Increasing the Reach of Government Social Media: A Case Study in Modeling Government–Citizen Interaction on Facebook

Jorge Goncalves, Yong Liu, Bin Xiao, Saad Chaudhry, Simo Hosio, and Vassilis Kostakos

Facebook posts compete for human attention in a zero-sum game; this makes it a challenge for government organizations to engage with their citizens through this medium. In a large-scale longitudinal study we investigate what makes Facebook posts popular (seen by many) and effective (commented, liked, or shared by many) in a nonprofit context: the official Facebook page of a mid-sized city (Oulu, Finland). We model the competition dynamics that shape the fate of Facebook posts using Structural Equation Modeling. Our analysis reveals that audience demographics, the timing of posts, and the media type of post are significant factors in post reach and effectiveness, and argue that our method can be applied to other contexts to determine which factors can lead to improved government–citizen communication and engagement. Finally, we argue for more actionable research to be conducted on the use of social media by government.

KEY WORDS: e-Government, social media, Facebook, communication, public engagement

Introduction

There is substantial evidence to suggest a gradual rise in the prevalence of social media among citizens of all walks of life (cf. Chui, Manyika, Bughin, & Dobbs, 2012). Today, one in five hours spent online is on social networks (Chui et al., 2012), and Facebook, with over one billion monthly active members (The Wall Street Journal, 2012), is currently the second most visited website on the Internet, besides Google (Alexa, 2013). The use of social media has become such a landmark cultural, social, and economic phenomenon (Chui et al., 2012) that various commercial and noncommercial organizations have invested considerable resources in the use of social media for a diversity of purposes, including marketing, loyalty enhancement, and customer feedback.

Albeit with a certain delay, government organizations are now increasingly experimenting with social technology to communicate with their constituents. Social technologies have been seen as a powerful set of tools to reinvent government–citizen relationships (Picazo-Vela, Gutiérrez-Martínez, & Luna-Reyes,

2012). For example, Barack Obama's presidential campaigns made heavy use of social media to increase citizen participation and influence the behavior of social network site users. This entailed reaching an untapped source of constituents and convincing them to register to vote, ultimately leading to most of them appearing in the voting booths (Mergel, 2014). These efforts and others have given rise to great expectations in terms of reaching new audiences, building a relationship with citizens and stakeholders, establishing new patterns of communication, improving openness, transparency and participatory democracy, crowdsourcing solutions and innovations, and lowering government costs (Kavanaugh et al., 2012; Picazo-Vela et al., 2012).

In this article, we seek to provide actionable insights for strategic use of social media in government, something that has been largely overlooked in prior research (Magro, 2012). Here, we model the competition dynamics that make Facebook posts popular (seen by many) and effective (commented, liked, or shared by many) for citizens, rather than customers. We do so by studying in detail all interactions taking place over the period of one year on the official government Facebook page of the city of Oulu in Finland. The city is mid-sized with 190,000 inhabitants, 7,400 of who use the page at the time of this study.

Regarding these competition dynamics, each action performed (comment, share, like, etc.) is termed an "edge." The ranking of these edges by the EdgeRank algorithm constitutes the most crucial Facebook mechanism in terms of which posts are shown to users, determining which posts to display at the top of users' news feed. It's obviously important to consider EdgeRank when drawing conclusions on how to make effective posts; however, it is a moving target that is constantly changing and evolving. Factors that matter now may change in terms of importance or mechanism, while other factors are frequently introduced and removed. Effectively, due to EdgeRank, page administrators are competing with hundreds of other connections for a spot in their followers' news feed. We seek in this article to identify how various characteristics (or traits) of Facebook posts affect their chances of winning a spot in users' feeds.

An inspection of EdgeRank helps us identify which factors have consistently influenced a Facebook page and the popularity or effectiveness of its posts; in other words, it lays out the basic rules that drive competition between posts. However, an empirical analysis is needed to formulate actionable insights on these dynamics and to understand how they actually manifest in terms of competition between posts. For instance, when is the best time to create a post? To what extent does the media type affect the popularity and effectiveness of a post, and how do the demographic features of followers affect its success? Prior research has systematically shown that users exhibit strong patterns when interacting with different types of posts. For instance, photos may bring about more positive feelings in users than plain text (Simon & Peppas, 2004). Furthermore, text posed as a question may raise more responses since users may feel that their opinion is needed and wanted. Overall, text that "calls to action" is more engaging (Bullas, 2013) than just bare information of an ephemeral nature that is pushed to the users (Reynolds, Venkatanathan, Goncalves, & Kostakos, 2011; Venkatanathan, Kostakos, Karapanos, & Goncalves, 2014).

Yet these findings, and much of prior research, focus primarily on how individual users react to individual posts, thus necessitating a consideration of the content and semantics of these posts. Inevitably an important driver of what makes Facebook posts popular and effective relates to their content (not all kitten pictures go viral), but on a macro-level the fate of posts in Facebook is driven by the EdgeRank algorithm, which is blind to the content and semantics of posts. It is this aspect of the competition dynamics in Facebook that we seek to explore and model in our work, particularly in the nonprofit context of engaging citizens. Specifically, we seek to understand how the various Facebook mechanisms as a whole ecosystem, including EdgeRank, drive the popularity and effectiveness of posts independently of the content and semantics of individual posts. Here, we take a step back from considering how a single user interacts with a single post, to consider how a whole community interacts with a community page longitudinally.

Clearly, Facebook is an amalgamation of various types of communities and pages, and therefore abstracting from these nuances may result in decontextualized findings. We, therefore, highlight that the purpose of this study is to demonstrate the validity of our method, which can then be adapted and used by other Facebook page owners.

Related Work

The popularity of social media has motivated researchers to seek strategies for a more successful online campaign. Some approaches consider individual factors *in vacuo*, like post time, media type, content, and title when developing an understanding of what drives post effectiveness (Cvijikj, Spiegler, & Michahelles, 2011; Lakkaraju, McAuley, & Leskovec, 2013). While intuitive, such an approach cannot scale into a framework without considering the interdependencies between various factors. This is important because Facebook posts are not just influenced by their publishers but also by the users or viewers, thus adding complexity to the dynamics that drive the competition between posts. To investigate and begin to articulate these complex dynamics, we developed a model that can offer us a multifactorial perspective. By looking at posts' characteristics beyond their semantics we aim to identify and describe the broader dynamics within which individual posts compete for popularity and effectiveness in the "ecosystem" of the community we studied. Furthermore, by ignoring semantics, our modeling reflects more closely the mechanisms of Facebook, such as the EdgeRank algorithm, which does not take semantics into account.

Social Media in Government

Government agencies are increasingly looking to leverage social media to improve the quality of government services and enable greater citizen engagement, particularly in cities with enhanced information and communications technology infrastructures and high Internet penetration rates (Mainka, Hartmann, Stock, & Peters, 2014). In 2009, the departments in the executive branch of the U.S. federal government were given a mandate to "harness new technologies" with the goal of

becoming more transparent, collaborative, and participatory (Mergel, 2013). These online platforms are now, more than ever, widely available to government employees and citizens, facilitating the connection between them. These connections have the potential to extend government services, solicit new ideas, and improve decision-making and problem solving (Bertot, Jaeger, Munson, & Glaisyer, 2010).

