Understanding social media program usage in public transit agencies

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ABSTRACT

Social media has been gaining prominence in public transit agencies in their communication strategies and daily management. This study aims to better understand recent trends in social media usage in public transit agencies, to examine which agencies use what kind of social media programs for what purposes, and how they measure their programs. A survey was conducted of the top transit agencies in the nation, and results are examined through descriptive statistical analysis, correlation analysis and regression modeling. We found that while most agencies still lack clearly-defined goals and performance metrics to guide their social media development, many are increasing their social media capacity with more structural components. Public transit service usage and the level of transit service provision are the most significant determinants of agencies' social media programming and resource investments. In contrast, the measurement of social media usage and outcomes is more significantly related to city attributes and demographic characteristics. We anticipate an increase in the usage of social media to convey transit related stories and livability benefits, such as environmental sensitivity or safety improvements, as these programs expand. Public transit agencies' commitment to measuring social media outcomes underscores the future research need to develop best practices for measuring the impacts and performance of social media communications and investments.

Introduction

Many government agencies at the federal, state and local levels have been increasingly adopting social media as a communication mechanism for representation, engagement and networking (Mergel, 2013; TCRP, 2012), particularly after President Obama's 2009 memorandum (2009) that calls for executive agencies to "harness new technologies" to promote

transparency and participatory public engagement. This paper focuses on social media within public transit agencies particularly due to the frequency and intensity of information exchanges and interactions between these agencies and the population that they serve on a daily basis (e.g., transit system alerts, live transit arrival information, service disruptions, etc.).

In addition, research shows that a growing number of public transportation agencies are already using a variety of social media platforms to inform and engage riders, but there is less systematic understanding of specifically who uses what social media platform for what kind of purposes, and a significant lack of insight into the effectiveness, efficiency and other performance measurements of the usage of social media programs. The existing social media metrics mainly focus on collecting data with little analysis and provide few guidelines for future social media development in the public transportation operations. Therefore, there is room to improve our understanding of how and why public transit agencies are using social media and to establish effective performance metrics and analysis methods to guide the development of social media programs in public transit agencies to meet their goals and objectives.

Thus, this study seeks to understand how public agencies characterize the structure of their social media programs, the goals, strategies and objectives associated with social media usage, and performance metrics currently employed to measure outcomes. We begin with a literature review of existing studies about social media usage trends and characteristics, and the usage of social media in public agencies. We follow with a description of our public transit agency social media survey, data and methodology. Next, we present findings from our descriptive statistical analysis, correlation analysis and multivariate regression analysis, followed by a discussion of the conclusions, future research directions and policy implications.

Background & literature

Public transportation agencies are increasing their use of social media, which calls for better understanding of social media usage characteristics. Bregman and Watkins (2014) researched best practices for transportation agency use of social media and found that almost every state department of transportation, many public transit agencies, and airports have a social media presence, representing a dramatic revolution in how governments interact with its constituencies. Generally, agencies use the following types of social media platforms: social and professional networking, blogging, micro-blogging, media and document sharing sites, social curation, geolocation and crowdsourcing. For example, Facebook is a social networking platform and Twitter is a micro-blogging platform, but both are commonly used for public transit information updates and event announcements. While Facebook interactions focus on storytelling that position agencies as engaged community members, and Twitter is more rider-focused with consistent updates. Other social media platforms may serve niche purposes, such as Instagram, Flickr or Pinterest for image-focused communications, and LinkedIn for professional networking (MacDonald, 2015; Mainka et al., 2014). In 2011, 54% of public transportation agencies used Facebook, 51% used Twitter, and 37% used YouTube (The Use of Social Media by Transportation Agencies, 2011). There is a general consensus that social media is a worthy investment for public transportation agencies, but a survey on transportation providers across the US found that although 94% of them use some forms of social media, only 28% had a social media plan or strategy prior to implementation (Chin et al., 2012).

Understanding the people who utilize social media, particularly which groups of the population interact using which platforms for which purposes, is another important dimension in identifying the most effective structures or approaches for social media programs at public transit agencies. Unsurprisingly, research has shown that the younger generation is the dominant demographic group in the realm of social media participants (Chou et al., 2009; Duggan and Brenner, 2013), as "digital natives" (Prensky, 2001). Chou et al. (2009) and Correa et al. (2010) both identified women as more likely to be engaged with social media than men, while education levels and race/ethnicity are not significant predictors of social media usage. Pew Research Center conducted a study in 2013 (Duggan and Brenner, 2013) that found further demographic differences amongst different platforms, which may impact social media strategies employed by agencies in order to reach different segments of the population for various purposes. The researchers found that Facebook attracts more women and young adults, Twitter specifically attracts a larger percentage of African-Americans and urban users, while Pinterest appeals to more white women with some college education experience. On the other hand, Instagram appears to attract more minorities within urban areas, such as African-Americans and Latinos.

