



Comparing Twitter and YouTube networks in information diffusion: The case of the “Occupy Wall Street” movement

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ABSTRACT

Grounded by the micro approach to network theory, information diffusion theory, and the web ecology model, this study comparatively explores the network structure, interaction pattern, and geographic distribution of users involved in communication networks of the Occupy Wall Street movement on Twitter and YouTube. The results show that Twitter users generated a loosely connected hub-and-spoke network, suggesting that information was likely to be organized by several central users in the network and that these users bridged small communities. On YouTube, homogeneously themed videos formed a dense mesh network, reinforcing shared ideas and meanings. According to the geographic distribution, both Twitter and YouTube networks were actively organized by U.S. users, but the YouTube network was activated mainly by anonymous users. These results highlight differing roles of social media in political information diffusion in which the Twitter network not only organizes and coordinates information but also facilitate the exchange of ideas between different groups. YouTube is suitable for disseminating ideas and reinforcing solidarity among members. The results demonstrate useful analytical techniques for data mining and analyzing Twitter and YouTube networks and have important implications for distinct roles of social media platforms in organizing collective action.

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1. Introduction

Internet communication technologies provide new opportunities for individuals who are likely to initiate, organize, and diffuse information and ideas based on globally distributed social networks (Burgess et al., 2006). Massive like-minded actors exchange and discuss their local problems through horizontal networks beyond geographic boundaries (Khondker, 2011). Social media outlets are everyday communication platforms where users are connected to one another by sharing ideas and discussing social problems (Hsu et al., 2013). In the context of social movements, social media serve as useful communication tools for protesters, who may deploy social media not only to

disseminate their ideas but also to motivate others to engage in collective action (Choi and Park, 2014).

The Occupy Wall Street (OWS) protest aims at decentralizing power and addressing financial inequality and is a recent representative example of how social media contribute to the dissemination of social events across the world (Cottle, 2007). The local protest initially organized in New York City has spread rapidly across the world through social media networks and thus has become an international social issue (Caren and Gaby, 2011).

Previous studies have examined the role of social media in political information diffusion and social networks grounded by diffusion of innovation theory and network theory (Biddix and Park, 2008; Castells, 2009; Caren and Gaby, 2011; Choi and Park, 2014; Danowski et al., 2011; González-Bailón et al., 2011; Hsu et al., 2013; Rogers, 2003). Researchers have focused on which and how political information is spread through social networks (e.g., Biddix and Park, 2008; Caren and Gaby, 2011;

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Danowski and Park, 2014), the capability of communication networks to organize collective action (Benkler, 2006; Best and Kellner, 2001; Castells, 2009; Couldry and Curran, 2003), and the characteristics of key actors in the information diffusion process (e.g., Choi and Park, 2014; González-Bailón et al., 2011; Hsu et al., 2013). However, few studies have examined the distinct role of social media platforms as a channel of information diffusion, although characteristics of each medium may shape the way information is disseminated and shared by users (Nam et al., 2014; Rogers, 2000).

To fill this research gap and provide a better understanding of the dynamics of the political information diffusion process through social media, this study comparatively maps the communication network of the OWS movement on Twitter and YouTube, two global social media platforms. By employing the social network analysis method, this study investigates the structural characteristics of communication networks, patterns of interactions between users, and the geographic distribution of users. A social network analysis is useful for uncovering the structure of communication networks that illuminates how individuals exchange information online (Barnett et al., 2011). Taking the network structure and geographical distribution into account simultaneously is crucial for assessing the strength of an information system (Leydesdorff et al., 2006). In this regard, this study provides important theoretical and methodological insights into the process of protest-related information diffusion and distinct roles of social media platforms as communication channels for organizing collective action.

2. Literature review

2.1. The role of the Internet in civic engagement

Castells (2009) noted the ability of communication networks to generate a new public space in the process of social change. The Internet facilitates horizontal communication networks, allowing ordinary individuals to express their opinions and construct a certain image. Social actors who are willing to change their society against established authorities and institutions use such communication networks to counter these entities. For instance, Castells (2009) provided a case study of Obama's political campaign in 2008 and pointed out that the Internet was used to mobilize young voters who wanted social change and motivate them to participate in the election. This result implies that the Internet is a new means for initiating social change by mobilizing individuals and collective action.

There has been an increasing discussion among scholars that the Internet creates a new form of citizenship reflecting the less formal construction of one's identity, representation, and ideology through one's everyday practices in popular culture. Hermes (2005) defined cultural citizenship "as the process of bonding and community building, and reflection on that bonding that is implied in partaking of the text related practices of reading, consuming, celebrating, and criticizing offered in the realm of (popular) culture" (p. 10). Hof (2006) adapted this idea to examine scrapbook sites and suggested that online communities serve as platforms for forming cultural citizenship. She illustrated that a visible forum allows members to get a sense of what and whom others care about and which society they live in with which cultural values. This

implies that such online activities entail certain obligations and responsibilities to maintain attention to others and social issues as members of society.

Burgess et al. (2006) extended this concept to social networking sites (SNSs) such as photo-sharing, storytelling, and chatting sites. They described that producing everyday creative content and social networking represent an important element of a digital culture and emphasized that such social networking practices shift the way one's identity is politicized from a homogeneous public sphere mediated by the mass media to a heterogeneous, open cultural sphere based on everyday participation through social media. In this process, users experience both conscious and unconscious cultural citizenship practices. These discussions lead to the assumption that the greater the popularity of social networking platforms, the greater their capability to constitute and practice cultural citizenship based on daily use and a highly participatory culture. Along this line, Burgess and Green (2009) pointed out that globally popular social media such as YouTube are potential communication channels for constructing cosmopolitan cultural citizenship through which individuals share their identities and perspectives with others in diverse geographic locations. They also illustrated that during the 2008 U.S. presidential campaign, YouTube videos played a crucial role in constituting the cultural citizenship among posters and audiences. These findings provide support for the idea that social media users can build a collective identity by sharing common ideas and cultural values through their interaction. This view can be applied in a social movement context in which protesters can employ social media as tools for mobilizing other users by sharing cultural meanings to facilitate collective action.

