

A Case Study in Modelling Government-Citizen Interaction in Facebook

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Abstract

Facebook posts compete for human attention in a zero-sum game. The effectiveness of one post in grabbing the population's attention comes at the cost of another, due to humans' finite attention. This makes it challenging for government organizations to engage with their citizens through this bustling 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 non-profit context: the official Facebook page of a mid-sized city. We model the competition dynamics that shape the fate of Facebook posts using Structural Equation Modelling – independent of their semantics. Our analysis reveals that for this community audience demographics, the timing of posts, and the media type of post are significant factors, and argue that our method can be applied to other similar pages to determine which factors can lead to improved government-citizen communication. Finally, we argue towards more actionable research to be conducted in the context of social media use in e-government.

Introduction

Substantial evidence suggests a gradual and irreversible prevalence of social media amongst citizens of all walks of life (c.f. Chui et al., 2012). Today, one in five hours spent online is on social networks (Chui et al., 2012). Facebook, with over one billion monthly active members (The Wall Street Journal, 2012) is currently the second most-frequently-visited website on the Internet, behind 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 non-commercial organizations have invested considerable resources in the use of social media for a diversity of purposes, including marketing, loyalty enhancement, or 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 et al., 2012). These efforts have given rise to great expectations in terms of reaching new audiences, building relationship with citizens and stakeholders, establishing new patterns of communication, improving openness, transparency and participatory democracy, crowdsourcing solutions and innovations, and lowering government cost (Kavanaugh et al., 2012; Picazo-Vela et al., 2012).

In this paper 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 an official government Facebook page. The city is mid-sized with 190.000 inhabitants, 7400 of who use the page at the time of this study.

For these competition dynamics, the most crucial Facebook mechanism in terms of which posts are shown to users is the Edgerank algorithm: it determines which posts to display at the top of users' news feed. It is important to consider Edgerank when drawing conclusions on how to make effective posts. Edgerank is, however, a moving target constantly changing and evolving. Factors that matter now may change in terms of importance or mechanism while at the same time 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 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 its posts' popularity or effectiveness, or in other words 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, what is the best time to make a post? To what extent does the media type affect post popularity and effectiveness and how do the demographic features of followers affect the success of a post? 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 et al., 2004). Furthermore, text formed 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 ephemeral nature pushed to the users (Reynolds et al., 2011).

Yet these findings, and much of prior research, focus primarily on how individual users react to individual posts, thus necessitating a consideration of posts' content and semantics. 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 that is blind to the content and semantics of posts, the only constant amongst its many iterations. It is this aspect of the competition dynamics in Facebook that we seek to explore and model in our work, particularly in the non-profit 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 each post. Here we take a step back from considering how a single user interacts with a single post, and we 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 away from these nuances may result in decontextualized findings. Therefore we wish to highlight that the purpose of this study is to demonstrate the validity of our method which can then be adapted and used by other 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, title when developing an understanding of what drives Post Effectiveness (Cvijikj et al., 2011; Lakkaraju et al., 2013). While intuitive, such an approach cannot scale into a framework without considering interdependencies between various factors. This is important because Facebook posts are not just influenced by their publishers, but also 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 chose to develop a model that can offer us a multifactorial perspective.

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. These platforms are 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 et al., 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 et al., 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 et al., 2008). Furthermore, members of the public expect that government services will be available electronically and that government agencies will be accessible via social media technologies (Jaeger et al., 2010).

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 fail to reach a substantial portion of its constituents (Hosio et al., 2013; Hosio et al., 2014). However, implementing social media in government is 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 users' reaction. In social networks, user attention and interest can be highly "contagious" and subject to influences from social neighbours (Wen et al., 2010; Venkatanathan et al., 2012; Liu et al., 2014). Inevitably, when users face a wide range 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 prioritise paying attention to certain posts. For instance, people may pay more attention to or give a response to a post that was liked by their friends (c.f. Salganik et al., 2006), therefore making the post spread. As a result, audience size (the average amount of friends-of-the-followers of a page) could be one of the potential factors influencing the fate of post.

