Social Media Practices in Traffic Safety

A Study Conducted Under NCREP — The National Cooperative Research and Evaluation Program

U.S. Department of Transportation
National Highway Traffic Safety Administration

GHSA
Governors Highway Safety Association
The States' Voice on Highway Safety

NHTSA

Suggested APA Format Citation:

Sack, R., Foreman, C., Forni, S., Glynn, R., Lehrer, A., Linthicum, A., & Perruzzi, A. (2019, May). *Social media practices in traffic safety* (Report No. DOT HS 812 673). Washington, DC: National Highway Traffic Safety Administration.

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT HS 812 673		

4. Title and Subtitle	5. Report Date
Social Media Practices in Traffic Safety	May 2019
	6. Performing Organization Code
7. Authors Rachael Sack, Christina Foreman, Sara Forni, Russell Glynn, Andy Lehrer, Alex Linthicum, and Adam Perruzzi Volpe National Transportation Systems Center	8. Performing Organization Report No.
9. Performing Organization Name and Address John A. Volpe National Transportation Systems Center 55 Broadway Cambridge, MA 02142	10. Work Unit No. (TRAIS)
	11. Contract or Grant No.
12. Sponsoring Agency Name and Address National Highway Traffic Safety Administration 1200 New Jersey Avenue SE Washington, DC 20590	13. Type of Report and Period Covered Final Report
	14. Sponsoring Agency Code NPD-320

15. Supplementary Notes
The authors acknowledge the NHTSA Regional Offices and SHSOs from Kansas, Maryland, New Mexico, New York, Ohio, Pennsylvania, South Carolina, Tennessee, and Texas for data collection activities.
Mary T. Byrd was the NHTSA project manager.

16. Abstract
This study researched how State Highway Safety Offices (SHSOs) are using social media, and the opportunities, benefits, and challenges social media presents. While social media continues to rapidly evolve, this report provides statistical analysis on the state of the practice of SHSO social media. It also describes new and creative ways SHSOs are sharing information, ideas, and other content – and how these activities can be measured or tracked.

17. Key Word	18. Distribution Statement
social media, safety messaging, engagement	This document is available to the public through the National Technical Information Service, www.ntis.gov.

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	83	

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1. Acknowledgement

The project team would like to thank those who participated in the NHTSA Regional Office interviews and SHSO interviews. The information they provided was critical to the implementation of the project and informed many steps throughout. The team hopes that this report will be a useful resource to SHSOs who operate their social media at varying levels of development and that new information can be gleaned from the various sections of this report to help inform their future social media operations.

2. Executive Summary

This report features the results of the project, "Social Media for Traffic Safety," which was conducted by the U.S. Department of Transportation's Volpe Center (Volpe) for the National Highway Traffic Safety Administration (NHTSA) and Governors Highway Safety Association (GHSA) under the National Cooperative Research and Evaluation Program (NCREP). The study researched how State Highway Safety Offices (SHSOs) are using social media and the opportunities, benefits, and challenges social media presents. While social media continues to rapidly evolve, this report looks at the current state of the practice of SHSO social media, including new and creative ways SHSOs are sharing information, and how these activities are being measured or tracked.

Social media as a communications tool is growing in importance to the public safety community as they work to share meaningful and even life-saving information with their target audiences. Volpe developed this project to support NHTSA and GHSA in better understanding social media's evolving role in highway safety through an informative review that was both qualitative and quantitative. The study used publicly available data from the Twitter and Facebook accounts accessible from SHSO website homepages and paired the data with information collected from interviews with the 10 NHTSA Regional Offices and a sample of 9 SHSOs. Together, the data analysis and discussions provided insight into the multi-dimensional processes used by SHSOs to create engaging, safety-focused social media.

The project team conducted a series of analyses using both quantitative and qualitative data to explore three key areas: (1) What current SHSO social media looks like; (2) How SHSOs' social media approaches vary; and (3) How social media is being measured or tracked. To address these areas, this report describes the methodology used to collect this information along with the quantitative and qualitative analytical results. This report aims to increase the understanding at a national scale on how SHSOs are currently using social media for safety messaging and identifying areas that can be further explored to continue advancing the practice.

A common theme that arose is that there is no one way to deliver social media. Instead, there are a variety of ways to achieve a highly engaging social media approach; and, as such, there are also a variety of ways to both define and measure successful social media messaging. This variance is what makes social media an area filled with trial and error. To help inform this process, this report provides information on promising practices and case study examples for using social media in traffic safety.

Six promising practices are presented in this report. The promising practices are designed to help inform planning and decision-making within a platform; they are not designed for comparing Facebook and Twitter because both platforms are unique in how engagement can be measured. These promising practices derive from analysis and identification of national trends of safety messaging used by SHSOs for Facebook and Twitter, examples of safety messaging with high

engagement, and case study examples from the SHSO interviews that were conducted. The promising practices are:

- Reuse safety messaging on multiple platforms;
- Consider the tone of your safety messages;
- Use pictures, videos, and links strategically;
- Use hashtags selectively;
- Time the posting of content to meet stakeholders' needs; and
- Collaborate with other State and local accounts to increase visibility of safety messaging.

3. Introduction

Traditional media, like newspaper and television, are typically one-way interactions that lack any mechanism for active engagement with audiences. Social media sites, however, aim to create online communities to share information, ideas, personal messages, and other content. The goal is to create content that attracts attention and encourages readers to share it across their social networks. As such, social media can require a new level of staff expertise and place more demand on SHSOs, especially if it involves proactive posting of content, writing blogs, and managing forums. It can also be a very efficient and cost-effective method to launch new highway safety messages or services. This project will investigate the extent to which highway safety offices are using social media and the opportunities, benefits, and challenges it poses.

The research objectives for this study were two-fold: The first was to describe the SHSO social media programs for traffic safety. The second was to identify opportunities, benefits, and challenges tied to SHSO social media. The report is organized into sections as shown in Table 1.

Section Number	Description
1. Acknowledgement	Identifies stakeholders who have been engaged during the project
2. Executive Summary	Provides a summary of the research problem and project approach
3. Introduction	Identifies the research problem and provides an overview of the project approach
4. Methods	Describes the methodology used in the study, including the technical data collection and stakeholder information gathering
5. Results	Details the results of the quantitative and qualitative data collection
6. Discussion	Describes the data analysis results and introduces promising practices and SHSO case studies based on the analysis
7. Limitations	Explains the limitations in the data collected and analyzed as well as the information collected in interviews
8. Conclusion	Concludes the report with a brief summary and highlights research areas outside of this study that may help further the understanding of effective social media for safety messaging
9. Appendices	Provides information on relevant literature review resources and visual depictions of national trends based on SHSO safety messages collected from Facebook and Twitter

Table 1. Description of report sections.

4. Methods

The methodology for this project was comprised of three steps:

Preliminary Data Gathering – The initial data gathering step created an inventory of SHSO social media based on review of SHSO websites accessible via the GHSA website listing found at www.ghsa.org/about/shsos. This information was analyzed to assess what platforms were being used most frequently to prioritize what should be researched further. Data gathering was also done through introductory calls with each NHTSA Regional Office to better understand that office's awareness or knowledge of the maturity levels (e.g., resources, robustness, and impact) of varying State's traffic safety initiatives and gauge any awareness of SHSO social media use as a tool in educating and engaging the public on safety-related issues.

In addition, a literature review was conducted to better understand the overall state of the practice of social media. A summary of resources was compiled to serve as a tool for SHSOs with varying levels of expertise in social media. Appendix A includes a short-list of resources identified from fall 2016 that provides articles on a variety of social media operations and government use of social media.

Quantitative Scan – To begin this step, several tools were evaluated to determine how best to collect and analyze information on Twitter and Facebook, the most popular of the SHSO social media platforms used by SHSOs. Data was collected for the 12-month period from April 1, 2016 to March 31, 2017. Data was analyzed from multiple perspectives to identify statistical relationships between engagement and account managers (e.g., DOTs, SHSOs, law enforcement, or other agencies), message qualities (e.g., length, sentiment, hashtags), and messaging strategies (e.g., time of year, day of week, time of day).

Qualitative Scan – A qualitative scan was conducted by selecting 9 SHSOs to interview about their social media operations and successes and challenges. Interviewees were selected to represent varying sizes of social media accounts (based on followers), the degree of safety-focus in their social media messaging, engagement rates of their safety messaging, and a cross representation of SHSOs who operate independently or are managed under a State DOT, law enforcement agency, or other agency such as a registry or Department of Motor Vehicles or an economic development agency. The interviews focused on how these SHSOs use social media to promote safety as well as the successes and challenges they have experienced in this area. Table 2 on the following page provides the list of interviewees.

While each of these three steps had its own purpose as part of the project's methodology, they were closely linked and used together to inform the promising practices, additional findings, and featured case study examples.

SHSOs INTERVIEWED							
State	Owner / Operator	Facebook			Twitter		
		Followers	# Safety Messages	% Messages that are Safety	Followers	# Safety Messages	% Messages that are Safety
Kansas	DOT	3,012	608	80.85%	15,974	2,792	75.05%
Maryland	Other (DMV)	8,541	29	15.10%	4,540	1,742	37.76%
New Mexico	DOT	*Facebook and Twitter accounts for New Mexico not included in inventory because they are not accessible via the SHSO homepage.*					
New York	SHSO	5,869	118	71.52%	105	70	88.61%
Ohio	Law Enforcement	182,417	387	39.73%	37,405	1,677	46.71%
Pennsylvania	DOT	116,050	232	40.63%	39,046	1,164	30.40%
South Carolina	Law Enforcement	10,360	90	47.62%	6,136	813	42.26%
Tennessee	SHSO	5,824	715	92.38%	1,603	1,938	72.80%
Texas	DOT	185,049	411	36.15%	65,923	1,446	38.44%

Table 2. SHSOs interviewed and related summary statistics.

4.1 Assumptions and Approach

Account Selection There are many kinds of social media platforms and many ways to locate accounts on those platforms. Some accounts are linked directly to webpages, and others may be referenced in descriptions and content on other platforms. To standardize the process, the team started from the list of SHSOs available on the GHSA website From here, each State's webpage was investigated to search for social media accounts. Some social media accounts were highlighted directly, and others were accessible via social media icons at the top and/or bottom of the website pages.

All types of accounts that were listed on these pages were included in the inventory of accounts. This includes common platforms such as Facebook, Twitter, and YouTube, as well as newer social media platforms such as Snapchat and Nixle. This study analyzed Twitter and Facebook accounts because they were most common among SHSOs and represent the widest audience of social media users in the general population. Although there may be other SHSO Twitter and Facebook accounts in existence, accounts not linked from the State website were not included in the analysis.

Identifying Account Types Once all accounts were identified, they were grouped by account type. These types were determined based on who manages the social media account. The four types—SHSO, DOT, Law Enforcement, and Other—are defined later in this section. To determine the type, the team researched the organizations to which the account managers reported. Many of the managing groups were a part of the SHSO or a part of the State department of transportation. Of the remaining accounts, a segment was part of a law enforcement agency. This included State highway patrol and State public safety departments. The remaining accounts were run by the department of motor vehicles or the State community development department, or they were maintained as a general State government account.

Defining and Identifying Safety Messages The large volume of social media content generated by the accounts necessitated development of a machine-interpretable definition of safety messages. To develop a machine-interpretable definition, the team first developed a human-interpretable definition that specified criteria that human decision-makers could use to identify safety messages consistently. This standardization allowed multiple people to classify messages in the same manner, ensuring consistent training of the machine-interpretable definition.

The human-interpretable definition was broken into three components. Satisfaction of any one of these three criteria resulted in classification as a safety message. The three criteria were:

- Includes a call to action to influence transportation users—specifically motorists', cyclists', pedestrians', and passengers'—behaviors to reduce risk to self and/or others
- Raises awareness of transportation-related risks to persons or property
- Raises awareness of transportation safety-related offices, programs, activities, or events

The final component of the definition was that the messages were not related to a geographically and temporally contained event without a connection to a broader context. Using the above criteria, independent evaluators could correctly categorize the messages described in Table 3.

Social Media Message	Evaluation Rationale
Two drivers killed, three others injured in wrecks WITHOUT safety restraints. Buckle up.	This is a safety message because it both raises awareness of a transportation-related risk and a call to action.
Law enforcement agencies get traffic safety grants: <link>.	This is a safety message because it raises awareness of transportation safety-related offices and their activities.
I-35 Alert: 10-vehicle crash closed down all main lanes of I-35 SB @ Woodlawn Rd MM 319. Traffic backed up to FM 2837. Expect delays.	This is not a safety message, because though it raises awareness of a transportation-related risk, it is over a limited section of road and of limited duration.
I-95 Update: Construction along I-95 SB this week between MM 119 and MM 127. Slow down and keep our workers safe. #orangeVest	This is a safety message, because though the transportation-related risk is over a limited section of road and of limited duration, the message includes a safety message to drive safely in work zones.
Federal grant helps Japanese auto supplier create 150 jobs	This is not a safety message. Even though it is transportation-related, it is not safety-related.
Falling Back into Safety: Hoosiers Should Use the Time Change as a Reminder to Check Smoke Alarms	This is not a safety message. While safety-related, it is not transportation-related.

Table 3. Sample social media messages and evaluation used to categorize messaging.

4.2 Engagement-Related Definitions

Several terms are used throughout this paper to characterize the results. This section describes these terms.

Engagement is a common term within the field of social media analysis that describes the interactions social media users have with the content they encounter. These interactions are built into the user experience and vary from platform to platform. From the perspective of an account manager, the volume and type of engagement garnered by each post can indicate the success of a message. On Facebook and Twitter, users can like or favorite content, indicating their appreciation or support for a given post or tweet. Users can also share or, in the case of Twitter, retweet content to spread a message on their own account. On Facebook, users can also comment on posts, adding their voice to the conversation about the content of the post. On Twitter, users may reply to tweets, however, replies were not included in this study because Twitter's application programming interface (API) did not provide number of replies. The types of engagement analyzed in this study are shown in Figure 1.

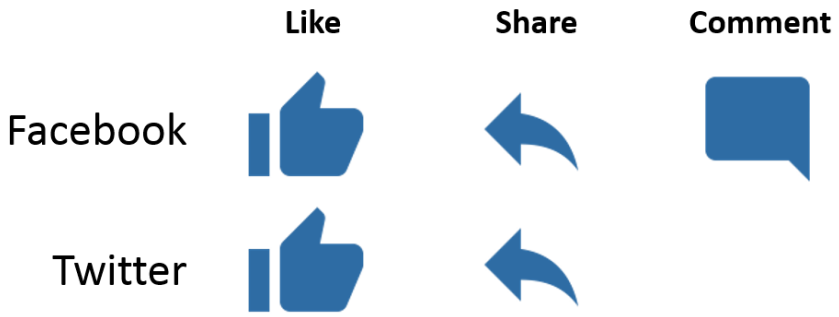

Figure 1: Types of Facebook and Twitter engagement analyzed in this study.

Engagement rate is also a common social media metric that measures the engagement an individual post or tweet receives within a given account. The engagement rate formula, shown in Figure 2, compares the amount of engagement generated by a post (the number of likes, shares, comments) to the number of account followers who could have engaged with the message at the time of posting. If each follower were only able to engage once, the engagement rate could be understood as the percentage of followers who engaged with the content. However, since Facebook and Twitter offer users multiple ways to engage with content, the engagement rate requires careful interpretation.

$$\frac{\text{Engagements}}{\text{Total Number of Followers}}$$

Figure 2: Formula for engagement rate calculation.

Engagement rate is a useful metric for analyzing the effectiveness of social media content, but it is most reliably used to compare posts that were viewed by a similar number of followers. Because the formula relates the engagement received with the number of account followers, engagement rates are on a similar scale for a given account, if the number of followers does not change rapidly. Thus, engagement rates are most useful in comparing the performance of messages within one account. When comparing among accounts with differing numbers of followers, the rates may not be comparable due to the substantial influence of the denominator value in the calculation. In other words, collections of social media messages with very small numbers of followers typically have higher engagement rates than those with considerably more followers.

Engagement Index is a metric developed for this study that attempts to address account-to-account comparison issues. It does this by standardizing each account's engagement rates based on its number of followers. Removing the variability in engagement rates allows for comparisons across multiple accounts. This standardization places the engagement rate of each post on a scale from zero to one, where each account's post with the lowest engagement rate receives a zero,

each account's post with the highest engagement rate receives a one, and all other posts are interpolated between zero and one. The formula for doing so is shown below.

$$EI = \frac{ER - ER_{min}}{ER_{max} - ER_{min}}$$

- EI = Engagement index
- ER = Engagement rate
- ER_{min} = Minimum engagement rate, among that account's messages
- ER_{max} = Maximum engagement rate, among that account's messages

The team found minimum and maximum engagement rates for each account and used these to determine the engagement index for messages from that account. The message with the lowest (minimum) engagement rate has an engagement index of zero because the top portion of the equation ($ER - ER_{min}$) will be zero. The message with the highest (maximum) engagement rate has an engagement index of one because the top and bottom portions of the equation will be the same ($ER - ER_{min} = ER_{max} - ER_{min}$).

Followers are users on the social media platforms who are tracking a given account's content. These users choose to follow another Twitter user and/or have liked a Facebook page. This means that the users see content from these other accounts and pages in their content stream they receive from the platform. While it is possible that other users can view an account's content, the account's followers are the primary viewers.

Account managers can come from many different organizations. To allow for analysis of differences among organizations, the account managing agencies were labelled with organization types. For this study, the possible organization types are:

- ***SHSO***: Run by the State highway safety office itself;
- ***DOT***: Run by the State's department of transportation;
- ***LE***: Run by a law enforcement agency within the State (e.g., State troopers); and
- ***Other***: Run by an agency that does not fit into those categories (e.g., State DMV).

Safety content refers to messages related to transportation safety as detailed in the Technical Data Analysis section of this report. All the observations that follow pertain to exclusively safety content.