Social media technologies hold great promise in their ability to transform governance by increasing a government's transparency and its interaction with citizens. Government employment of social media offers several key opportunities for the technology (Bertot et al., 2010), such as:

- Democratic participation and engagement, using social media technologies to engage the public in government, fostering participatory dialogue, and providing a voice in discussions of policy development and implementation.

- Co-production, in which governments and the public jointly develop, design, and deliver government services to improve service quality, delivery, and responsiveness.

- Crowdsourcing solutions and innovations, seeking innovation through public knowledge and talent to develop innovative solutions to large-scale societal issues.

As government social media initiatives are launched and evaluated, design lessons can be extracted and shared to achieve these and related goals (e.g., Johnston & Hansen, 2011). Much government activity is now focused on social media, with social media becoming a central component of e-government in a very short period of time (Bertot et al., 2010; Chang & Kannan, 2008). However, members of government are often criticized for their slow adoption of social media and their reluctance to use some of the functionalities (Mergel, 2012). As social media becomes more prevalent, members of the public expect that government services will be available electronically and that government agencies/representatives will be accessible via social media technologies (Jaeger & Bertot, 2010).

Even though agencies are increasing their use of social media technologies as a way to extend government services, further reach individuals, offer government information, and engage members of the public in government efforts, agencies are in large part doing so through an antiquated policy structure that fails to reach a substantial portion of its constituents (Goncalves, Hosio, Liu, & Kostakos, 2014; Hosio, Goncalves, Kostakos, Cheverst, & Rogers, 2013; Hosio, Goncalves, Kostakos, & Riekki, 2014). However, implementing social media in government requires more than simply creating a city Facebook page or a Twitter account with an officer to upload content. Government investment and well-warranted policy may have just a marginal influence on the success of social media use in government. Therefore, considering the gap between knowledge and practice, our study aims to shed some new insights regarding the dialog between these two parties, in particular through the appropriate maintenance of an official Facebook page.

Theoretical Approach

An effective Facebook post is not only determined by successful publishing, but also by user reactions. In social networks, user attention and interest can be highly contagious and subject to influences from social neighbors (Liu, Venkatanathan, Goncalves, Karapanos, & Kostakos, 2014; Venkatanathan, Karapanos, Kostakos, & Goncalves, 2012; Wen & Lin, 2010). Inevitably, when users face a wide range of posts they are likely to sacrifice paying attention to certain posts. In this case, social signals from one's network of friends can be used to prioritize paying attention to certain posts. For instance, people may pay more attention to or respond to a post that was liked by their friends (cf. Salganik, Dodds, & Watts, 2006), therefore making the post spread. As a result, audience size (the average number of friends-of-the-followers of a page) could be one of the potential factors influencing the fate of a post. Furthermore, since gender accounts for differences in user behavior (Lenhart, Purcell, Smith, & Zickuhr 2010), it can be argued that the gender of the audience may influence the fate of posts as well.

Finally, because users of social networks adopt a passive model (Romero & Galuba, 2011), meaning that by default they are not positive in making any contribution to popularize information (i.e., comment, share, create stories, click, like), an effective post must be one that not only gets exposure but also evokes a response. Thus, we make a distinction between the popularity a post ("post reach"), which refers to how many people see a post, and "post effectiveness," which refers to how many people explicitly react to the post through user interface mechanisms such as likes or comments.

Research Framework

Prior studies suggest that the media richness of a website affects users' evaluation and preferences of the website. From the perspective of media richness theory, Simon and Peppas (2010) have classified "rich media sites" as those including text, pictures, sounds, and video clips, while the "lean media sites" contain only text. Their study found that, regardless of the complexity of the product, most users initiated more positive attitudes and higher levels of satisfaction toward websites that provided richer media. Therefore, we assume that media type affects post reach and effectiveness. In this regard, our study adopts an alternative analytic approach. Instead of employing an intuitive mean-comparison method to differentiate the effectiveness of different media types, we adopt a categorical regression approach to quantify the degree to which media type as a single overall factor affects post reach and effectiveness. Thus, we hypothesize:

H1a Media type significantly relates to post reach.

H1b Media type significantly relates to post effectiveness.

Vitrue (Cisler, 2010) conducted a study to identify the days and times when certain brands experience peak activity from their Facebook fans. The results indicated that even if brands tend to create the bulk of their posts toward midday (3:00 pm), morning posts performed best and gained more comments per post. The results imply that the timing of making a post seems to exert a significant influence on the success of the post. In our study, we investigate two features of timing with regard to the time of day (daily wise) and the day of week (weekly wise). We assume that post timing can significantly affect the size of the audience as well as the audience response. Similar to the media type, we formulate the timing of a post as categorical variables. Therefore, we hypothesize:

H2a Daily wise significantly relates to post reach.

H2b Daily wise significantly relates to post effectiveness.

H2c Weekly wise significantly relates to post reach.

H2d Weekly wise significantly relates to post effectiveness.

Intuitively, we assume that a larger audience is more likely to attract more responses, that is, comments and likes, for a post. Therefore, we also hypothesize a positive influence of post reach on post effectiveness and seek to quantify the degree of this influence. Thus, we hypothesize:

H3 Post reach positively relates to post effectiveness.

Gender differences have been reported to induce different ways of using various communication technologies (Yang & Lee, 2010). For instance, Geser (2006) indicated that females see the telephone mainly as a medium for subjective personal communication, while males emphasize instrumental functions (i.e., increasing personal mobility and role coordination). Thelwall (2009) reported women author disproportionately more public comments in MySpace. Thelwall, Wilkinson, and Uppal (2010) found that women are likely to give and receive more positive comments than men.

Thelwall (2009) and Thelwall et al. (2010) argued that women are probably more successful social network users partly because of their greater ability to textually harness positive affect. Therefore, we assume that females are more willing to browse, communicate, and interact with posts, leading to an increase of both post reach and post effectiveness. Accordingly, we hypothesize:

H4a Gender significantly relates to post reach.

H4b Gender significantly relates to post effectiveness.

Finally, audience size reflects the average number of friends-of-followers of the page. It's worth noting that, in Facebook, when a page follower interacts with a post, the follower's own set of friends will also be exposed to the post. Accordingly, as shown in Figure 1, we hypothesize:

H5a Audience size positively relates to post reach.

H5b Audience size positively relates to post effectiveness.

Research Method

We approached a city in Finland to provide us administrative access to its official Facebook page at https://www.facebook.com/Oulu.Finland. At the time of this study, Oulu had around 190,000 citizens, with around 7,400 following its Facebook page. According to www.socialbakers.com/ Finland has a Facebook penetration of around 43 percent, making the total Facebook accounts in the city around 81,700, therefore around nine percent of the city's population could be assumed to be following this Facebook page.

