset 2 and 3).

Table 3 here

Figure 1 shows the number of tweets per hour from January 10 to 16. Between the announcement 1 and 3, the average number of tweets per day was higher than the other period. The number of tweets sharply increased between the announcement 1 and 2, and about one hour after the announcement 3, the number of tweets reached the peak ($n = 2,541$).

Figure 1 here

The semantic network of dataset 1 before the announcement 2

Table 4 here

Figure 2 here

The semantic network of the dataset 1 was comprised of 71 words in total (See Table 4), and three clusters were identified (See Table 4 and Figure 2). In the first cluster (C1), the words with high DC were ‘*Park Sang-gi* (the Minister of Justice) ($DC = 2.290$, $EC = 0.108$)’, ‘exchange ($DC = 2.263$, $EC = 0.093$)’, ‘gambling ($DC = 2.096$, $EC = 0.102$)’ and ‘shutdown ($DC = 2.026$, $EC = 0.090$)’. These words were frequently connected to the words with high EC including ‘prohibition’, ‘government’, ‘the Ministry of Justice’ and ‘bill’. Interestingly, the words with negative valence were found in the network, such as ‘addiction’ and ‘*toogichoong* (Korean word negatively referring to cryptocurrency investors as spectators)’. Considering these words together, C1 was related to the narrative that the Justice Minister’s announcement regarding the bill about exchange shutdown served as the countermeasure against people’s cryptocurrency transaction suggestive of gambling or addictive behavior.

The second cluster (C2) contained three highly central concepts such as ‘investor ($DC = 1.895$, $EC = 0.381$)’, ‘petition ($DC = 1.888$, $EC = 0.428$)’ and ‘dismissal ($DC = 1.802$, $EC = 0.443$)’, and these words were associated with the words of high EC including ‘the Governor of the Financial Supervisory Service (FSS)’, ‘*Cheongwadae* (the Korean Presidential Office)’ and ‘pressure’. In addition, several words frequently observed in the C2 were related to the fluctuation of cryptocurrency prices: ‘collapse’, ‘market price’ ‘decrease’ and ‘profit’. This co-occurrence pattern in C2 implied that the collapse of cryptocurrency market price caused by the government’s pressure on the cryptocurrency market led the frustrated investors to make the online petition to the Presidential Office for dismissing the Governor of the FSS in charge of protecting domestic investors.

The third cluster (C3) centered on the words including ‘investment ($DC = 1.460$, $EC = 0.053$)’, ‘technology ($DC = 1.328$, $EC = 0.027$)’ and ‘industrial revolution ($DC = 1.092$, $EC = 0.024$)’, and other co-occurred words with high EC were ‘corporation’, ‘capital’ and ‘stock’. The word ‘Kodak’, the name of a famous international image solution corporation, also frequently appeared in this cluster. This was because many Twitter users in this period shared news articles about Kodak’s launch of its own cryptocurrency named ‘Kodak-coin’, that can be used to buy and sell the copyright of photos. C3 reflected the public’s expectation that the blockchain technology has potential to serve as an important power of the new industrial revolution, since large corporations declared the investment in the blockchain technology and the participation in cryptocurrency market.

The semantic network of dataset 2 before the announcement 3

Table 5 here

Figure 3 here

The semantic network of the dataset 2 included 90 words constituting six clusters (See Table 5 and Figure 3). In the first cluster (C1), the words ‘national people ($DC = 2.300$, $EC = 0.094$)’, ‘government ($DC = 2.187$, $EC = 0.100$)’ and ‘regulation ($DC = 1.653$, $EC = 0.040$)’ showed high DC and they co-occurred with the words with relatively high EC such as ‘bubble’, ‘pyramid selling’ and ‘delusion’. Several Korean words negatively referring to cryptocurrency investors also appeared in the network: ‘*gaemi*’ and ‘*coinchoong*’, both of which compared cryptocurrency or stock investors to powerless or harmful insects. C1 represented that the Korean government agencies’ general direction of regulating cryptocurrency transactions continuously gained their power, since the frequent words in C1 reflected the attribution of the blame for the problematic market bubble to the misguided individuals who participated in this harmful pyramid selling of cryptocurrency.

The second cluster (C2) contained the high DC words like ‘*Cheongwadae* ($DC = 1.284$, $EC = 0.022$)’, ‘remark ($DC = 1.061$, $EC = 0.038$)’, ‘abolition ($DC = 1.308$, $EC = 0.013$)’ and ‘*Park Sang-gi* ($DC = 0.947$, $EC = 0.015$)’. Subsequently, they were densely

connected to the high EC words including ‘rise and fall’, ‘criticism’, ‘regime’ and ‘National Assembly’. This cluster highlighted the National Assembly’s criticism on the government agencies since their successive but conflicting announcements regarding the shutdown of cryptocurrency exchange were suspected to be responsible for the cryptocurrency’s unstable market price.

Both ‘technology ($DC = 1.447$, $EC = 0.093$)’ and ‘industrial revolution ($DC = 1.434$, $EC = 0.036$)’ exhibited the high levels of degree centrality in the third cluster (C3). However, the associative words such as ‘confusion’, ‘function (of money)’ and ‘slush fund’ indicated the rising skepticism about the social value of blockchain technology because it could be abused for illegal purpose and cryptocurrency’s function as money for trading off values were becoming more suspicious.

The fourth (C4), fifth (C5) and sixth (C6) clusters centered on the different words, ‘Liberty Korea Party (political party in Korea) ($DC = 3.048$, $EC = 0.364$)’, *Chosun Ilbo* (Korean daily newspaper) ($DC = 2.469$, $EC = 0.127$) and *Jeong Jae-seung* (well-known professor at the Korea Advanced Institute of Science and Technology) ($DC = 1.137$, $EC = 0.027$). What these distinct social actors had in common was that they were vocal in their criticism on the Korean government’s stance toward the blockchain technology and cryptocurrency market. Meanwhile, their associative words with high EC indicated the narratives or frames used to defame them or undermine their argument.

