

# A New Perspective on Twitter Hashtag Use: Diffusion of Innovation Theory

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## ABSTRACT

Twitter is a fast growing real-time social media tool. As Twitter evolves, more and more people are partaking in sharing what is happening around the world through various Twitter applications. Hashtag use has become a unique tagging convention to help associate Twitter messages with certain events or contexts. Prefixed by a # symbol with a keyword, a Twitter hashtag serves as a bottom-up user-proposed tagging convention. It also embodies user participation in the process of hashtag innovation, especially as it pertains to information organization tasks. Diffusion of innovation (DoI) is a theory that helps to explain the adoption process of an innovation by modeling its entire life cycle according to the aspects of communications and human information interactions. Hence, diffusion theory offers valuable insights into interface design that supports Twitter hashtag use and access. It also assists in evaluating hashtag life cycles and thus offering information required for decision-making, in regard to hashtag management.

## Keywords

Diffusion of innovation, Twitter hashtags, collaborative tagging, social media.

## INTRODUCTION

Metadata management has become an essential issue for knowledge organizations because of the recent proliferation of user-generated content in the Web 2.0 environment. A Twitter hashtag is a new tagging format which associates a user created tag with an event or a context using a prefix symbol, #. With shared hashtags, it is possible to sort and bring together Internet resources across websites. Several hashtag directory portals collect existing hashtags, but organize them in different ways. In addition, the

development of Twitter archiving tools reflects the user needs to preserve specific parts of Twitter messages. One concern raised, centers on whether current web archiving practices could shed light on Twitter archiving. This paper begins with explaining why DoI theory is suitable to examine the trend of hashtag adoption. It is followed by a brief introduction to DoI and recent Twitter studies organized by the DoI theoretical framework. Finally, it suggests applying DoI theory to study hashtag adoption versus non-adoption behavior and explore user interactions with hashtags. As the Library of Congress (2010) announced the decision on archiving all public Twitter messages on April, 2010, it is evident that DoI research on Twitter hashtag-use could improve design considerations of hashtag management.

## STANDARDIZATION VERSUS INNOVATION

When it comes to information management, the choice is always based on choosing standardization or innovation. While the Common Tag project of implementing a semantic web approach appears to be promising, the Twitter hashtag innovation, suggested by the early user community, remains more widely adopted. Even so, in terms of information life cycle, it is difficult to predict whether the common tag standard will alternate in the future with the Twitter hashtag of community consensus. As shown in the Figure 1, Twitter aggregated and announced top trending topics across several categories at the end of 2009. Taking News Events as an example, two topics surfaced repeatedly among the top ten trending topics: “Iran” vs. “#iranelection” and “Swine Flu” vs. “#swineflu”.

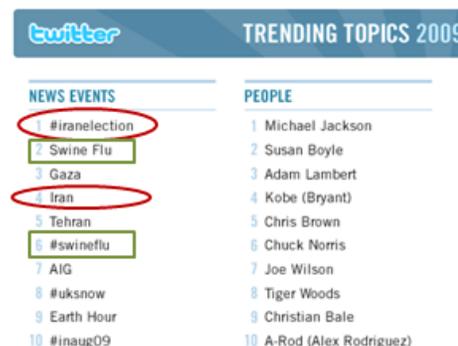


Figure 1. Snapshot of the Twitter Trending Topics 2009.  
Source: Chowdhury, A. (2009)

Interestingly, the same keyword and hashtag topics are competing despite their representations. In addition, it is noteworthy that if hashtag use is voluntary on Twitter, determining how and why people adopt and share the same hashtags instead of creating new ones, is one of the most engaging topics. In attempting to understand whether the diffusion of certain hashtags has been successful, it is reasonable to claim that Twitter trending topics indicate signs of adoption. Twitter current/daily/weekly trending topics data are available through Twitter application programming interface (API).

### DIFFUSION THEORY AND TWITTER ADOPTION

Studying diffusion theory in the context of innovation is important because an innovative product or idea affects different levels of stakeholders: individuals, communities, organizations, and countries, regardless of the form of innovation. Since the DoI theory has been applied to various disciplines, including: marketing, economics, sociology, and technology management, the notion of innovation has been related to new products, ideas, services, methods, and inventions. Therefore, diffusion theory appears to be germane in explaining the spread of new tagging conventions on Twitter, i.e., hashtag usage and the adoption of a new hashtag within a social system. Despite the fact that Twitter has become a prevailing social media, there is currently a lack of diffusion research on microblogging or Twitter applications. The closest one is the study by Günther et al. (2009), in which they applied the Unified Theory of Acceptance and Use of Technology (UTAUT), an extension of technology acceptance model (TAM), to model microblogging adoption within an enterprise.

A description regarding the rationale of DoI theory and major components that can be measured during the diffusion process will be presented in the next section.

