



The network effect on information dissemination on social network sites



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ABSTRACT

Interconnections between people on social network sites enhance the process of information dissemination and amplify the influence of that information. This study designed a Facebook application to examine the influence of peoples' network on information dissemination. The results showed that both network degree and network cluster significantly affected information dissemination frequency. In other words, people with more connections and with high clustered connections might exert a greater influence on their information dissemination process. The findings of this study have useful implications for the theory of network effect, as well as useful references and suggestions for marketers.

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1. Introduction

The proliferation of social network sites (SNSs) has promoted new forms of social interaction and collaboration (Bakshy, Hofman, Mason, & Watts, 2011), allowing hundreds of millions of people to provide information and demonstrate preferences, and connect and interact with others (Hofer & Aubert, 2013; Katona, Zubcsek, & Sarvary, 2011). Members of SNSs are connected by mutual interests or friendships in the real world, and use SNSs to meet new friends, maintain existing relationships, and further build their personal social networks (Boyd & Ellison, 2007; Ellison, Steinfield, & Lampe, 2007; Nosko, Wood, & Molema, 2010; Ross et al., 2009). In addition to offering communication and interaction to users, personal networks on SNSs are efficient at disseminating information and recommendations (Bakshy et al., 2011; Zhao, Grasmuck, & Martin, 2008). Partially replacing the function of a search engine, SNSs allow people to search, share, and receive information using their personal networks (Lerman & Ghosh, 2010; Lipsman, Mudd, Rich, & Bruich, 2012). People influence information dissemination differently on SNSs. Information shared by certain people can be seen by thousands, whereas other people have more limited audiences. Such phenomenon is worth to be examined and is the motivation of this research.

Past studies have investigated the selection of initial targets or seeding points to promote marketing campaigns, to assist marketers in budget allocation. Certain people are well-connected, and can more easily influence others to adopt new products or information (Iyengar, Van den Bulte, & Valente, 2011). Therefore, many studies have investigated key people on SNSs. For example, Gode and Mayzlin (2009) indicated that heavy users are influential; such users are typically early adopters, and tend to connect people in a network. Through heavy users, information can be efficiently disseminated. Harrigan, Achananuparp, and Lim (2012) indicated that on Twitter, people with a large number of followers have a greater influence on information dissemination. These studies investigated specific users, and not only assumed that communication and interaction between two people was independent, but that networks were fixed (Carpenter, Esterling, & Lazer, 2004).

The development of technology has enabled the analysis of information dissemination from the perspective of the network structure (Lerman & Ghosh, 2010). The largest SNSs, Facebook, connects hundreds of thousands of users, and reflects information regarding users' activities and social networks, such as friends (friend list), tie-strength (comments and likes), and information dissemination (shares and messages). Interactions, such as liking, sharing, and commenting, are published on peoples' friends' walls, enabling them to directly or indirectly influence other people in their networks, who might further share that information (Wilson, Fornasier, & White, 2010). Thus, information can be disseminated to many users. For example, when a person shares a diet program on Facebook, that information is shown on other users' walls. If other people are interested in this information and share

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it, other friends will see this information; the information then begins to spread virally. Viral information dissemination is conducted through peoples' networks (Balthrop, Forrest, Newman, & Williamson, 2004; Eubank et al., 2004). The power, information dissemination, and innovation of social networks depend on individual characteristics and specific network structures (Van den Bulte & Wuyts, 2007).

The network effect is the influence of a network structure on user behavior by two factors: network degree and network cluster (Katona et al., 2011). The network degree is the numbers of friends (nodes) people have in their networks, and represents network size. More connections of a node in a network imply this node can affect more adjacent nodes (Dover, Goldenberg, & Shapira, 2012). SNSs enable easier maintenance of existing relationships, and lower the barrier to forging new relationships; thus, the use of SNSs increases the degree of peoples' networks (Donath & Boyd, 2004). Moreover, the use of SNSs prevents the further weakening of weak ties; weak connections can be maintained on SNSs, or developed whether the relationship become intimate attachments (Kim & Lee, 2011). Network cluster is the connection density of neighboring nodes in a network; denser network implies high levels of intimacy and familiarity (Katona et al., 2011). Previous studies have shown that information disseminated by familiar people is considered more credible (Burt, 2005). In fact, SNSs allow people to view friends in common with new connections, increasing the familiarity of those new connections. Therefore, exploring whether dense network facilitates stronger information dissemination on SNSs was warranted.