Furthermore, since gender accounts for differences in user behaviour (Lenhart et al., 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 et al., 2011), meaning that by default they are not positive to 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) that 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 media richness of a website affects users' evaluation and preferences of the website. From the perspective of media richness theory, Simon and Peppas (2010) classified "rich media sites" as those including text, pictures, sounds and video clips, while the "lean media sites" contained only text. Their study found that, regardless of the complexity of the product, most users initiated more positive attitudes and higher levels of satisfaction towards the 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

Vitruve (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 make 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 significantly influence on the success of the post. In our study we investigate two features of timing with regard to the time of a day (Daily Wise) and the day of a week (Weekly Wise). We assume that post timing can significantly affect the size of the audience as well as the response from the audience. Similar to the Media Type, we formulate the timing of 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, i.e., comment and likes, for a post. Therefore, we 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 et al., 2010). For instance, Geser (2006) indicated that females see the phone mainly as a medium for subjective personal communication, while boys emphasize instrumental functions (i.e. increasing personal mobility and role coordination). Thelwall (2009) reported women author disproportionately more public comments in MySpace. Thelwall et al. (2010) found that women are likely to give and receive more positive comments than men.

They 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 amount of friends-of-the-followers of the page. It is 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.

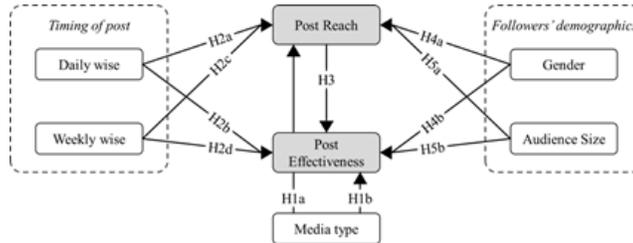


Figure 1. Modelling Framework

Study

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, the city had ca. 190.000 citizens, with ca. 7400 following its Facebook page. According to www.socialbakers.com, Finland has a Facebook penetration of around 43%, making the total Facebook accounts in the city ca. 81700. Therefore ca. 9% of the city’s population were following this Facebook page.

Our interviews with city officials suggested that the Facebook page is an important campaign mechanism that the city uses 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 the local language, and 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.

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

Data Collection

We collected data relating to posts published on the page over the course of 12 months. Specifically we recorded each post that was published on this 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 5 months after the end of the study period.

Static Metrics

- *Post type*: The type of the post i.e. 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-the-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 5 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.
- *Shares*: The number of times a post was shared.
- *Clicks*: The number of times a post was clicked.

Post Reach

Post reach is the number of unique Facebook users who saw a particular post. This was recorded 5 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 et al., 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.

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 paper.

Results

Posts

During the 12 months of the study period, 211 posts were posted on the page (Figure 2). Of the top-20 liked posts 12 are links, 7 are photos and 1 is a video.

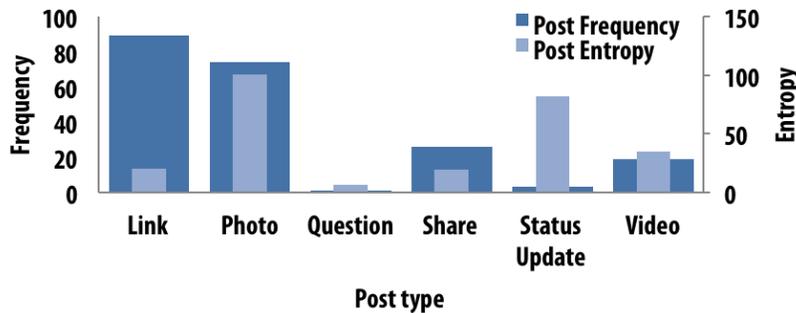


Figure 2. The frequency average post entropy by type

More than 90% of the posts were posted during weekdays (Figure 3), roughly 50% were posted during morning hours (8am to 12am), and 20% outside working hours (4pm to 8am) (Figure 4). In Figures 3, 4, and 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.