The words frequently connected to ‘Liberty Korean Party (LKP)’ in C4 were ‘reckoning’, ‘kicking out’, ‘neglect’ and ‘longstanding evil’ that became common words in Korea since the impeachment of the former president. Considering that the ruling party in the former regime was Great National Party from which the LKP originated, the network of these words brought politically negative valence to both the LKP and its criticism on government’s plan to regulate on cryptocurrency transactions.

In C5, the words with high EC such as ‘attack’, ‘corruption’, ‘*Byun Sang-ouk* (journalist)’ and ‘*Yoo Si-min* (political journalist)’ co-occurred with ‘*Chosun Ilbo*’. The two figures appeared in this cluster once expressed strong criticism on several newspapers that concerned about the possible side effects caused by Korean government’s decision to shut down cryptocurrency exchanges. The interviews with *Byun Sang-ouk* and *Yoo Si-min* were popular news articles in Twitter that received high number of retweets. In short, the widespread public distrust on Korean news media made people to negatively respond

to the news media's critical comments on government's regulatory policy plans. It also led people to believe the suspicion that several Korean news media themselves had private interest on the cryptocurrency issue.

The word '*Jeong Jae-seung*', the name of Korean professor who made objection to *Yoo Si-min* by saying that the shutdown of exchanges is the worst solution to the problem, exhibited the highest DC in C6. This central word showed triadic relationships with 'economics' and 'understanding' or 'illegal'. Through this triad connections, *Jeong Jae-seung* was recalled in discourse in which scientists or engineers were considered lacking the understanding of social issues accompanied with economic or legal problems.

The semantic network of dataset 3 after the announcement 3

Table 6 here

Figure 4 here

The semantic network of the dataset 3 consisted of 88 words constructing seven semantic clusters (See Table 6 and Figure 4). The most central words in the first cluster (C1) were 'exchange ($DC = 2.812, EC = 0.279$)', '*Ahn Cheol-su* (Korean politician, the representative of The People's Party in January 2018) ($DC = 2.379, EC = 0.367$)' and '*Kim Jin-wha* (the representative of Korea Blockchain Association) ($DC = 2.351, EC = 0.388$)'. These cluster represented some people's suspicion that cryptocurrency exchanges and opposition parties had connection with each other. This narrative tried to politicize the stakeholders who opposed to the exchange shutdown and treat them as homogeneous interest groups.

In the second cluster (C2), the words with high DC such as 'shutdown ($DC = 2.116, EC = 0.136$)', 'real-name system ($DC = 1.934, EC = 0.136$)', 'response ($DC = 1.612, EC = 0.074$)' and '*Kim Dong-yeon* ($DC = 1.564, EC = 0.088$)' were densely connected to 'decision', 'principle', 'countermeasure' and 'promotion'. This cluster pertained to the principle of the Korean government's countermeasure against cryptocurrency frenzy comprised of introducing the real-name transaction system, promoting the technological research and development, and keeping shutdown of exchanges an available policy option.

Interestingly, the highly centered word ‘technology ($DC = 1.930$, $EC = 0.094$)’ in the third cluster (C3) was linked to the words with negative valence such as ‘speculation ($DC = 2.268$, $EC = 0.122$)’ and ‘gambling’, in comparison to the clusters found in the networks of dataset 1 and 2. This cluster implied the increase in public perception of the blockchain technology itself as the equivalence of its product (cryptocurrency) and consequently, the belief that the technology was also subject to the government’s regulation.

In the fourth cluster (C4), the high DC words including ‘regulation ($DC = 1.916$, $EC = 0.084$)’, ‘Moon Jae-in (the president of Korea) ($DC = 1.721$, $EC = 0.052$)’ and ‘investment ($DC = 1.559$, $EC = 0.067$)’ were associated with ‘*Giraegi* (Korean new word negatively referring to news media)’, ‘approval rating’, ‘agreement’ and ‘Realmeter (survey research organization in Korea)’. These words suggested that the public’s attention to the blockchain and cryptocurrency issue was extended to its impact on the support rate of the Korean president and the ruling party (Democratic Party of Korea).

Both the fifth (C5) and sixth (C6) cluster were mainly concerned with the implication of government’s countermeasure against the problems derived from cryptocurrency transaction frenzy. In C5, the most centered words such as ‘risk ($DC = 1.838$, $EC = 0.066$)’ and ‘transaction ($DC = 1.780$, $EC = 0.082$)’ were associated with ‘market’, ‘price’, ‘the Ministry of Justice’ and ‘prohibition’. This word connection implied that the Justice Minister’s strong comment (the prohibition of cryptocurrency transactions) was perceived as countermeasure against the market risk derived from price bubble. The most central word ‘economy ($DC = 2.017$, $EC = 0.079$)’ in C6 was densely connected to ‘interview’, ‘policy’ and ‘Jeong Jae-seung’. The association of words in C6 suggested that the economic perspective was the most dominant in public understanding of the policy making process for blockchain technology and cryptocurrency transactions.

Lastly, the words ‘investor ($DC = 1.067$, $EC = 0.035$)’ and ‘going bankrupt ($DC = 1.001$, $EC = 0.025$)’ were positioned centrally in the seventh cluster (C7), and their associative words ‘fraud’ and ‘*Coinchoong* (Korean new word negatively referring to the investors)’ reflected the narrative that the misguided and powerless individuals were responsible to their own bankruptcy.