SNSs facilitate information availability of network structure and path of information dissemination (Sun, Rosenn, Marlow, & Lento, 2009). This study developed an application to collect interaction records and personal information to understand how users spread information on Facebook and determine the influence of network degree and network cluster. This study examined Facebook from the perspective of network effect, to address the insufficiency of previous studies, which have examined SNSs from the perspective of individual people.

This study is organized as follows. Section 2 provides a synopsis of the extant literature on SNS, information dissemination process, and network effect. We then make inferences based on previous research to determine the network degree and network cluster of an individual is positively related to the frequency of information dissemination. Section 3 presents the method of development tool and data acquisition for examining the influence of network effect. Section 4 discusses the results of the follow-up study testing the hypotheses. Finally, Section 5 concludes, offers directions for future research, and provides a theoretical discussion and managerial implications.

2. Theoretical background

2.1. Social network sites

Social network sites (SNSs) provide hundreds of thousands of users with a platform to interact, cooperate, create, and share information (Boyd & Ellison, 2007; Zhao et al., 2008). On Facebook, users can acquire information about others by viewing their "About," "Status," and "Photo" entries, enabling them to develop friendships. SNSs connection can be divided into two-way connections (friends) and one-way connections (fans and followers). These connections can be tight, loose, dependent, or independent and further enable users to build their personal networks on SNSs (Katona et al., 2011).

Friend and follower lists enable the visualization of network connections. Unlike traditional, anonymous sites, SNSs offer their users publicity, visibility, and accessibility to others, and have par-

tially replaced actual social connections (Benevenuto, Rodrigues, Cha, & Almeida, 2009). SNSs have influenced the way people socialize and disseminate information, and have transformed interactions between consumers and companies (Haythornthwaite, 2002; Lewis, Kaufman, Gonzalez, Wimmer, & Christakis, 2008; Zhao et al., 2008). SNSs connect hundreds of thousands of people, who interact through comments, private messaging, sharing photos and videos, blogging, and instant messaging. These interactions can be fully recorded and analyzed. Unlike SNSs studies conducted from the perspective of individual people, this study examined the influence of network structures on information dissemination, and determined how network degree and network cluster affected the frequency of information dissemination. Based on the available data, the goal of this study is to clarify the influence of the network effect on information dissemination on SNSs.

2.2. The process of information dissemination on social network sites

Following Watts & Dodds' (2007) study, this study assumed that an individual i in a population of size N influenced n_i others, where n_i was drawn from an influence distribution $p(n)$. A single node ($i = 1$) was selected as the initial transmitter at time $t = 0$. Accordingly, this node transmitted a piece of information to all n_i Facebook friends. Each of the n_i friends independently decided to view information with a probability $q = P(\text{view}|\text{exposure})$. Each of the n_i friends that viewed the information decided whether to retransmit the information to friends. Thus, n_i represents the portion of a population of size N influenced by particular information.

Information dissemination proceeded from an initial state in which all N individuals were inactive (state 0). An initial i was activated (exogenously) to transmit a piece of information on their wall. This study expected this information to spread among i 's friends (state 1), and then continue spreading among i 's friends of friends in a chain reaction, generating a sequence of activations (state 2), which we have termed a cascade (Watts, 2002). For example, if John is the initial transmitter who disseminate the information on his newsfeed, all of his friends has the opportunity to see this information. It may become the cascade when John's friend (Bob and Claire) saw this information and retransmit to their newsfeed. The size of a cascade is simply the cumulative number of activations. This study observed people who viewed, then shared information on Facebook; these people were "retransmitters" (state 2). The program built in this study recorded retransmitters' personal information and the timing of their dissemination, enabling the visualization of information spread, and observation of the quantity and the level of dissemination by each individual retransmitter. Information dissemination paths ended when receivers of information had no desire to retransmit the information.

2.3. The influence of network effect on information dissemination

The network effect is defined as the influence of network structure on user behavior (Katona et al., 2011). As suggested by Granovetter (1973), connection patterns in network structures influence the speed of information dissemination. Information dissemination is broader in long ties network compared with clustered networks; however, information dissemination in clustered networks is faster than loose networks (Centola & Macy, 2007). An empirical method was used to examine the effect of network structure from two angles, network degree and network cluster. Thus, this study used these two variables to explore the influence on frequency of information dissemination.

2.3.1. Network degree

Network degree (also called degree centrality or network connectivity) was measured according to the number of connections

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