2.2. Network theory and information diffusion

Network theory explores human behavior in terms of relationships among members of societies (Castells, 2009; Monge & Contractor, 2003). Two major theoretical approaches have been employed by network theorists. They can be classified into 1) the macro network approach and 2) the micro network approach in terms of the definition of networks and the unit of analysis (Monge & Contractor, 2003). The macro approach treats a network as a social system or structure constituting a society and focuses on power relationships between human collectives or individuals who struggle with achieving their interests and values (Castells, 2009). On the other hand, the micro approach regards a network as an association of individuals and focuses on who act together for what, how collectives construct a society, and how they produce cultural meanings (Granovetter, 1973; Latour, 1987).

As a type of structural analysis, the social network analysis method is used to examine characteristics of network structures, relationship properties of networks, patterns of communication between actors, and roles of actors embedded in networks (Danowski et al., 2011). Scholars have argued that networks are important in innovation diffusion because social ties and communication between individuals can facilitate the spread of an innovation (Danowski et al., 2011; Monge & Contractor, 2003; Rogers, 2003).

Recent studies grounded in network theory and diffusion of innovation theory have explored the role of social networks, the network structure, and the pattern of interactions between

actors in the context of **organizing collective action** (Benkler, 2006; Biddix and Park, 2008; Castells, 2009; Caren and Gaby, 2011; Choi and Park, 2014; Danowski et al., 2011; González-Bailón et al., 2011; Hsu et al., 2013; Redden, 2001).

Benkler (2006) found that computer-mediated social networks allow individuals to organize collective action by **reporting and commenting on political issues and generate political discourse**. Redden (2001) noted the potential of networked communication through Internet technologies and suggested that a noticeable advantage of a **decentralized network** is not only to **weaken the ability of the state and authority to control information distribution** but also to **empower individuals to extend their ideas beyond geographic boundaries**. The above discussion suggests that communication networks play a crucial role in the diffusion of information by effectively mediating collective ideas and facilitating ties between diverse individuals to “think something” and even “enact something” in community-based contexts.

González-Bailón et al. (2011) investigated the dynamics of protest recruitment through **Twitter networks** and found that early participants are typically not in topological positions but that **influential spreaders are centrally positioned in the network**. Biddix and Park (2008) employed a mixed method employing hyperlink network analysis and interview techniques to identify structural characteristics of networks and the role of Internet communities for a campus living wage movement among college students in the U.S. and suggested that the networked social movement allowed it to overcome previous limitations of student protests and sustained the issue longer. Hsu et al. (2013) examined the characteristics of key actors in South Korea's political discourse on Twitter and found that media outlets are central actors in terms of their message output, whereas their tweets are not likely to be circulated by other users. By contrast, ordinary citizens geographically affiliated with the local political issue are likely to play an important role in the flow of communication, and their content is likely to be retweeted by others.

Although previous studies have provided some theoretical implications for how Internet-based communication technologies influence the formation of collective action based on social networks and the pattern of information diffusion across actors, few studies have examined the distinct role of social media platforms as a channel of information diffusion. This gap is a remarkable limitation of the literature on information diffusion. Rogers (2000) pointed this out in one of his seminal works, suggesting that the diffusion of social events is a complicated process in which **structural characteristics of communities and information channels influence the way information is disseminated and adopted by individuals**. Along this line, Nam et al. (2014) noted that the concept of the web ecology refers to interrelationships between human behaviors, information systems, and technologies. Oriented by the biological ecology, the concept emphasizes that different individuals employ different information tools in a complementary manner. Indeed, these findings provide evidence of a web ecology in which different online media platforms such as Twitter, Facebook, blogs, and news websites formed differently structured communication networks for civic engagement during Korea's general election campaign in 2012. These findings suggest that, to understand the dynamics of

the information diffusion process of social media, technological aspects of information systems and their differing roles in forming collective action need to be considered.

2.3. How social media are used in social movements

Since the 1990s, there has been a growing debate over how digital media are used in political discourse and social movements (Best and Kellner, 2001; Couldry and Curran, 2003). Social movement scholars have started to interpret various contributions of digital media, including their ability to make collective action easier and efficient and its inherent limitations. Cottle (2007) introduced the term “**mediatized conflict**” to highlight the complex ways in which digital media are used for political conflicts in disseminating ideas and images and stated that they can empower conflicts beyond simply representing the reality by highlighting certain types of symbolic presentations. When social movements meet social media, in which ideas, images and information are produced and exchanged on a real-time basis, mediated political action can become more powerful in dealing with conflicts.

In analyzing the role of the Internet and mobile technologies in Moldova's Revolution of April 2009, Lysenko and Desouza (2012) found that **IT has considerable influence on consequences of contentious political confrontations**. The use of social media is helpful not only in organizing protestors' initial mobilization but also in facilitating local and global communication on protests.

The role of social media in facilitating social movements and revolutions has been a controversial issue among scholars in recent years. Although social media alone cannot instigate revolutions, they offer affordable tools for social actors to organize supporters and publicize their goals (Noonan, 2011). The regimes in the Middle East clearly demonstrate the importance of social networking through social media for protests. In Tunisia and Egypt, Facebook and Twitter helped to initiate civil disobedience campaigns and street demonstrations. For instance, Iran's “Green Revolution” in 2009 and Moldova's 2009 revolution are regarded as successful models of communication revolutions through YouTube and Twitter (Noonan, 2011). Bennett (2003) pointed out that vast numbers of anonymous users and dispersed networks without central nodes can pose serious challenges to authorities in their efforts to control or subvert citizens' collective action.

Although the function of social media as social movement tools has been acknowledged by scholars in terms of intensifying connectivity and mobilization (Khondker, 2011), the consequence of its use has also been questioned. Outcomes of political activities through social media vary across social contexts and allow dissidents to be easily exposed by government censorship (Morozov, 2009; Kendzior, 2012). However, the capacity of social media as a communication channel to attract global citizens' interest in political issues and motivate them in forming collective resistance can be an important facilitator of social change or even revolutions (Doctorow, 2012).