Discussion

The goal of this study was to examine the impact of government pseudo-events on social media public discourse about emerging technological issues. Some changes in the clusters of the semantic networks were observed from the data and the overall results are as below.

First, public discourse made before the release of the message from the Korean Presidential Office included the perceived necessity of regulating people's cryptocurrency transaction behaviors suggestive of speculation or gambling. In addition, the conflicting announcements from different government departments also produced social anxiety that resulted in the online petition to the Korean Presidential Office. On the contrary, public's hopeful expectation of the blockchain technology as the new power of industrial innovation was also found in this semantic network.

Second, several changes in public discourse clusters were observed after the announcement of the Korean Presidential Office revealed the government's undecided stance on the shutdown of cryptocurrency exchanges. The negative words referring to cryptocurrency investors reflected the increased public support of government's regulation on the cryptocurrency transactions. The skepticism about the blockchain technology also newly appeared on the semantic network. Various social actors who criticized the direction of government's regulatory policies were undermined by the negative pre-existing frames or discourse about them.

Third, the Korean Office for Government Policy Coordination announced the government's promotion of the real-name transaction system and support for the research and development of relevant technologies, but the climate of public opinion on Twitter was generally negative toward the emerging blockchain technology and its products (cryptocurrency). The stakeholders who defended the retention of the cryptocurrency transactions via domestic exchanges suffered discredit for sharing private interest with each other. The economic effect of an emerging technology was considered as the most important criteria in making policy on the technological innovation. Individual cryptocurrency investors were strongly blamed for causing the market anxiety and laughed at their failure to their investment.

This study makes several contributions to the previous academic literature and offers a useful idea to the practitioners. First, this study supported the results of previous research that public discussion on the social implication of technological innovations was strongly influenced by the institutional context. Furthermore, this study explained the interplay of social media, governments and the public in the social construction of contested technologies.

Second, this study complemented the previous literature on pseudo-events by presenting their impact on public discourse about social issues, since most scholars have paid attention to the process in which pseudo-events are created by organizations and amplified by journalists. That was, the government agencies' releases of information about their policy plans served as pseudo-events in terms of their characteristics and impact on public discourse on social media. These governmental announcements were publicized by news media that made them into news, and the news articles about them were widely diffused throughout the network by the retweet function of Twitter. This leak of information motivated diverse social actors on Twitter to publicly express their opinion about the effectiveness and the legitimacy of the policy in the making. The discourse about the necessity for regulating cryptocurrency transactions continuously gained its power, and this trend reminded the self-fulfilling prophecy inherent in pseudo-events.

Lastly, this study proposes the active utilization of social media contents as useful implements to observe public discourse on social media using network analysis methods to the government officials, who consider the incorporation of various social actors' values into the process of planning policies on technological innovations.

This study has limitation that could be improved by future research. First, the context of the research was limited to Twitter, and Twitter users are not representative of the whole public with the interest in the given issue. Future research should investigate the broader social media environment with heterogeneous users. Another limitation is that this study did not consider the effect of distinct news content types on social media public discourse. Future research should inquire into the characteristics of online news articles (for example, quotes from sources or the use of frames in news articles) reporting diverse organizations' pseudo-events.

Appendix

Table 1. Important Governmental Announcements about Regulating Cryptocurrency Transaction

No.	Announced date and time (GMT)	Speakers (Name)	Announcements (Context)
1	03:00, January 11	The Minister of Justice (Park Sang-gi)	“The Ministry of Justice is preparing for a bill to ban cryptocurrency trading through the domestic exchanges” (at press meeting)
2	07:00, January 11	The Head of National Communication in the Presidential Office (Yoon Young-chan)	“Exchange shutdown is one of the measures being prepared, and the final decision will be made after further discussion.” (text messages sent to the news media)
3	00:42, January 15	The Senior officer at the Office for Government Policy Coordination (Jeong Ki-joon)	“The government will push real-name transactions, make a decision on a proposed shutdown of the exchanges, and support the research and development of blockchain technology.” (at press meeting)

Table 2. The Explanation of the Datasets Periods

Dataset No.	Dataset Period (GMT)		Explanation
	From	To	
1	January 10, 00:00	January 11, 06:59	one day before announcement 1 - before announcement 2
2	January 11, 07:00	January 15, 00:41	announcement 2 - before announcement 3
3	January 15, 00:42	January 16, 23:29	announcement 3 - one day after announcement 3

Table 3. Summary of the Twitter Datasets Used in This Study

Dataset No.	# of users (%)	# of tweets (%)	# of retweets (% ^{**})
1	3,795 (13.18)	6,593 (3.79)	3,480 (52.78)
2	22,715 (78.90)	116,993 (67.18)	100,441 (85.85)
3	13,161 (45.71)	50,561 (29.03)	43,413 (85.86)
Total	28,791* (100)	174,147 (100)	147,334

* Because of the users who participated in more than two different datasets periods, the sum of the number of users in each dataset exceeds the total number of users.