Transportation agencies mainly utilize social media to establish direct lines of connections with customers, share stories, manage emergencies, address customers' concerns, widen the reach of agencies and enhance government transparency. Raymond and O'Hara (2014) synthesized the usage into the four Es of social marketing: to entice participation, to exchange information, to engage, and to experience. It is also an important tool for agencies' marketing plans and emergency management (TCRP, 2012; Bregman and Watkins, 2014; Kavanaugh et al., 2012). Recent studies have found that engaging in interactive communications through social media could improve the overall image of an agency (Schweitzer, 2014; Marshall, 2015). Interactive messages that respond directly to questions, concerns, and comments received more positive sentiments and fewer slurs directed at patrons, independent of actual service quality, even if agencies respond only to a select number of tweets each day. For example, the Southeastern Pennsylvania Transportation Authority (SEPTA), who consistently ranked at the bottom of customer sentiments measured by the number of negative Twitter comments, improved their opinion score by 70% only one year after they introduced its customer service dialog feed to run parallel with its blast feed (Schweitzer, 2014).

Another study found that creatively using crowdsourced information with social media can help to address the limitation of losing control of large amounts of outgoing information under staff shortage, thereby increasing the reliability of real-time

information provision (Pender et al., 2014). The authors presented a solution that allowed individuals both directly and indirectly affected to report on problems (rather than relying solely on media outlets). For example, the Pittsburgh bus system created a system called Tiramisu to increase interactivity between commuters and bus operators to accurately predict bus arrival time by crowdsourcing bus location and capacity information. In addition, an alert mechanism to inform commuters of potential disruptions to service was also provided to address the reliability issue. Emerging research (Fu et al., 2015; Gu et al., 2016) explores data-mining techniques for early traffic incident detection and management using data from social media messages, which may have implications on transit system reliability and quality.

Given the wide usage of social media within public transportation agencies, the goals, strategies, objectives and effectiveness of using social media still appear to be unclear and inconsistent. Social media presence represents significant investments of staff resources to maintain sites, to respond to users' comments and to constantly update the public face of the agency on social media. Although social media replaces some communications via printed materials and physical mail, the savings from printing and postage may be offset by corresponding increases in social media staffing costs. Moreover, there is concern that social media may be effective in communicating with current riders, but less effective in communicating with potential riders (TCRP, 2012).

Most agencies currently measure social media effectiveness through built-in metrics such as numbers of "friends and followers" or "likes" or by using Google analytics. For example, Maryland Transit Administration tracks the growth of re-tweets and re-posting as indication of success in their social media approach. However, this information does not go far enough in justifying the investment of human resources in social media (TCRP, 2012). Simply collecting data without meaningful analysis is insufficient, and metrics developed with specific business objectives and approaches in mind are more likely to be useful (Owyang and Lovett, 2010). Therefore, it is necessary for social media programs to tie-in with the mission of the transportation agency, its purpose, operation objectives, priorities and agency's communication plan, and social media program monitoring and measurement need to be institutionalized to ensure benefits are accounted for and the cost of the program is justified (Bregman and Watkins, 2014).

Some recent efforts in attempting to develop social media performance metrics for public transit focus on "sentiment analysis" using Twitter for its real-time capabilities. Methods used for this type of analysis included "text mining", scanning text for positive and negative opinion words, and "machine learning", how a computer selects information based on a programmed algorithm (Schweitzer, 2014). Although sentiment analysis is a relatively cost effective approach to measuring transit rider satisfaction, and provides a straight-forward method to collect real-time data and to assess user-specific needs (Collins et al., 2013), it fails to adequately to assess other aspects of the relationship between social media investments and agency goals and objectives. The relevance of social media performance metrics and analytics for government agencies has been demonstrated by many scholars (Kavanaugh et al., 2012; Paris and Wan, 2011; Stieglitz and Dang-Xuan, 2013), but currently available analytics tools such as Hootsuite, Sprout or Google Analytics may not provide data and analysis that are applicable or adequate to address goals and objectives of public transit agencies or other government entities.