Before analyzing the insights information of the page, we conducted an interview with two city officials that are responsible for social media outreach. During this interview, we asked the officials their opinions on the importance of government social media outreach and what was their currently posting strategy for the page. The city officials suggested that the Facebook page is an important campaign mechanism used by the city to disseminate information about events and news. The posts that are published on this page span entertainment, culture, life, environment, and social events. Most posts are made in Finnish and normally early in the morning. These posts may contain a mixture of text, photos, and links. Only the page administrators can publish posts on this page (on behalf of the city), while "followers" of the page can like, share, comment on, and click on these posts. To see the contents of this page, a user must have a Facebook account.
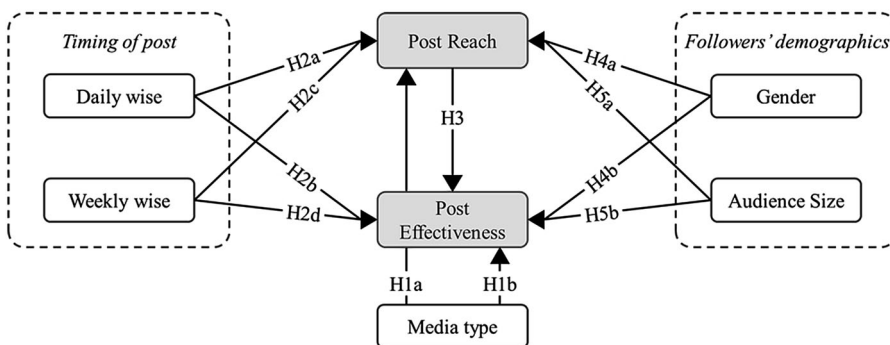

Figure 1. Modeling Framework.

Any Facebook user may choose to follow this page and thus receive its posts directly to their new feed. Facebook users who do not follow the page can see posts published on it by visiting the page directly, if any of their friends interact with one of its posts. These dynamics mean that posts made on the page are immediately visible to the page's followers, but as these followers begin to interact with the posts (like, comment, etc.) then a broader set of people (the page-followers' friends) begins to see these posts.

Data Collection

We exported data relating to posts published on the page over the course of 12 months (January 1, 2012–December 31, 2012) through the administrative interface that Facebook provides for managing pages. Specifically, we collected every post published on the page, along with a number of associated metrics. As we will specify later, some of these metrics are static, but most are calculated a *posteriori*. In the latter case, we captured these metrics at the time of writing, which was five months after the end of the study period.

Static Metrics

- *Post type*: The type of the post, that is, link, photo, video, shared post, status update, or question.

- *Post time*: The time that a post is published at (minute/hour/day/month/year). Note that we use this raw time to infer the hour-of-the-day and day-of-the-week the post was made.

Community Metrics

The following metrics were captured on a daily basis throughout the duration of the study:

- *Direct followers*: Page-level data reflecting the number of Facebook users who are direct followers of the page.

- *Indirect followers*: Page-level data reflecting the unique number of Facebook users who are friends of the direct followers of the page. These "friends-of-followers" can potentially see the posts of the page indirectly through their friends who are direct followers of the page.

- *Audience size*: The average number of Facebook friends each page follower has.

- *Gender*: The gender breakdown of followers of the page (male/female).

Engagement Metrics

The following metrics were captured five months after the end of the study period:

- *Likes*: The number of times users "liked" a post.

- *Comments*: The number of times users "commented" on a post.

- *Stories*: The number of times users generated a story from a post. A story is generated when a fan likes, comments on, shares the post, answers a question, or responds to an event.

- *Shares*: The number of times a post was shared.

- *Clicks*: The number of times a post was clicked on.

Post Reach

Post reach is the number of unique Facebook users who saw a particular post. This was recorded five months after the end of the study period.

Post Entropy

Since we are dealing with multiple latent factors, we need to determine each factor's weight in the model depending on how much information it can provide, or its entropy. The higher the weight the more a factor can "tell us" and vice versa. This weighting method is known as objective evaluation. We use an information theory metric (Tian, Liu, & Jiao, 2008) to quantify the entropy of each post. This metric is calculated using all the above engagement factors, and reflects the extent to which a certain post evokes reactions from Facebook users. Given m posts and our n engagement metrics, we construct a matrix as:

$$A = (a_{ij})_{m \times n}$$

Post entropy is calculated as:

$$PE_i = a_{ij} \times w_j$$

Where w is a weight for each metric:

$$w_j = \frac{v_j}{\sum_{j=1}^{n} v_j}$$

Using:

$$v_j = 1 + \frac{1}{m}\sum_{i=1}^{m} h_{ij}\ln(h_{ij})$$

Where, after column vector normalization, h_{ij} refers to:

$$\frac{a_{ij} - \min_j\{a_{ij}\}}{\max_j\{a_{ij}\} - \min_j\{a_{ij}\}}$$

Post entropy is used to assign values to categorical factors (media type, daily wise, and weekly wise) in our model, as we will specify later in the article.

Results

Posts

During the 12 months of the study period, 211 posts were posted (Figure 2). Of the top-20 liked posts, 12 are links, seven are photographs, and one is a video.

More than 90 percent of the posts were posted during weekdays (Figure 3), roughly 50 percent were posted during morning hours (8 am–12 am), and 20
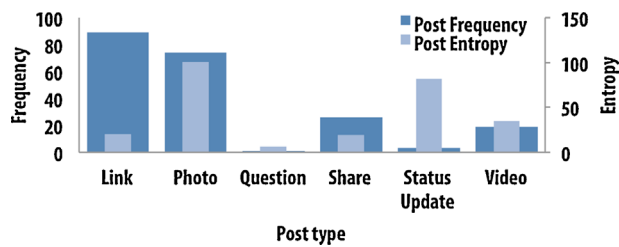

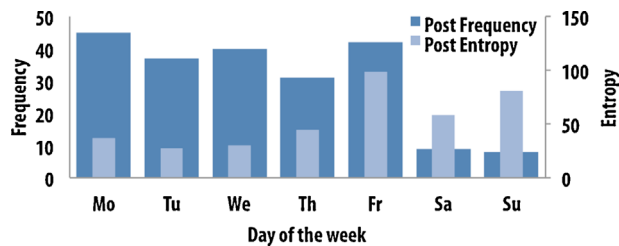**Figure 2.** Post Frequency and Average Post Entropy by Type.

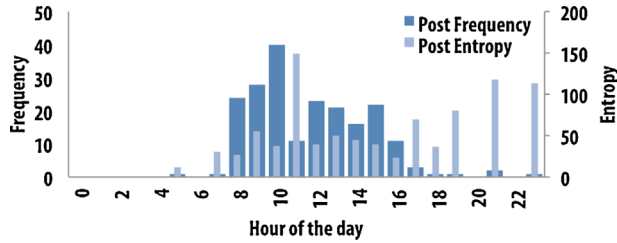**Figure 3.** Frequency of Posting and Average Post Entropy Per Day of the Week Published.