4.3 Technical Data Analysis

12-Month Timeline When choosing which data to include in the analysis, a uniform 12-month period from April 1, 2016 to March 31, 2017, was selected. At the beginning of this period, all accounts on both platforms had been created, and no accounts were deactivated during the analysis period. This full-year period allowed for an analysis of seasonal variation, and the results were not potentially skewed because of a season.

Twitter Data Retrieval Twitter data was retrieved using the Twitter application programming interface (API) via the Python[1] package Tweepy.[2] This interface allowed tweets to be directly downloaded for all 38 Twitter accounts. During the data collection period, the Twitter API did not provide a count of replies for each tweet. The tweets were returned in Javascript Object Notation (JSON) format. Each tweet carried many useful pieces of information, including the following.

- Text of the tweet itself
- Hashtags used
- Number of likes and retweets
- Types of media included in the tweet
- Date and time of tweet
- Accounts mentioned or replied to in the tweet

Facebook Data Retrieval Facebook posts made during the analysis period (April 1, 2016, to March 31, 2017) were retrieved programmatically from 39 accounts using a Python script.

Media Types Messages were categorized by media content: video, picture, link, or only text. A message could have a link in addition to a picture or video, so some messages fell into multiple categories.

Keyword-Based Safety Message Definition The team adapted the safety definition introduced in the Assumptions and Approach Section into a keyword-based definition that could programmatically identify safety-related messages.

The team used tweets from all the Twitter accounts to train and test the keyword definition. The keyword definition was applied to samples of these tweets, which were manually checked against the human definition. Of the approximately 90,000 tweets downloaded, 45,000 were randomly selected for definition testing, using the remainder to train the definition. An algorithm drew samples of 650 tweets from these training tweets and applied the machine-readable definition to determine whether the tweet contained a safety message.

After a training sample had been drawn and scored, a team member manually inspected each tweet and determined if the tweet satisfied any of the three criteria described in the first section of this memo, making it a safety tweet. The team compared the human inspection to the decision made by the computer, generating the following outcomes.

- True positives (TP) (Safety tweets properly classified as safety tweets)
- False positives (FP) (Non-safety tweets improperly classified as safety tweets)
- True negatives (TN) (Non-safety tweets properly classified as non-safety tweets)
- False negatives (FN) (Safety tweets improperly classified as non-safety tweets)

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[1] Python was used to download data from the respective platforms, and to perform additional ad-hoc analyses. All were done using open-source modules, or through the development of customized scripts. Many of the word-level tasks—e.g. hashtag analysis, word frequency, and sentiment—were completed using the natural language toolkit package, and its built-in sentiment processing engine.

[2] http://docs.tweepy.org/en/v3.5.0/

Because of the chosen sample sizes, these estimates were accurate enough to allow for refining the existing definition between successive iterations. The training samples were kept small to provide feedback on the success of the definition, allowing for rapid modification of the keyword lists. This process continued for four iterations before pulling a testing sample for analysis.

The sample size for testing was determined using the following formula.[3]

$$n = \frac{\left(z_{\alpha/2}\right)^2 p(1-p)}{E^2}$$

- n = sample size
- $z_{(\alpha/2)}$ = standard normal distribution percentile corresponding with selected confidence level
- p = best estimate of population proportion (0.5 as a default if unknown)
- E = margin of error

The testing samples were drawn from the half of the population reserved exclusively for testing. This means that no tweets in these samples were used to modify the definition. After the analysis of the first testing sample (Iteration 5), it was clear that the definition needed additional refining. The team completed four more training iterations, which improved the accuracy of the algorithm to 95% (± 1.4%) in the analysis of the second testing sample (Iteration 9). The complete results are shown in Table 4.

Iteration	Sample Size	Correctly Classified (TP + TN)	Incorrectly Classified (FP + FN)	Margin of Error	Confidence Level
1	647	523 (80.8%)	124 (19.2%)	3.9%	95%
2	449	418 (93.1%)	31 (6.9%)	5%	95%
3	621	588 (94.7%)	33 (5.3%)	3.9%	95%
4	650	605 (93.1%)	35 (6.9%)	3.8%	95%
5	2,800	2,511 (89.7%)	289 (10.3%)	1.8%	95%
6	650	592 (91.1%)	58 (8.9%)	3.8%	95%
7	650	604 (92.9%)	46 (7.1%)	3.8%	95%
8	650	604 (92.9%)	46 (7.1%)	3.8%	95%
9	4,200	3,527 (95.2%)	178 (4.8%)	1.4%	95%

Table 4. Definition refining results from nine iterations.

This refined definition was then applied to the entire body of tweets. Though this definition was trained using tweets, sample testing confirmed the definition is applicable to Facebook messages as well with a 95 percent confidence level.

[3] This equation is dependent on a chosen margin of error and confidence level. The margin of error indicates how large the range is surrounding the resulting proportion estimates. For example, if the margin of error is 5 percent, then examining a sample with a proportion of 0.7 means that the actual population proportion lies between 0.65 and 0.75. The confidence level is how reliable that range is. If that sample was at a confidence level of 95%, which means that there is a 5 percent chance that the actual population proportion falls outside of the margin of error previously discussed. Both decreasing the margin of error and increasing in the confidence level increased the required sample size.

Statistical Analysis The resulting set of safety-related social media messages were explored from multiple perspectives to understand their effectiveness as safety messaging. Exploratory findings were tested using several statistical methods. Due to the number of accounts being analyzed and vastly different approaches to social media messaging across these accounts, the observations and groups being compared violated assumptions of some common statistical procedures such as normality and homogeneity of variance between groups, as tested by the Shapiro-Wilk test and Levene's test, respectively.

For comparisons of two sample populations Welch's unequal variances t-test was conducted. Although the sample populations were not normal, simulation studies using data from different distributions have shown the t-test to be robust against non-normality,[4] particularly in cases with sample sizes greater than 25.[5] For these tests, bar charts showing means and standard deviations accompany the test results. Maximum and minimum values are not shown to better visualize the shapes of the distributions.

For comparisons of three or more sample populations, nonparametric procedures including the Kruskal-Wallis test and Dunn's (1964) post-hoc procedure with a Bonferroni correction were conducted. These tests assume neither population normality nor homogeneity of variance.

The Kruskal-Wallis test is a rank-based nonparametric test that determines if there are statistically significant differences between two or more groups of an independent variable on a continuous or ordinal dependent variable. It is generally considered the nonparametric alternative to the one-way ANOVA when data fail the test assumptions.

The Kruskal-Wallis test must be interpreted and reported in one of two ways: by mean ranks or medians. Mean ranks must be reported when the shapes of the distributions being tested are different and the results indicate which of the distributions has higher or lower values. The group with the lowest mean rank is the group with the greatest number of lower values, while the group with the highest mean rank would have the greater number of higher values. However, if the shapes of the distributions being tested are the same, then it is the location of the distribution that is driving differences among the groups. Thus, the median can be used as a measure of location. The shapes of the distributions (as opposed to whether the distributions have uniformly higher or lower scores) were evaluated by visual inspection of box and whisker plots, which are interpreted as shown in Figure 3. Distributions were considered similar if the vertical elements–the percentile bars, as well as the lower and upper adjacent values–were in the same location proportional to the overall size of the boxplot for each group. A visual reference for distinguishing between similar and dissimilar distributions using a box and whisker plot can be found in Figure 4.

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[4] Posten, H. O. (1978). The robustness of the two-sample t-test over the Pearson system. *Journal of Statistical Computation and Simulation, 6*, 295-311.
Posten, H. O. (1982). Two-sample Wilcoxon-Power over the Pearson system and comparison with the t-test. *Journal of Statistical Computation and Simulation 16*, 1-18.
Guiard, V., & Rasch, D. (2004). The robustness of two sample tests for means. A reply on von Eye's comment. *Psychology Science, 46*(4), 549-554.
Steiger, J. H. Robust T-test. (www.statpower.net/Content/311/Lecture%20Notes/RobustT.pdf)

[5] Beasley, T. M., Erickson, S., & Allison, D. B. (2009). Rank-based inverse normal transformations are increasingly used, but are they merited? *Behavioral Genetics, 39*, 580-595.

Generally, these determinations were conservative. If the visual inspection did not clearly indicate similar distributions across groups, the analysis erred on the side of caution and used mean ranks for interpretation and discussion. Both the median and mean rank are used to interpret and characterize differences in distributions between groups as visualized in a box and whisker plot but these values are not included in the plots themselves.

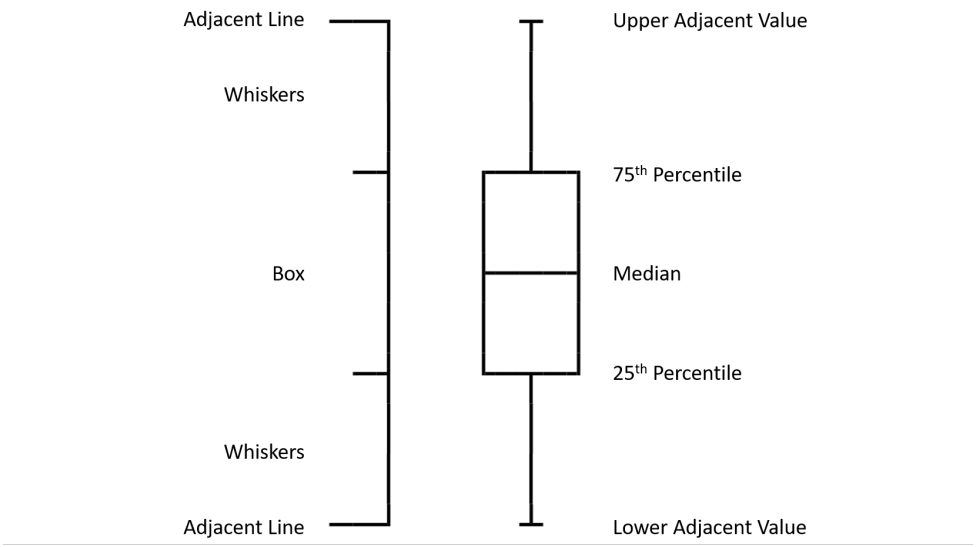

Figure 3: Interpretation of box and whisker plots in this report. Adapted from Stata Manual.[6]

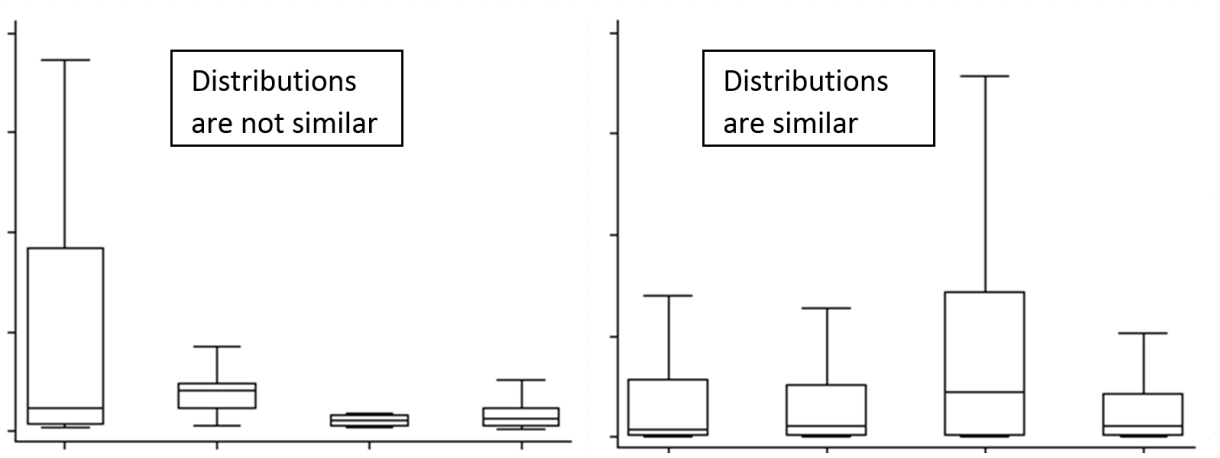

Figure 4: Example box and whisker plots depicting not similar versus similar distributions. Created by USDOT Volpe Center.

The interquartile range (IQR) is defined as the third quartile minus the first quartile. The upper adjacent value (UAV) is the largest observation that is less than or equal to the third quartile plus 1.5*IQR. The lower adjacent value (LAV) is the smallest observation that is greater than or equal

[6] Stata.com, www.stata.com/manuals13/g-2graphbox.pdf

to the first quartile minus 1.5*IQR. To improve chart readability and facilitate visual inspection of the distribution, maximums, minimums, and observations that are outside the upper and lower adjacent values are not displayed. Further, elements other than median were not labeled on the charts to prevent crowding. Values for the first quartile and third quartile, as well as upper and lower adjacent values, can be found in Appendix D.

The null hypothesis is the same for detecting both differences among mean ranks and medians using the Kruskal-Wallis test; namely, that the distributions of the groups are equal. If the alternative hypothesis is accepted, a Dunn's (1964) post-hoc procedure with a Bonferroni correction is used to analyze the Kruskal-Wallis results. Dunn's (1964) procedure with a Bonferroni correction is a non-parametric equivalent of the Tukey-Kramer post-hoc analysis and is used to report which of the paired groupings (if any) differs significantly. All tests are measured at the 0.05 level of significance; reported p-values are rounded to "$p < 0.0001$" when their actual value was less than 0.0001.

Safety Message Sentiment Analysis All the messages categorized as safety messages were also categorized based on message sentiment using the Natural Language Toolkit's VADER sentiment engine.[7] VADER, or Valence Aware Dictionary and sEntiment Reasoner, is a lexicon and rule-based sentiment analysis tool that is specifically attuned to sentiments expressed in social media. Each message was categorized with a sentiment of either positive, negative, or neutral. The sentiment was determined based on the words included in each tweet and post and attempted to take sarcasm into consideration.

4.4 Qualitative Information Gathering

NHTSA Regional Office Interviews Initial data gathering tasks for this project included interviews with staff from the 10 NHTSA Regional Offices to understand their involvement in and/or awareness of social media use by the SHSOs in their regions. NHTSA Regional Office interviews provided a baseline roadmap for the project team to follow when identifying SHSOs to interview, and questions to prompt.

SHSO Interviews The project team selected 9 SHSOs to further interview based on a synthesis of the results of the digital data scans and suggestions and anecdotal information from the 10 NHTSA Regional Offices. Specifically, the project team based their decision on SHSO recommendations using the following criteria.

1. **Social Media Messaging Has Safety Focus**. Data from Twitter and Facebook activity was analyzed to determine the percentage of content focused on: safety, roadwork/ incidents, or other areas. For purposes of this study, most SHSOs have a high percentage of safety-focused messaging relative to the other areas, unless otherwise noted.

[7] This categorization was done using the Natural Language Toolkit's VADER sentiment engine. www.nltk.org/howto/sentiment.html. More information on the development of VADER can be found at http://comp.social.gatech.edu/papers/icwsm14.vader.hutto.pdf

2. **Engagement Rates are Near or Above Average for SHSOs**. Data from the respective Twitter and Facebook accounts was analyzed to measure engagement rates[8] of different social media factors, including: overall, safety messaging only, and messages with only text, only links, only pictures, or only video. Those with engagement rates near or above average, compared across other SHSO data, were favorably considered given the potential for best practices to be shared.
3. **Selected SHSOs Represent a Mix of SHSO-, DOT-, Law Enforcement, and Other Agency-Operated Social Media.** Preliminary data gathering identified the mix of owners/operators for SHSO social media. The study team interviewed States with SHSO accounts operated by the SHSOs themselves, the DOT, law enforcement agencies, and the DMV. This mix was used to feature varied best practices and approaches based on the different circumstances.

Interviewees for each SHSO included social media managers, contractors or consultants, and other staff active in SHSO social media and related activities. Additionally, the project team shared and collected preliminary questionnaires (10 to 15 questions) from the 9 SHSOs prior to interviews to collect preliminary information to inform the focus of the interview (Appendix B). Prior to the interviews, which usually lasted 60 minutes, the project team shared a list of interview questions with the SHSOs for preparation purposes. Due to time constraints and results from the questionnaire, the interviews only focused on a subset of the questions. Some of the SHSOs interviewed also provided supplemental materials to further highlight their social media campaign success.

4.5 Literature Review

A literature review was conducted to identify current topics being discussed about social media by those who create it, implement it, and measure it. To help inform the direction of the project, dozens of resources were collected to understand what practices were being discussed. Based on the interviews and analysis, the comprehensive list was shortened to include sources thought to be most relevant to SHSOs. See Appendix A for the shortened list.

[8] Engagement rate is defined as the engagement volume divided by the number of followers that could have triggered the action. Engagement volume for Twitter is measured in terms of the sum of likes and retweets associated with a single Twitter message. For Facebook, engagement volume is measured in terms of the sum of likes, shares, and comments associated with a single message.

5. Results

5.1 Quantitative

This section contains results of quantitative analyses performed on available Facebook and Twitter data. The quantitative results are divided into three broad categories: social media accounts, safety content, and social media messaging approaches. Key findings are presented in bold with supporting descriptions of analyses provided in text and figures.

5.1.1 Social Media Accounts

The team produced an inventory of SHSO social media accounts and investigated differences in social media usage and engagement rates related to the account-manager types.

5.1.1.1 SHSO Social Media Account Inventory

Twitter and Facebook were the most common platforms. As detailed in the methodology section, the team began with a thorough search of SHSO social media. The search began on GHSA's website, and it examined all SHSO pages with links on the GHSA page. All social media accounts listed on the SHSO pages were included in the analysis. This search found that:

- 54 of 56 SHSOs listed on GHSA's website had an online presence;
- 44 of the 56 SHSOs were using social media; and
- A total of 141 accounts were identified from the 44 SHSOs using social media.

There was an average of three social media accounts per SHSO using social media. The 141 social media accounts comprised 12 different platforms as shown in Figure 5. Twitter and Facebook were the most common platforms with 40 accounts total on each platform. YouTube was the third most common with 29 accounts. The other 9 platforms accounted for the remaining 32 social media accounts.