Porta and Mosca (2005) examined online communities during the anti-G protest in Genoa in July 2001 and the European Social Forum in Florence in November 2002 through a survey of online activists focusing on their use of the Web for protest purposes. They found that these activists engaged in protests both offline and online. They acknowledged that the

Web is a relative new resource and thus that it still has some limitations in fostering the success of such protests. They also noted that the **key motivation for global justice in social movements successfully can sensitize public opinion.**

Caren and Gaby (2011) explored how the OWS movement was diffused on Facebook and found that more than 400 unique fan pages were established across the U.S., with an average of 73,812 posts and comments per day between September and October 2011. In addition, these pages recruited over 170,000 Facebook users and garnered more than 1.4 million “likes.” By October 22, there were **1,170,626 posts and comments.** Based on these findings, they suggested that the **major objectives of online activities were recruiting protesters and resources for local activities, sharing information, and telling stories about the protest** and evaluated that Facebook activities were useful for mobilizing individuals to offline demonstrations. **Xie et al. (2011)** tracked 28,478 relevant videos featuring the Iranian election on YouTube (28,478) from May 2009 to March 2010 and identified the **effects of topical hubs** and authors in terms of the extent of being reposted by other users and view counts. They found that most of the videos in the central topic hub focused on postelection street protests. Central contributors in the distribution network with large numbers of view counts and comments were voluntary political activists paying roles as “citizen buzz leaders.” The videos included iconic images and **provided good summaries of the event timeline.**

Chang, Pimentel, and Svistunov (2011) examined tweets about the OWS protest by labeling sentiments reflected in a total of 1980 tweets and revealed that most were neutral or irrelevant (53%) and there were similar numbers of positive (24%) and negative (23%) tweets. Given the nature of social movements resulting in political discontent and social inequality, these findings are surprising. However, space limitations imposed by Twitter might have hindered the expression of certain opinions, and the participants might have used Twitter as an **information delivery channel, not as a discussion forum.** **Biddix and Park (2008)** examined U.S. college students' movement regarding the campus living wage through a network analysis and in-depth interviews and suggested that online communities contributed to sustain the movement through unintentional networked communities. For example, during the protests, online communication occurred mainly for sharing demonstration tactics and experiences, and personal contact. Noteworthy is that, after the protest, they sustained their relationships through interpersonal contact. This resonates with the **role of social media as community-based platforms** maintaining relationships between users with common social interests. These studies and empirical findings illuminate that, in a social movement context, despite some limitations, social media can play a role as an effective communication channel for facilitating collective action and proliferating political discourse.

3. Research objectives

Although information diffusion theory and the web ecology model suggest the necessity of considering differing roles of social media in the information diffusion process and organizing collective action, previous studies of political information diffusion through social media have focused mainly on specific social media platforms (Rogers, 2000; Nam et al., 2014). This

significant bias can hinder the understanding of distinct functions of social media platforms for collective action. To address this research gap and contribute to the theoretical understanding of information diffusion through social media and the web ecology in the context of social movements, this study **comparatively investigates communication networks of the OWS movement formed by two popular social media platforms, namely Twitter and YouTube.** For this, this study takes the **micro approach to network theory** and examines the **characteristics of the network structure, the pattern of interactions between users, and the geopolitical distribution of users on both platforms.** This comparative analysis of social media platforms in information diffusion is expected to **reveal the distinct roles of social media in network formation and political information diffusion.**

4. Methods

4.1. Data collection and analysis

To investigate the structure of the OWS Twitter network, a **network analysis** was conducted using the API tool of **NodeXL** embedded in Excel 2007 (Hansen et al., 2010). A Twitter network addressing the term “OccupyWallSt,” the official OWS account, was mapped on May 1, 2012, by using NodeXL. It **represented “mention” and “reply-to” relationships** by capturing users who tweeted this search term or who replied or mentioned to the official account. This also allowed the collection of posters who had the hashtag “#OccupyWallSt,” that was very popular at the moment of data collection.

A **total of 328 users were identified.** The number of followers, followees (people users follow), tweets, and favorites of users were collected. In addition, **geographic information** on users was crawled, except for those users not specifying their locations or presenting fictitious ones such as “right behind you” and “on the globe.”

To examine the network of YouTube, **NodeXL** was used to extract YouTube videos whose titles, **keywords, descriptions, categories, or usernames contained the keyword “OccupyWallStreet.”** A total of 462 videos created from May 29, 2010, to May 2, 2012, were captured. Their **ratings, views, comments, and “favorites”** were quantified. To identify the geographic distribution of posters contained in their profiles on YouTube, the API-based network analysis program **Webometric Analyst 2.0** was employed (Thelwall, 2012).

We adapted the micro approach to network such that a **network is regarded as associations of individuals.** Both Twitter and YouTube networks were considered to be formed by human agencies featuring some social movement, although **objects on each platform were considered to have different types of content** (e.g., text-based content on Twitter and video-based content on YouTube). This approach was taken to justify the sampling approach.

In addition, **descriptive network metrics of both networks were computed to measure structural characteristics of Twitter and YouTube networks through NodeXL, including network density, clusterability, and degree centrality.** These metrics are described as follows.

4.1.1. Network density

Network density refers to the proportion of lines between a set of actors in the network as a whole and suggests the extent to which the actors communicate with all other actors (Wasserman and Faust, 1994).

4.1.2. Clusterability

The clustering coefficient quantifies the extent to which the nodes in a network are clusterable instead of balanced. The higher the clustering coefficient, the greater the probability of a small-world network is (Wasserman, 2011).

4.1.3. Modularity

Modularity is indicative of the community structure of a network. It is calculated by the number of edges, falling within groups minus the expected number in an equivalent network with edges placed randomly. A positive modularity value implies the possible presence of a community structure, meaning natural divisions in the network (Newman, 2006).

5. Results

5.1. Communication network structure

5.1.1. Twitter

The OWS Twitter network was mapped. The official Twitter account of the OWS movement (@occupywallst) sent 7911 tweets, had 159,274 followers, and 949 followees as of May 1, 2012. Fig. 1 shows the communication network of users who addressed the OWS movement. In the figure, the link between

two nodes denotes their communication. That is, these two users were replied to or mentioned by other users for the term. Node size indicates the number of followers. The color of node denotes the number of favorites a user's profile obtained from other users. Red or colored nodes are those whose content received more favorites from others, whereas blue nodes are those with few favorites.

The network included 328 users. There were 226 interactions between users embedded in the OWS network. In addition, 59 duplicate connections between these users were excluded from the network.