Figure 4. Frequency of Posting and Average Post Entropy Per Hour of the Day Published.

percent outside working hours (4 pm–8 am) (Figure 4). In Figures 3–5 we compare the frequency per category against the average entropy per category. These results contrast what the page administrators focus on (frequency of posts) and what the audience interactions focuses on (entropy), respectively.

Each post was clicked 122 times on average, including opening the full post, going to one's wall to see the post, or clicking on like, comment or hide buttons, giving a total of 25,742 explicit interaction events for all 211 posts.

Each post reached on average 1,740 followers of the page and 2,144 unique Facebook users (Figure 5). In other words, around 404 nonfollowers saw a post via their friends who are followers of the page. Each post had on average 32.8 likes, 11 comments, and was shared 7.3 times. On average, videos were played 29 times and photos were viewed 183 times each.

Furthermore, on average 2.16 users opted to hide the post, while another 1.35 users clicked the "Hide all posts from this source" button after each post was made. During the study there were five instances of a post being reported as spam, each time for a different post.

Community

During the study the number of page followers increased by 12 percent from 6,309 to 7,100. The number of friends-of-followers increased by 21 percent from 777,860 to 944,020 during the study. The gender ratio (male/female) breakdown of the page followers varied throughout the study (Figure 6).
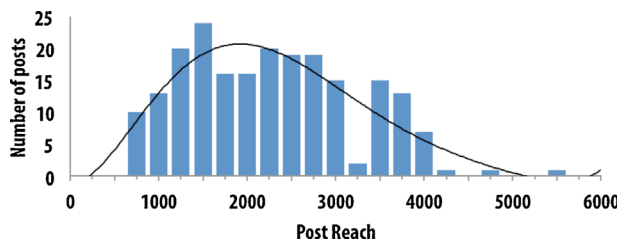

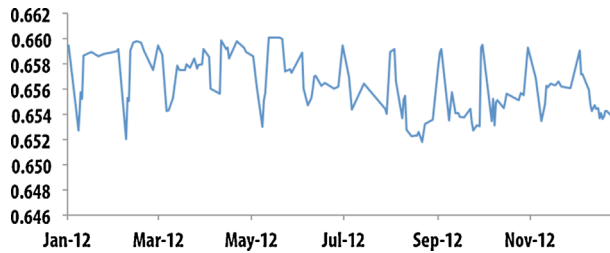**Figure 5.** Histogram of Post Reach.

Figure 6. Number of Male Page Followers Divided by Number of Female Page Followers.

Number of Followers, Post Reach/Effectiveness

We investigated whether the page having more followers resulted in a larger reach for posts, and whether posts with a larger reach were more engaging and effective.

We first investigated the relationship between the number of followers and post reach, which results in an unexpected reverse relationship visualized in Figure 7 ($R^2 = -0.31$). This shows that post reach generally decreases as the number of page followers increases. This weakness of the relationship suggests that other factors are influencing the reach of a post beyond simply how many followers a page has at any given time.

Next we investigate whether a larger reach leads to greater engagement; in other words, to what extent having more users see a post results in more interaction with it. In Figure 8, we show the correlation between post reach and post entropy ($R^2 = 0.14$), which suggests a positive but very weak relation between these two metrics. Note that the x-axis is logarithmic.

This shows that as more people see a post we can expect an overall increase in its entropy; however, entropy varies substantially for any given value of post reach. Once again, the low variance explained suggests that other factors are influencing the entropy of a post beyond simply how many people see it.
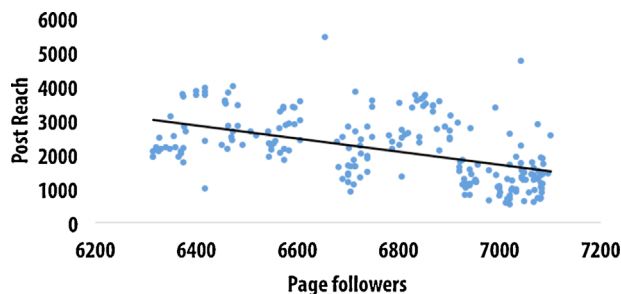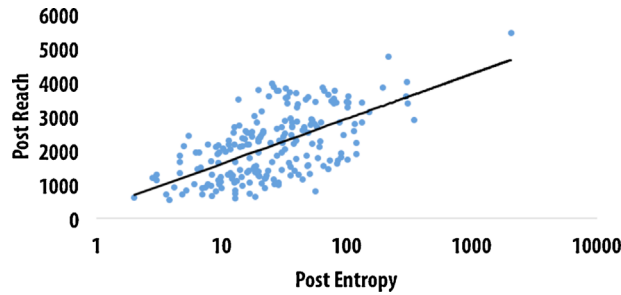

Figure 7. Correlation Between Post Reach and Followers.

Figure 8. Correlation Between Post Reach and Post Entropy (Note, X-Axis Is Logarithmic).

Multifactor Modeling

Using Structural Equation Modeling (SEM) we attempt to model pairwise relationships in our data simultaneously, thus allowing for a multifactorial perspective of the dynamics in our data. The nominal variables in our data set cannot be used directly in SEM (e.g., media type, post time, and gender), we therefore grade each variable category using our entropy measure as shown in Figures 3–5. Specifically, we first calculate the entropy of each post, and then the mean entropy per category of the nominal variable. This mean is used to rank the categories of the nominal variable, and these ranks are then used in subsequent analysis.

The constructs of media type, post time (daily wise and weekly wise), gender, and audience size were measured by one-item indicators as formative variables. Post effectiveness is a reflective variable consisting of all our engagement metrics since they exhibit relatively high correlations with each other, and therefore should be defined as a reflective construct (Freeze & Raschke, 2007). All the indicators of post effectiveness are found to have a high factor loading value, above the threshold of 0.7, as shown in Table 1. A principal component analysis is performed to further analyze post effectiveness. Only one latent factor is returned and the factor loading values are all over 0.9, meaning they can be used to reliably model post effectiveness. In addition, the measurement of post effectiveness reports a satisfactory value of Cronbach's Alpha (0.98), composite reliability (0.98), and average variance explained (0.93), indicating the reliability and validity of the measurement.