** the proportion (%) of retweet = # of retweets / # of tweets * 100 (%)

Figure 1. Temporal Evolution of the Number of Tweets per Hour Between January 10 and 16

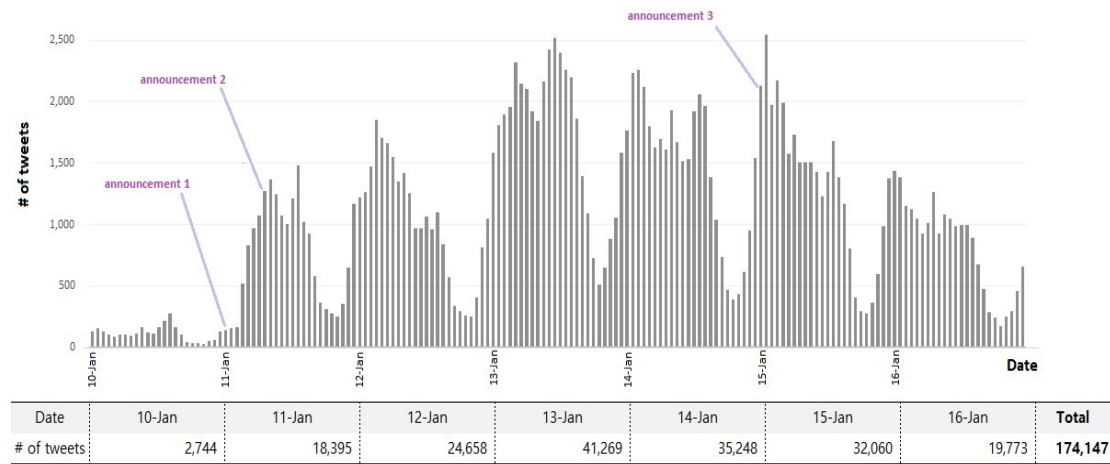


Table 4. The Words and the Clusters for Semantic Network of Dataset 1*

Cluster	Word	DC	EC	Cluster	Word	DC	EC
C1 (n = 24)	<i>Park Sang-gi</i> ¹	2.290	0.108	C3 (n = 15)	investment	1.460	0.053
	exchange	2.263	0.093		technology	1.328	0.027
	gambling	2.096	0.102		industrial revolution	1.092	0.024
	shutdown	2.026	0.090		corporation	1.085	0.031
	prohibition	1.757	0.083		capital	1.067	0.026
	government	1.654	0.080		stock	0.985	0.028
	the Ministry of Justice	1.540	0.060		stock price	0.983	0.009
	bill	1.512	0.075		Kodak	0.899	0.008
	concern	1.481	0.040		platform	0.625	0.007
	special act	1.127	0.058		advancement	0.606	0.007
	value	1.105	0.038		industry	0.589	0.016
	addiction	1.061	0.046		bank	0.494	0.010
	<i>Toogichoong</i> ²	0.980	0.044		market	0.429	0.013
	shock	0.968	0.031		remittance	0.323	0.003
	investigation	0.824	0.021		data	0.257	0.004
	China	0.809	0.036	n = 11	funds	1.143	0.027
	Sea Story	0.806	0.029		Japan	1.101	0.022
	base	0.804	0.027		group	1.075	0.013
	frenzy	0.739	0.023		bankruptcy	1.046	0.009
	countermeasure	0.717	0.035		modification	0.984	0.008
	<i>Kimchi</i> -premium	0.474	0.014		Youbit	0.981	0.008
	sympathy	0.453	0.021		side effect	0.958	0.020
	abolition	0.393	0.027		small cottage	0.957	0.019
	common people	0.344	0.012		debut	0.925	0.011
C2 (n = 21)	investor	1.895	0.381		<i>Gazua</i> ⁴	0.662	0.021
	petition	1.888	0.428		stir	0.248	0.008
	dismissal	1.802	0.443				
	the Governor of the FSS	1.784	0.436				
	Bitcoin	1.640	0.086				
	<i>Cheongwadae</i> ³	1.633	0.392				
	regulation	1.341	0.061				
	national people	1.025	0.084				
	market price	0.987	0.034				
	pressure	0.962	0.128				
	Bithumb	0.943	0.031				
	profit	0.745	0.017				
	suspicion	0.744	0.023				
	Ethereum	0.626	0.017				
	decrease	0.487	0.019				
	National Tax Service	0.485	0.016				
	Ripple	0.479	0.019				
	collapse	0.467	0.042				
	delusion	0.425	0.022				
	mining	0.309	0.008				
	crime	0.169	0.005				
				N = 71	(Average)	1.176	0.050

*word frequency threshold value = 63

¹ The Korean Minister of Justice

² Korean new word negatively referring to cryptocurrency investors

³ the Korean Presidential Office

⁴ Korean new word that means ‘cheers’