There is a growing number of public transportation agencies using various social media platforms to inform and engage with public transportation users and citizens. Social media has helped agencies to establish direct and transparent relationships with users, and qualitative evidence has suggested that it helps improve transportation services and operations. But well-designed social media performance metrics are needed to quantify and clarify the effectiveness of investments into these programs. Social media is becoming one of the primary modes of communication between agencies and the public, and yet there is still a lack of comprehensive understanding about when do different types of public transportation agencies utilize different social media platforms for various types of communications and the corresponding outcomes. In addition, it is essential to examine current social media measurements used by agencies to develop performance metrics and best practices in the evaluation of social media for public transportation agencies. In sum, the main research goal of this study is to understand the degree to which agencies are currently using social media, how they are using the platforms, what current social media measurements or metrics are in place, and what types of performance metrics may be practical and useful going forward.

Methodology & data

Based on the literature review and a preliminary examination of social media usage and measurement at public transit agencies, the research team designed and conducted an online survey of top transit agencies around the country in early 2015. In this survey, we collected general information about the agency's usage of social media programs, what purpose they use social media for and how they measure their programs. For example, how their social media programs are structured (e.g., objectives, measurements, strategies, etc.), which platforms they use, how many staff members are involved in social media usage, at what frequencies do they use social media for various purposes, how they measure their social media program outcomes and how they value these usages and metrics.

To construct the survey panel of transit agencies, we started with the *Transit Profiles: Top 50 Agencies* report from Federal Transit Administration's (FTA) National Transit Database (NTD). Additional contact information regarding individual staff members in each agency who manage the social media program were found through online searches, and verified via email and phone. The survey commenced in January 2015 with 43 public transportation agencies on the survey panel, and three rounds of reminders via emails and phone calls were completed to generate as many responses as possible. Twenty-seven

agencies completed the survey, representing a 63% overall response rate. Due to human subjects confidentiality restrictions, average characteristics of the responding agencies by region (Census Bureau designated statistical regions) are summarized in Table 1 with additional transit operations and supply data from FTA's NTD, and supplemental demographic data from the Census. We have a diverse mix of responding agencies representing larger metropolitan areas as well as mid-sized cities in terms of geographical area and population size, with an average percentage of population within the 18–44 age group between 36.9% and 39.4%, between 11.1% and 13.2% population aged 65 and above, and between 28.6% and 37.5% of population who identify as non-white. These agencies operate approximately 773 to 1262 vehicles at maximum (VOMS), with an annual average of 18 million to 25 million vehicle revenue miles (VRM), servicing 40 million to 80 million unlinked passenger trips (UPT).

In the next section, we analyze the characteristics of public transit agencies and their social media usage through descriptive statistical analysis. And then, we conduct a correlation analysis to examine how social media programs, structures, uses and measures at public transit agencies are correlated with demographic and transit operation characteristics. Finally, we will analyze the determinants of social media usage and program structure among those cities and agencies with several multivariate regression models. In addition to hypothesizing that demographics such as service population size, age distribution or geographic location and transit operation characteristics may impact social media usage, we utilize the Akaike information criterion (AIC) approach, a method optimizes the tradeoff between the goodness-of-fit and the complexity of the model, to narrow down variables chosen for each model. Each model was checked for multicollinearity by examining the variance inflation factors (VIF), dropping explanatory variables with high multicollinearity factors to arrive at the final models detailed below.

Findings

Social media usage and measurement in public transit agencies

All responding public transit agencies indicate some level of social media presence. Nearly all agencies use multiple social media platforms, averaging 3.7 platforms. As shown in Fig. 1, Twitter, Facebook and YouTube are the most common-used social media, with 100%, 93% and 81% of the agencies using each of these three platforms, respectively. In addition, nearly half of the respondents also use Instagram, while a handful of agencies indicate usage of LinkedIn, Flickr, Nextdoor, Pinterest, and SmugMug, etc. The structure of their social media programs usually includes some planning and/or evaluative processes, with 81% structured with social media strategies, 78% with methods to measure results, 74% with targeted audiences, 63% with clearly defined goals, and 63% with measurable objectives.

In terms of staff resources invested in social media, most agencies have multiple staff members working on their social media programs. Over 40% of responding public transportation agencies have full-time staff exclusively dedicated to social media work, with an average of 1.36 full-time equivalent staff members. In many agencies, while there is not personnel dedicated exclusively to social media communications, the responsibility is spread amongst multiple staff members who have other job responsibilities, averaging around 5 employees. A small proportion of agencies (11%) have one person fully dedicated to social media, but no other staff have any social media responsibilities.

Public transit agencies responded to questions regarding the frequency that they used social media communications for specific purposes, and how much they valued these uses. We found that public transit agencies most frequently use social

Table 1
City and agency attributes of responding public transit agencies by census statistical region.