In order to quantify the relationship between the different factors of the model we calculated their path coefficients. These results (Figure 9) show that

Table 1. Factor Loading (FL) Values for Post Effectiveness as a Reflective Factor

Indicator	FL	T-Value
Clicks	0.955	15.339
Stories	0.988	87.481
Comment	0.962	13.049
Like	0.985	31.609
Share	0.939	14.554
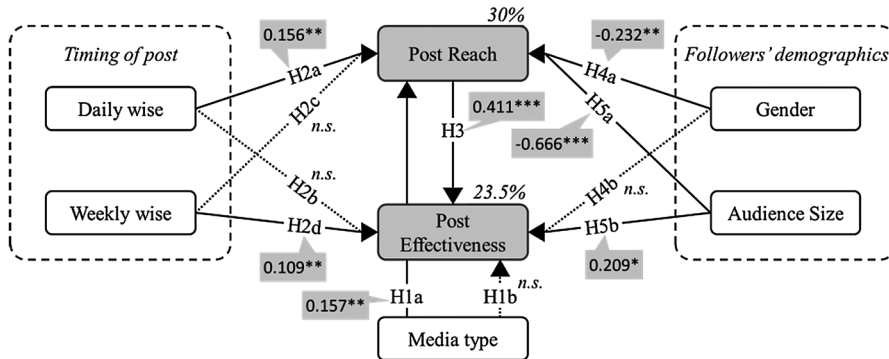
Figure 9. Results of the Model Evaluation.
Notes: n.s., not significant; $^*p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$.

media type affects post reach ($\beta = 0.157$, $p < 0.01$), but not post effectiveness. In a similar way, daily wise has a significant influence on post reach ($\beta = 0.156$, $p < 0.01$), but not on post effectiveness. On the other hand, weekly wise has a significant influence on post effectiveness ($\beta = 0.109$, $p < 0.01$), but not on post reach. Post reach significantly affects post effectiveness ($\beta = 0.411$, $p < 0.001$). Gender significantly affects post reach ($\beta = -0.232$, $p < 0.01$), but not post effectiveness.

Interestingly, audience size positively relates to post effectiveness ($\beta = 0.209$, $p < 0.05$), but negatively influences post reach ($\beta = -0.666$, $p < 0.001$). The hypothesized framework interprets 30 percent of the variance of post reach, and 23.5 percent of the variance of post effectiveness.

Based on our results, the timing of publishing posts significantly influences both post reach and effectiveness. However, a key distinction is that while the hour of posting has a direct effect on how many people see the post (possibly due to circadian rhythms), the day of posting impacts significantly the effectiveness of a post, or in other words how likely people are to interact with it. We also find that demographic characteristics of page followers have a significant influence on both post popularity and effectiveness. Consistent with our expectation, a post will reach a larger audience when the page followers consist of more females than males (Figure 9).

Furthermore, we found that audience size (measured as followers divided by friends-of-followers) has a negative influence on post reach, yet it affects post effectiveness positively. This implies that a follower with lots of friends, and therefore a very busy news feed, is less likely to even see any single post due to the very active news feed. Despite this, the results suggest that when these followers do see the post they are very likely to engage with it and possibly get their own circle of friends to engage with it, thus making a disproportionately high contribution to post effectiveness.

Finally, we find that media type significantly affects post reach but not post effectiveness. This means that the type of post affects how many people see it but not necessarily how many people interact with it.

Discussion

Clearly a big aspect of popularity and effectiveness on Facebook has to do with the content and semantics of posts. For instance, not all photo posts are likely to perform the same, and this is something we acknowledge. However, our study seeks to investigate the dynamics of posts beyond their actual semantics, even though we observed a handful of posts going viral due to their content. For instance, it is to be expected that high quality content will more times than not lead to an effective post. Crucially, our results show that those few viral posts are the exception. Our analysis showed that entropy follows a power-law distribution, and therefore we use a logarithmic scale to visualize it in Figure 8. Such a heavy distribution is akin to the 80:20 rule, whereby in general we would expect 20 percent of the posts to account for 80 percent of the views and interaction with posts. Thus, we argue that for the vast majority of posts that do not go viral, content may not play such a crucial role in their popularity and effectiveness. In these cases it can be crucial to simply give the post appropriate "traits" in order to compete in the Facebook ecosystem. For instance, just being ahead of all the other potential connections of one's followers by adopting a strategic publishing schedule can make a difference.

Such insights are crucial for better use of social media by government organizations. More often than not, they haphazardly implement social media simply for the sake of using it (Magro, 2012). In Europe, social media is in use but is not being used to their potential, and with limited citizen engagement and participation (Magro, 2012). Most governmental organizations have adopted social technologies in a trial-and-error manner at the expense of important organizational resources (Picazo-Vela et al., 2012). Given the rich literature discussing government's use of social media on a macro level and from an organizational perspective, there is a notable lack of user-oriented insights on citizens' interaction with the government's social media sites in a daily context. For instance, in an extensive review of literature on social media use in e-government, Magro (2012, p. 157) concludes that even though we know there are various potentials for using social media in government, "yet in practice we often do not even strive for this" and "we don't yet know how to do it."

Our work seeks to provide actionable insights for using social media as a platform to improve government–citizen interaction in the city of Oulu. Our methodology can be adopted by other page administrators to provide them with actionable insights on improving the effectiveness of their social media strategy on Facebook. For government-managed Facebook pages, this means reaching as many of their followers/citizens as possible, as well as engaging with them effectively. In the next two sections, we discuss the findings of our case study and our model. The findings clearly do not apply to other cities besides Oulu, but the methodology does.

When and How to Post on Facebook?

Prior research on usage patterns of Facebook (Oracle, 2012) suggests that users log into Facebook regularly throughout the day between 8 am and 8 pm, but peaks in the number of logged-in users are observed around 11 am, 3 pm, and 6 pm. Our entropy-based analysis is consistent with these findings, indicating a spike in entropy at 11 am as well as in the late evening. This was confirmed by members of our focus group who reported an increase in Facebook usage during lunch, coffee break, and when arriving at home. However, our results show that the publishing pattern of the city of Oulu's Facebook page is currently only taking advantage of the first usage peak by posting relatively more often around 10 am (Figure 4). Thus, shifting the publishing schedule to focus on times where entropy peaks is one easy action the administrators can take to increase the effectiveness of their posts. We note that Facebook provides a delay mechanism when publishing posts, so in essence those responsible for social media outreach could easily set appropriate publishing times without much overhead. It is very likely that in a different country and for a different community page the daily usage patterns are likely to differ, but nevertheless identifying those patterns can provide an opportunity for more effective citizen engagement.

Prior analysis (Oracle, 2012) also suggests that Mondays receive the most posts, and our results are consistent with this finding, although we observe a relatively wider fluctuation in the number of posts per day of week (Figure 3). The high frequency of publishing on Mondays is explained by the amount of new content that has "accumulated" over the weekend. Furthermore, previous work has shown that the interaction rate for posts on weekends is 14.5 percent higher than for weekday posts (BuddyMedia, 2013). In our case, we also observed that weekend posts have substantially higher entropy, but so do posts made on Friday (Figure 3). Once again, our results show that the publishing pattern of the page does not match our observed entropy measures. Very few posts are created over the weekend, meaning that an opportunity for engagement is missed. Facebook's publishing delay mechanism could prove useful by strategically scheduling posts for the weekend without much overhead.