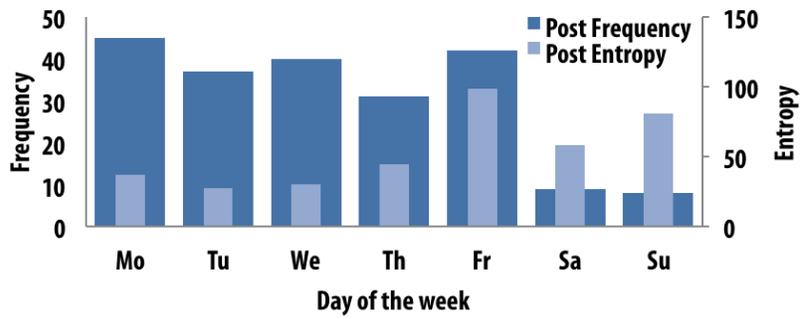


Figure 3. The frequency of posting and the average post entropy per day of the week published

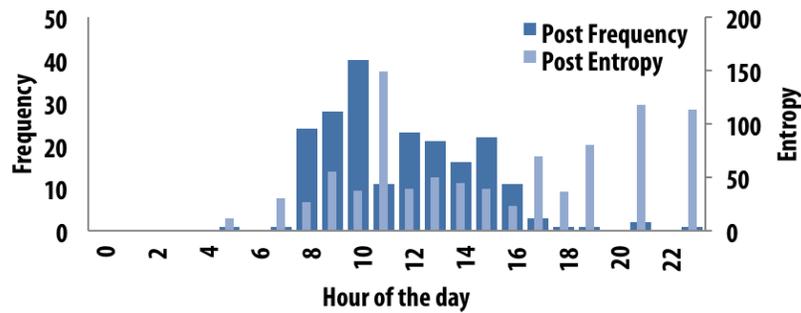


Figure 4. The frequency of posting and the average post entropy per hour of day published

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 1740 followers of the page and 2144 unique Facebook users (Figure 5). In other words, around 404 non-followers saw the 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.

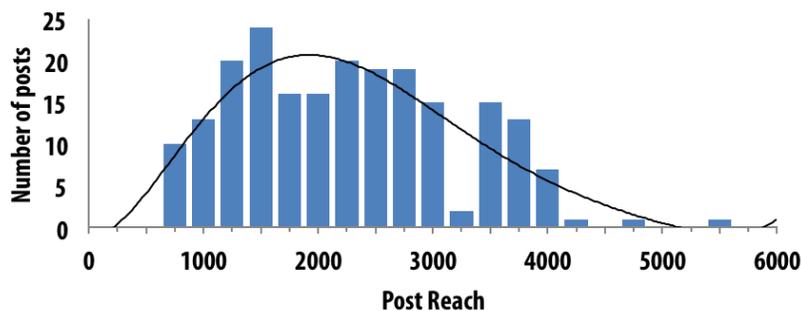


Figure 5. Histogram of post reach

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 5 instances of a post reported as spam, each time for a different post.

Community

During the study the number of page followers increased by 12% from 6309 to 7100. The number of friends-of-the-followers increased by 21% from 777.860 to 944.020 during the study. The gender breakdown of the page followers varied throughout the study (Figure 6).

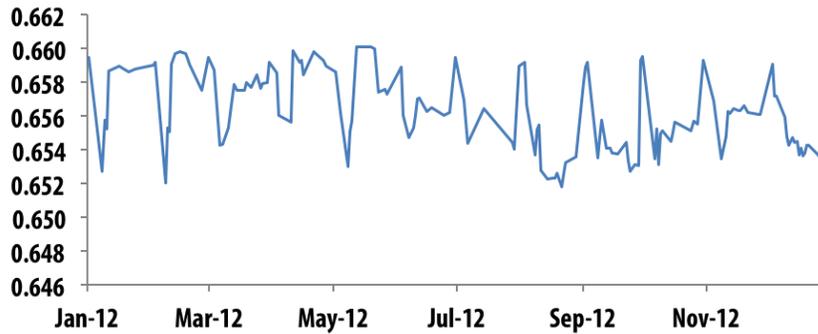


Figure 6. Male/female ratio of page followers.