	Midwest	Northeast	South	West
Agencies sampled	6	10	11	16
Number of responses	4	7	5	11
Demographics *(average)*				
Service area (sqkm)	5254	2916	2464	2008
Service population	3,922,902	2,059,246	1,800,018	1,896,442
% age 18–44	37.3%	36.9%	39.4%	39.0%
% age 65 +	11.5%	13.2%	11.1%	11.6%
% non-white	28.6%	32.8%	31.3%	37.5%
Transit operations *(average)*				
Vehicles operated in annual maximum service (VOMS)	975	1262	773	969
Vehicle revenue miles (VRM)	25,122,218	18,871,957	18,748,511	18,375,619
Deadhead miles	3,357,675	2,872,843	2,830,736	2,564,176
Unlinked passenger trips (UPT)	54,217,603	80,347,369	40,335,393	53,452,994

Note: Census Bureau statistical region designations include the following states in each region: Midwest (Illinois, Indiana, Michigan, Ohio, Wisconsin, Iowa, Kansa, Minnesota, Missouri, Nebraska, North Dakota and South Dakota), Northeast (Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont, New Jersey, New York and Pennsylvania), South (Delaware, District of Columbia, Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia, West Virginia, Alabama, Kentucky, Mississippi, Tennessee, Arkansas, Louisiana, Oklahoma and Texas) and West (Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, Wyoming, Alaska, California, Hawaii, Oregon and Washington).
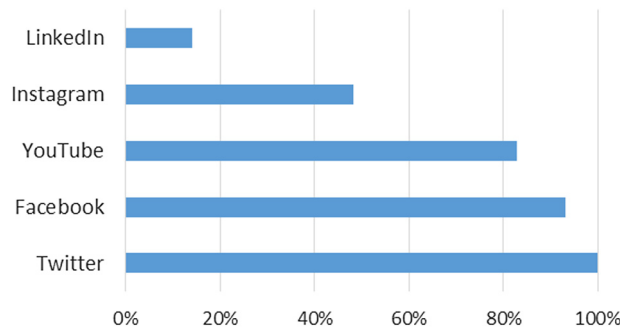
Fig. 1. Use of major social media platforms by responding public transit agencies.

media to communicate with and to respond to comments from their customers as shown in Fig. 2. More than half of the agencies frequently use social media to provide transit system information and updates, but less than a quarter of the agencies frequently use social media as a channel to provide transit-related livability or sustainability benefits, such as how public transit enhances quality of life, reduces congestion, enhances positive environmental impacts and safety issues. Although social media is not frequently utilized to provide messages and information regarding livability or sustainability enhancements through public transportation, we found public agencies place a relatively high value on this type of livability-related usage of social media, compared to other usages.

With regards to the measurement of social media usage within agencies, we found that more than half of public transit agencies frequently measure their social media programs through users' engagement activities and subscriber levels (i.e., re-tweets or followers). Few of them are likely to measure their social media outcomes utilizing users' positive perceptions similar to sentiment analysis (Collins et al., 2013), such as the number of people who are receiving real-time information, number of people who consider public transit agencies as reliable and/or environmentally sensitive, and number of positive-toned messages about the transit agencies. For all types of measurement of social media, we observe that public transit agencies place high value on measuring many aspects of their social media engagement, yet they do not frequently measure them in practice. This result greatly underscores the underlying need to not only utilize social media but to better understand its impacts and outcomes. Additionally, we observe a similar trend as when we analyze the purposes of social media usage: the discrepancies between the frequency of use of measurement metrics and the perceived value of these metrics by public transit agencies are much greater for those metrics that are less frequently utilized.