The total number of the latest interactions between the OWS account and other users was 57. Among the 328 actors in the network, 48 sent tweets, including mentions, retweets, and replies to users adjacent to the OWS account. As shown in Fig. 1, the typology of the network reflected a hub-and-spoke structure, indicating that there were several key users who were opinion leaders in the communication network. The official OWS account occupied a central position in the network. This implies that the user successfully played a role not only as a key informant in the movement but also as a broker of the issue, forming bridges between other key clusters in the network. Given the profound value of a broker's characteristics in the process of information diffusion, the official OWS Twitter organization functioned as a facilitator of collaboration by translating, interpreting, and moderating protest information (Lee, 2013).

The graph density was 0.004, and the average clustering coefficient was 0.000, suggesting that the network had a relatively limited number of interactions between actors in the

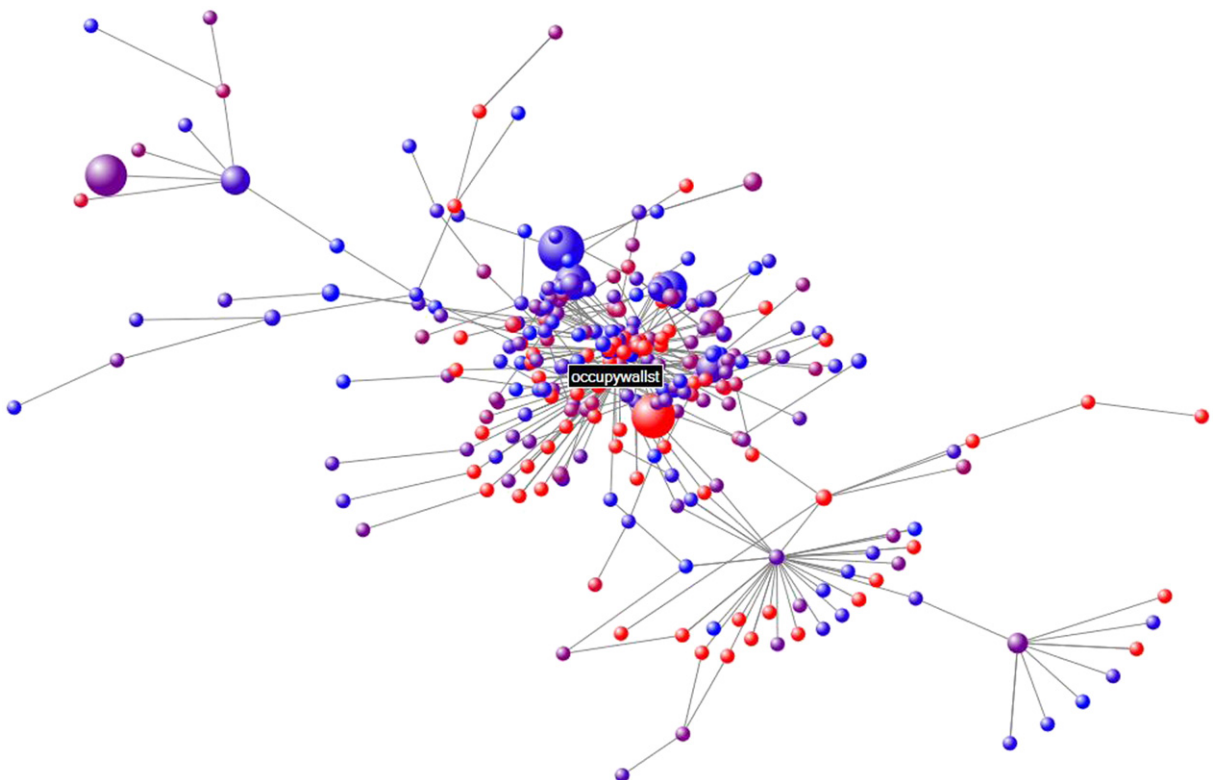


Fig. 1. The Occupy Wall Street movement network on Twitter.

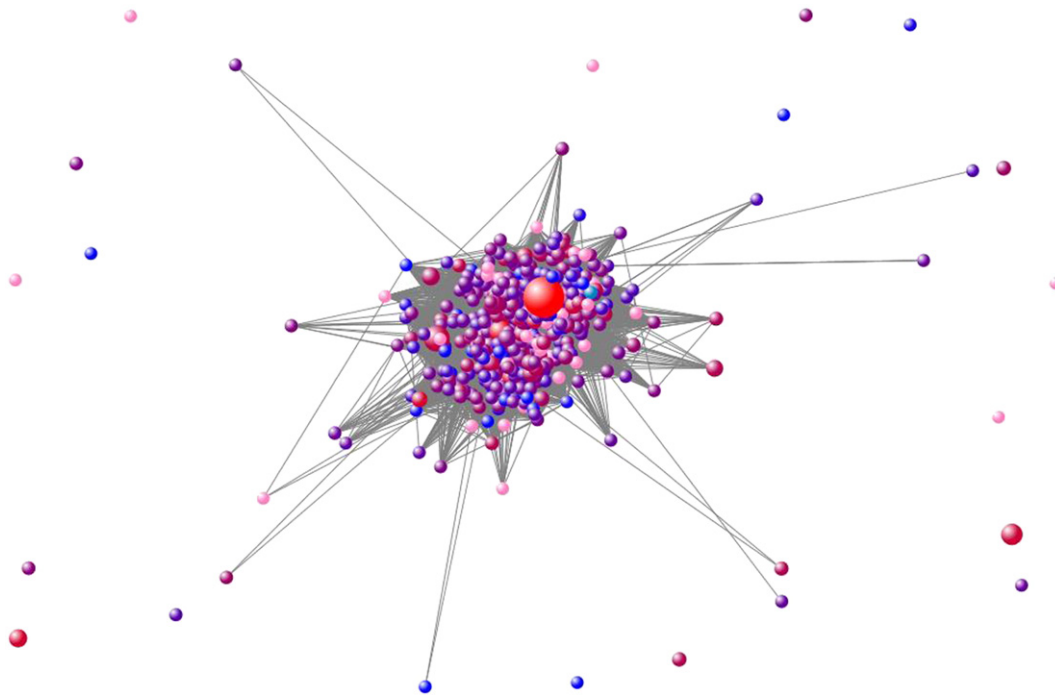


Fig. 2. The Occupy Wall Street movement network on YouTube.

whole structure, although the OWS account had substantial numbers of followees and followers. The low density could have resulted from limitations in collecting data, which presented only recent interactions between users.