Number of Followers, Post Reach/Effectiveness

We investigated whether the page having more followers will result in a larger reach for a post, and whether posts with larger reach are more engaging and effective.

We first investigated the relationship between the number of followers and Post Reach, which results in an unexpected reverse relationship visualised 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.

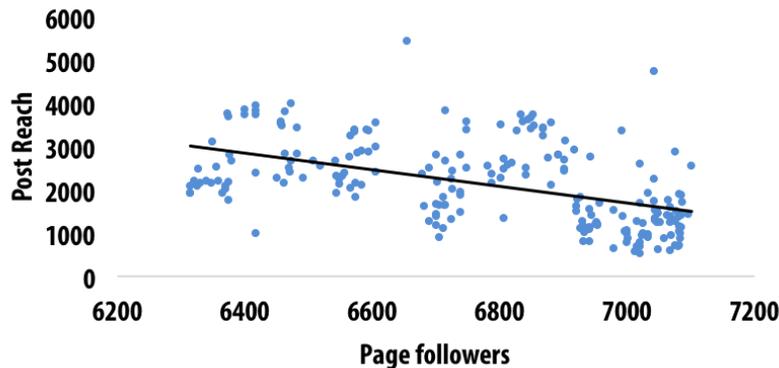


Figure 7. Correlation between reach and followers

Next we investigate whether a larger reach leads to more engagement. In other words, to what extent having more users see a post will result in more interaction with a post? 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.

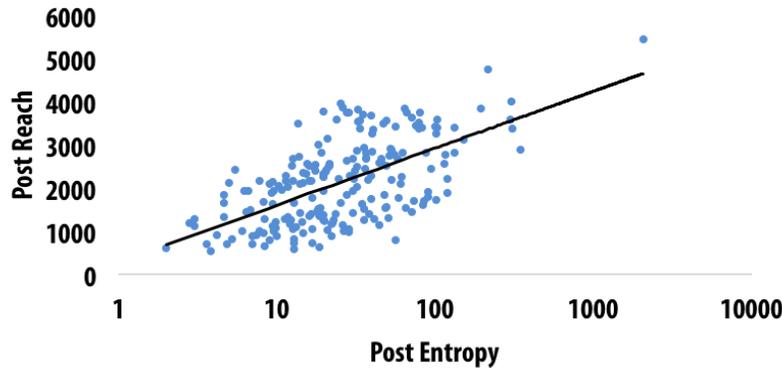


Figure 8. Correlation between post reach and post entropy. Note the x-axis is logarithmic.

This shows that as more people see a post we can expect an overall increase in the entropy of a post, 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 the post.

Multifactor Modelling

Using Structural Equation Modelling (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 dataset cannot be used directly in SEM (e.g. Media Type, Post Time and Gender). Therefore, we grade each variable category using our entropy measure as shown in Figures 3 to 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 indicator 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 et al., 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 analyse Post Effectiveness. Only one latent factor is returned and the factor loading values are all over 0.9. 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), implying the reliability and validity of the measurement.

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

Table 1. Factor loading (FL) values for Post Effectiveness as a reflective factor.

The modelling results (Figure 9) show that 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% of the variance of Post Reach, and 23.5% of the variance of Post Effectiveness.