Social media usage across regions and agencies

Social media programs and usage patterns also vary across geographic regions as shown in Table 2. Public transit agencies in the Northeast tend to have more staff members (either full-time or other staff) working on social media programs on aver-
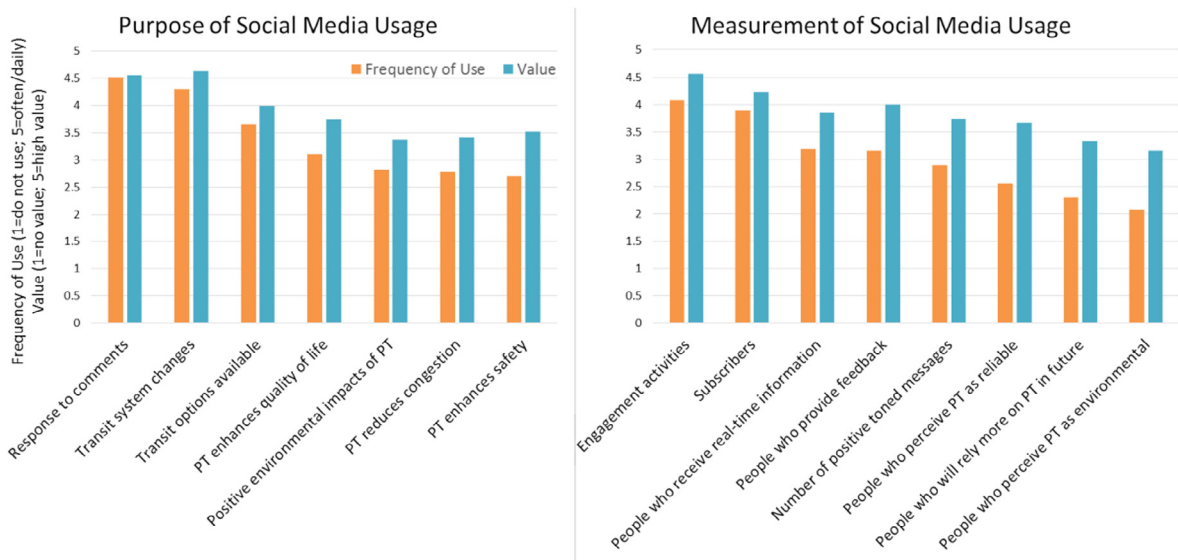

Fig. 2. Purpose and measurement of social media usage – frequency of use and value.

Table 2
Social media usage survey results by census statistical region.

Variable	Midwest	Northeast	South	West	Overall average
Social media program structure[a]	4.00	3.43	3.80	3.45	3.59
Number of social media platforms	4.25	3.14	3.60	3.91	3.70
Full-time staff dedicated to social media	0.75	0.93	0.60	0.30	0.58
Other staff with social media responsibilities	3.25	4.86	2.60	6.93	5.04
Purpose of social media usage					
Frequency of use[b]					
For transit information updates [F1]	4.25	4.29	4.20	3.64	4.00
For conveying transit related livability benefits [F2]	2.88	2.68	3.35	2.73	2.85
For communication with users [F3]	4.50	4.29	4.80	4.55	4.52
Value of use[c]					
For transit information updates [FV1]	4.13	4.57	4.40	3.41	4.31
For conveying transit related livability benefits [FV2]	3.75	3.21	4.00	3.41	3.52
For communication with users [FV3]	4.50	4.29	4.60	4.73	4.56
Measurement of social media usage					
Measurements[d]	1.00	0.71	0.80	0.73	0.78
Frequency of use[e]					
Number of subscribers [M1]	4.25	4.43	4.60	3.18	3.89
Users' positive perception/sentiments [M2]	3.13	3.12	2.70	2.27	2.70
Users' engagement [M3]	4.25	3.86	4.00	3.18	3.61
Future commitment to utilize public transit [M4]	2.50	2.14	3.00	2.27	2.30
Value of use[f]					
Number of subscribers [MV1]	4.00	4.71	4.60	3.82	4.22
Users' positive perception/sentiments [MV2]	3.75	3.61	3.70	3.50	3.60
Users' engagement [MV3]	4.63	4.36	4.30	4.09	4.28
Future commitment to utilize public transit [MV4]	3.00	3.00	3.80	3.45	3.33

[a] Structure: How is the social media program structured? This value varies from 0 to 5, indicating the total number of social media program components (goals, objectives, strategies, ways to measure results and target audiences) that exist in the public transit agency.

[b] Purpose of Social Media Usage - Frequency of use: How frequently the public transit agency uses social media for specific purposes? Frequency ranges from 1 to 5, indicating do not use, infrequent, somewhat, frequent and often/daily.

[c] Purpose of Social Media Usage - Value of use: How valuable is the usage of social media for specific purposes at the public transit agency. Value of use ranges from 1 to 5 to represent no value, little, some, valued, and high value.

[d] Measurements: Whether the agency's social media program is structured with ways to measure results (1 = yes; 0 = no).

[e] Measurement of Social Media Usage – Frequency of use: How frequently the public transit agency measures its social media usage using certain metrics. This value ranges from 1 to 5, stands for no use, somewhat, frequent and often. Frequency ranges from 1 to 5, indicating do not use, infrequent, somewhat, frequent and often/daily.

[f] Measurement of Social Media Usage – Value of use: How valuable of the agency measure social media using certain metrics. Value of use ranges from 1 to 5 to represent no value, little, some, valued, and high value.

age, while agencies in the West are more likely structure their social media staffing to spread social media responsibilities amongst multiple staff members instead of dedicated social media employees. On average, agencies in the Midwest have social media programs with the most structured components (e.g., goals, objectives, strategies, ways to measure results and target audiences) and engage in an average of 4.25 social media platforms, even though these agencies did not have the largest number of exclusive social media employees or other staff members.