It is important to note that our modeling shows that these two scales of timing (daily wise and weekly wise) affected post reach and effectiveness differently. While the hour of posting had a significant effect on how many people saw each post ($\beta = 0.156$, $p < 0.01$) possibly due to people's daily work schedules, the day of posting had a significant effect on the effectiveness of a post ($\beta = 0.109$, $p < 0.01$) possibly due to users having more time to interact with posts during Friday–Sunday. These findings suggest that if the goal of a page is to maximize how many people see a post without caring about engagement through likes, shares, and comments, then a short-term optimization should be employed by posting at appropriate times during the day. Such posts include, for instance, providing information about a street being closed the next day. On the other hand, if the goal is to maximize engagement with the page's followers, then a longer-term optimization should be employed by posting on appropriate days, in

our case Friday, Saturday, or Sunday. Such posts could ask, for instance, to collect feedback on a recent event organized by the city.

Furthermore, our model indicates that media type affected the number of people that saw each post ($\beta = 0.157$, $p < 0.01$) but not its effectiveness. We argue that this suggests that page owners use more effective media types, such as photos (Figure 2), when their objective is merely to pass information to as many people as possible. In our case, the page administrators used links most frequently (42 percent), which have lower entropy than photos (Figure 2). This, however, can be a valid strategy if the main concern of these posts is maximize citizen engagement rather than reach by providing the user with relevant contextual cues (Goncalves, Kostakos, Hosio, Karapanos, & Lyra, 2013).

The results we present here are highly contextualized and culturally driven. A different community in a different country will likely have substantially different patterns. However, our findings still apply: administrators need to close the gap between their publishing schedule and the entropy fluctuation of their audience.

Is Bigger Better?

A counter-intuitive finding in our analysis was that as the audience of the page grew, post reach declined (Figure 7). A possible explanation for this finding comes from prior work. There are an ever-growing number of pages on Facebook competing for an increasingly smaller "share of news feed" of their fans. In response, Facebook introduced an adjustment to page reach to compensate for the growing number of pages that its users are fans of, and the increased number of posts coming from those pages (Grant, 2012).

This adjustment, together with an increased amount of pages followed by users, may exert a dominant influence on the post reach, outperforming the possible positive influence of number of followers (Grant, 2012). Hence, we do not believe that our finding means that page owners should actively try to reduce their audience in order to achieve a higher post reach, but it does increase dramatically the importance of optimizing posts when a high reach is the objective. However, practitioners should be aware that our model indicates that some factors may significantly affect post effectiveness without affecting post reach, and vice versa. Therefore, it is possible to enhance post effectiveness without significantly affecting post reach and vice versa.

On the other hand, the increase in post effectiveness as the audience grows ($\beta = 0.209$, $p < 0.05$) can be mainly attributed to more appropriate targeting (Geckler, 2012; Goncalves, Kostakos, et al., 2013). As mentioned previously, the competition for a spot in a user's newsfeed increases every time a user likes a new page. This in turn means that those who actually end up seeing the posts are more likely to be interested in their content and therefore actively engage with it. Interestingly, gender was also shown to have an effect on post reach ($\beta = -0.232$, $p < 0.01$) but not post effectiveness. One explanation for this finding is that, overall, females engage in more Facebook activity than males and spend more

time on Facebook (McAndrew & Jeong, 2012). Even though this is most likely the case, we do not argue that our finding means that page owners should actively try to attract more female than male fans, but only that they should be aware of these fluctuations in page demographics and react accordingly. Certain pages, for instance, may be more interested in appealing to a certain gender over the other depending on their goals. Therefore, our finding only suggests that, *ceteris paribus*, as the ratio of females in the audience increases, so does post reach.

In summary, page owners should not be overly concerned with signs of decreasing post reach, as it is to be expected due to Facebook's EdgeRank intricacies and the rise of competition within Facebook over time. It then falls to the page owners to exploit posting dynamics to maximize reach and/or effectiveness depending on what their goal is for each individual post.

Toward Actionable e-Government Research

Because of their tremendous potential, the phenomena surrounding social media use in government have drawn increasing attention from academia (Kavanaugh et al., 2012; Yi, Oh, & Kim, 2013), and academics have labeled governments driven by social media as Government 2.0 (Eggers, 2005), collaborative government (Chun, Luna-Reyes, & Sandoval-Almazán, 2012), government as a platform (O'Reilly, 2010), Open Government (McDermott, 2010), or we-Government (Linders, 2012).

However, much of the prior academic literature has been focused on the theoretical framework or policy issues of social media use in governments and is mostly descriptive or exploratory in nature. In Scandinavian regional governments, for instance, while there has been some effort aimed at facilitating citizens and public sector collaboration on social media platforms from a design perspective (Näkki et al., 2011), explanatory investigations on the citizens' perceptions, expectations, and use experience of interacting with governments' social media services are lacking. There is a lack of knowledge on the effectiveness of various practices in using social media for government–citizen communication, in terms of their real impact, cost, and risks. In this case study, examples of actionable insights given to city officials included using the scheduling of post feature provided by Facebook to precisely target hours and days that would more likely lead to more people seeing and engaging with the content, and making sure that the more important posts are accompanied by more successful media types.

Therefore, we argue that researchers should also concern themselves with significantly facilitating the advance of knowledge on government use of social media by offering actionable insights to inform government–citizen communication in daily life contexts. As stated by Mergel (2013), research in this domain should help academics and practitioners design effective social media strategies to reach their audience and guarantee that their online interactions have an impact on both the organization and the citizens. A similar call-to-action for "relevance" by Benbasat and Zmud (1999) in Information Systems research has

enabled significant progress in the quality and rigor of work done in this discipline. In their work they identify four key dimensions to make articles more relevant: these should be interesting, applicable, current, and accessible (Benbasat & Zmud, 1999). Our study aims to be a step toward bridging this notable gap between knowledge and practice by investigating how to improve government–citizen communication using social media, a *current* topic of research in this area. Furthermore, our study is *interesting* as it addresses concerns regarding reachability and effectiveness of social media strategies by government officials. It is also *applicable* as it improves the understanding of the mechanism underlying citizen participation in government social media by offering flexible strategies and actionable insights. Finally, the presented methodology is *accessible* to academics and researchers alike, and can assist them in improving their social media outreach.

Limitations

We note a number of limitations of this study. First, the analysis and conclusions presented in this study are made using data from a city's official Facebook page. Therefore, given that our main contribution is a set of methods of achieving such insights, the analysis would need to be repeated for every specific case. Second, the data used in this study were collected directly from the insights interface in the administrator panel of the city's Facebook page. We acknowledge that this will not be possible in most cases and crawling the data needed to employ our methodology using the Facebook API may be required. Finally, the research model is evaluated via the use of a relatively small data set collected within one year. Clearly, given a larger data set we would provide increased confidence in our findings.