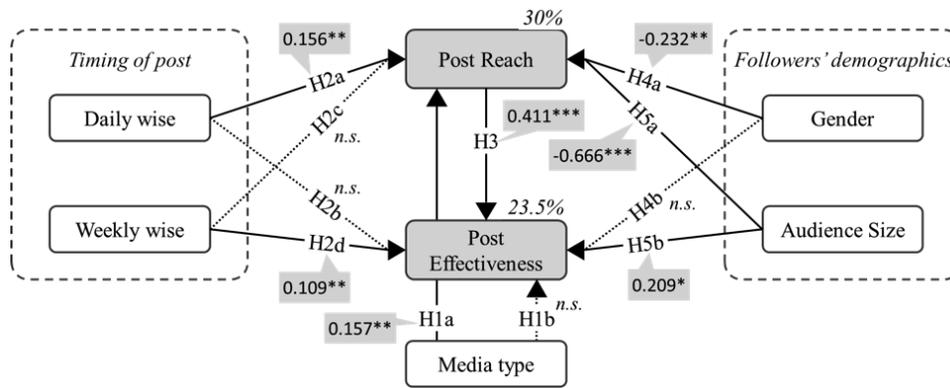


Figure 9. Results of the model evaluation (n.s.: not significant; *: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$)

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 are people to interact with a post.

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.

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 a post 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 visualise it in Figure 8. Such a heavy distribution is akin to the 20-80 rule, whereby in general we would expect 20% of the posts to account for 80% 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 as we discussed above.

By looking at posts characteristics beyond only 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 modelling reflects more closely the mechanisms of Facebook, such as Edgerank algorithm, which does not take semantics into account.

Such insights are crucial for the betterment of 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, 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) 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. 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?

Prior research on usage patterns of Facebook (Oracle, 2012) suggests that users log into Facebook regularly throughout the day between 8am and 8pm, but peaks in the number of logged-in users are observed around 11am, 3pm and 6pm. Our entropy-based analysis is consistent with these previous findings, indicating a spike in entropy at 11am as well as in late evening. This was confirmed by members of our focus group stating increase in Facebook usage during lunch, coffee break and when arriving at home. However, our results show that the publishing pattern of the page is currently only taking advantage of the first usage peak by posting relatively more often around 10am (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 have the most posts per day, and our results are consistent with this finding, although in our results 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" during the weekend. Furthermore, previous work has shown that the interaction rate for posts on weekends is 14.5% higher than 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 made during 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 modelling 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 schedule, 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 maximise how many people see a post without caring about engagement through likes, shares and comments, then a short-term optimisation 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 maximise engagement with the page's followers, then a longer-term optimisation 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 organised 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%), which have lower entropy than photos (Figure 2). This, however, can be a valid strategy if the main concern of those posts was maximise citizen engagement rather than reach by providing user with relevant contextual cues (Goncalves et al., 2013a).

The results we present here are highly contextualised 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 all pages’ 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, which outperforms the possible positive influence of amount of followers (Grant, 2012). Hence, we do not believe that our finding means the page owners should actively try to reduce their audience in order to have 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 engagement without affecting Post Reach, and vice versa. Therefore, it is possible to enhance Post Effectiveness without significantly affecting the level of 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 et al., 2013a). 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 page’s post are more likely to be interested in its 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 et al., 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 maximise reach and/or effectiveness depending on what their goal for each individual post is.

Towards 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 et al., 2013), and academics have labelled governments driven by social media as Government 2.0 (Eggers, 2005), collaborative government (Chun et al., 2012), government as a platform (O’Reilly, 2010), Open Government (McDermott, 2012), 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 aiming to facilitate citizens and public sector collaboration on social media platforms from a design perspective (Näakki 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 in significantly facilitating the advance of knowledge on governments’ use of social media by offering actionable insights to instruct government-citizen communication in daily life contexts. Our study aims to be a step towards bridging this notable gap between knowledge and practice, by investigating how to improve government-citizen communication using social media. In this regard, our study is of particular societal and practical importance to understand the mechanism underlying citizens’ participation in governments’ social media by offering flexible strategies.

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 research model is evaluated via the use of a relatively small dataset collected within one year. Clearly, given a larger dataset we would provide increased confidence in our findings.