The network formed four major clusters, including one large group at the center and three small ones in the periphery. This type of structural feature suggests that a few hub users dominated the network and effectively influenced and controlled others in diffusing information (Park and Kluver, 2009). The modularity of this network was 0.058, providing evidence of a community-based structure. The formation of the community illustrates the capability of mobilizing users by maintaining interpersonal contact and interactions between users. This suggests that the **Twitter network was used to strengthen solidarity between online protesters through their connections.**

5.1.2. YouTube

The OWS YouTube network was mapped. The total number of links between the 461 nodes was 90,713 and there were 25,297 unique links. This suggests that there were a large number of duplicate connections between nodes (65,413 links) and that most videos shared the same keywords in tags with others at least several times. This tendency is generally consistent with the results for the clustering coefficient and network density as a whole. That is, **video content was more likely to include similar topics than dissimilar ones.** Sharing a tag in content was regarded as a proxy for a content provider's explicit interest in an issue. Jun et al. (2014) proposed the search traffic analysis method as a way to track online users' behaviors, suggesting that specific keywords such as YouTube tags can be indicators of content producers' interest and intention for a given theme.

Fig. 2 presents a map of the video-sharing network, featuring the OWS movement on YouTube.

In this figure, the connection between two nodes represents a pair of videos tagged with the same keyword. Node size indicates the degree of views. The color of node denotes the number of favorites a video received from other users. Red and colored nodes indicate those users whose content received more favorites from others, and blue nodes indicate those with few favorites.

As shown in Fig. 2, the YouTube network indicated a messy network topology. The high and positive value of the average clustering coefficient (0.731) indicates the tendency of nodes to form clusters with one another and implies that the OWS network on YouTube formed a small-world network, voicing homogeneous themes. The network density was 0.43, indicating that almost 43% of actors in the network were, to a certain extent, densely interconnected with one another, sharing the same keywords.

The average rating was 4.77, the average number of favorites was 247.97, and the average number of comments was 722.49. In general, a majority of dominant videos were highly rated and favorited, implying that OWS videos were generally popular among viewers and that viewers were likely to respond to them. In the network, the redder and larger the node (the larger the number of views and favorites), the more central the node was, whereas the smaller and bluer the node (the smaller the number of views and favorites), the more peripheral the node was. This indicates that popular YouTube clips were more likely to receive favorites from viewers.¹ This implies that YouTube-viewing patterns were related to

¹ The number of views and favorites were significantly correlated ($r = 0.923$, $p < .01$).

positive responses and that the number of views was not only indicative of the public's interest and attention for a sociopolitical issue but also related to the public's positive perception. These results shed light on the potential influence of popular videos with a large number of views in a social movement context.

5.2. The geographic distribution of actors

5.2.1. Twitter

The results identify the geographic location of users in a Twitter network based on their profile information to examine the information distribution range and Twitter's potential to mobilize collective action. Fig. 3 shows the geographic distribution of posters in the Twitter network.

As shown in Fig. 3, 55.35% of these users were U.S. residents, and 10.40% were from 15 other countries. A majority of actors were residents of Western countries such as the U.K. and Canada, and others were from Spain, Catalonia, and the Netherlands. The rest (34.25%) did not clearly indicate their locations. Fig. 4 shows the geographic distribution of Twitter actors in the U.S. The West (30.77%), the South (30.77%), and the Northeast (23.08%) showed more actors than the Midwest (15.38%).

More specifically, residents of New York, California, and Washington D.C. were core actors in disseminating the issue on Twitter by interacting with the official OWS account, implying that the online demonstration was particularly active in large cities.

Fig. 5 shows the geographic distribution of non-U.S. Twitter actors. A large number of Twitter actors were from well-developed countries such as the U.K., Canada, and Spain.

These results imply that OWS-related information was disseminated mainly by residents from various areas of the U.S., whereas a large number of non-U.S. users also engaged in information diffusion. This illustrates the potential capability of Twitter to globalize a local issue through social networking among users. Kluver (2004) described the significance of globalization through IT in redefining politics, and this study's results indicate that Twitter provided greater awareness of the movement and empowered individuals to engage in international political issues.

5.2.2. YouTube

YouTube video posters' geographic information was obtained using their profiles. Fig. 6 shows the geographic distribution of posters in the YouTube network.

Noteworthy is that a majority of OWS videos were posted by anonymous actors (44.81%) in terms of their physical locations, unlike in the case of Twitter. Many verified actors (43.94%) were U.S. residents, and a few (11.26%) were from other countries. Fig. 7 shows the geographic distribution of YouTube actors in the U.S.

The Northeast (57.14%) and the West (23.81%) showed more actors than the South (11.11%) and the Midwest (7.94%). This indicates that residents of large cities such as New York and California were core actors in disseminating the issue on YouTube, which is consistent with the results for the Twitter network. Fig. 8 shows the geographic distribution of non-U.S. YouTube posters.

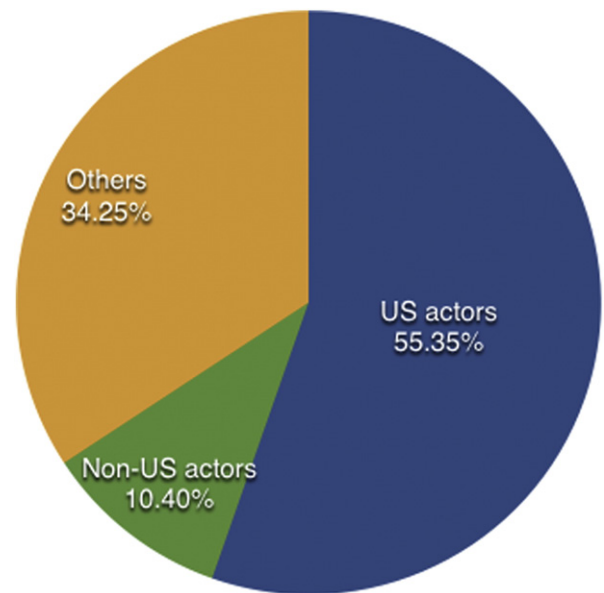


Fig. 3. The geographic distribution of Twitter actors.