Conclusion and Future Work

In this study, we sought to develop a methodology to achieve actionable insights to improve government–citizen communication on Facebook. We do this by modeling how various factors alter the dynamics of post popularity and effectiveness on Facebook. We approached this by conducting a longitudinal investigation on post popularity and effectiveness in the context of an online community managed by a local government organization. Our analysis used entropy measures to identify optimal times and days when organizations should post to increase the popularity and effectiveness of their posts, respectively. Our work also provides a multifactor model that shows how timing, number of followers and their gender, as well as media type contributes to the popularity and effectiveness of posts. We find that having a larger community of followers does not necessarily result in having more popular posts or more effective posts.

In future work we aim to apply our methodology to multiple government pages across different countries and cultures. At the same time, we will follow up on changes to post reach and effectiveness as a result of these actionable insights.

In addition, it would also be important to investigate how our methodology performs in the context of various other communities, including commercial or interest-driven pages.

Jorge Goncalves, M.Sc., is a doctoral candidate at the Department of Computer Science and Engineering, University of Oulu in Finland [jgoncalv@ee.oulu.fi].
Yong Liu, Ph.D., is a Postdoctoral Fellow at the Department of Computer Science and Engineering, University of Oulu in Finland.
Bin Xiao, B.Sc., is a master's student at the Department of Computer Science and Engineering, University of Oulu in Finland.
Saad Chaudhry, B.Sc., is a master's student at the Department of Computer Science and Engineering, University of Oulu in Finland.
Simo Hosio, Dr. Tech., is a Postdoctoral researcher at the Department of Computer Science and Engineering, University of Oulu in Finland.
Vassilis Kostakos, Ph.D., is a Professor of Computer Engineering in the University of Oulu's Department of Computer Science and Engineering.

References

Alexa. 2013. "Alexa Top 500 Global Sites." http://www.alexa.com/topsites.

Benbasat, I., and R.W. Zmud. 1999. "Empirical Research in Information Systems: The Practice of Relevance." *MIS Quarterly* 23 (1): 3–16.

Bertot, J.C., P.T. Jaeger, S. Munson, and T. Glaisyer. 2010. "Social Media Technology and Government Transparency." *Computer* 43 (11): 53–9.

BuddyMedia. 2013. "Strategies for Effective Wall Posts: A Timeline Analysis." http://www. salesforcemarketingcloud.com/resources/ebooks/strategies-for-effective-wall-posts-a-timeline-analysis/.

Bullas, J. 2013. "5 Great Examples of Calls to Action for Your Facebook Cover Photo." http://www. jeffbullas.com/2013/05/17/5-great-examples-of-calls-to-action-for-your-facebook-cover-photo/.

Chang, A.M., and P.K. Kannan. 2008. *Leveraging Web 2.0 in Government*. Washington, DC: IBM Center for the Business of Government. http://wiki.douglasbastien.com/images/f/f7/ Ibm-Leveraging_Web_2.0_in_Government.pdf.

Chui, M., J. Manyika, J. Bughin, and R. Dobbs. 2012. "The Social Economy: Unlocking Value and Productivity Through Social Technologies." McKinsey Global Institute. http://www.mckinsey. com/insights/high_tech_telecoms_internet/the_social_economy.

Chun, S.A., L.F. Luna-Reyes, and R. Sandoval-Almazán. 2012. "Collaborative e-Government." *Transforming Government: People , Process and Policy* 6 (1): 5–12.

Cisler, E. 2010."Study Reveals What Times Facebook Users Are Most Active." http://allfacebook.com/ study-reveals-when-facebook-users-are-most-active_b21314.

Cvijikj, I., E. Spiegler, and F. Michahelles. 2011. "The Effect of Post Type, Category and Posting Day on User Interaction Level on Facebook." In *Proceedings of Privacy, Security, Risk and Trust (PASSAT) and the 2011 IEEE Third International Conference on Social Computing (SocialCom)*. New York: IEEE, 810–13. http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=6113221.

Eggers, W.D. 2005. *Government 2.0: Using Technology to Improve Education, Cut Red Tape, Reduce Gridlock, and Enhance Democracy*. Lanham, MD: Rowman & Littlefield Publishers.

Freeze, R., and R. Raschke. 2007. "An Assessment of Formative and Reflective Constructs in IS Research." In *Proceedings of the 15th European Conference on Information Systems (ECIS 2007)*.

Atlanta, GA: AIS, 1480–92. http://aisel.aisnet.org/cgi/viewcontent.cgi?article=1025&context=ecis2007.

Geckler, V. 2012. "Use Page Post Targeting to Increase Facebook Engagement." http://www.digett.com/blog/12/19/2012/use-page-post-targeting-increase-facebook-engagement.

Geser, H. 2006. "Are Girls (Even) More Addicted? Some Gender Patterns of Cell Phone Usage." Sociology in Switzerland: Sociology of the Mobile Phone, Online Publications, Zurich. http://socio.ch/mobile/t_geser3.htm.

Goncalves, J., S. Hosio, Y. Liu, and V. Kostakos. 2014. "Eliciting Situated Feedback: A Comparison of Paper, Web Forms and Public Displays." *Displays* 35 (1): 27–37.

Goncalves, J., V. Kostakos, S. Hosio, E. Karapanos, and O. Lyra. 2013. "IncluCity: Using Contextual Cues to Raise Awareness on Environmental Accessibility." In *Proceedings of the 15th International ACM SIGACCESS Conference on Computers and Accessibility*. New York: ACM, article 17, 8 pp. http://dl.acm.org/citation.cfm?id=2517030.

Goncalves, J., J. Venkatanathan, and V. Kostakos. 2013. "Narrowcasting in Social Media: Effects and Perceptions." In *Proceedings of the 2013 ACM International Conference on Advances in Social Network Analysis and Mining*. New York: ACM, 502–9. http://dl.acm.org/citation.cfm?id=2492517.2492570.

Grant, R. 2012. "Facebook Has Decreased Page Reach, and Here's Why." http://techcrunch.com/2012/11/16/facebook-has-decreased-page-reach-and-heres-why/.

Hosio, S., J. Goncalves, V. Kostakos, K. Cheverst, and Y. Rogers. 2013. "Human Interfaces for Civic and Urban Engagement: HiCUE '13." In *Adjunct Proceeds of the 2013 ACM International Joint Conference on Pervasive and Ubiquitous Computing*. New York: ACM, 713–20. http://dl.acm.org/citation.cfm?id=2494091.2495993.

Hosio, S., J. Goncalves, V. Kostakos, and J. Riekki. 2014. "Exploring Civic Engagement on Public Displays." In *User-Centric Technology Design for Nonprofit and Civic Engagements, Public Administration and Information Technology 6*, ed. S. Saeed. Switzerland: Springer, 91–111.

Jaeger, P.T., and J.C. Bertot. 2010. "Transparency and Technological Change: Ensuring Equal and Sustained Public Access to Government Information." *Government Information Quarterly* 27 (4): 371–76.

Johnston, E.W., and D.L. Hansen. 2011. "Design Lessons for Smart Governance Infrastructures." In *Transforming American Governance: Rebooting the Public Square?*, eds. D. Ink, A. Balutis, and T. Buss. Armonk, NY: M.E. Sharpe, 197–212.