Figure 2. The Semantic Network and the Clusters of Dataset 1

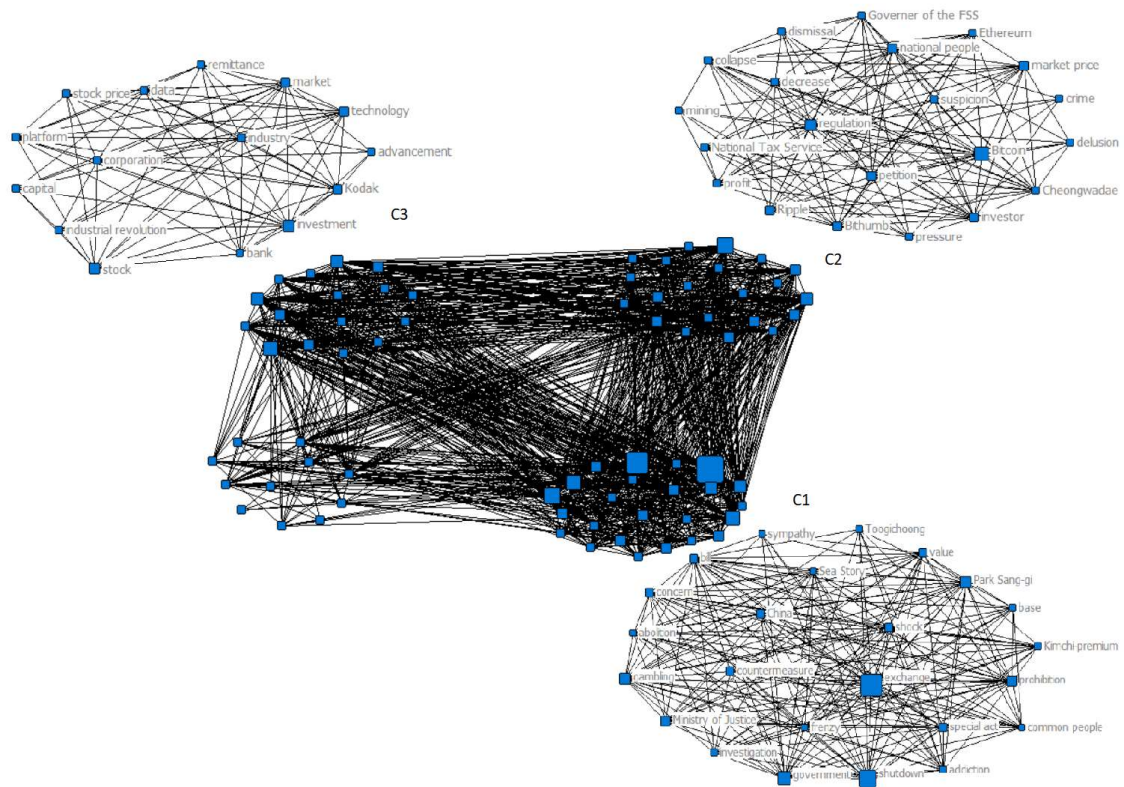


Table 5. The Words and the Clusters for Semantic Network of Dataset 2*

Cluster	Word	DC	EC	Cluster	Word	DC	EC
C1 (n = 18)	national people	2.300	0.094	C5 (n = 11)	<i>Chosun Ilbo</i> ⁷	2.469	0.127
	government	2.187	0.100		crime	1.847	0.074
	regulation	1.653	0.040		the press	1.840	0.051
	pyramid selling	1.106	0.016		corruption	1.801	0.075
	measure	0.919	0.015		<i>Byun Sang-ouk</i> ⁸	1.793	0.074
	<i>Gaemi</i> ¹	0.912	0.012		attack	1.734	0.156
	delusion	0.777	0.016		<i>Yoo Si-min</i> ⁹	1.711	0.057
	happy	0.710	0.014		doubt	1.609	0.064
	bubble	0.652	0.021		risk	1.222	0.023
	drug	0.642	0.011		sanction	0.79	0.011
	<i>Coinchoong</i> ²	0.631	0.014		Netherlands	0.608	0.009
	expert	0.510	0.006	C6 (n = 10)	<i>Jeong Jae-seung</i> ¹⁰	1.137	0.027
	agreement	0.502	0.015		illegal	0.992	0.023
	reinforcement	0.472	0.011		Economics	0.754	0.017
	concern	0.326	0.005		understanding	0.718	0.008
	decrease	0.254	0.004		worry	0.566	0.008
	handling	0.196	0.005		production	0.508	0.005
	approval system	0.152	0.003		misunderstanding	0.487	0.006
C2 (n = 14)	<i>Cheongwadae</i>	1.284	0.022		acquaintance	0.449	0.003
	remark	1.061	0.038		mental breakdown	0.416	0.003
	abolition	1.038	0.013		business magazine	0.377	0.002
	<i>Park Sang-gi</i>	0.947	0.015	n = 15	policy	1.442	0.024
	National Assembly	0.911	0.012		market	1.384	0.035
	legislation	0.721	0.009		countermeasure	0.918	0.019
	resist	0.717	0.010		signal	0.819	0.01
	criticism	0.612	0.025		real estate	0.785	0.009
	government ministry	0.477	0.007		support	0.691	0.011
	plan	0.473	0.009		stock	0.675	0.016
	rise and fall	0.468	0.039		withdrawal	0.589	0.006
	damage	0.402	0.006		regret	0.585	0.006
	regime	0.363	0.016		student	0.531	0.004
	<i>Ilbe</i> ³	0.214	0.005		opium	0.448	0.002
C3 (n = 11)	technology	1.447	0.093		order	0.412	0.006
	industrial revolution	0.790	0.019		utilization	0.377	0.005
	confusion	0.668	0.028		rear blast	0.375	0.002
	industry	0.667	0.015		gain	0.264	0.009
	function	0.653	0.025				
	<i>Park Young-sun</i> ⁴	0.527	0.017				
	slush fund	0.485	0.019				
	hacking	0.450	0.008				
	stupid	0.411	0.022				
	fund	0.329	0.004				
	fake	0.149	0.010				
C4 (n = 11)	Liberty Korea Party	3.048	0.364				
	fraud	2.252	0.244				
	reckoning	2.119	0.373				
	neglect	2.090	0.357				
	longstanding evil	2.083	0.342				
	kicking out	2.058	0.368				
	anger	1.813	0.17				
	Sea Story ⁵	1.779	0.153				
	opportunity	1.766	0.157				
	<i>Park Geun-hye</i> ⁶	1.686	0.296				
	debt	0.161	0.003	N = 90	(Average)	0.957	0.052

*word frequency threshold value = 654

¹ Korean word referring to individual investors² Korean word negatively referring to cryptocurrency investors

- ³ Korean online community
- ⁴ Korean politician affiliated to Democratic Party of Korea
- ⁵ Korean video slot machine game
- ⁶ Korean former president impeached in 2017
- ⁷ Korean daily newspaper
- ⁸ Korean journalist
- ⁹ Korean political writer
- ¹⁰ professor in KAIST