In terms of the purpose of using social media, agencies in West use social media less frequently to provide transit system information or to convey transit-related benefits to public compared to their counterparts across the country. Agencies in the West typically utilize social media most frequently for responding to users' comments and criticisms. In contrast, agencies in the South spread their social media usage across diverse purposes. Similarly, agencies in the West value responding to users through social media much more compared to agencies in other regions, and more importance is placed on this particular use when compared with other purposes of social media.

When asked about the measurement of their social media program through various metrics, all Midwest responding agencies indicated the usage of some social media measurement metric, while only 80%, 73% and 71% of agencies in the South, West and Northeast regions employed metrics, respectively. Agencies in the South and the Midwest are more likely to use multiple metrics to measure their programs than other two regions. Numerous comments from agencies specifically point out the lack of uniform performance measures and best practices available for social media usage.

Expanding upon the descriptive statistical analysis, we conduct a correlation analysis with results presented in Fig. 3. The colored dots in this correlation matrix represent correlation relationships between public transit agency social media usage characteristics that we obtained from our survey results and city/agency demographic and transit operation attributes that are statistically significant at 5%, with blue dots indicating positive correlation and red dots indicating negative correlation. Although one would surmise that a larger city may utilize social media at a higher rate due to its larger geographic area, diverse population, the public transit agency's need to communicate with a large audience, and more resource availability, we find that this is not the case according to our survey results. Larger cities, measured both in terms of public transit service
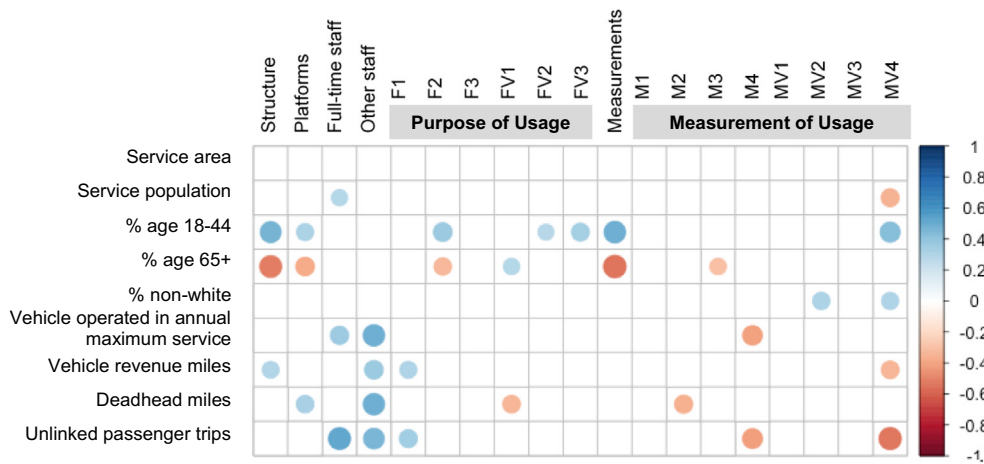
Fig. 3. Correlation matrix of social media usage and city/agency attributes ($n = 27$) Note: Dots indicate statistical significance at 5% level. Please refer to Table 2 for variable descriptions.

area and population size, show weak or insignificant correlations with almost all measures of social media usage. In addition, agencies in larger cities appear more likely to use social media to provide transit system information as opposed to communicating livability benefits of public transit or interacting directly with users. However, larger transit systems, in terms of the maximum number of operated vehicles (VOMS), vehicle revenue miles (VRM) and unlinked passenger trips (UPT), are positively associated with more labor inputs invested in social media programs.

On the other hand, the age composition within a city is strongly correlated with agencies' social media usage, in terms of social media program structure, purpose of use and performance metrics. This result fits with intuition and previous research (Chou et al., 2009; Duggan and Brenner, 2013) that indicate stronger engagement of the younger population through social media platforms, although this may be a shifting trend. If the proportion of people in the 18–44 age group is higher in a city, the public transit agency's social media program is more likely to be structured with multiple components, engaged in a greater number of social media platforms, and would be used for larger variety of purposes. In addition, "younger cities" are positively associated with the usage of multifaceted social media metrics, and tend to place particular importance on whether or not social media users are indicating a commitment to utilize public transportation more in the future. These strong correlation patterns are reversed when considering the percentage of population aged 65 or above. Racial composition generally has no relationship with social media usage, which implies that the usage and measurement of social media appears to be consistent regardless of the level of racial diversity within the service population.