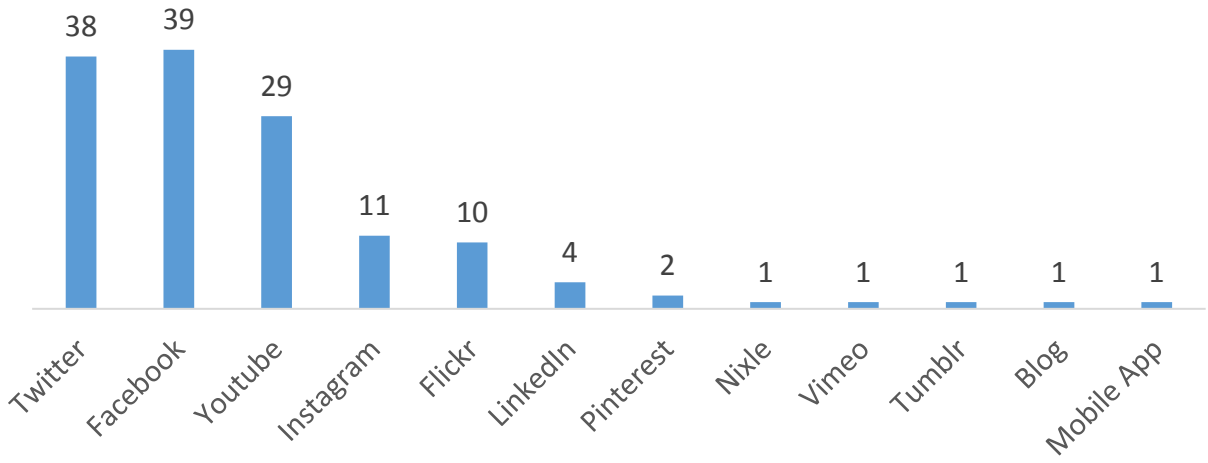

Figure 5. Distribution of SHSO social media accounts by platform.

5.1.1.2 Account Type Characteristics

The team made comparisons within the available Facebook and Twitter data on an account-type basis. For these comparisons, accounts were divided into SHSO, DOT, Law Enforcement, and Other categories described in the methodology section.

On Twitter, DOT-managed accounts had a higher median number of followers than SHSO-managed accounts. A Kruskal-Wallis test was conducted to determine if there were differences in the number of followers between account manager types: “SHSO” (n = 14), “DOT” (n = 14), “LE” (n = 6) and "Other" (n = 4). Distributions of the number of followers were similar for all groups, as assessed by visual inspection of a boxplot as shown in Figure 6; therefore, the median was used. Median numbers of followers were statistically significantly different between account manager types on Twitter, $\chi^2(3) = 14.164$, $p = 0.003$. Subsequently, pairwise comparisons were performed using Dunn's (1964) procedure with a Bonferroni correction for multiple comparisons. Adjusted p-values are presented. This post hoc analysis revealed a statistically significant difference in the number of followers between SHSO-managed accounts, with the lowest median value of 1,906 followers, and DOT-managed accounts, with the highest median value of 14,716 followers ($p < 0.001$). No other group differences were statistically significant.

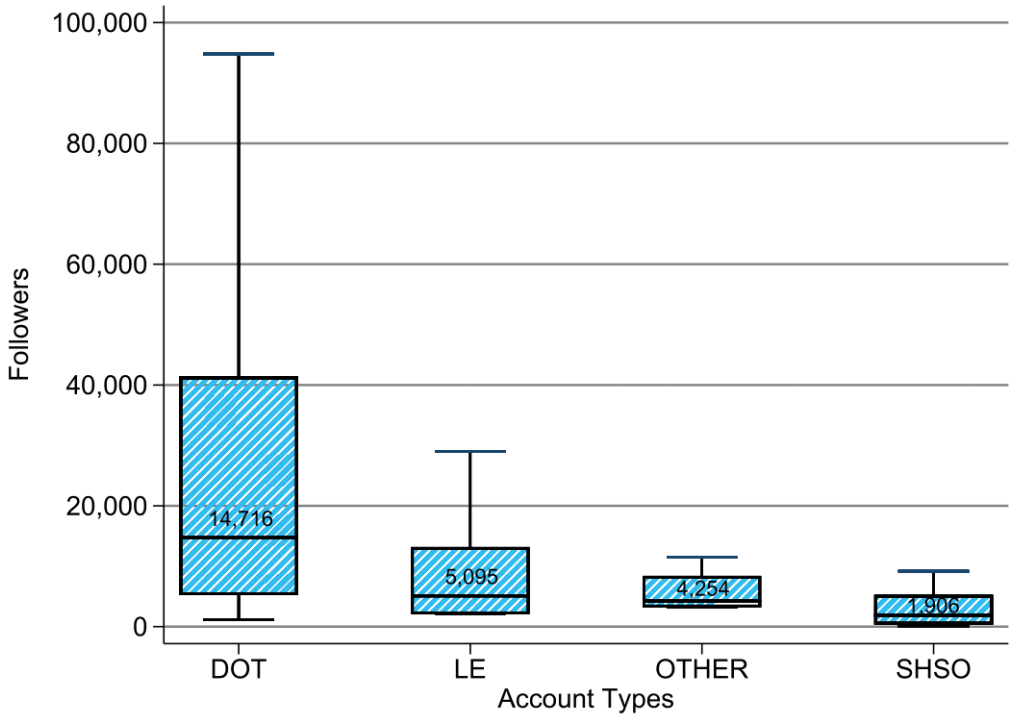

Figure 6: Account types and followers on Twitter (labeled values are medians).

On Facebook, the number of followers for a given account was similar across all account manager types. A Kruskal-Wallis test was conducted to determine if there were differences in the number of followers between account manager types: “SHSO” (n = 15), “DOT” (n = 15), “LE” (n = 5), and "Other" (n = 4). Distributions of the number of followers were not similar for all groups, as assessed by visual inspection of a boxplot as shown in Figure 7; therefore, mean rank was used. The numbers of followers appear different across the four account types, but the differences were not statistically significant ($\chi^2(3) = 5.982$, $p = 0.113$).

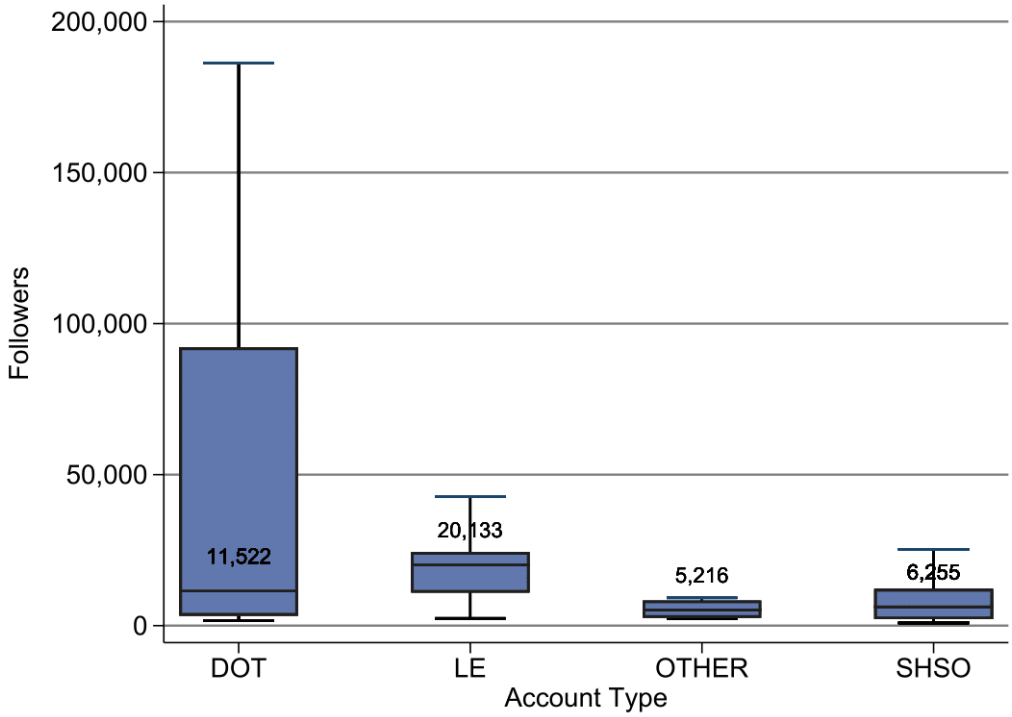

Figure 7: Account type and followers on Facebook (labeled values are medians).

On Facebook and on Twitter, all account types post about the same volume of safety content per day. A Kruskal-Wallis test was conducted to determine if there were differences in safety-related Facebook posts per day between account manager types: “SHSO” (n = 15), “DOT” (n = 15), “LE” (n = 5), and "Other" (n = 4). Distributions of safety posts per day were not similar for all groups, as assessed by visual inspection of a boxplot, shown in Figure 8; therefore, mean rank was used. The numbers of safety posts per-day appear different across the account types, but the differences were not statistically significant ($\chi^2(3) = 4.185$, $p = 0.242$).

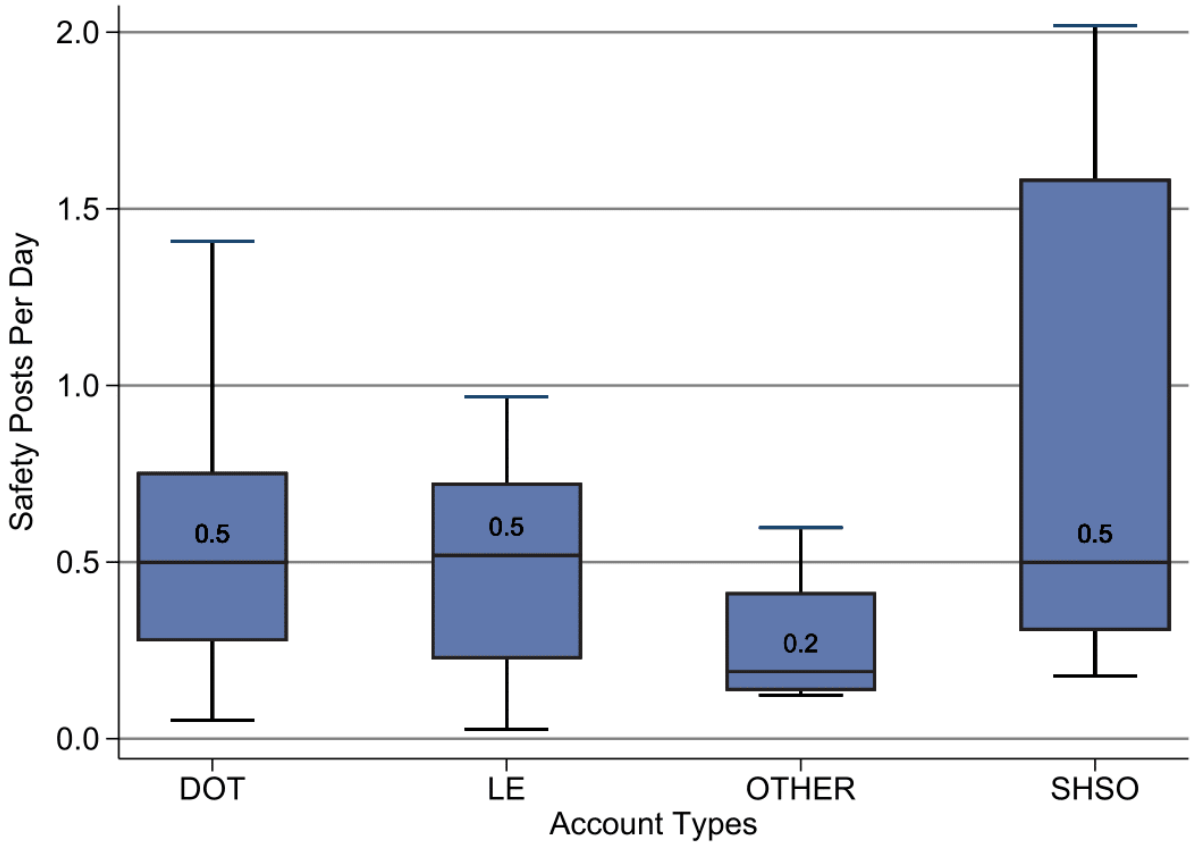

Figure 8: Box and whisker plot of account types and safety posts per day on Facebook (labeled values are medians).

A similar Kruskal-Wallis test was conducted for Twitter to determine if there were differences in the volume of safety content per day between account manager types: ”SHSO” (n = 14), “DOT” (n = 14), “LE” (n = 6) and "Other" (n = 4). Distributions of safety tweets per day were not similar for all groups, as assessed by visual inspection of a boxplot shown in Figure 9; therefore, mean rank was used. The number of safety tweets per-day appear different across the account types, but the differences were not statistically significant ($\chi^2(3) = 2.478$, $p = 0.479$).

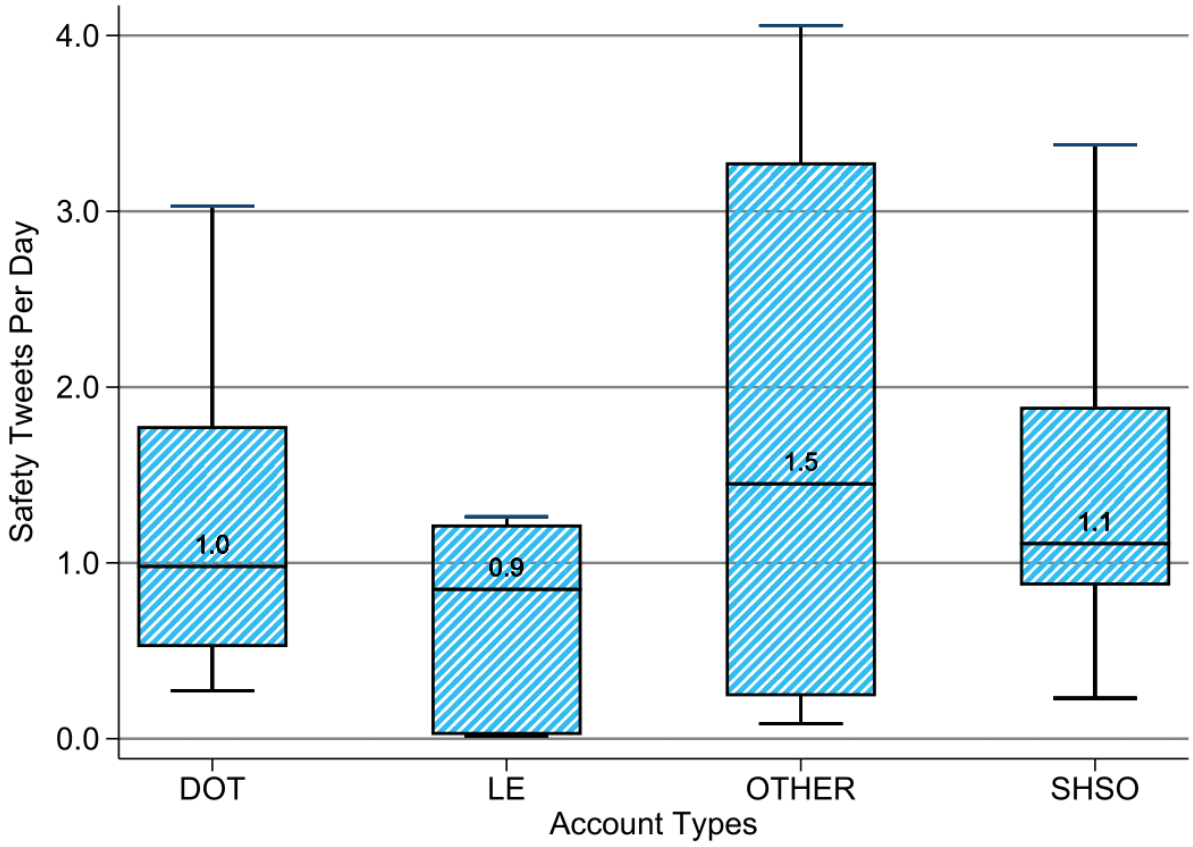

Figure 9: Box and whisker plot of account types and safety tweets per day on Twitter (labeled values are medians).

5.1.2 Safety Content

The team made comparisons of safety content with non-safety content and explored the relationships of characteristics such as message length and message sentiment on the engagement indices of safety content.

5.1.2.1 Engagement by safety/non-safety

Safety content makes up more of the total content on Facebook but generates proportionally more engagement on Twitter. Fifty-four percent of the Facebook posts analyzed in this study were characterized as safety related, which generated 50 percent of the platform's total engagements. On Twitter, only 34 percent of the analyzed content is safety related, but safety-related tweets accounted for 45 percent of the platform's total engagements. As shown in Figure 10, safety content on Twitter generates more engagement per tweet—relative to non-safety content—than safety content on Facebook.

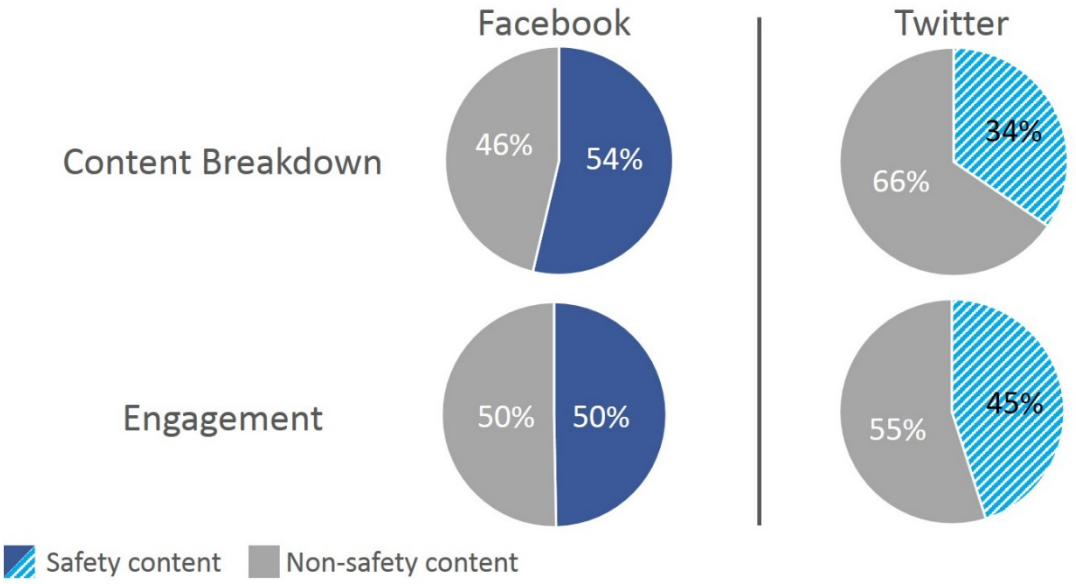

Figure 10: Content and engagement breakdown by platform (labeled values are medians).