Figure 3. The Semantic Network and the Clusters of Dataset 2

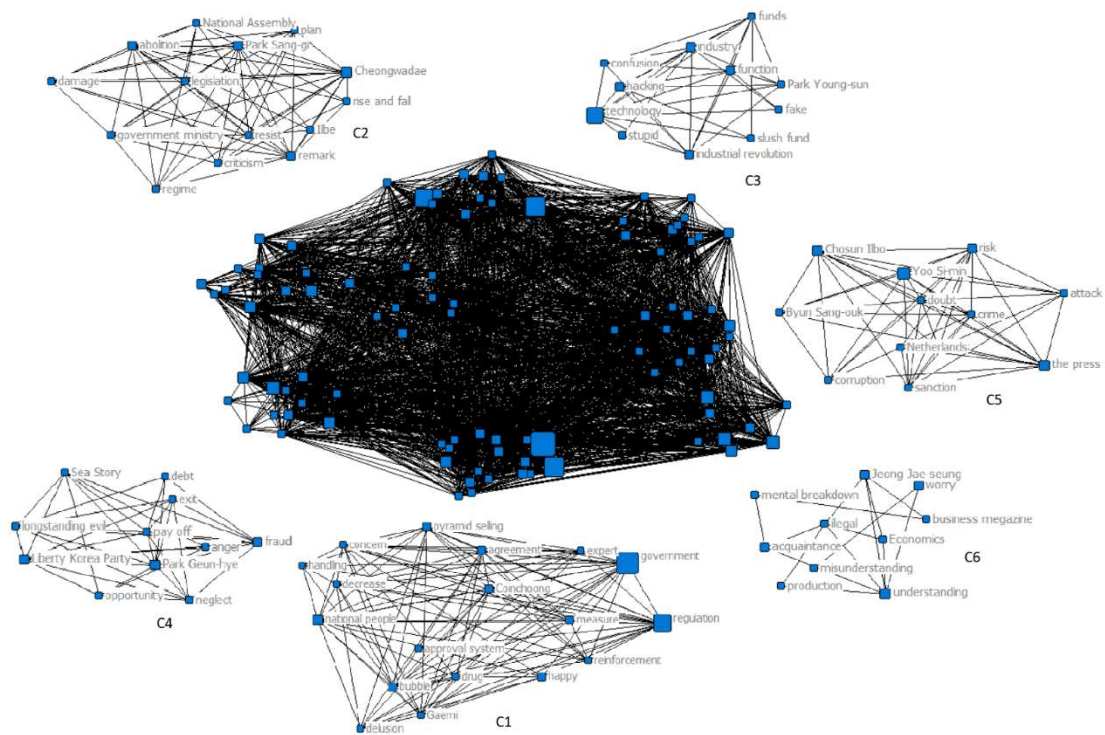


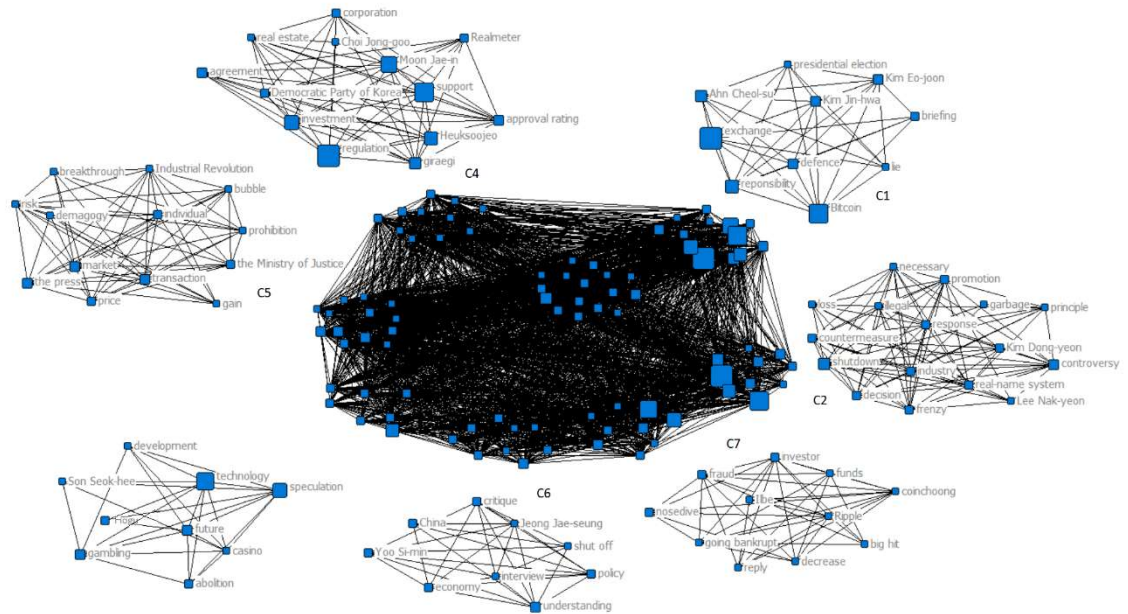
Table 6. The Words and the Clusters for Semantic Network of Dataset 3*