### Diffusion of Innovation Theory: Two Research Streams

Rogers (1962), who developed the first model of diffusion, defined diffusion of innovation as, “the process by which an innovation is communicated through certain channels over time among the members of a social system”. For its adopter, an innovation could be any “idea, practice, or object that is perceived as new by an individual or other unit of adoption” (Rogers, 2003). The diffusion process consists of four key elements: innovation, the social system which the innovation affects, the communication channels of that social system, and time (Rogers, 2003). As one of the most influential theories of communication in marketing, the focus of diffusion theory is on the means by which information about an innovation is disseminated. Although Rogers’ model is classic and widely established, it has several limitations regarding its predictive power related to the dissemination of an innovation (Bass, 1969). Bass, therefore, proposed the Bass model to explain his discovery that the number of adopters during a time period is almost identical to the number of sales throughout most of the diffusion process. This suggests that the number of

adoptions in a time period serves as a good proxy for sales. Thus, the Bass model has been revised and implemented in forecasting innovation diffusion in multiple fields (Mahajan, Muller, & Bass, 1990). While the Bass model has potential to predict the distribution of the adoption curve, Rogers’ model serves as a comprehensive framework for understanding diffusion process of an innovation and its underlying factors driving the diffusion.

### The Diffusion of Twitter Hashtags

Twitter self-defined its service as “a real-time information network powered by people all around the world, that lets you share and discover what’s happening now” (Twitter.com). In between blogging and instant messaging, Twitter, which essentially is a microblogging system, has become a popular social media tool to facilitate communication for interpersonal or professional usage (Java et al., 2007; Thomas, 2010). Twitter’s popularity can be attributed to its ease of use and concise content requirements (message must be composed within 140 characters including space and links) (Thomas, 2010). One can send and read the Twitter messages (tweets) through any compatible interface, such as: Internet, mobile phone, and short message service. As presented in the Figure 2 (Chen, Kirkley, & Raible, 2008), the following section deploys the four main elements, including: characteristics of innovation itself, communication channels, time, and social system, to discuss the diffusion of Twitter and hashtag use.

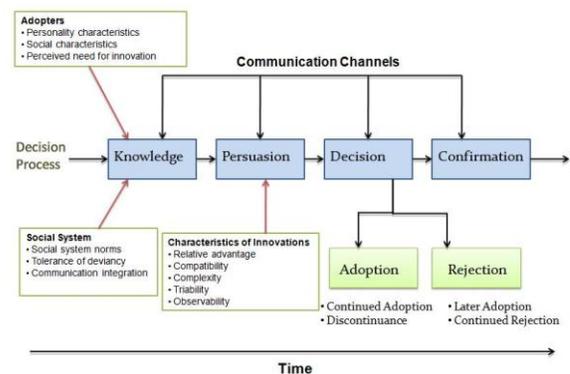


Figure 2. The four components in the diffusion of innovation adoption (Chen, Kirkley, and Raible, 2008).

### Characteristics of Twitter hashtags

When launched in March 2006, Twitter did not have a hashtag feature. The user could only share messages with a specific person by pre-cursing a name or Twitter ID with the symbol (@); as a result, some users thought that Twitter needed to support a tagging function. An early Twitter user, Mr. Chris Messina, suggested hashtag use by adopting the Internet Relay Chat (IRC) convention in 2007, which became accepted as the Twitter tagging feature. Hashtags, words or phrases prefixed with a pound sign (#), are the primary way in which Twitter users organize the information they tweet. The hashtags that are currently most widely used appear in the Twitter sidebar as *trending*

*topics*. This enables tweets on a specific subject to be found more easily by searching for their common hashtag than by searching for the full text of specific tweets. Hashtags are quite useful in the context of conferences or events, provided that the hashtags have been announced or promoted; thereby, all event-related information can be tagged in the same way and shared by the participants. A Twitter hashtag archive is the result of a collective effort because the posts can be aggregated into a single stream with the common #hashtag. Nevertheless, the Twitter hashtags still suffer from their fragmentary and redundant nature, as do other collaborative tagging applications. Even so, Twitter hashtags and tags created by other tagging applications differ in the way in which they are created and shared, but probably not in kind.

#### *Communication channels*

According to Rogers (2003), communication is “a process in which participants create and share information with one another in order to reach a mutual understanding” and mass media and interpersonal communications are two communication channels in the dissemination process. As shown in the Figure 2, there are five stages of innovation adoption: obtaining knowledge, persuasion, decision making, implementation, and confirmation. In the innovation-adoption decision process, mass media channels are more significant at the knowledge stage, while interpersonal channels are more important at the persuasion stage (Rogers, 2003).

Twitter has become a relatively new method of mass communication, arguably, because it operates in real-time and was designed for mobility (Zhao & Rosson, 2009). The most closely followed Twitter user accounts are primarily celebrities and mass media organizations (Kwak et al. 2010). In addition, people use Twitter at work to simultaneously communicate with other team members and to stay informed on current trends relevant to their practices (Zhao & Rosson, 2009); professionals also use Twitter to acquire conference updates (Reinhardt et al., 2009). Therefore, social networking is not Twitter’s sole utility; rather, it is employed for real-time content sharing.