Actors residing in Western countries such as the U.K. and Canada dominated the network, which is consistent with the geography of the Twitter network. The other actors were from Russia, Brazil, Afghanistan, Armenia, Australia, Brazil, the Czech Republic, France, and other countries.

This reveals that, as in the case of the Twitter network, a wide range of international actors was engaged in the diffusion process in the YouTube network. These results implicate that both Twitter and YouTube communication networks were organized by actors from major states in the U.S. and that the YouTube network was organized mainly by anonymous actors. This reflects the nature of social networks on YouTube, which is more anonymous and deindividuated as a broadcasting medium.

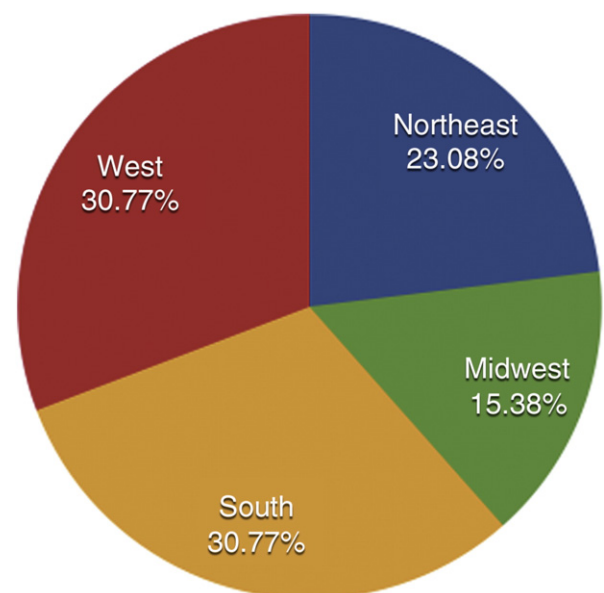


Fig. 4. The geographic distribution of Twitter actors in the U.S.

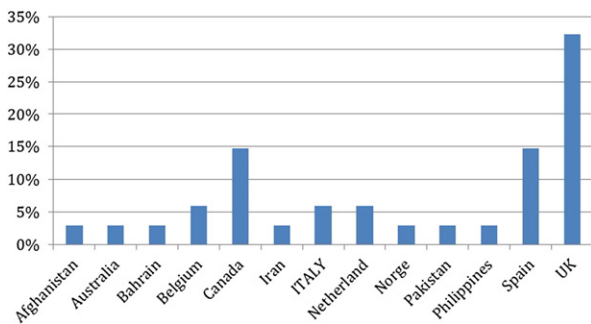


Fig. 5. The geographic distribution of non-U.S. Twitter actors.

(Halpern and Gibbs, 2013) than Twitter, which is based more on interpersonal communication between people who want to share their daily lives.

6. Discussion and conclusions

Grounded by the micro approach to network theory, information diffusion theory, and the web ecology model, this study comparatively explores the network structure, interaction pattern, and geographic distribution of users involved in communication networks by addressing the OWS movement.

The results provide several important implications for understanding the dynamics of the political information diffusion process and differences in the nature of Twitter and YouTube in a social movement context. First, the Twitter network had a hub-and-spoke structure, which indicates that information was more likely to be organized by several powerful users with central network positions. They not only played core roles as opinion leaders in disseminating information but also bridged other small communities in the network. From a social network perspective, this structural characteristic suggests that a few opinion leaders on Twitter hierarchically organized information (Monge & Contrator, 2003). In other words, there may be

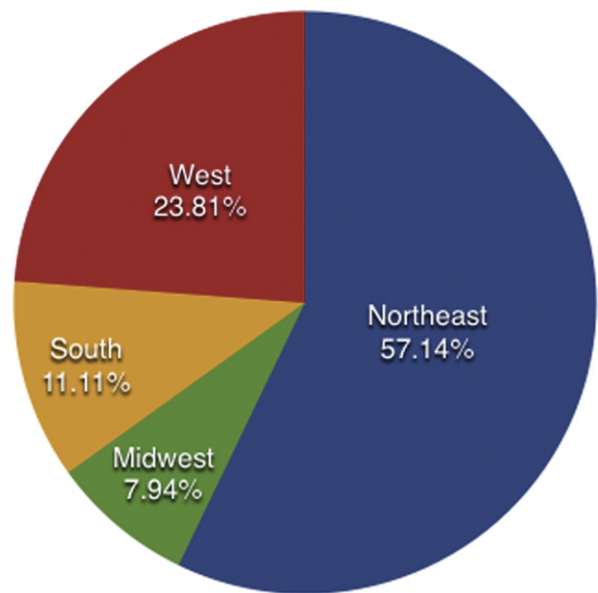


Fig. 7. The geographic distribution of YouTube actors in the U.S.

limitations in sharing all meanings without a few key actors who bridge different communities. In other words, information is likely to be controlled by opinion leaders. This illuminates that the Twitter network functions not only to organize and coordinate information but also to facilitate the exchange of different ideas between different groups (Danowski et al., 2011).

Unlike in the case of Twitter's hierarchical and loose network, actors formed a dense and highly interconnected network on YouTube. In other words, most actors were interlinked by sharing ideas and meanings. Noteworthy is that popular videos rated by a number of viewers were highly clustered, reinforcing their similar voice by using the same keywords in tags. This implies that YouTube is suitable for disseminating ideas and reinforcing solidarity among members. This distinct function of Twitter and YouTube in forming collective action shows that the functional combination of social media platforms can facilitate the information diffusion process.

Second, the geographic distribution of actors in both Twitter and YouTube networks reveals that a majority of actors were U.S. residents from large states such as New York and Washington D.C., where the protest was much more active. Despite the limited number of non-U.S. users in both networks, the diversity of international actors implies the potential function of social media in disseminating social events across countries. As asserted in Strand and Leydesdorff (2013), interactions between geographically heterogeneous agents can contribute to synergies in knowledge exploration. This implies the quality of information diffusion through social media.

Finally, a majority of actors in the YouTube network were anonymous, unlike in the case of Twitter, whose actors generally verified their geographic information in their profiles. This reflects the nature of these two social networking platforms. Twitter is a public communication and information exchange channel for identified users, whereas YouTube is an anonymous and deindividuated broadcasting medium that delivers politically sensitive content (Halpern and Gibbs, 2013).