Cluster	Word	DC	EC	Cluster	Word	DC	EC
C1 (n = 10)	exchange	2.812	0.279	C5 (n = 13)	risk	1.838	0.066
	<i>Ahn Cheol-su</i> ¹	2.379	0.367		transaction	1.780	0.082
	<i>Kim Jin-hwa</i> ²	2.351	0.388		market	1.778	0.091
	Bitcoin	2.226	0.252		price	1.770	0.072
	<i>Kim Eo-joon</i> ³	2.027	0.347		the Ministry of Justice	1.431	0.065
	defense	1.804	0.357		the press	1.340	0.058
	responsibility	1.554	0.287		demagoguery	1.103	0.036
	briefing	1.127	0.05		gain	1.012	0.035
	presidential election	1.023	0.112		industrial revolution	0.376	0.016
	lie	0.975	0.102		bubble	0.317	0.013
C2 (n = 16)	shutdown	2.116	0.136		prohibition	0.036	0.060
	real-name system	1.934	0.136		individual	0.035	0.049
	response	1.612	0.074		breakthrough	0.034	0.055
	<i>Kim Dong-yeon</i> ⁴	1.564	0.088	C6 (n = 9)	economy	2.017	0.079
	countermeasure	1.488	0.069		interview	1.205	0.059
	decision	1.466	0.084		critique	1.163	0.044
	frenzy	1.406	0.057		<i>Jeong Jae-seung</i>	1.135	0.045
	illegal	1.402	0.055		policy	1.132	0.056
	promotion	1.379	0.064		shut off	0.825	0.029
	principle	1.285	0.071		<i>Yoo Si-min</i>	0.779	0.026
	controversy	1.193	0.053		China	0.539	0.017
	necessary	1.121	0.05		understanding	0.406	0.015
C3 (n = 9)	garbage	0.523	0.022	C7 (n = 11)	investor	1.067	0.035
	<i>Lee Nak-yeon</i> ⁵	0.506	0.014		going bankrupt	1.001	0.025
	industry	0.034	0.064		fraud	0.987	0.037
	loss	0.013	0.015		<i>Coinchoong</i>	0.895	0.028
	speculation	2.268	0.122		big hit	0.691	0.017
	technology	1.930	0.094		reply	0.588	0.021
	future	1.477	0.066		funds	0.541	0.017
	gambling	1.160	0.044		Ripple	0.493	0.017
	<i>Hogu</i> ⁷	0.851	0.055		nosedive	0.376	0.016
	abolition	0.714	0.029		decrease	0.014	0.014
C4 (n = 13)	casino	0.569	0.020		<i>Ilbe</i>	0.007	0.009
	<i>Son Seok-hee</i> ⁶	0.385	0.012	n = 7	<i>Cheongwadae</i>	1.327	0.049
	development	0.011	0.023		petition	0.991	0.031
	regulation	1.916	0.084		currency	0.859	0.01
	<i>Moon Jae-in</i>	1.721	0.052		protection	0.716	0.005
	investment	1.559	0.067		the United States	0.670	0.023
	<i>Giraegi</i> ⁸	1.177	0.040		mining	0.653	0.020
	Realmeter ⁹	1.109	0.029		bill	0.622	0.010
	approval rating	1.041	0.031	N = 88	(average)	1.071	5.914
	agreement	0.921	0.030				
	Democratic Party of Korea	0.829	0.027				
	support	0.734	0.028				
	<i>Heuksoojeo</i> ¹⁰	0.592	0.019				
	<i>Choi Jong-goo</i> ¹¹	0.522	0.015				
	corporation	0.464	0.022				
	real estate	0.436	0.014				

*word frequency threshold value = 290

- ¹ a Korean politician (member of BAREUNMIRAE Party)
² the representative of Korea blockchain association
³ Korean journalist
⁴ the Korean Minister of Economy
⁵ the Korean Prime minister
⁶ Korean broadcaster
⁷ Korean word referring to a credulous person
⁸ new Korean word negatively referring to the new media
⁹ Korean survey research organization
¹⁰ new Korean word negatively referring a person born in poor
¹¹ the chairman of Korean Financial Services Commission

Figure 4. The Semantic Network and the Clusters of Dataset 3



REFERENCES

- Aslam, S. (2018). Twitter by the numbers: Stats, demographics and fun facts. *Omnicores*. Retrieved April 29, 2018 from <https://www.omnicoreagency.com/twitter-statistics/>
- Atteveldt, W. (2008). *Semantic network analysis: Techniques for extracting, representing, and querying media content*. Charleston, SC: Booksurge publishing.
- Bae, H. (2018. 1. 12). Ministries stand at odds over cryptocurrency regulations. *The Korea Herald*. Retrieved April 29, 2018 from <http://www.koreaherald.com/view.php?ud=20180112000782>.
- Bimber, B. (1990). Karl Marx and the three faces of technological determinism. *Social Studies of Science*, 20, 333-351.
- Bonacich, P., & Lloyd, P. (2001). Eigenvector-like measures of centrality for asymmetric relations. *Social Networks*, 23, 191-201.
- Boorstin, D. (1992). *The image: A guide to pseudo-events in America*. New York: Vintage Books.
- Brossard, D., & Scheufele, D. A. (2013). Science, new media, and the public. *Science*, 339(6115), 40-41.
- Borgatti, S.P. (1995). Centrality and AIDS. *Connections*, 18, 112-114.
- Boyd, D. & Ellison, N. (2007). Social network sites: Definition, history and scholarship. *Journal of Computer-Mediated Communication*, 13(1), 210-230.
- Cho, K., Yuji, N., & Kim, N. (2017. 12. 7). A Bitcoin frenzy like no other is gripping south Korea. *Bloomberg Technology*. Retrieved April 29, 2018 from <https://www.bloomberg.com/news/articles/2017-12-06/bitcoin-frenzy-like-no-other-has-koreans-paying-a-16-premium>.