Factors influencing social media usage in public transit agencies

To delve further into understanding factors that determine public transit agencies' social media usage, we constructed several multivariate regression models. These models are not intended to determine causality of certain attributes on social media usage or participation by agencies; rather, these types of regression specifications allow us to expand upon one-on-one correlation analysis to allow us to elucidate how specific attributes of agencies or cities are related to social media usage and measurement while controlling for other variables. The regression models results with the best goodness-of-fit measures are shown below in Table 3, and standardized coefficients are reported to reflect the independent variables which have the largest effects in describing the usage of social media. We find that social media usage is most significantly determined by agencies' geographic region, age composition of the city, and its public transportation system characteristics.

In our regression analysis, we use a variety of variables as proxies of the extent of social media usage as the dependent variable. In Model 1, an agency's social media program structure, whether it includes components such as goals, objectives, strategies, ways to measure results and target audiences, is the dependent variable. The number of full time staff members with exclusive social media responsibilities is modeled in Model 2 to explore the determinants of resource investment. Models 3–5 utilize dependent variables which represent how public transit agencies measure its social media usage or outcomes. R-squared values range between 0.30 and 0.478 for the estimated models, indicating that the explanatory variables describe approximately 30–47.8% of the variation in various measures of social media usage. F-statistics for all models indicate statistical significance at 5% or better.

In Model 1 and Model 2, unlinked passenger trips (UPT) is the most positive predictor of both social media structure and number of full time social media staff, which means the transit service consumption is the most important determinant of social media program structure and labor investments. The number of vehicle operated in annual maximum service (VOMS) and vehicle revenue miles (VRM) are estimated to have negative and significant coefficients in these models. It is interesting to note that transit service consumption or usage (UPT) and the service supplied (VOMS and VRM) have opposite effects on social

Table 3
Regression model results with standardized coefficients (*t*-statistic) for social media usage ($n = 27$).

Variables	Model 1	Model 2	Model 3–1	Model 3–2	Model 4	Model 5
	Social media structure	Full-time staff	Use of social media measurement metrics		Positive perception	Engagement
Geographic variables (reference region = Midwest)						
Region - Northeast			−0.207 (−0.85)	−0.075 (−0.33)	0.049 (0.22)	−0.034 (−0.14)
Region - South			−0.464* (−1.85)	−0.449* (−2.04)	−0.336 (−1.46)	−0.131 (−0.60)
Region - West			−0.581* (−2.06)	−0.471* (−1.86)	−0.627** (−2.51)	−0.584** (−2.44)
Demographic variables						
Service area (sqkm)			0.092 (0.51)	0.289 (1.58)		
Service population		0.268 (1.61)				
% age 18–44		0.193 (1.19)	0.715** (3.64)	0.909*** (4.89)	0.394* (2.00)	
% age 65+	−0.707*** (−4.66)					−0.509** (−2.74)
Transit operation variables						
Vehicles operated in annual maximum service (VOMS)	−0.545* (−2.63)			−0.718** (−2.74)		−0.415* (−1.76)
Vehicle revenue miles (VRM)		−0.516** (−2.33)			0.298* (1.74)	
Deadhead miles				0.413** (2.30)	−0.403** (−2.26)	
Unlinked passenger trips (UPT)	0.806*** (3.72)	0.84*** (3.84)		0.486** (2.22)		0.517** (2.09)
Adjusted R-square	0.478	0.354	0.300	0.466	0.357	0.328
F-statistic (p-value)	8.93 (0.000)	4.56 (0.008)	3.32 (0.026)	3.83 (0.009)	3.42 (0.018)	3.11 (0.026)

The dependent variable is listed in the top row of each regression model.
*** Statistically significant at 1% level.
** Statistically significant at 5% level.
* Statistically significant at 10% level.

media usage. These agencies with more passenger trips and provide lower supply of transit services are usually perceived to be more efficient; namely, they serve larger number of trips with fewer vehicles or miles. Therefore, the combination of these coefficient estimates strongly indicate that more "efficient" public transit agencies tend to have more comprehensive social media program structures and higher levels of labor inputs in their programs. These two models confirm that while larger population size and having a younger population positively influence social media usage (although not statistically significant), the percentage of senior population shows statistically significant negative impacts on the structure of social media programs. It fits with common intuition that the older generation in cities are less likely to be active in social media.