Conclusion

In this study we sought to model 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 organisation. Our analysis used entropy measures to identify optimal times and days when organisations can 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, contribute to the popularity and effectiveness of posts. We find that having a bigger community of followers does not necessarily result in having neither more popular posts nor more effective posts. It is certainly important to investigate how our findings hold in the context of various other communities including commercial or interest-driven pages.

References

- Alexa. (2013). Alexa Top 500 Global Sites, available from: <http://www.alexa.com/topsites>, accessed on September 19, 2013
- Bertot, J.C., Jaeger, P.T., Munson, S., and Glaisyer, T. (2010). Social media technology and government transparency. *Computer* 43 (11): 53-59.
- 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 Kannan, P.K. (2008). Leveraging Web 2.0 in government. *IBM Center for the Business of Government*.
- Chui, M., Manyika, J., Bughin, J., and Dobbs, R. (2012). The social economy: Unlocking value and productivity through social technologies. *McKinsey Global Institute*.
- Chun, S. A., Luna-Reyes, L. F., and Sandoval-Almazán, R. (2012). Collaborative e-government. *Transforming Government: People, Process and Policy* 6 (1): 5–12.
- Cvijikj, I., Spiegler, E., and Michahelles, F. (2011). The Effect of Post Type, Category and Posting Day on User Interaction Level on Facebook. In *Proc. PASSAT&SocialCom 2011*, 810-813.
- Eggers, W. D. (2005). *Government 2.0: Using Technology to Improve Education, Cut Red Tape, Reduce Gridlock, and Enhance Democracy*, Lanhma, MD: Rowman & Littlefield Publishers.
- Freeze, R. and Raschke, R. (2007). An Assessment of Formative and Reflective Constructs in IS Research. In *Proc. ECIS 2007*, 1418-1492.
- Geckler, V. (2012). Use Page Post Targeting to increase Facebook engagement, available from: <http://www.digett.com/blog/12/19/2012/use-page-post-targeting-increase-facebook-engagement>, accessed on May 28, 2013.
- Geser, H. (2006). Are girls (even) more addicted? Some gender patterns of cell phone usage. In *Sociology in Switzerland: Sociology of the Mobile Phone*, Online Publications, Zurich.
- Goncalves, J., Kostakos, V., Hosio, S., Karapanos, E. and Lyra, O. (2013a). IncluCity: Using contextual cues to raise awareness on environmental accessibility. In *Proc. ASSETS'13*, article 17.
- Goncalves, J., Venkatanathan, J. and Kostakos V. (2013b). Narrowcasting in Social Media: Effects and Perceptions. In *Proc. ASONAM'13*, 502-509.
- 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/>, accessed on 13 August, 2013.