On Facebook, the average engagement index is lower for safety content than for non-safety content. As discussed in the methods section above, the engagement index is a standardized engagement rate that facilitates comparisons across accounts with significantly different numbers of followers. As shown in Figure 11, the average engagement index for safety-related Facebook posts is 0.025 and for non-safety-related posts is 0.031. The median values are 0.002 and 0.005, respectively. The difference between the mean and median indices suggests that most posts generate very little engagement while a very small number of posts generate relatively greater engagement, which would increase the mean but have little effect on the median. A Welch t-test was conducted to compare the effect of content type on post engagement index for both safety (n=8,762) and non-safety (n=7,555) content. Facebook posts with safety content had a statistically significant lower post engagement index than those without safety content [$t(15, 693) = -4.45$, $p < 0.0001$].

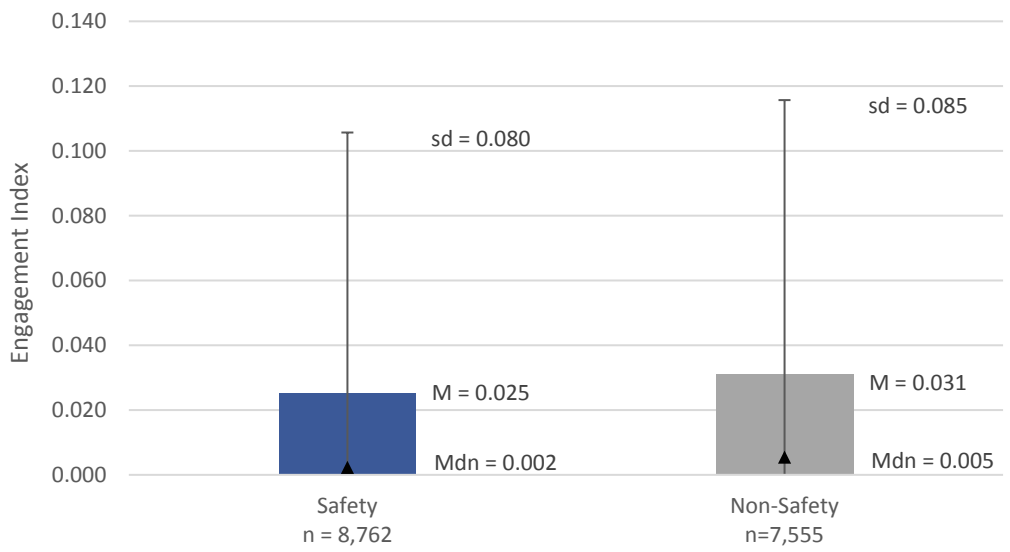

Figure 11: Bar chart showing mean and standard deviation of engagement index by content type on Facebook (labeled values are medians).

On Twitter, the average engagement index is higher for safety content than for non-safety content. As shown in Figure 12, the average engagement index for safety-related Twitter content is 0.023, which is higher than the average engagement index of 0.018 for non-safety content, A Welch t-test was conducted to compare the effect of content type on tweet engagement index for both safety (n=18,118) and non-safety (n=34,400) content. Tweets with safety content had a statistically significant higher post engagement index than those without safety content [t(29, 932) = 9.57, p < 0.0001].

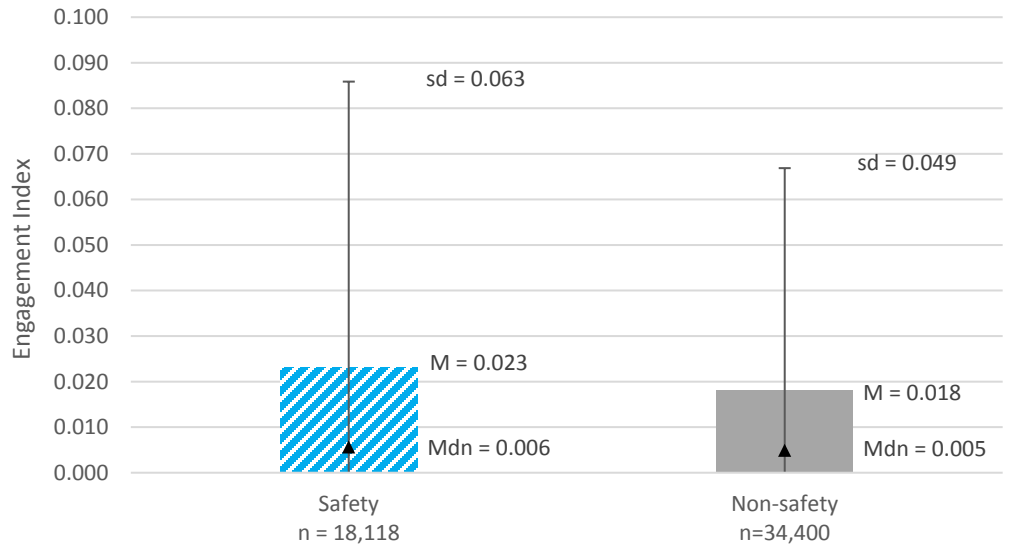

Figure 12: Bar chart showing mean and standard deviation of engagement index by content type on Twitter (labeled values are medians).

On Twitter, SHSO-managed accounts generate messages with the highest engagement rates. A Kruskal-Wallis test was conducted to determine if there were differences in the engagement rates of individual Twitter messages generated between account manager types: “SHSO” (n = 7,700), “DOT” (n = 6,299), “LE” (n = 1,542) and "Other" (n = 2,574). This account type analysis used engagement rate instead of engagement index – engagement indices cannot be aggregated for account type comparisons, they are designed to be used when comparing individual accounts or messages within a given account. Distributions of engagement rates were not similar for all groups, as assessed by visual inspection of a boxplot shown in Figure 13; therefore, mean rank was used. The engagement rates of individual messages were statistically significantly different between account manager types on Twitter ($\chi^2(3) = 2643.809$, $p < 0.0001$). Subsequently, pairwise comparisons were performed using Dunn's (1964) procedure with a Bonferroni correction for multiple comparisons. Adjusted p-values are presented in Table 5. This post hoc analysis revealed statistically significant differences in engagement rates between all group combinations. SHSO-managed Twitter accounts generated messages with the highest engagement rates (mean rank = 11,016), engagement rates were lower for Other-managed accounts (mean rank = 9,623) and LE-managed accounts (mean rank = 8,870), and lowest for DOT-managed accounts (mean rank = 6,478).

	DOT (Mean rank = 6,478)	LE (Mean rank = 8,870)	Other (Mean rank = 9,623
LE (Mean rank = 8,870)	$p < 0.0001$		
Other (Mean rank = 9,623	$p < 0.0001$	$p < 0.0001$	
SHSO (Mean rank = 11,016)	$p < 0.0001$	$p < 0.0001$	$p < 0.0001$

Table 5: Matrix of statistically significant pairings identified by Dunn’s post-hoc analysis.

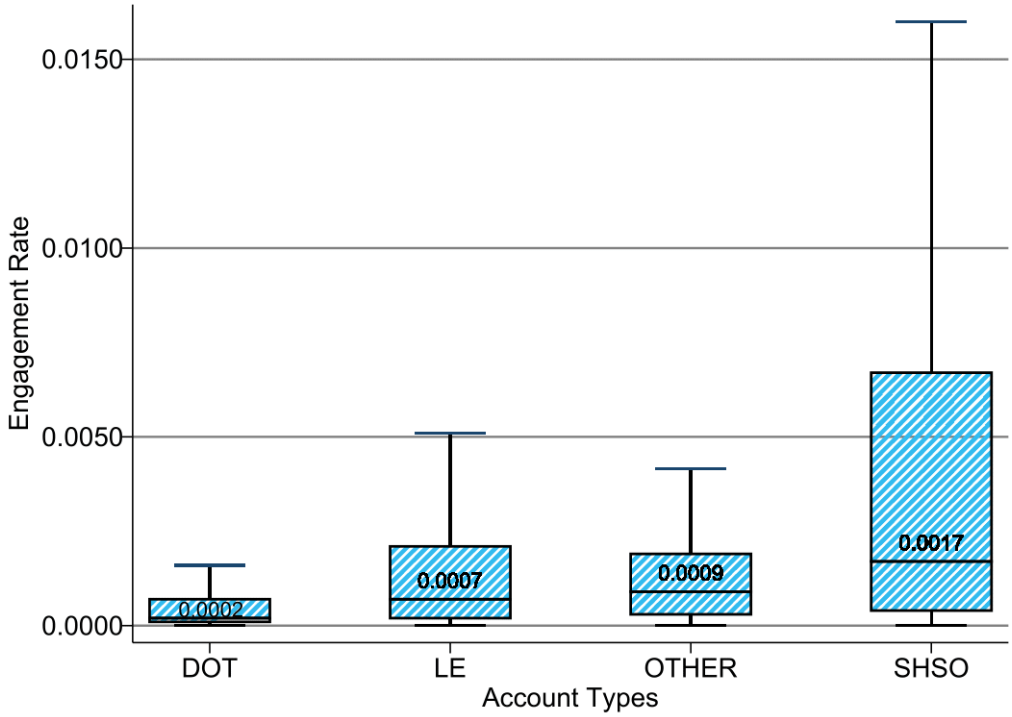

Figure 13: Box and whisker plot of account types and engagement rates on Twitter (labeled values are medians).

On Facebook, Other account manager types, such as departments of motor vehicles, generate messages with the highest engagement rates. A Kruskal-Wallis test was conducted to determine if there were differences in the engagement rates of individual Facebook messages generated between account manager types: “SHSO” (n = 4,552), “DOT” (n = 2,906), “LE” (n = 899) and "Other" (n = 405). This account type analysis used engagement rate instead of engagement index – engagement indices cannot be “rolled up” for account type comparisons, they are designed to be used when comparing individual accounts or messages within a given account. Distributions of engagement rates were not similar for all groups, as assessed by visual inspection of a boxplot shown in Figure 14; therefore, mean rank was used. The engagement rates of individual messages were statistically significantly different between account manager types on Facebook ($\chi^2(3) = 300.700$, $p = 0.0001$). Subsequently, pairwise comparisons were performed using Dunn's (1964) procedure with a Bonferroni correction for multiple comparisons. Adjusted p-values are presented. This post hoc analysis revealed statistically significant differences in engagement rates between all group combinations ($p < 0.0001$ for all combinations). Facebook accounts run by Other account manager types generated messages with the highest engagement rates (mean rank = 6,043), engagement rates were lower for LE-managed accounts (mean rank = 4,960) and DOT-managed accounts (mean rank = 4,477), and lowest for SHSO-managed accounts (mean rank = 4,057).

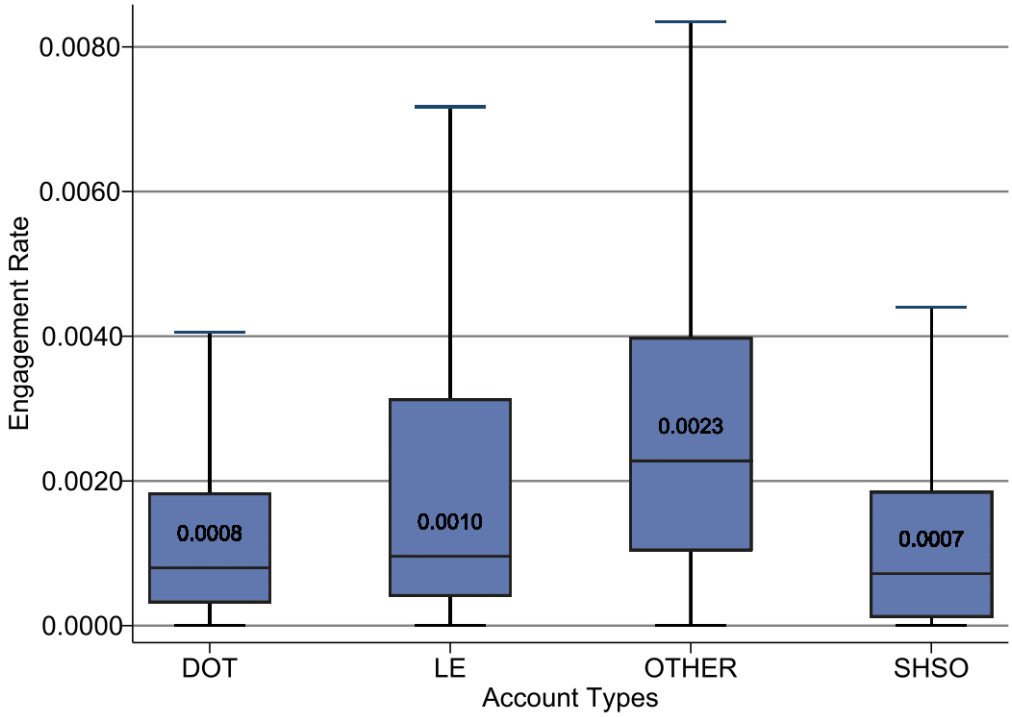

Figure 14: Box and whisker plot of account types and engagement rates on Facebook (labeled values are medians).

5.1.2.2 Message length

Twitter messages in the highest length quintile (those with the most characters) had higher engagement indices than those in lower quintiles. Quintiles of message length were generated for individual messages based on the full set of unique character lengths across all Twitter messages (i.e., messages with the fewest characters were assigned to the first quintile, while messages with the greatest number of characters constituted the fifth quintile). A Kruskal-Wallis test was then conducted to determine if there were differences in the distribution of engagement indices across the five Twitter message length quintiles: “20th percentile” (n = 165), “40th percentile” (n = 788), “60th percentile” (n = 1,522), “80th percentile” (n = 2,726) and "100th percentile" (n = 12,917). Distributions of engagement indices were similar for all groups, as assessed by visual inspection of a boxplot shown in Figure 15; therefore, medians can be used. The engagement index distributions were statistically different between message length quintiles on Twitter ($\chi2(4) = 332.276$, $p = 0.0001$). Subsequently, pairwise comparisons were performed using Dunn's (1964) procedure with a Bonferroni correction for multiple comparisons. Adjusted p-values are presented in Table 6. This post-hoc analysis revealed statistically significant differences in engagement indices between all group combinations except for the 40th and 60th percentile groups. Twitter messages with lengths in the 100th percentile had the highest engagement index (Median = 0.008), with those in the 80th percentile having slightly lower indices (Median = 0.007). Messages with lengths in the 20th percentile had the lowest median engagement index (Median = 0.003).

	20th percentile (Mdn = 0.003)	40th percentile (Mdn = 0.004)	60th percentile (Mdn = 0.004)	80th percentile (Mdn = 0.007)
40th percentile (Mdn = 0.004)	p = 0.0110			
60th percentile (Mdn = 0.004)	p = 0.0006	p = 1.0000		
80th percentile (Mdn = 0.007)	p < 0.0001	p < 0.0001	p < 0.0001	
100th percentile (Mdn = 0.008)	p < 0.0001	p < 0.0001	p < 0.0001	p < 0.0001

Table 6: Matrix of statistically significant pairings identified by Dunn's post-hoc analysis.

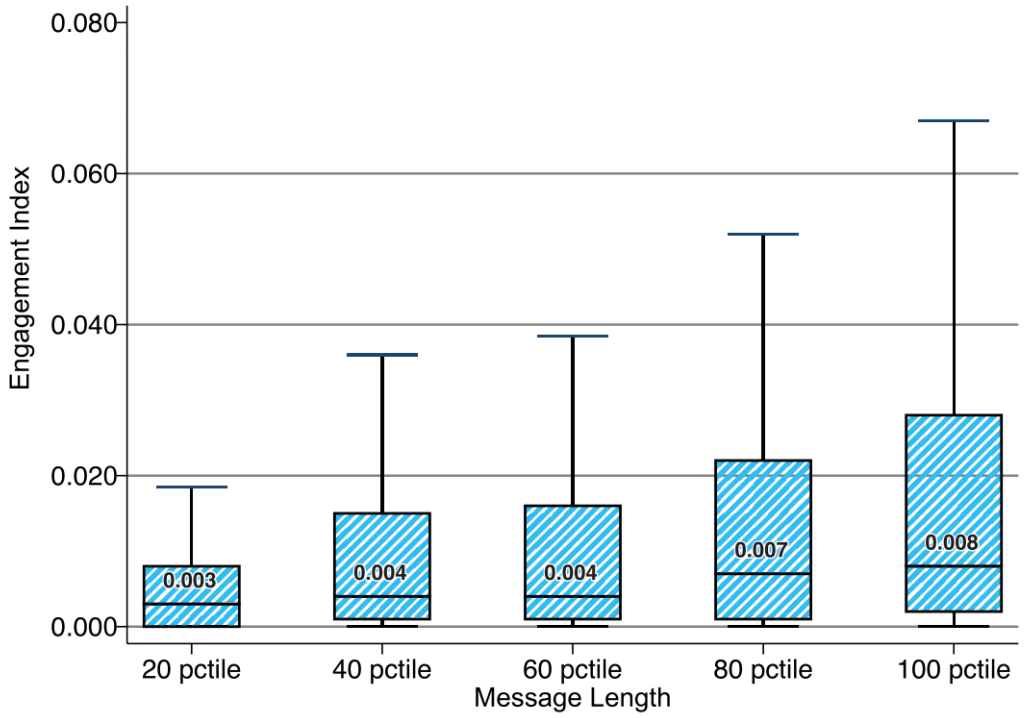

Figure 15: Box and whisker plot of message length quintiles and engagement indices on Twitter (labeled values are medians).