In Model 3-1, we confirm the descriptive statistical analysis detailed in the previous section that agencies in cities with a younger population tend to have a significantly higher likelihood of using some type of social media metrics, even after controlling for other variables. With a population and generation that is engaged with social media on a daily (or even hourly) basis, it is reasonable these agencies are invested in figuring out how well their social media program is reaching its audiences and whether engagement and interaction on social media may meet the agency's objectives and goals. Again, regional differences in the measurement of social media usage and outcomes are evident in these models. Similar to Models 1 and 2, we find that agencies with higher service consumption and lower service provision to be more engaged in the measurement of their social media at present. Agencies typically aim to reduce deadhead miles in order to increase its operational efficiency. Interestingly, Model 3-2 shows that the higher the transit service operation efficiency, in terms of fewer deadhead miles, the lower the likelihood of using social media metrics. This is possibly an indication of the allocation of resources toward managing transit operations rather than toward communications or outreach in these types of agencies.

Model 4 and Model 5 are constructed to more thoroughly examine the factors that influence the specific kind of measurement metrics used by agencies. Even after controlling for demographic variables and transit operation characteristics, we find that agencies in West are less frequently using metrics that measure users' positive perception of public transit services or users' level of engagement with transit agencies, which is possibly due to their lower social media staff levels and social media programs with fewer structural components. Again, age composition in the public transit agency's city significantly affects the usage of social media metrics: agencies in cities with a younger or less senior population use positive perceptions and engagement measures more frequently as social media metrics.

In conclusion, we find that public transit service consumption or usage as measured by unlinked passenger trips (UPT) and the level of transit service provision are the most significant determinants of public transportation agencies' social media programming and labor resource investments. In contrast, the measurements of social media usage and outcomes are determined more by city attributes and demographic characteristics, such as age composition and geographic region.

Conclusion & future research

Social media has been gaining prominence in public transit agencies in their communication strategies and daily management. There are many more public agencies with social media presence currently, and they are engaged in more platforms than ever. While most public transit agencies still lack clearly-defined goals and comprehensive performance metrics to guide their social media development, they are gradually organizing and increasing their social media capacity through more structural components. Many of the agencies surveyed are well-invested in social media usage and have staff members who are exclusively dedicated to social media, but it is still common for agencies to distribute social media responsibilities amongst multiple staff members who perform other job duties. In essence, agencies primarily use social media to respond to users' needs and provide transit system information. Our survey results indicate that it is reasonable to anticipate increasing usage of social media to convey transit related stories and benefits, such as environmental benefits, safety and livability improvements, as social media programs expand.

We find that there are many patterns and trends in social media usage and the measurement of its outcomes that vary across geographic regions and agencies from our descriptive statistical analysis, correlation analysis and multivariate regression modeling. Note that these results come from analytic tools that are not intended to establish causality.

- Social media usage is not significantly different between bigger and smaller cities, but it varies across geographic regions. Agencies in West have fewer full time staff dedicated to social media, and they tend to utilize social media for only a select handful of purposes and employ simpler metrics to measure programs. Agencies surveyed in the South and Midwest, on average, tend to engage in social media for larger variety of purposes and use more diverse metrics.
- Age composition in cities significantly impacts nearly all aspects of social media usage. In cities with a younger population, the public transit agencies tend to have more structured goals, objectives or strategies for its social media programs, higher levels of staff resource commitments, and multiple metrics for measuring social media outcomes. Because the younger generation tends to be heavily engaged in social media population, we expect that transit agencies in "younger cities" may have the most to gain from better organizing their social media programs, using the platforms for diverse purposes, and to design comprehensive performance metrics to better target investments in their transit service development.
- The number of passenger trips (transit service consumption) and the level of public transit service provision are significant determinants of the structure of social media programs, level of staffing, and the usage of metrics in public transit agencies.

Public transportation agencies have made investments to incorporate social media into their operations and communities, and consider social media to be an important channel to interact and respond to transit riders as well as other citizens. Although many agencies are committed to measuring their social media outcomes and highly value these performance metrics, there does not currently exist consistent methodology for evaluating the impacts of social media usage and investments.

We believe that it will be essential to develop best practices for measuring the impacts and performance of social media communications in public transit agencies, and this study serves as a fundamental starting point. Consistent performance measures will assist agencies to achieve their overarching goals of advancing their public transit missions, better allocating scarce resources, improving customer satisfaction, and addressing performance efficiency and effectiveness for future development. While this research provides much needed understanding about what types of agencies are using social media, how much staffing is invested, the purposes and values of social media usage as well as the utilization and valuation of social media measurements, the logical next step would require analyzing public transit agency social media and/or communication strategies and plans to synthesize social media goals and objectives. Further data-mining techniques can also be employed to analyze content and interactions. Finally, best practices guidelines and consistent performance measures for social media in public transit agencies can then be developed to map directly to these goals and objectives.

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