- Hosio, S., Goncalves, J., Kostakos, V., Cheverst, K. and Rogers, Y. (2013). Human Interfaces for Civic and Urban Engagement: HiCUE '13. In *Adj. Proc. UbiComp'13*, 713-720.
- Hosio, S., Goncalves, J., Kostakos, V., and Riekkki, J. (2014). Exploring Civic Engagement on Public Displays. In: Saeed, S. (ed.), *User-Centric Technology Design for Nonprofit and Civic Engagements*, Public Administration and Information Technology 6, Springer: 91-111.
- Jaeger, P.T. and Bertot, J.C. (2010). Transparency and technological change: Ensuring equal and sustained public access to government information. *Government Information Quarterly* 27 (4): 371-376.
- Johnston, E.W. and Hansen, D.L. (2011). Design lessons for smart governance infrastructures. *American Governance*, 3.
- Kavanaugh, A. L., Fox, E. a., Sheetz, S. D., Yang, S., Li, L. T., Shoemaker, D. J., Natsev, A., and Xie, L. (2012). Social media use by government: From the routine to the critical. *Government Information Quarterly* 29 (4): 480-491.
- Lakkaraju, H., McAuley, J., and Leskovec, J. (2013). What's in a Name? Understanding the Interplay between Titles, Content, and Communities in Social Media. In *Proc. ICWSM'13*, 311-320.
- Lenhart, A., Purcell, K., Smith, A., and Zickuhr, K. (2010). Social Media & Mobile Internet Use Among Teens and Young Adults. Project Report.
- 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): 446-454.
- Liu, Y., Venkatanathan, J., Goncalves, J., Karapanos, E. and Kostakos, V. (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): 148-161.
- McAndrew, F.T. and Jeong, H.S. (2012). Who does what on Facebook? Age, sex, and relationship status as predictors of Facebook use. *Computers in Human Behavior* 28 (6): 2359-2365.
- McDermott, P. (2010). Building open government. *Government Information Quarterly* 27 (4): 401-413.
- Näkki, P., Bäck, A., Ropponen, T., Kronqvist, J., Hintikka, K. A., and Harju, A. (2011). Social media for citizen participation Report on the Somus project. available from: <http://www.vtt.fi/inf/pdf/publications/2011/P755.pdf>, accessed on 5 September 2013.
- 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>. accessed on 8 September 2013.
- O'Reilly, T. (2010). Government as a Platform. In *Open government: Collaboration, transparency, and participation in practice*, D. Lathrop and L. Ruma (eds.), O'Reilly Media.
- Picazo-Vela, S., Gutiérrez-Martínez, I., and Luna-Reyes, L. F. (2012). Understanding risks, benefits, and strategic alternatives of social media applications in the public sector. *Government Information Quarterly* 29 (4): 504-511.
- Reynolds, B., Venkatanathan, J., Goncalves, J., and Kostakos, V. (2011). Sharing ephemeral information in online social networks: Privacy perceptions and behaviours. In *Proc. INTERACT'11*, 204-215.
- Romero, D. and Galuba, W. (2011). Influence and Passivity in Social Media. In *Proc. WWW 2011*, 113-114.
- Salganik, M.J., Dodds, P.S., and Watts, D.J. (2006). Experimental Study of Inequality and Unpredictability in an Artificial Cultural Market. *Science* 311 (5762): 854-856.
- Simon, S. and Peppas, C. (2004). An examination of media richness theory in product Web site design: an empirical study. *The Journal of Policy, Regulation and Strategy for Telecommunications, Information and Media* 6 (4): 270-281.
- The Wall Street Journal. (2012). Facebook: One Billion and Counting, available from: <http://online.wsj.com/article/SB10000872396390443635404578036164027386112.html>, accessed on September 10, 2013.
- Thelwall, M. (2009). Homophily in MySpace. *Journal of the American Society for Information Science and Technology* 60 (2): 219-231.

- Thelwall, M., Wilkinson, D., and Uppal, S. (2010). Data mining emotion in social network communication: Gender differences in MySpace. *Journal of the American Society for Information Science and Technology* 61 (1): 190–199.
- Tian, J., Liu, T. and Jiao, H. (2008). Entropy weight coefficient method for evaluating intrusion detection systems. In *Proc. ISECS 2008*, 592-598.
- Wen, Z. and Lin, C. (2010). On the Quality of Inferring Interests From Social Neighbors. In *Proc. KDD 2010*, 373-382.
- Venkatanathan, J., Karapanos, E., Kostakos, V. and Goncalves, J. (2012). Network, Personality and Social Capital. In *Proc. Web Science '12*, 326-329.
- Vitruve (2010). Study Reveals What Times Facebook Users Are Most Active, http://allfacebook.com/study-reveals-when-facebook-users-are-most-active_b21314, accessed on May 22, 2013.
- Yang, K., and Lee, H. (2010). Gender differences in using mobile data services: utilitarian and hedonic value approach. *Journal of Research in Interactive Marketing* 4 (2): 142-156.
- Yi, M., Oh, S. G., and Kim, S. (2013). Comparison of social media use for the U.S. and the Korean governments. *Government Information Quarterly* 30 (3): 310–317.