Facebook messages in the lowest length quintile (those with the least characters) had lower engagement indices than those in upper quintiles. Quintiles of message length were generated for individual messages based on the full set of unique character lengths across all Facebook messages (i.e., messages with the fewest characters were assigned to the first quintile, while messages with the greatest number of characters constituted the fifth quintile). A Kruskal-Wallis test was then conducted to determine if there were differences in the distribution of engagement indices across the five Facebook message length quintiles: "20th percentile" (n = 5,101), "40th percentile" (n = 2,460), "60th percentile" (n = 708), "80th percentile" (n = 286) and "100th percentile" (n = 207). Distributions of engagement indices were similar for all groups, as assessed by visual inspection of a boxplot shown in Figure 16; therefore, medians can be used. The

engagement index distributions were statistically significantly different between message length quintiles on Twitter ($\chi2(4) = 68.076$, $p < 0.0001$). Subsequently, pairwise comparisons were performed using Dunn's (1964) procedure with a Bonferroni correction for multiple comparisons. Adjusted p-values are presented in Table 7. This post-hoc analysis revealed statistically significant differences in engagement indices between the 20th percentile of messages lengths and all other groups as well as between messages in the 100th percentile and the 40th percentile. Based upon these results, Facebook messages with lengths in the 20th percentile of message length had the lowest engagement index (Median = 0.004) compared to all other groups. Those in the 100th percentile had the highest value (Median = 0.11), but the difference was only statistically significant for one comparison.

	20th percentile (Mdn = 0.004)	40th percentile (Mdn = 0.007)	60th percentile (Mdn = 0.007)	80th percentile (Mdn = 0.008)
40th percentile (Mdn = 0.007)	p < 0.0001			
60th percentile (Mdn = 0.007)	p < 0.0001	p = 1.000		
80th percentile (Mdn = 0.008)	p = 0.0349	p = 1.000	p = 1.000	
100th percentile (Mdn = 0.011)	p < 0.0001	P = 0.0392	p = 0.2385	p = 0.2510

Table 7: Matrix of statistically significant pairings identified by Dunn's post-hoc analysis.

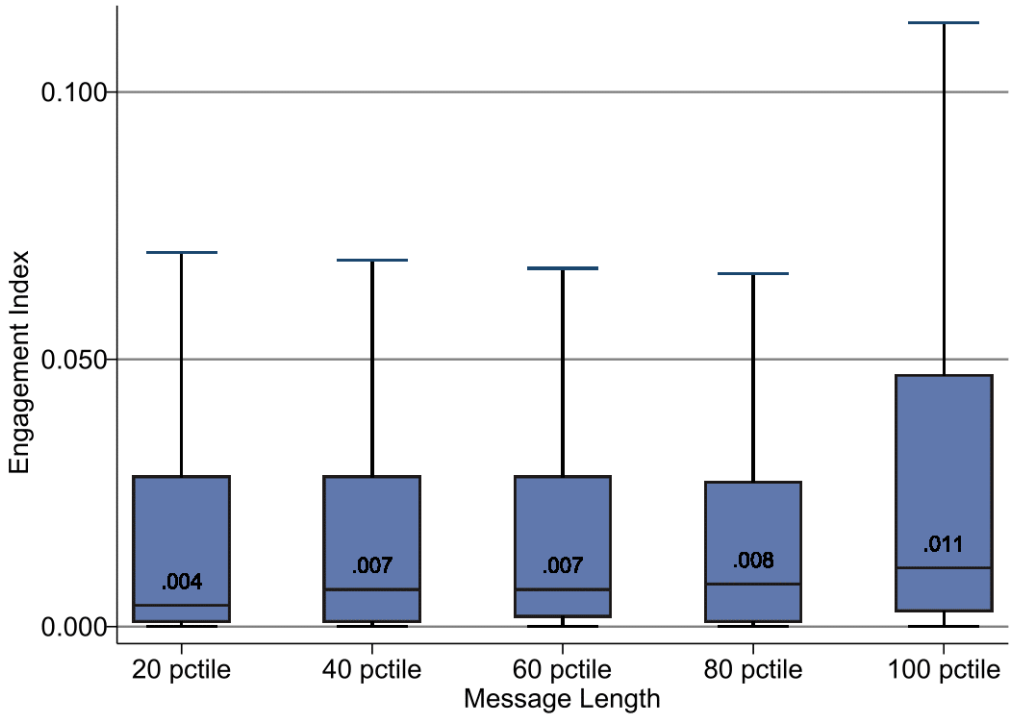

Figure 16: Box and whisker plot of message length quintiles and engagement indices on Facebook (labeled values are medians).

On Facebook, posts with message lengths greater than 140 characters have similar engagement indices to posts with message lengths less or equal to 140 characters. As shown in Figure 17, there is a peak in the frequency of messages with about 140 characters on Facebook. This observation, in addition to the fact that Twitter messages were capped at 140 characters during the analysis period, informed the decision to investigate the difference between messages with less than or greater than 140 characters.

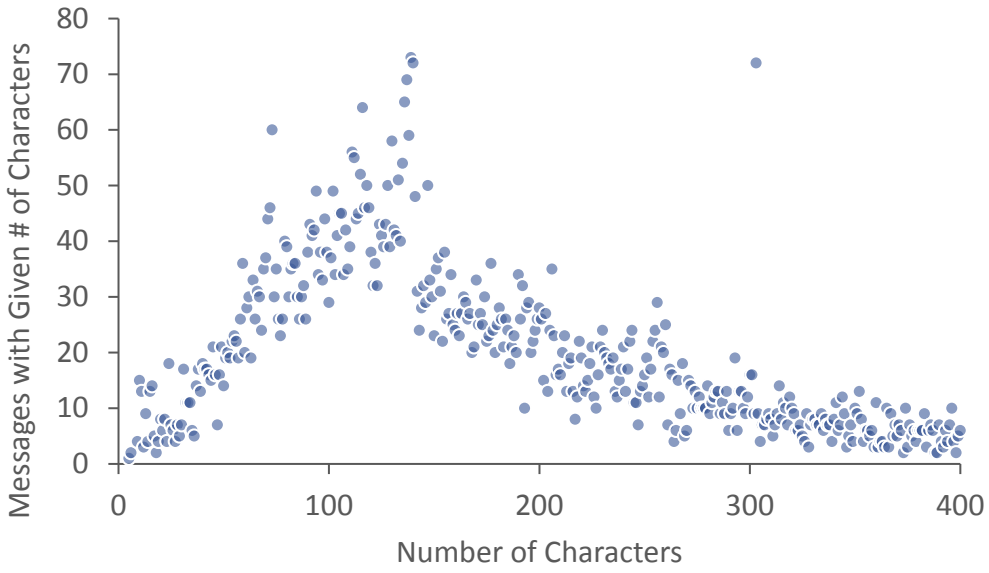

Figure 17: Histogram of message length on Facebook. Showing only 0 through 400 characters.

Figure 18 shows the average engagement index for Facebook posts above or below the 140-character threshold. A Welch t-test was conducted to compare the effect of post length on engagement index for both posts with 140 or fewer characters (n=3,854) and posts with greater than 140 characters (n=4,908). The test found no significant effect of post length on engagement index for the two post length categories [t(8,686) = -0.81, p = 0.42].

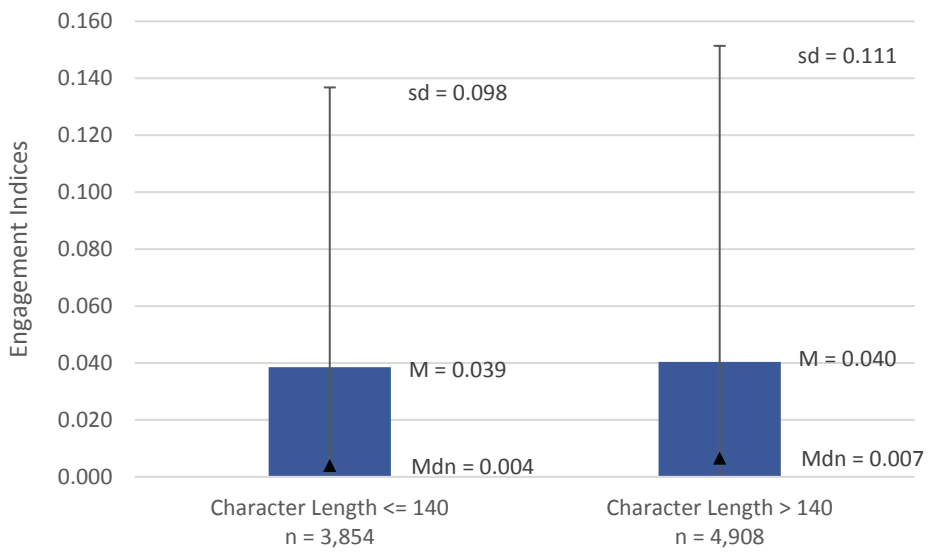

Figure 18: Bar chart of mean and standard deviation of average engagement indices by message length on Facebook.

5.1.2.3 Message sentiment

This section presents the effect of the sentiment of each safety message on the engagement index. Natural Language Toolkit's Vader sentiment engine categorized the Facebook and Twitter messages as positive, negative, or neutral.

On Facebook, messages with positive sentiments had higher engagement indices than those with neutral sentiments. Almost 75 percent of Facebook posts were positive in tone. Slightly more neutral posts than negative posts comprise the remaining 25 percent. A Kruskal-Wallis test was conducted to determine if there were differences in the engagement indices of Facebook posts based on sentiment: "Negative" (n = 1,173), "Neutral" (n = 1,309), and "Positive" (n = 6,280). Distributions of engagement indices were similar for all groups, as assessed by visual inspection of the boxplot shown in Figure 19; therefore, median was used. The median engagement indices were statistically significantly different between sentiments on Facebook ($\chi^2(2) = 8.575$, $p = 0.014$). Subsequently, pairwise comparisons were performed using Dunn's (1964) procedure with a Bonferroni correction for multiple comparisons. This post-hoc analysis revealed statistically significant differences ($p = 0.010$) in the engagement index between the sentiment category with the highest engagement (Positive) and the category with the lowest engagement (Neutral) but not between any other group combinations.

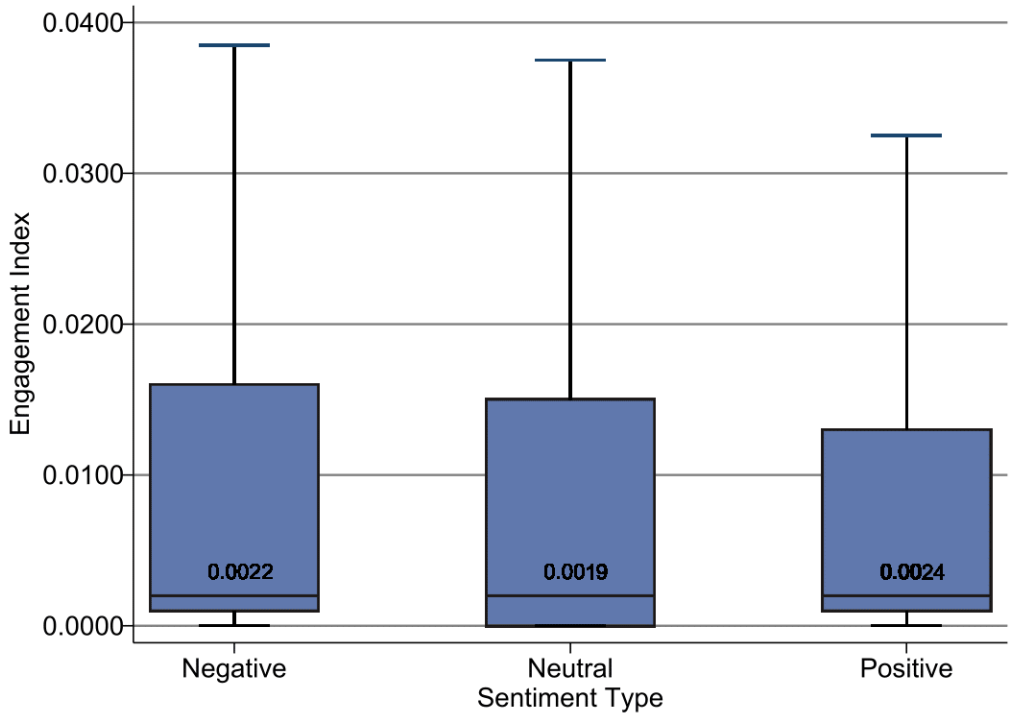

Figure 19: Box and whisker plot of sentiment and engagement indices on Facebook (labeled values are medians).

On Twitter, sentiment of safety messages does not make a significant difference in engagement index. Among the analyzed tweets, almost half were positive in tone. Slightly more neutral posts than negative posts make up the other half. A Kruskal-Wallis test was conducted to determine if there were differences in the engagement indices of Twitter messages based on sentiment: “Negative” (n = 2,514), “Neutral” (n = 3,180), and "Positive" (n = 6,369). Distributions of engagement indices were similar for all groups, as assessed by visual inspection of a boxplot shown in Figure 20. The median engagement indices were not statistically significantly different between sentiments on Twitter ($\chi^2(2) = 0.271$, $p = 0.8974$).

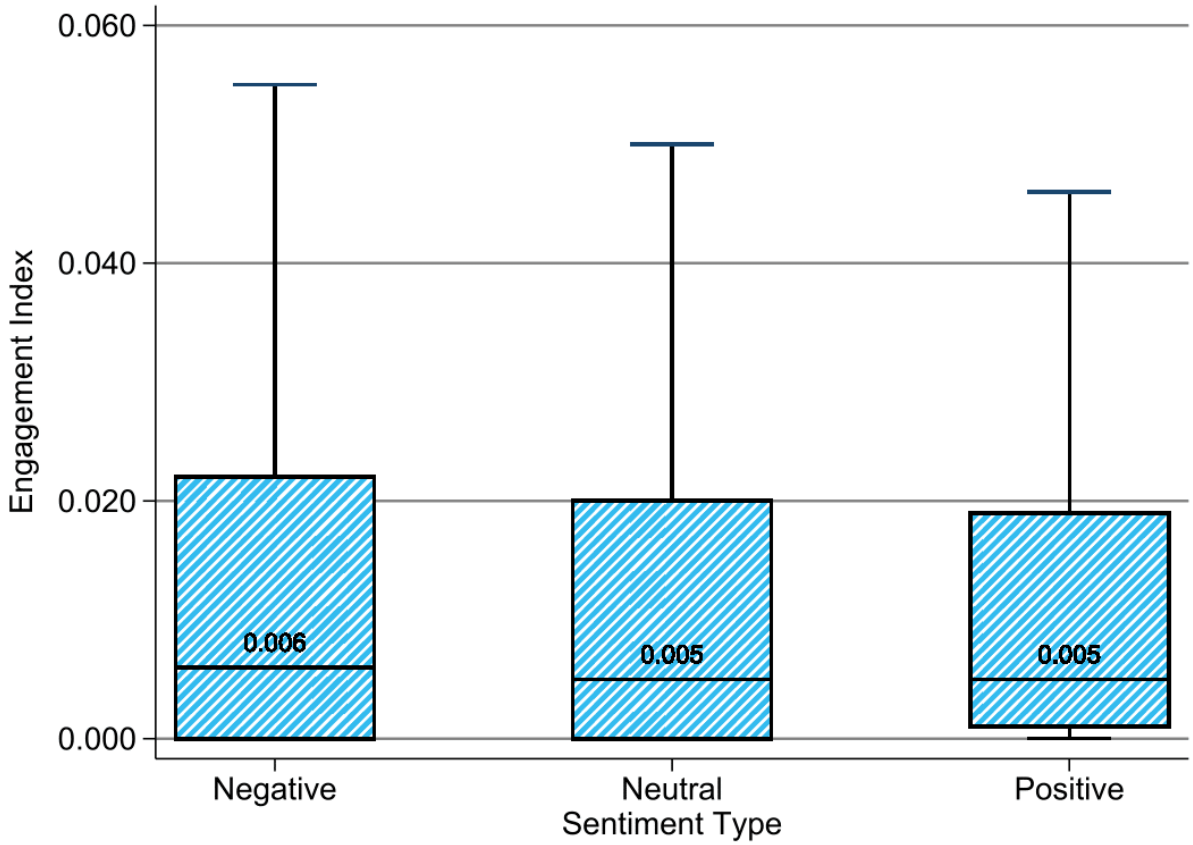

Figure 20: Box and whisker plot of sentiment and engagement indices on Twitter (labeled values are medians).

5.1.3 Messaging approach

The team investigated specific safety messaging strategies that SHSO social media managers employ to increase engagement.

5.1.3.1 Media

On both Facebook and Twitter, account managers are given the choice of including a photo, video, or link with their posts, or they may choose to create text-only posts. The effect of including media on engagement indices differed by platform.

On Facebook, text-only posts had higher engagement indices than posts with links, photos, or videos. A Kruskal-Wallis test was conducted to determine if there were differences in the engagement indices of Facebook posts based on media type: “Text only” (n = 618), “Link-based” (n = 2,101), "Photo-based" (n = 5,032), and “Video-based” (n = 1,011). Distributions of engagement indices were similar for all groups, as assessed by visual inspection of a boxplot shown in Figure 21. The median engagement indices were statistically significantly different between media types on Facebook ($\chi^2(3) = 60.099$, $p < 0.0001$). Subsequently, pairwise comparisons performed using Dunn's (1964) procedure with a Bonferroni correction for multiple comparisons revealed statistically significant differences in engagement indices between Text-only posts, which had the highest median engagement index, and all three other types of posts ($p < 0.0001$ versus Link-based posts, $p < 0.0001$ versus Photo-based posts, and $p < 0.001$ versus

Video-based posts). The analysis also found a statistically significant difference ($p = 0.002$) in engagement index between Photo-based posts, which had the second highest median engagement index, and Linked-based posts, which had the lowest median.