As for information organization other than hashtags, Twitter offers a *list* function to help users categorize friends into groups, e.g., colleges and family, because users may have content targeted at various audiences. In general, hashtag and list use are voluntary rather than mandated adoptions. However, all of the studies reviewed so far do not examine how and when hashtags or lists can be used for supporting communications and for finding useful information through mass or interpersonal channels.

#### *Time*

The time dimension in the diffusion of innovation is often ignored in most behavioral research (Rogers, 2003). However, the time aspect is essential for studying the innovation-diffusion process, the impact of innovators on adaptors, and the growth rates of adoptions.

#### *Social system*

Rogers (2003) defined a social system as “a set of interrelated units engaged in joint problem solving to accomplish a common goal”. It refers to diffusion among members of a social system. Rogers further denoted the characteristics of social systems as: social norms, opinion leaders, change agents, and types of innovation decisions, which can promote or hinder the diffusion of innovations. To enhance one’s credible image or status, Twitter offers *verified accounts* badges (currently in the testing phase) for government agencies, businesses or website owners. Although such a mechanism is under beta-testing, it could be a good indicator to verify the reliability of an information source. A study on social interactions within Twitter showed that the linked structures of social networks do not reveal actual interactions among users (Huberman, Romero, & Wu, 2009). Twitter has a relatively sparse social network because relationships between followers and those being followed do not rest on friendship (Huberman, Romero, & Wu, 2009) but rather on information exchange.

### **APPLYING THE TWO DIFFUSION MODELS TO TWITTER HASHTAG ADOPTION**

From the diffusion of innovation and user interface perspectives, the question of hashtag adoption or non-adoption could depend on whether the user has been exposed to hashtag information. After all, sharing tweets on Twitter is not limited to one interface; users can do so directly from the Twitter website, or indirectly through any of desktop or smart phone applications. Twitter users have over 100,000 third-party applications as choices to tweet; 60 percent of all tweets are related to these third-party applications (Watters, 2010). Therefore, due to different interface designs of various devices, the focus of interface design should be on human information interaction (HII) rather than human computer interaction (HCI). The user may make different decisions about what, and how, hashtags are to be adopted.

There are at least two major research streams regarding the application of DoI theory.

#### **Rogers’ Diffusion of Innovation Theory**

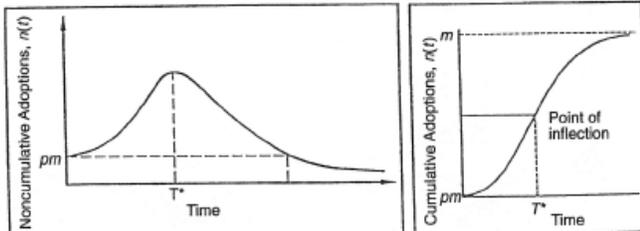
Rogers’ theory (1962, 2003) serves as a comprehensive framework for understanding the spread of an innovation and its driving factors accelerating the rate of adoption. It basically addresses user motivations and adoption behavior. After several years of studying collaborative tagging applications, we still have a lot to learn about folksonomy and the diffusion of user-generated tags in the Web 2.0 environment. Twitter hashtag adoption is a unique form of folksonomy since the initiating adaptors of the hashtag can be viewed as innovators and they attract or influence another group of users, namely imitators, to conform the same hashtag.

#### **The Bass Forecasting Model**

An extension of Rogers’ theory, the bass diffusion model (1969) was developed by Frank Bass; it describes the

process of how new products get adopted as an interaction between early adopters and potential adopters. It has been perceived as one of the most influential empirical generalizations in marketing and has been implemented and refined in different fields (Mahajan, Muller, & Bass, 1990). The Bass model has the potential to model the entire life cycle of the adoption process. Hence, it is feasible to be used in forecasting the patterns of hashtag growth.

Analytical structure of the Bass model



**Figure 3. The analytical structure of the Bass model**  
**Source: Mahajan & Muller & Bass (1990).**

According to Twitter's recent usage statistics (Watters, 2010), Twitter has 105,779,710 registered users and about 300,000 new users sign up per day; approximately, 60% of these are from outside the United States. In this sense, the Bass model can help in examining whether the hashtag-use activities vary as they are disseminated across the six countries (U.S., U.K., Canada, Ireland, Brazil, and Mexico) as well as worldwide. It is feasible to extend the Bass model from single-market scope to international diffusion (Sarvary, Parker, & Dekimpe, 2000).

## CONCLUSION

In general, DoI theory facilitates the investigation of the competing dynamics between Twitter trending topics with and without hashtags during certain time periods. It is thought-provoking why some users adopt the same hashtags but others do not while sharing relevant tweets. The future research directions of applying DoI theory are twofold: First, integrating marketing related variables to examine the pattern of hashtag adoption behavior based on the impact of marketing variables (i.e. advertising strategy, word of mouth, and providing hashtag definitions). Second, a hashtag growth model drawn from the Bass model can assist in evaluating the hashtag life cycle and analyzing the diffusion process of how new hashtags get adopted and disseminated as an interaction between early users and potential users.

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