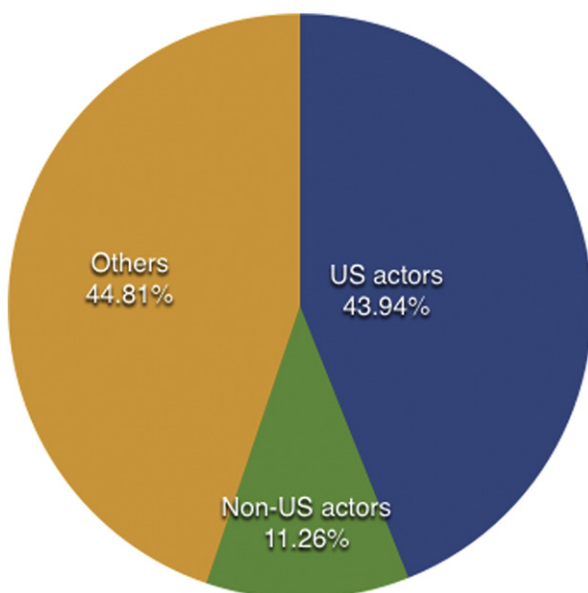


Fig. 6. The geographic distribution of YouTube actors.

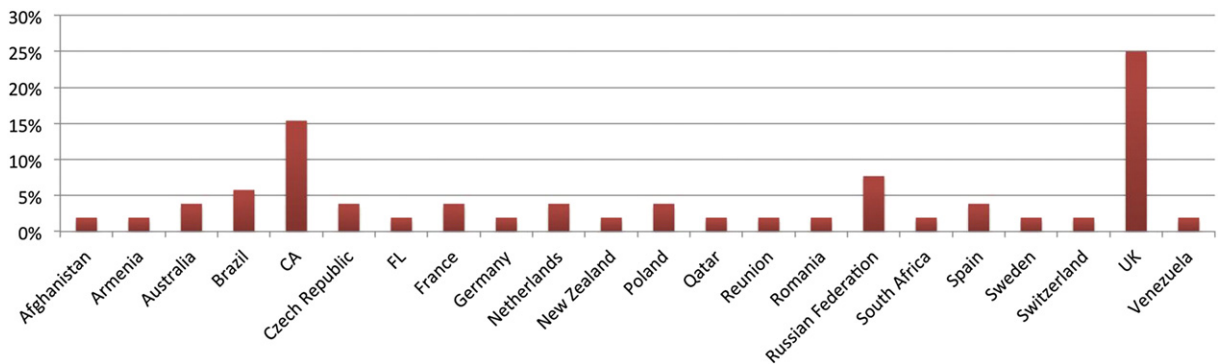


Fig. 8. The geographic distribution of non-U.S. YouTube actors.

The results not only demonstrate useful analytical techniques for data mining and analyzing Twitter and YouTube but also have theoretical implications for understanding the web ecology by identifying the distinctive network structure and interaction pattern of users on two relevant social media platforms of Twitter and YouTube (Nam et al., 2013). In this way, the study contributes to the literature on online information diffusion and the role of social media in mobilizing social movements. However, this study has several limitations.

First, many users did not disclose their geographic information, and therefore the results may not fully identify their geographic distribution. For example, it is unclear whether anonymous users were from the U.S. or other countries. Second, data limitations make it difficult to generalize the results for the web ecology. In addition, the API-based software package captured only the latest interactions between actors and content, including the term “OccupyWallst.” Therefore, it could not draw all meaningful patterns of connections between actors. An inherent limitation of the social network analysis method is that the package provides only a snapshot of the population, not a general picture. In this regard, future research should provide an in-depth analysis of content formed through networks and extend the range of data to other social movements for a better understanding of information diffusion through social media.