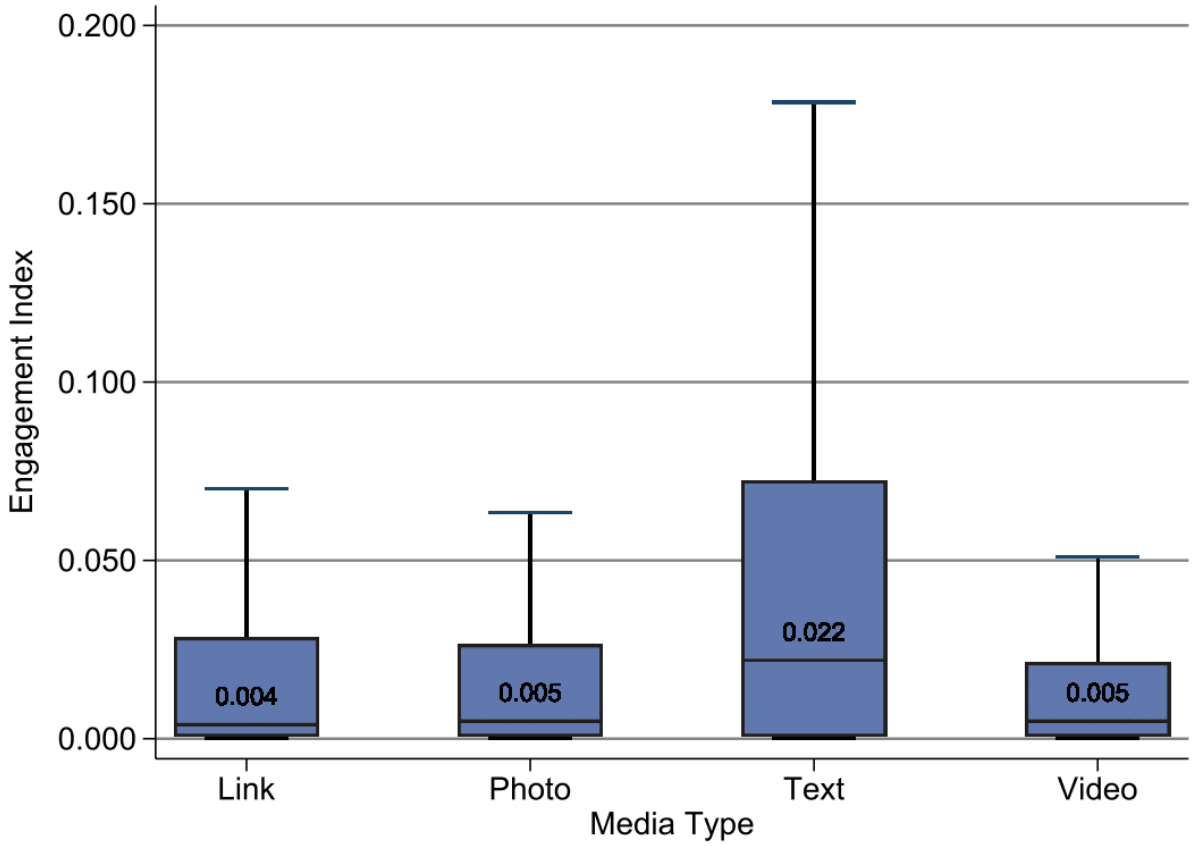

Figure 21: Box and whisker plot of media type and engagement indices on Facebook (labeled values are medians).

On Twitter, tweets containing a photo or video received higher engagement indices than posts containing no media. Contrary to what was observed among Facebook safety posts, photos and videos helped to boost engagement on Twitter. A Kruskal-Wallis test was conducted to determine if there were differences in the engagement indices of Twitter messages based on media type: "Text only" (n = 6,079), "Link-based" (n = 7,805), "Photo-based" (n = 4,000), and "Video-based" (n = 234). Distributions of engagement indices were similar for all groups, as assessed by visual inspection of a boxplot shown in Figure 22**Error! Reference source not found.**. The median engagement indices were statistically significantly different between media types on Twitter ($\chi^2(3) = 369.428$, $p < 0.0001$). Subsequently, pairwise comparisons performed using Dunn's (1964) procedure with a Bonferroni correction for multiple comparisons revealed statistically significant differences in engagement indices between Photo-based messages, with the highest median engagement, and Link-based and Text only messages, which had the lowest levels of median engagement ($p < 0.0001$). The analysis also found statistically significant differences in engagement index between Video-based messages, which had the second highest median engagement and Link-based and Text only messages at the low end of engagement ($p < 0.0001$).

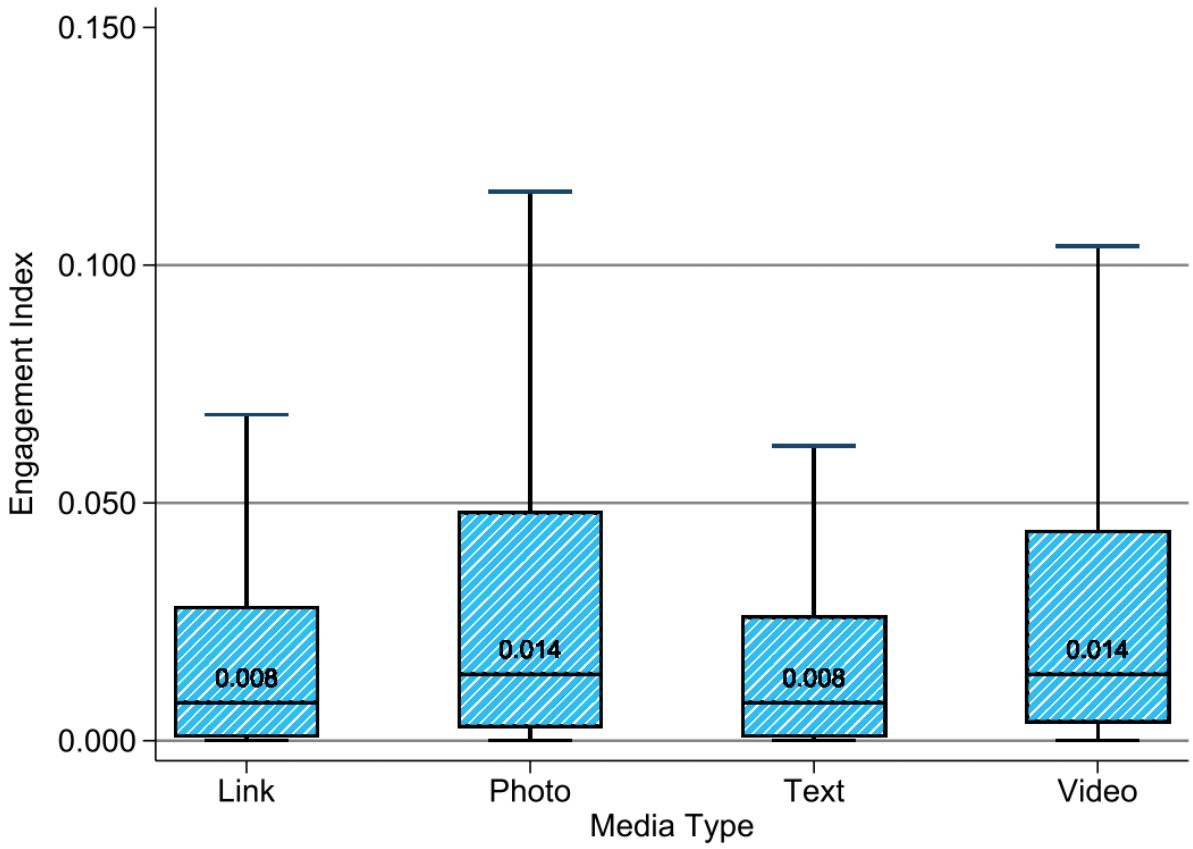

Figure 22: Box and whisker plot of media type and engagement indices on Twitter (labeled values are medians).

5.1.3.2 Hashtags

Adding hashtags to tweets or Facebook posts allow users to attribute their messages to a certain topic or category. Hashtags also permit users to search and sort by specific topics and trends and receive a customized stream of tweets.

Tweets with between one and four hashtags have higher engagement indices than those without any. A Kruskal-Wallis test was conducted to determine if there were differences in the engagement indices of Twitter messages based the number of hashtags: “Zero” (n = 7,495), “One” (n = 6,600), "Two" (n = 2,765), “Three” (n = 897), “Four” (n = 260), “Five” (n = 67), “Six” (n = 21), and “Seven” (n = 10). Distributions of engagement indices were not similar for all groups, as assessed by visual inspection of a boxplot shown in Figure 23. The engagement indices for individual Twitter messages were statistically significantly different based on the number of hashtags ($\chi^2(7) = 106.935$, $p < 0.0001$). Subsequently, pairwise comparisons performed using Dunn's (1964) procedure with a Bonferroni correction for multiple comparisons revealed a statistically significant lower engagement index between messages with Zero hashtags (mean rank = 8,587) and those with One, Two, Three, or Four hashtags ($p < 0.001$, $p < 0.001$, $p = 0.001$, $p = 0.001$). No other differences in engagement indices were found to be statistically significant.

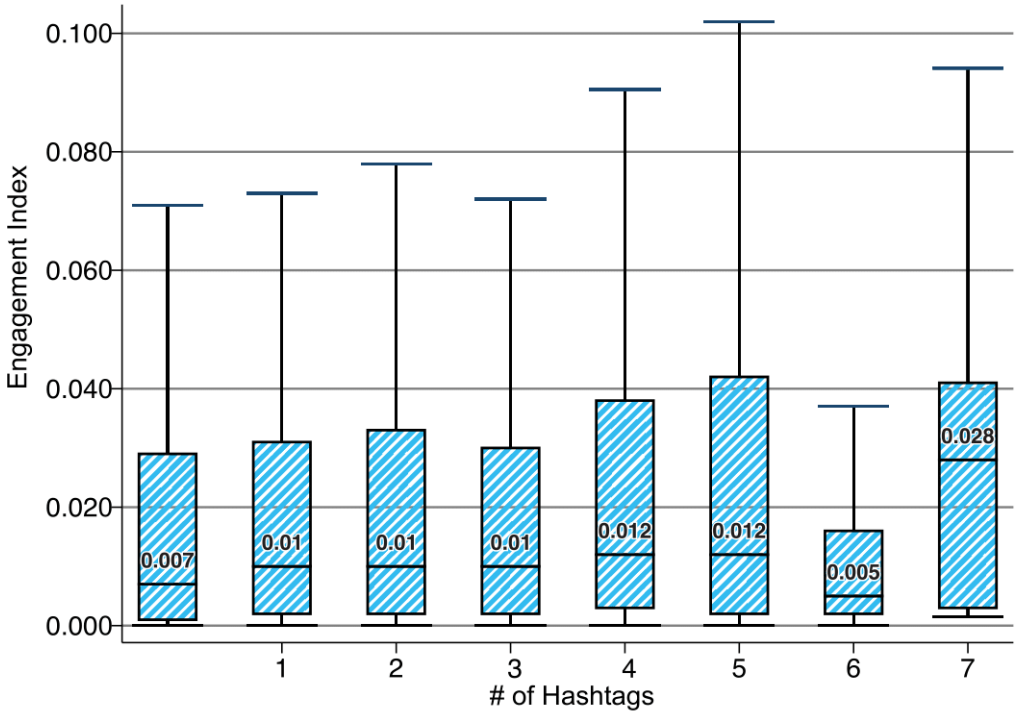

Figure 23: Box and whisker plot of hashtag counts and engagement indices on Twitter (labeled values are medians).

On Facebook, posts with zero hashtags had higher engagement indices than posts with one to five hashtags. Out of 8,759 posts, 4,353 did not contain a hashtag (50%), and 4,406 contained one to eleven hashtags (50%) with higher hashtag counts appearing less frequently. A Kruskal-Wallis test was conducted to determine if there were differences in the engagement indices of Facebook posts based on the number of hashtags: “Zero” (n = 4,353), “One” (n = 2,264), "Two" (n = 1,227), “Three” (n = 483), “Four” (n = 188), “Five” (n = 87), “Six” (n = 75), “Seven” (n = 45), “Eight” (n = 13), “Nine” (n = 12), “Ten” (n = 7), and “Eleven” (n = 5). Distributions of engagement indices were not similar for all groups, as assessed by visual inspection of a boxplot shown in Figure 24. The engagement indices for individual Facebook posts were statistically significantly different based on the number of hashtags ($\chi^2(10) = 129.374$, $p < 0.0001$). Subsequently, pairwise comparisons performed using Dunn's (1964) procedure with a Bonferroni correction for multiple comparisons revealed statistically significant differences in engagement indices between posts with Zero hashtags, which had the highest mean rank engagement, and One, Two, Three, Four, and Five hashtags ($p<0.001$ for all comparisons). No other differences in engagement indices were not found to be statistically significant.

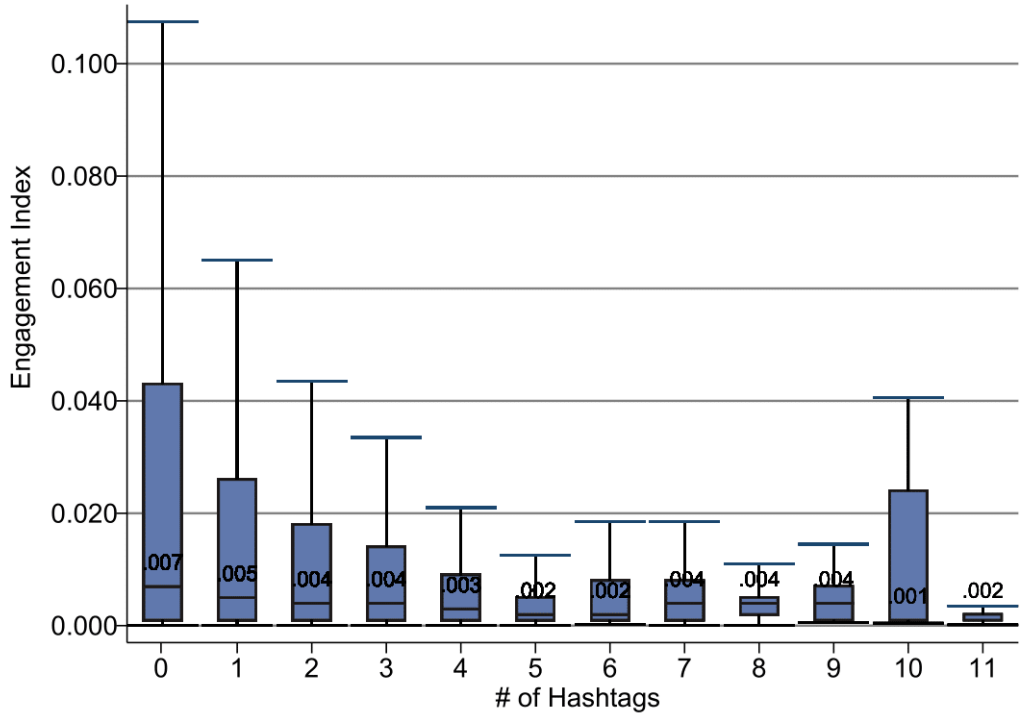

Figure 24: Box and whisker plot of hashtag counts and engagement rates on Facebook (labeled values are medians).

On Facebook, messages with hashtags in the lowest frequency quintile had lower engagement indices than messages with hashtags in all other frequency quintiles. Quintiles were generated for individual messages with hashtags based on the range of unique frequencies observed for all hashtags included in the Facebook messages analyzed (i.e., messages with a hashtag used once and only once were assigned to the first quintile, while messages with a very popular hashtag might be included in the fifth quintile). A Kruskal-Wallis test was then conducted to determine if there were differences in the distribution of engagement indices across the five hashtag frequency quintiles for Facebook messages with hashtags: “20th percentile” (n = 1,124), “40th percentile” (n = 79), “60th percentile” (n = 45), “80th percentile” (n = 26) and “100th percentile” (n = 23). Distributions of engagement indices were not similar for all groups, as assessed by visual inspection of a boxplot shown in Figure 25; therefore, mean ranks were used. The engagement index distributions were statistically significantly different between hashtag frequency quintiles on Facebook ($\chi2(4) = 54.080$, $p < 0.0001$). Subsequently, pairwise comparisons performed using Dunn's (1964) procedure with a Bonferroni correction for multiple comparisons revealed statistically significant differences in engagement indices between the 20th percentile (mean rank = 620) and 40th, 60th, 80th, 100th percentiles ($p = 0.0006$), $p = 0.0024$, $p = 0.0007$, and $p < 0.0001$).

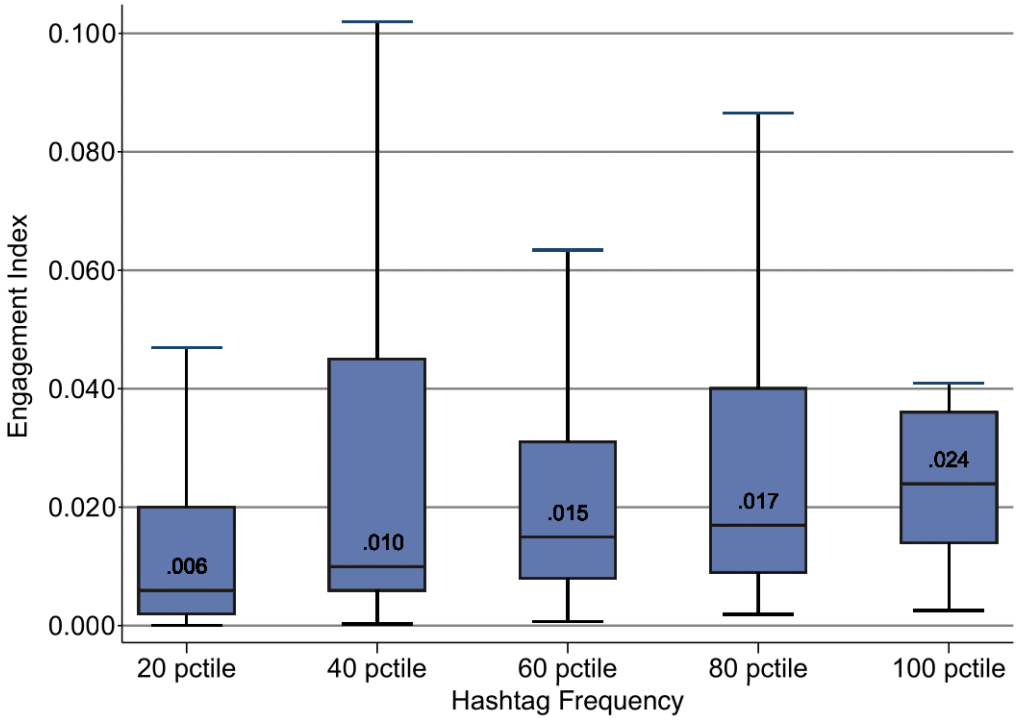

Figure 25: Box and whisker plot of hashtag frequency quintiles and engagement indices on Facebook (labeled values are medians).