- Choi, B. (2017. 10. 11). Hanguk bitcoin guraeryang jeonsegye ilwui...segye sijang judo [Korean transaction volume of Bitcoin ranked the first...world market leader]. *Focus Daily*. Retrieved April 29, 2018 from <http://www.ulsanfocus.com/news/articleView.html?idxno=86910>.
- Choi, C., & Lecy, J. (2012). A semantic network analysis of changes in North Korea's economic policy. *Governance*, 25(4), 589-616.
- Clarke, J. (2003). How journalists judge the 'reality' of an international 'pseudo-event': A study of correspondents who covered the final withdrawal of Vietnamese troops from Cambodia in 1989. *Journalism*, 4(1), 50-75.
- Correljé, A., & Groenewegen, J. (2009). Public values in the energy sector: economic perspectives. *International Journal of Public Policy*, 4(5), 395–413.
- Cowan, R. (1999). How the refrigerator got its hum. In MacKenzie, D. & Wajcman, J. (Ed). *The social shaping of technology* (pp. 202-218). Buckingham, UK: Open University Press.
- Demirhan, K., & Çakır-Demirhan, D. (2015). Gender and politics: Patriarchal discourse on social media. *Public Relations Review*, 41(2), 308-310.
- Fellenor, J., Barnett, J., Potter, C., Urquhart, J., Mumford, J. D., & Quine, C. (2017). The social amplification of risk on Twitter: the case of ash dieback disease in the United Kingdom. *Journal of Risk Research*, 1-21.
- Friedland, L., Hove, T., & Rojas, H. (2006). The networked public sphere. *Javnost-the public*, 13(4), 5-26.
- Funtowicz, S. & Ravetz, J. (1993). Science for the post-normal age. *Futures*, 25, 739-755.
- Han, A. (2018. 1. 15). gukmoojojeongsil “amhowhapye silmyungjae chajilupshi choojin [real name cryptocurrency transaction system will be pushed

- forward without a problem]. *JoongAng Ilbo*. Retrieved May 7, 2018 from <http://news.join.com/article/22286120>.
- Hopke, J., & Simis, M. (2017). Discourse over a contested technology on Twitter: A case study of hydraulic fracturing. *Public Understanding of Science*, 26 (1), 105-120.
- Kim, B. (2018). A Study on the characteristics of the use of moral and ethical terms in Korean society through big data analysis. *Journal of Moral & Ethics Education*, (58), 27-58.
- Kim, H. (2004). Analysis of news value of pseudo-events broadcasts. Unpublished master's thesis, Korea University, Seoul, South Korea.
- Kim, Y., Ham, S., Kim, Y., & Choi, J. (2017). A critical discourse analysis on a social issue focusing on the THAAD deployment big data analysis. *Communication Theory*, 13(4), 40-91.
- Kim, D. & Kim, J. (2015). *Application of social network analysis for analyzing public opinion on social media: Focused on nuclear power tweet*. Paper presented at 2015 Spring Joint Conference of KORMS, KIE, ESK, KSIE, KSSS. Jeju, Korea.
- Kwon, K., Bang, C., Egnoto, M., & Raghav Rao, H. (2016). Social media rumors as improvised public opinion: semantic network analyses of twitter discourses during Korean saber rattling 2013. *Asian Journal of Communication*, 26(3), 201-222.
- Law, J., & Bijker, W. E. (Eds.). (1994). *Shaping technology/building society: Studies in sociotechnical change*. Cambridge, MA: MIT press.
- Lidskog, R. (2008). Scientised citizens and democratised science. Re-assessing the expert-lay divide. *Journal of Risk Research*, 11 (1-2), 69-86.
- Mody, C. (2004). Small, but determined: Technological determinism in nanoscience. *International Journal for Philosophy of Chemistry*, 2, 101-130.

- MacKenzie, D. & Wajcman, J. (1999). Introduction essay: The social shaping of technology. In MacKenzie, D. & Wajcman, J. (Ed.), *The social shaping of technology* (pp. 3-27). Buckingham, UK: Open University Press.
- Murthy, D. (2013). *Twitter: Social communication in the Twitter age*. Hoboken, NJ: John Wiley & Sons.
- National Science Board. (2018). Science and technology: Public attitudes and understanding. *National Science Board: Science & engineering indicators 2018*. Retrieved May 4, 2018 from <https://www.nsf.gov/statistics/2018/nsb20181/report/sections/science-and-technology-public-attitudes-and-understanding/interest-information-sources-and-involvement#s-t-information-sources>
- Priebe, J. (2018). My Twitter data has lots of duplicates. How can I eliminate identical tweets? *Texifter*. Retrieved May 8, 2018 from <https://texifter.zendesk.com/hc/en-us/articles/216548217-My-Twitter-data-has-lots-of-duplicates-How-can-I-eliminate-identical-tweets->
- Runge, K., Yeo, S., Cacciatore, M., Scheufele, D., Brossard, D., Xenos, M., ... & Liang, X. (2013). Tweeting nano: How public discourses about nanotechnology develop in social media environments. *Journal of Nanoparticle Research*, 15(1), 1-11.
- Taebi, B., Correlje, A., Cuppen, E., Dignum, M., & Pesch, U. (2014). Responsible innovation as an endorsement of public values: The need for interdisciplinary research. *Journal of Responsible Innovation*, 1(1), 118-124.
- Taebi, B., & Kadak, A. (2010). Intergenerational considerations affecting the future of nuclear power: Equity as a framework for assessing fuel cycles. *Risk Analysis*, 30 (9), 1341–1362.]
- Wasserman, S., & Faust, K. (1994). *Social network analysis*. Cambridge: Cambridge University Press.

White, L. (2005). Social change and medieval technology (Gang, I. Trans.). Landscape of Knowledge. (Original work published 1962).

Xin, L., Qianqian, X., Lucheng, H., & Zhou, Y. (2017). *Twitter data mining for the social awareness of emerging technologies*. Paper presented at International Conference on Management of Engineering and Technology, Portland, USA.

Yeonhap News (2017. 11. 26). Twiteo siwol guknae jeomyuyul geupdeung...peisubuk jecheotda [Twitter shows sharp increase in domestic share in October...casting behind Facebook]. *Yeonhap News*. Retrieved May 5, 2018, from <http://www.yonhapnews.co.kr/bulletin/2017/11/24/0200000000AKR20171124160000033.HTML?input=1195m>.