References

- Barnett, G.A., Chung, C., Park, H.W., 2011. Uncovering transnational hyperlink patterns and web-mediated contents: a new approach through cracking.com domain. *Soc. Sci. Comput. Rev.* 29, 369–384.
- Benkler, Y., 2006. *The Wealth of Networks: How Social Production Transforms Markets and Freedom*. Yale University Press, New Haven, CT.
- Bennett, L., 2003. New media power: the internet and global activism. In: Couldry, N., Curran, J. (Eds.), *Contesting Media Power*. Rowman & Littlefield, Lanham, MD, pp. 17–37.
- Best, S., Kellner, D., 2001. *The Postmodern Adventure*. Guilford Press and Routledge, New York and London.
- Biddix, J.P., Park, H.W., 2008. Online networks of student protest: the case of the living wage campaign. *New Media & Society* 10 (6), 871–891.
- Burgess, J., Green, J., 2009. *YouTube: Digital Media and Society Series*. Polity Press, UK.
- Burgess, J., Foth, M., Klaebe, H., 2006, September. *Everyday creativity as civic engagement: a cultural citizenship view of new media*. Paper Presented at the Communications Policy & Research Forum (Sydney).
- Caren, N., Gaby, S., 2011, October. Occupy online: Facebook and the spread of Occupy Wall Street. Paper Presented at the Social Science Research Network <http://dx.doi.org/10.2139/ssrn.1943168> (Retrieved from).
- Castells, M., 2009. *Communication Power*. Oxford University Press, New York, NY.
- Chang, R., Pimentel, S., Svistunov, A., 2011. Sentiment analysis of Occupy Wall Street tweets. CS 229 Machine Learning Final Projects (Autumn).
- Choi, S., Park, H.W., 2014. An exploratory approach to a Twitter-based community centered on a political goal in South Korea: who organized it, what they shared, and how they acted. *New Media & Society* 16 (1), 129–148.
- Cottle, S., 2007. *Mediatized Conflict: Developments in Media and Conflict Studies*. Open University Press, Maidenhead, England.
- Couldry, N., Curran, J., 2003. *Contesting Media Power: Alternative Media in a Networked World*. Rowman & Littlefield, Boulder Lanham, MD.
- Danowski, J.A., Park, H.W., 2014. Arab spring effects on meanings for Islamist web terms and on web hyperlink networks among Muslim-majority nations: a naturalistic field experiment. *J. Contemp. Eastern Asia* 14 (2) (September/October, Pages are not yet specified).
- Danowski, J.A., Gluesing, J., Riopelle, K., 2011. The revolution in diffusion theory caused by new media. In: Vishwanath, A., Barnett, G.A. (Eds.), *The Diffusion of Innovations: A Communication Science Perspective*. Peter Lang, New York, NY, pp. 123–144.
- Doctorow, C., 2012, March 1. The internet is the best place for dissent to start. *The Guardian*. (Retrieved from:). <http://www.guardian.co.uk/technology/blog/2012/jan/03/the-internet-best-dissent-start>.
- González-Bailón, S., Borge-Holthoefer, J., Rivero, A., Moreno, Y., 2011. The dynamics of protest recruitment through an online network. *Scientific reports* 1.
- Granovetter, M.S., 1973. The strength of weak ties. *Am. J. Sociol.* 78 (6), 1360–1380.
- Halpern, D., Gibbs, J., 2013. Social media as a catalyst for online deliberation? Exploring the affordances of Facebook and YouTube for political expression. *Comput. Hum. Behav.* 29 (3), 1159–1168.
- Hansen, D., Shneiderman, B., Smith, M.A., 2010. *Analyzing Social Media Networks with NodeXL: Insights From a Connected World*. Morgan Kaufmann.
- Hermes, J., 2005. *Re-reading Popular Culture*. Blackwell, Malden.
- Hof, K., 2006. Something you can actually pick up: scrapbooking as a form and forum of cultural citizenship. *Eur. J. Cult. Stud.* 3 (9), 363–384.
- Hsu, C.L., Park, S.J., Park, H.W., 2013. Political discourse among key Twitter users: the case of Sejong city in South Korea. *Journal of Contemporary Eastern Asia* 12 (1), 65–79.
- Jun, S.P., Yeom, J., Son, J.K., 2014. A study of the method using search traffic to analyze new technology adoption. *Technol. Forecast. Soc. Chang.* 81, 82–95.
- Kendzior, S., 2012 January 8. Central asia: an exception to the “Cute Cats” Theory of internet revolution. (Registan. Retrieved from). <http://registan.net/index.php/2012/01/08/central-asia-an-exception-to-the-cute-cats-theory-of-internet-revolution>.
- Khondker, H.H., 2011. Role of the new media in the Arab Spring. *Globalizations* 8 (5), 675–679.
- Kluver, R., 2004. Globalization, informatization, and intercultural communication. In: Jandt, F.E. (Ed.), *Intercultural Communication: A Global Reader*. Sage, Beverly Hills, pp. 425–437.
- Latour, B., 1987. *Power, action, and belief: A new sociology of knowledge?* Routledge & Kegan Paul, London, UK.
- Lee, Y.G., 2013. Multidisciplinary team research as an innovation engine in knowledge-based transition economies and implication for Asian countries. *Journal of Contemporary Eastern Asia* 12 (1), 49–63.
- Leydesdorff, L., Dolfma, W., Van der Panne, G., 2006. Measuring the knowledge base of an economy in terms of triple-helix relations among ‘technology, organization, and territory’. *Res. Policy* 35 (2), 181–199.

- Lysenko, V.V., Desouza, K.C., 2012. Moldova's internet revolution: analyzing the role of technologies in various phases of the confrontation. *Technol. Forecast. Soc. Chang.* 79 (2), 341–361.
- Monge, P.R., Contractor, N.S., 2003. *Theories of communication networks*. Oxford University Press, New York.
- Morozov, E., 2009, November 18. How dictators watch us on the web. *Prospect Magazine*. (Retrieved from). <http://www.prospectmagazine.co.uk/2009/11/how-dictators-watch-us-on-the-web>.
- Nam, Y., Lee, Y.-O., Park, H.W., 2013. Can web ecology provide a clearer understanding of people's information behavior during election campaigns? *Soc. Sci. Inf.* 52 (1), 91–109.
- Nam, Y., Lee, Y.O., Park, H.W., 2014. Measuring web ecology by Facebook, Twitter, blogs and online news: 2012 general election in South Korea. *Qual. Quant.* 1–15.
- Newman, M.E.J., 2006. Modularity and community structure in networks. *Proc. Natl. Acad. Sci. U. S. A.* 103 (23), 8577–8696.
- Noonan, 2011, February 3. Social media as a tool for protest. <http://www.stratfor.com/weekly/20110202-social-media-tool-protest> (STRATFOR. Retrieved from).
- Park, H.W., Kluver, R., 2009. Trends in online networking among South Korean politicians—a mixed-method approach. *Gov. Inf. Q.* 26 (3), 505–515.
- Porta, D., Mosca, L., 2005. Global-net for global movements? A network of networks for a movement of movements. *Journal of public policy* 25, 165–190. <http://dx.doi.org/10.1017/S0143814X05000255>.
- Redden, G., 2001. Networking dissent: the internet and the anti-globalization movement. <http://motspluriels.arts.uwa.edu.au/MP1801gr.html> (MotsPluriels, 18. Retrieved from).
- Rogers, E.M., 2000. Reflections on news event diffusion research. *J. Mass Commun. Q.* 77, 561–576.
- Rogers, E.M., 2003. *Diffusion of Innovations*. Free Press, New York.
- Strand, Ø., Leydesdorff, L., 2013. Where is synergy indicated in the Norwegian innovation system? Triple-helix relations among technology, organization, and geography. *Technol. Forecast. Soc. Chang.* 471–484.
- Thelwall, M., 2012. Introduction to Webometric Analyst 2.0: A Research Tool for Social Scientists. <http://lexiurl.wlv.ac.uk/searcher/IntroductionToWebometricAnalyst2.doc> Accessed 12 August 2012.
- Wasserman, S., 2011. Mr. Holland's networks: a brief review of the importance of statistical studies of local subgraphs or one small tune in a large opus. In: Dorans, N.J., Sinharay, S. (Eds.), *Looking Back: Proceedings of a Conference in Honor of Paul W. Holland*. Springer, New York, NY, pp. 39–50.
- Wasserman, S., Faust, K., 1994. *Social Network Analysis*. In: Granovetter, M. (Ed.), University of Cambridge, New York, NY, USA.
- Xie, L., Natsev, A., Kender, J., Hill, M., Smith, J., 2011. Visual Memes in Social Media: Tracking Real-world News in YouTube Videos. *ACM Multimedia*.

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