Among Twitter messages with hashtags, hashtags in the lowest frequency quintile were used in messages with the lowest engagement indices, while the popular hashtags in the fifth quintile corresponded to messages with the highest engagement indices. Quintiles were generated for individual messages with hashtags based on the range of unique frequencies observed for all hashtags included in the Twitter messages analyzed (i.e., messages with a hashtag used once and only once were assigned to the first quintile, while messages with a very popular hashtag might be included in the fifth quintile). A Kruskal-Wallis test was then conducted to determine if there were differences in the distribution of engagement indices across the five hashtag frequency quintiles for Twitter messages with hashtags: “20th percentile” (n = 6,103), “40 percentile” (n = 1,815), “60th percentile” (n = 1,732), “80th percentile” (n = 2,093) and "100th percentile" (n = 4,651). Distributions of engagement indices were not similar for all groups, as assessed by visual inspection of a boxplot shown in Figure 26; therefore, mean ranks were used. The engagement index distributions were statistically significantly different between hashtag frequency quintiles on Twitter ($\chi2(4) = 1927.427$, $p < 0.0001$). Subsequently, pairwise comparisons performed using Dunn's (1964) procedure with a Bonferroni correction for multiple comparisons revealed statistically significant differences in engagement indices between the 20th percentile (mean rank = 6,898) and 40th, 60th, 80th, and 100th percentiles ($p = 0.0003$, $p < 0.0001$, $p < 0.0001$, and $p < 0.0001$). The analysis also revealed statistically significant differences between the 100th and 40th, 60th, and 80th percentiles ($p < 0.0001$, $p < 0.0001$, and $p<0.0001$).

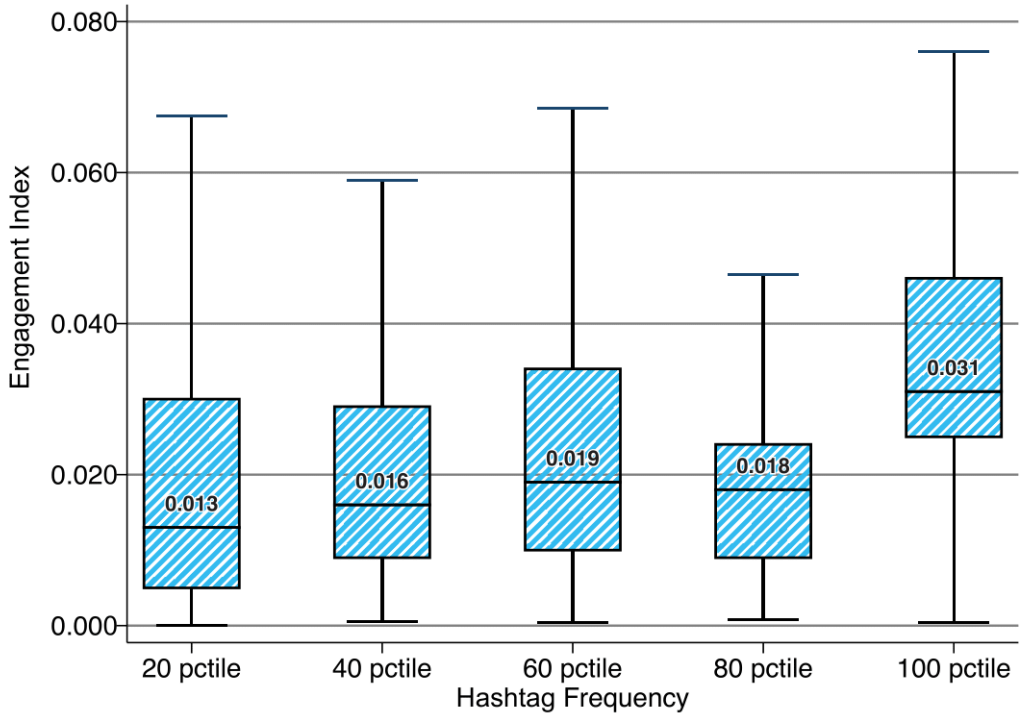

Figure 26: Box and whisker plot of hashtag frequency quintiles and engagement indices on Twitter (labeled values are medians).

On both Facebook and Twitter, usage of campaign-specific hashtags generally follows the NHTSA social media calendar. Analysis of several popular hashtag categories shows that their usage on both platforms generally peaks around the time of the related national campaign. The team investigated impaired driving, distracted driving, motorcycle and bicycle safety, teen driving, child passenger safety, and seatbelt usage campaigns. The graphs of each of these six campaigns are shown below in Figure 27 through Figure 32, for both Facebook and Twitter. By visual inspection we see:

- The use of impaired driving hashtags is correlated with holidays, including Valentine's Day and St. Patrick's Day.
- The use of distracted driving hashtags is most frequent during April–distracted driving month–and has a local peak in early July on Twitter.
- Motorcycle and bicycle safety hashtags are used most frequently during May–cycling safety month.
- Occupant protection hashtags are used most during the two-week campaign in May, Thanksgiving through New Year's Day, and Valentine's Day.
- Child passenger safety hashtag is used most frequently during the September campaign week.
- Young driver safety hashtags are used almost exclusively during the campaign week in October.

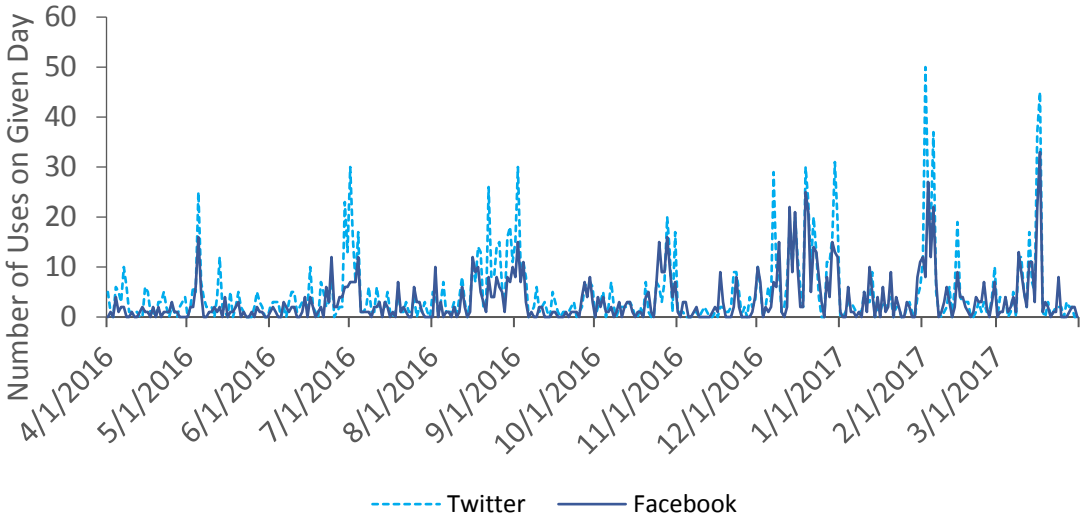

Figure 27: Line graph impaired driving hashtag use.

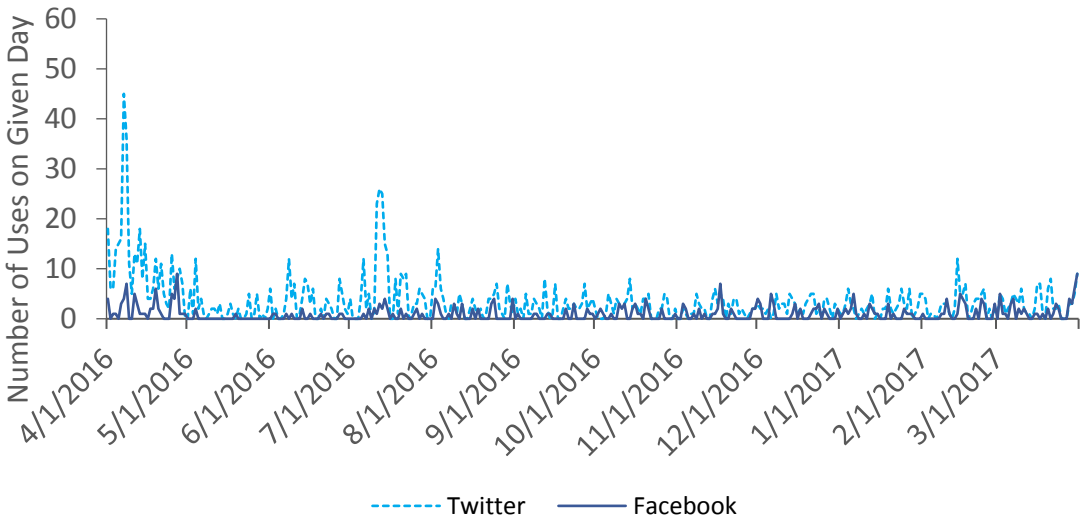

Figure 28: Line graph of distracted driving hashtag use.

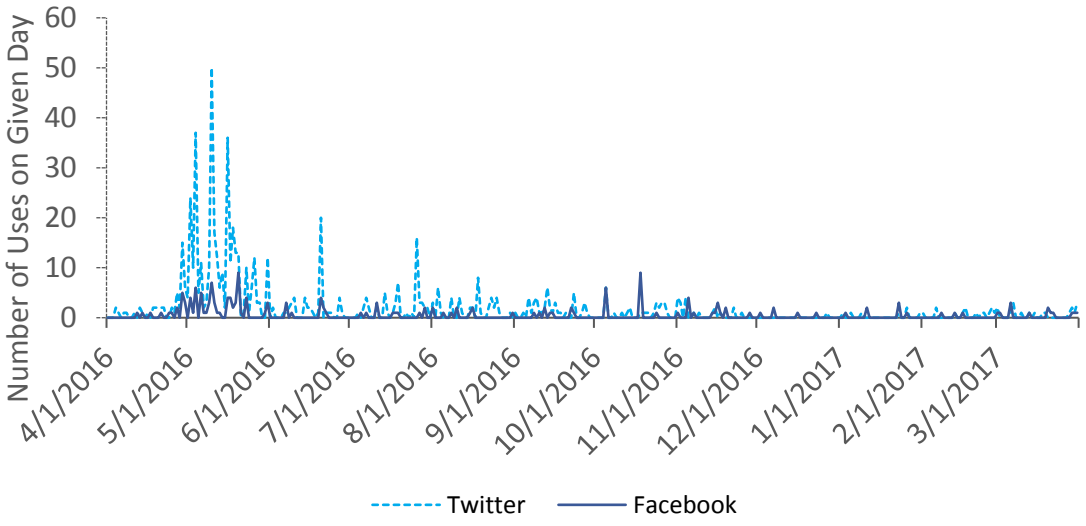

Figure 29: Line graph of motorcycle and bicycle safety hashtag use.

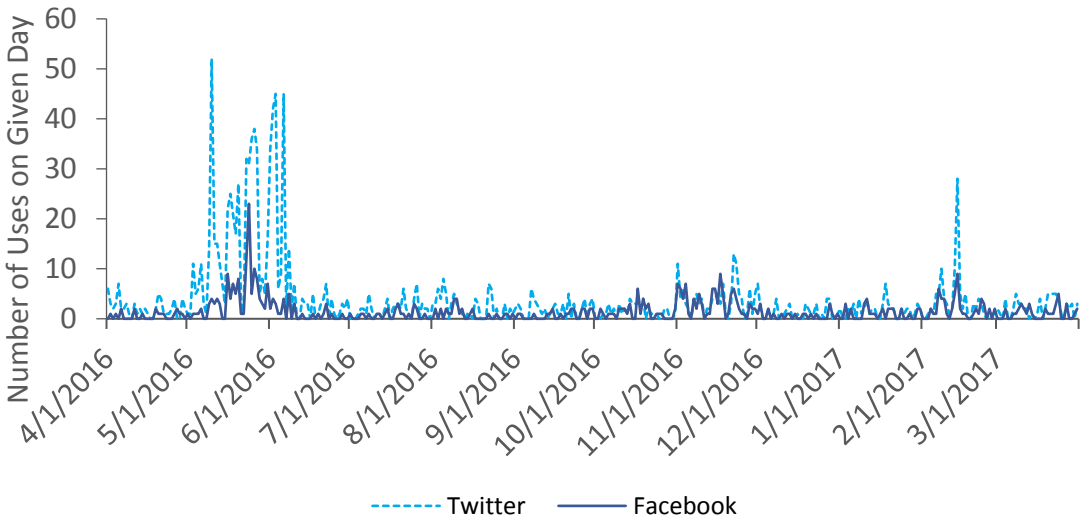

Figure 30: Line graph of occupant protection hashtag use.

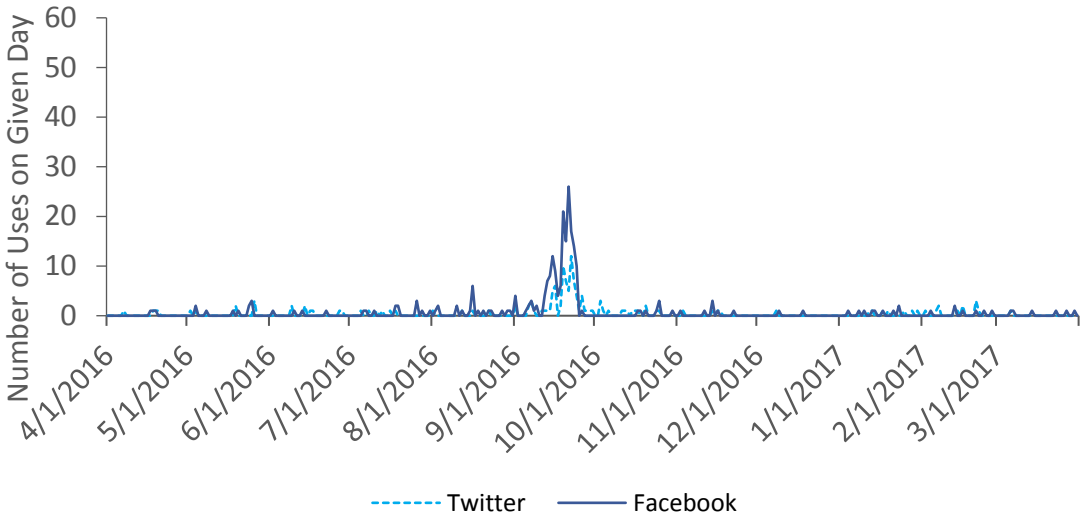

Figure 31: Line graph of child passenger safety hashtag use.

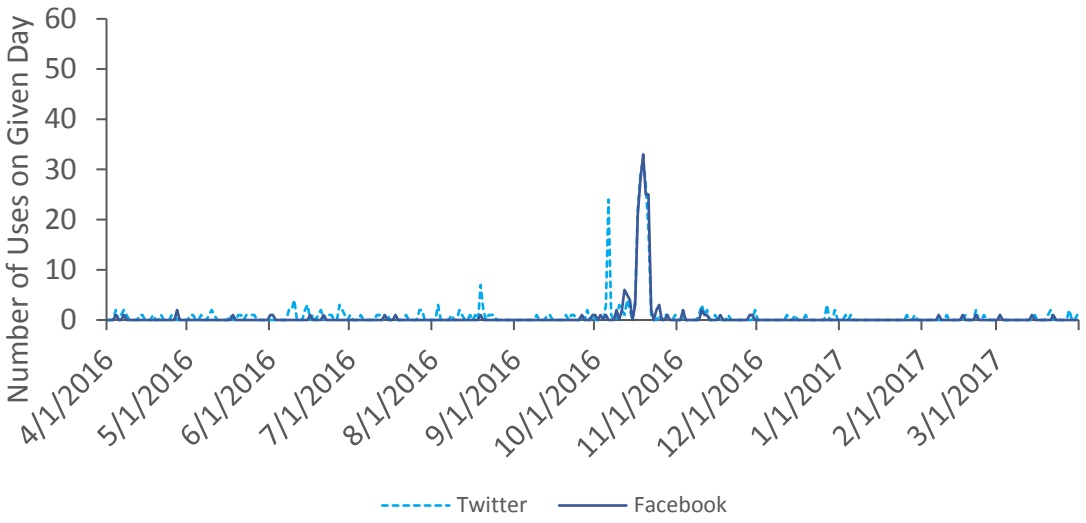

Figure 32: Line graph of young driver safety hashtag use.

On both Facebook and Twitter, some hashtags perform better outside of the campaigns, some perform better during the campaigns, and others have similar effectiveness during both periods. For each campaign on each platform, a Welch t-test was conducted to compare the effect of including campaign hashtags on engagement index both for messages generated during and outside of campaign periods. Of the six campaigns analyzed on both platforms, only some showed more effectiveness on engagement during campaign periods.

As shown in Table 8, the Facebook results indicate that impaired and distracted driving hashtags were more likely to have a higher engagement index when used inside of their related campaigns, while motorcycle and bicycle safety hashtags were more likely to have higher engagement when used outside of the associated campaign period. For occupant protection, child passenger safety, and young driver safety, the results did not indicate a statistically significant difference in engagement index between Facebook posts using the hashtag during the campaign week and those outside of the campaign week.