Kavanaugh, A.L., E.A. Fox, S.D. Sheetz, S. Yang, L.T. Li, D.J. Shoemaker, A. Natsev, and L. Xie. 2012. "Social Media Use by Government: From the Routine to the Critical." *Government Information Quarterly* 29 (4): 480–91.

Lakkaraju, H., J. McAuley, and J. Leskovec. 2013. "What's in a Name? Understanding the Interplay Between Titles, Content, and Communities in Social Media." In *Proceedings of the 7th International AAAI Conference on Web and Social Media*. Palo Alto, CA: AAAI, 311–20. http://www.aaai.org/ocs/index.php/ICWSM/ICWSM13/paper/view/6085.

Lenhart, A., K. Purcell, A. Smith, and K. Zickuhr. 2010. "Social Media & Mobile Internet Use Among Teens and Young Adults. Project Report." *Pew Internet*. http://www.pewinternet.org/files/old-media/Files/Reports/2010/PIP_Social_Media_and_Young_Adults_Report_Final_with_toplines.pdf.

Linders, D. 2012. "From e-Government to We-Government: Defining a Typology for Citizen Coproduction in the Age of Social Media." *Government Information Quarterly* 29 (4): 446–54.

Liu, Y., J. Venkatanathan, J. Goncalves, E. Karapanos, and V. Kostakos. 2014. "Modelling What Friendship Patterns Reveal About Personality and Social Capital." *ACM Transactions on Computer-Human Interaction* 21 (3): article 17.

Magro, M.J. 2012. "A Review of Social Media Use in E-Government." *Administrative Sciences* 2 (4): 148–61.

Mainka, A., S. Hartmann, W.G. Stock, and I. Peters. 2014. "Government and Social Media: A Case Study of 31 Informational World Cities." In *Proceedings of the 47th Hawaii International Conference on System Sciences*. New York: IEEE, 1715–24. http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=6758816.

Mergel, I. 2012. "'Connecting to Congress': The Use of Twitter by Members of Congress." *Journal of Policy Advice and Political Consulting* 3: 108–14.

Mergel, I. 2013. "Social Media Adoption and Resulting Tactics in the U.S. Federal Government." *Government Information Quarterly* 30 (2): 123–30.

Mergel, I. 2014. "Social Media Adoption: Toward a Representative, Responsive or Interactive Government?" In *Proceedings of the 15th Annual International Conference on Digital Government Research*. New York: ACM, 163–70. http://dl.acm.org/citation.cfm?id=2612740.

McAndrew, F.T., and H.S. Jeong. 2012. "Who Does What on Facebook? Age, Sex, and Relationship Status as Predictors of Facebook Use." *Computers in Human Behavior* 28 (6): 2359–65.

McDermott, P. 2010. "Building Open Government." *Government Information Quarterly* 27 (4): 401–13.

Näkki, P., A. Bäck, T. Ropponen, J. Kronqvist, K.A. Hintikka, and A. Harju. 2011. "Social Media for Citizen Participation Report on the Somus Project." http://www.vtt.fi/inf/pdf/publications/2011/P755.pdf.

Oracle. 2012. "Managing Your Facebook Community: Findings on Conversation Volume by Day of Week, Hour, and Minute; An Oracle White Paper." http://www.oracle.com/us/products/managing-your-facebook-community-1840523.pdf.

O'Reilly, T. 2010. "Government as a Platform." In *Open Government: Collaboration, Transparency, and Participation in Practice*, eds. D. Lathrop and L. Ruma. Sebastopol, CA: O'Reilly Media, 13–40.

Picazo-Vela, S., I. Gutiérrez-Martínez, and L.F. Luna-Reyes. 2012. "Understanding Risks, Benefits, and Strategic Alternatives of Social Media Applications in the Public Sector." *Government Information Quarterly* 29 (4): 504–11.

Reynolds, B., J. Venkatanathan, J. Goncalves, and V. Kostakos. 2011. "Sharing Ephemeral Information in Online Social Networks: Privacy Perceptions and Behaviours." In *Proceedings of the 13th IFIP TC.13 International Conference on Human-Computer Interaction*. New York: Springer, 204–15. http://dl.acm.org/citation.cfm?id=2042182.2042201.

Romero, D., and W. Galuba. 2011. "Influence and Passivity in Social Media." In *Proceedings of the 20th International World Wide Web Conference*. New York: Springer, 18–33. http://dl.acm.org/citation.cfm?id=1963192.1963250.

Salganik, M.J., P.S. Dodds, and D.J. Watts. 2006. "Experimental Study of Inequality and Unpredictability in an Artificial Cultural Market." *Science* 311 (5762): 854–56.

Simon, S., and C. Peppas. 2004. "An Examination of Media Richness Theory in Product Web Site Design: An Empirical Study." *The Journal of Policy* 6 (4): 270–81.

The Wall Street Journal. 2012. "Facebook: One Billion and Counting." http://online.wsj.com/article/SB10000872396390443635404578036164027386112.html.

Thelwall, M. 2009. "Homophily in MySpace." *Journal of the American Society for Information Science and Technology* 60 (2): 219–31.

Thelwall, M., D. Wilkinson, and S. Uppal. 2010. "Data Mining Emotion in Social Network Communication: Gender Differences in MySpace." *Journal of the American Society for Information Science and Technology* 61 (1): 190–99.

Tian, J., T. Liu, and H. Jiao. 2008. "Entropy Weight Coefficient Method for Evaluating Intrusion Detection Systems." In *Proceedings of the 2008 International Symposium on Electronic Commerce and Security*. New York: IEEE, 592–98. http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=4606135.

Wen, Z., and C. Lin. 2010. "On the Quality of Inferring Interests From Social Neighbors." In *Proceedings of the 16th ACM SIGKDD Conference on Knowledge Discovery and Data Mining*. New York: ACM, 373–82. http://dl.acm.org/citation.cfm?id=1835853.

Venkatanathan, J., E. Karapanos, V. Kostakos, and J. Goncalves. 2012. "Network, Personality and Social Capital." In *Proceedings of the 4th Annual ACM Web Science Conference*. New York: ACM, 326–29. http://dl.acm.org/citation.cfm?id=2380760.

Venkatanathan, J., V. Kostakos, E. Karapanos, and J. Goncalves. 2014. "Online Disclosure of Personally Identifiable Information With Strangers: Effects of Public and Private Sharing." *Interacting With Computers* 26 (6): 614–26.

Yang, K., and H. Lee. 2010. "Gender Differences in Using Mobile Data Services: Utilitarian and Hedonic Value Approach." *Journal of Research in Interactive Marketing* 4 (2): 142–56.

Yi, M., S.G. Oh, and S. Kim. 2013. "Comparison of Social Media Use for the U.S. and the Korean Governments." *Government Information Quarterly* 30 (3): 310–17.