Campaign	Posted During Campaign		Not Posted During Campaign		T Statistic	p-Value	When hashtag use resulted in highest average engagement index
	n	Average Engagement Index	n	Average Engagement Index			
Impaired Driving	531	0.030	686	0.015	t(813) = 3.61	3.28×10^{-4}	During campaign
Distracted Driving	74	0.089	282	0.025	t(89) = 2.81	6.02×10^{-3}	During campaign
Motorcycle/Bicycle Safety	82	0.013	98	0.029	t(145) = -2.64	9.23×10^{-3}	Not during campaign
Occupant Protection	102	0.036	425	0.020	t(124) = 1.45	0.149	No difference
Car Seat Safety	113	0.031	142	0.018	t(167) = 1.48	0.140	No difference
Young Driver Safety	137	0.008	57	0.008	t(105) = 0.07	0.942	No difference

Table 8: Use of campaign hashtags and their average engagement indices on Facebook.

The analysis for Twitter shown in Table 9 indicates that tweets using motorcycle and bicycle safety hashtags during the campaign week had statistically significant higher engagement indices than those using the hashtag outside of the campaign week. Hashtags for distracted driving, child passenger safety, and young driver safety were more likely to increase engagement index for tweets sent outside of the campaign. The use of hashtags for impaired driving and occupant protection did not have a statistically significant difference in impact on engagement index inside or outside the campaign week.

Campaign	Posted During Campaign		Not Posted During Campaign		T Statistic	p-Value	When hashtag use resulted in highest average engagement index
	n	Average Engagement Index	n	Average Engagement Index			
Impaired Driving	806	0.029	941	0.026	t(1,578) = 1.12	0.26	No Difference
Distracted Driving	343	0.021	961	0.056	t(1,291) = -6.87	$p < 0.0001$	Not during campaign
Motorcycle/Bicycle Safety	414	0.035	262	0.023	t(668) = 2.93	3.48×10^{-3}	During campaign
Occupant Protection	309	0.033	1102	0.032	t(462) = 0.29	0.77	No Difference
Child Passenger Safety	47	0.012	100	0.024	t(141) = -2.52	0.01	Not during campaign
Young Driver Safety	133	0.015	175	0.023	t(294) = -2.32	0.02	Not during campaign

Table 9: Use of campaign hashtags and their average engagement indices on Twitter.

5.1.3.3 Timing

On both Twitter and Facebook, the day of week a message is posted does not typically affect its engagement index. Almost 90 percent of messages are posted or tweeted between Monday and Friday as shown in Figure 33. The volume of messages ranges from 1,938 tweets and 1,449 posts on Monday to 2,236 tweets and 1,625 posts on Friday.

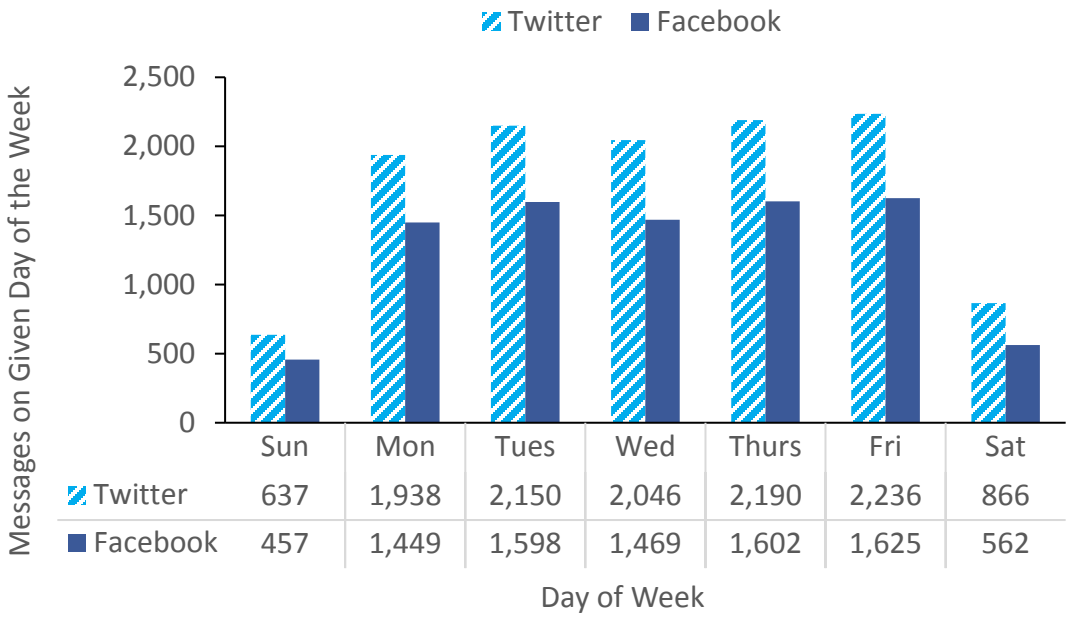

Figure 33: Posting volume by day of the week on both platforms.

A Kruskal-Wallis test was conducted to determine if there were differences in engagement indices for Facebook posts between the days of the week: Sunday (n=457), Monday (n=1,449), Tuesday (n=1,598), Wednesday (n=1,469), Thursday (n=1,602), Friday (n=1,625), and Saturday (n=562). Distributions of engagement indices were not similar for all groups, as assessed by visual inspection of a boxplot shown in Figure 34. Engagement indices were not statistically significantly different based on the day of the week posted ($\chi^2(6) = 5.210$, $p = 0.517$).

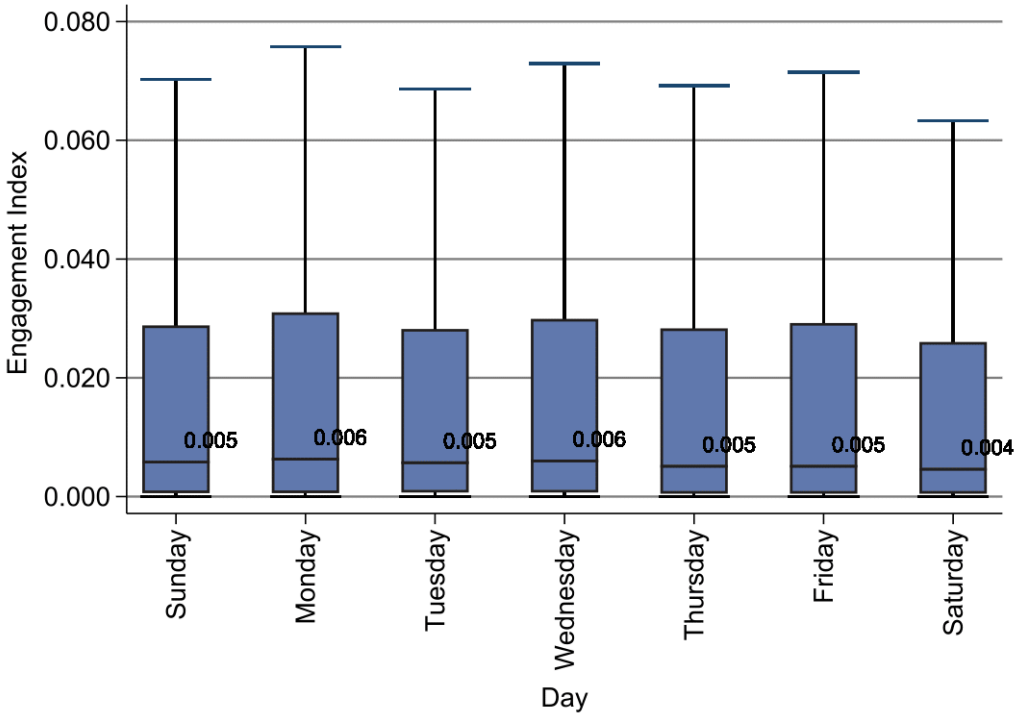

Figure 34: Box and whisker plot of day of week and engagement index on Facebook (labeled values are medians).

On Twitter, tweets posted on Saturday and Sunday have higher engagement indices than those posted on Monday, Wednesday, Thursday, or Friday. A Kruskal-Wallis test was conducted to determine if there were differences in engagement indices for Twitter messages between the days of the week: Sunday (n=798), Monday (n=2,986), Tuesday (n=3,267), Wednesday (n=3,219), Thursday (n=3,379), Friday (n=3,411), and Saturday (n=1,058). Distributions of engagement indices were similar for all groups, as assessed by visual inspection of a boxplot shown in Figure 35. The median engagement indices for individual Twitter messages were statistically significantly different based on the day of the week ($\chi^2(6) = 41.272$, $p < 0.0001$).

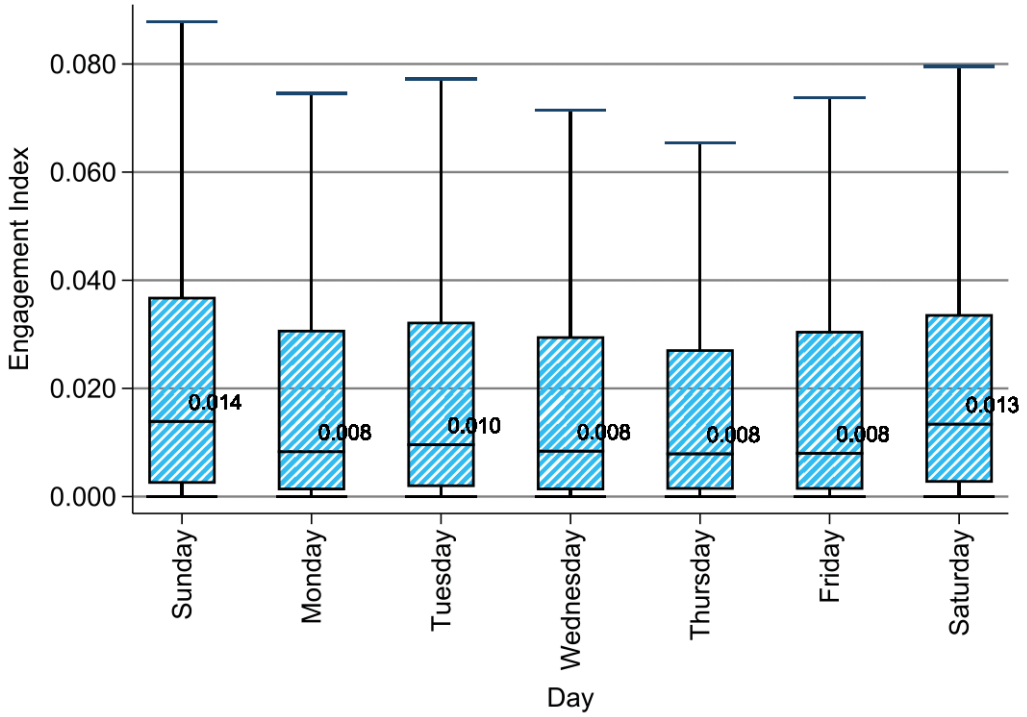

Figure 35: Box and whisker plot of day of week and engagement index on Twitter (labeled values are medians).

As shown in the table below, pairwise comparisons performed using Dunn's (1964) procedure with a Bonferroni correction for multiple comparisons revealed statistically significant differences in engagement indices between tweets on Saturday and Sunday, and those on Monday, Wednesday, Thursday, and Friday. The analysis also found statistically significant higher engagement indices for tweets on Tuesday than on Thursday.

	Saturday (Mdn = 0.0134)	Sunday (Mdn = 0.0139)	Tuesday (Mdn = 0.0096)
Monday (Mdn = 0.0083)	p = 0.0086	p = 0.0012	
Wednesday (Mdn = 0.0084)	p = 0.0046	p = 0.0006	
Thursday (Mdn = 0.0079)	p = 0.0040	p < 0.0001	p = 0.0444
Friday (Mdn = 0.0080)	p = 0.0010	p = 0.0014	

Table 10: Matrix of statistically significant pairings identified by Dunn's post-hoc analysis.

On both Facebook and Twitter, safety messages posted at night had the highest engagement indices. A visual inspection of the distribution of messages over a 24-hour period, shown in Figure 36, reveals that the vast majority of content on both Twitter and Facebook is generated during the daytime.

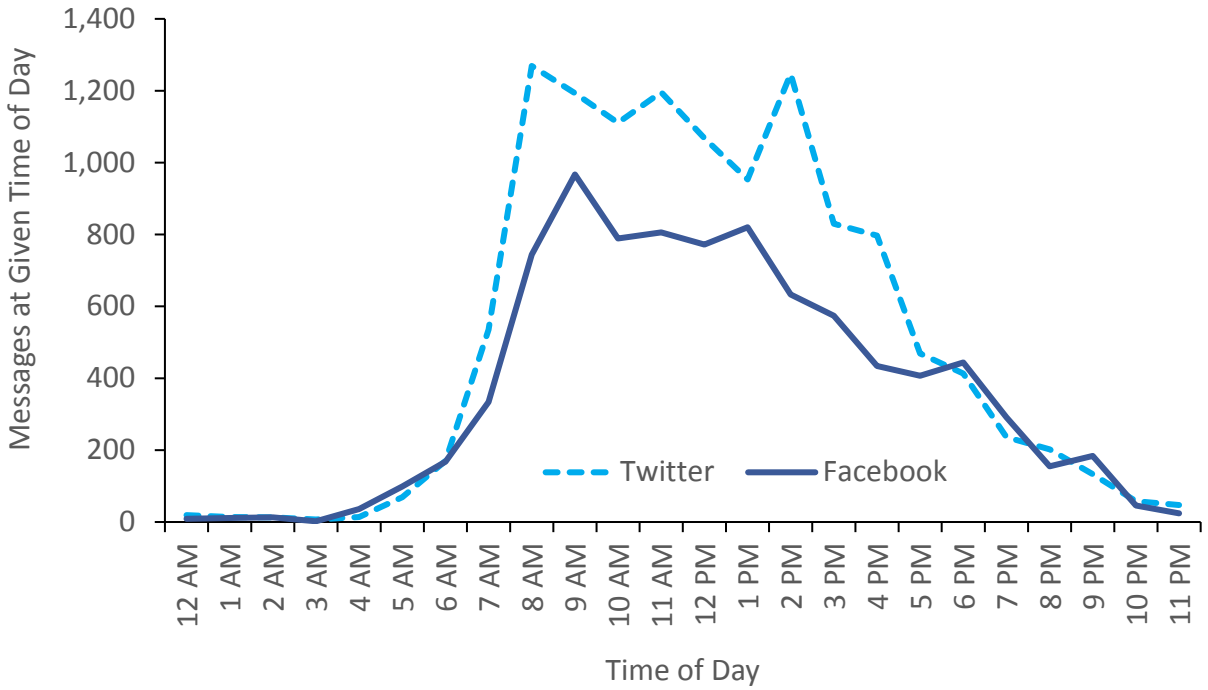

Figure 36: Line graph of posting volume by time of day on both platforms.

A Welch t-test was conducted to compare the effect of time of posting on engagement index for Facebook posts sent between 6 a.m. and 6 p.m. (n = 7,891) versus those sent between 7 p.m. and 5 a.m. (n = 870). There was a statistically significant effect of time of posting on Facebook post engagement index at the $p < 0.05$ level based on daytime or nighttime posting [$t(1{,}011) = 3.740$, $p = 0.0002$]. As shown in Figure 37. Facebook posts generated during the nighttime hours had higher engagement indices ($M = 0.054$, $SD = 0.122$) than those generated during the day ($M = 0.038$, $SD = 0.103$).

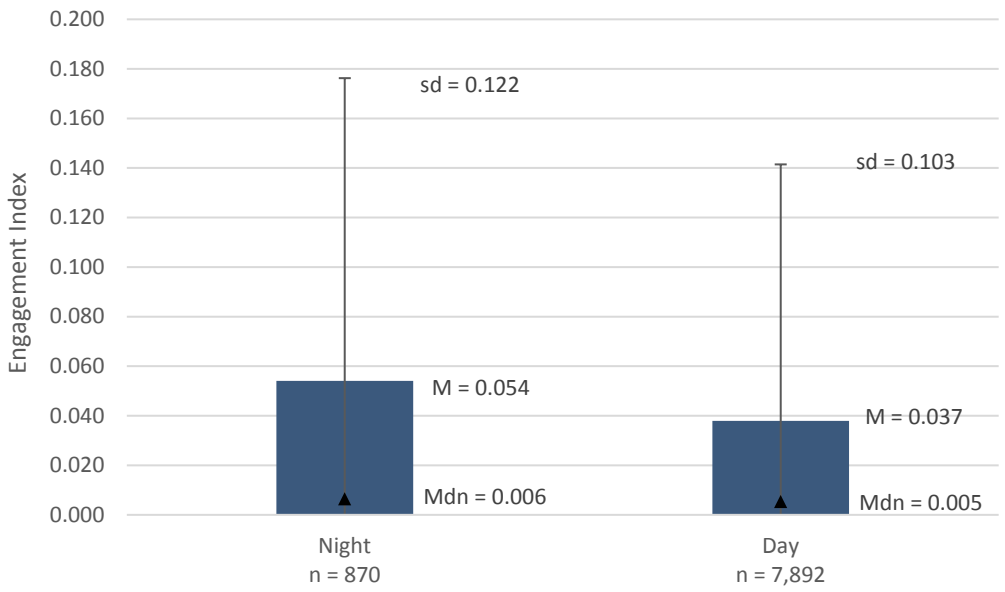

Figure 37: Bar chart of mean and standard deviation of engagement index and day versus night on Facebook.

A Welch t-test was conducted for Twitter to compare the effect of time of posting on engagement index for tweets sent between 6 a.m. and 6 p.m. (n = 17,094) versus those sent between 7 p.m. and 5 a.m. (n = 1024). There was a statistically significant effect of time of posting on Twitter message engagement index at the $p < 0.05$ level based on daytime or nighttime posting [$t(1,130) = 2.357$, $p = 0.0185$]. Tweets sent during the nighttime hours had higher engagement indices ($M = 0.039$, $SD = 0.087$) than those generated during the day ($M = 0.033$, $SD = 0.080$), as shown in Figure 38.

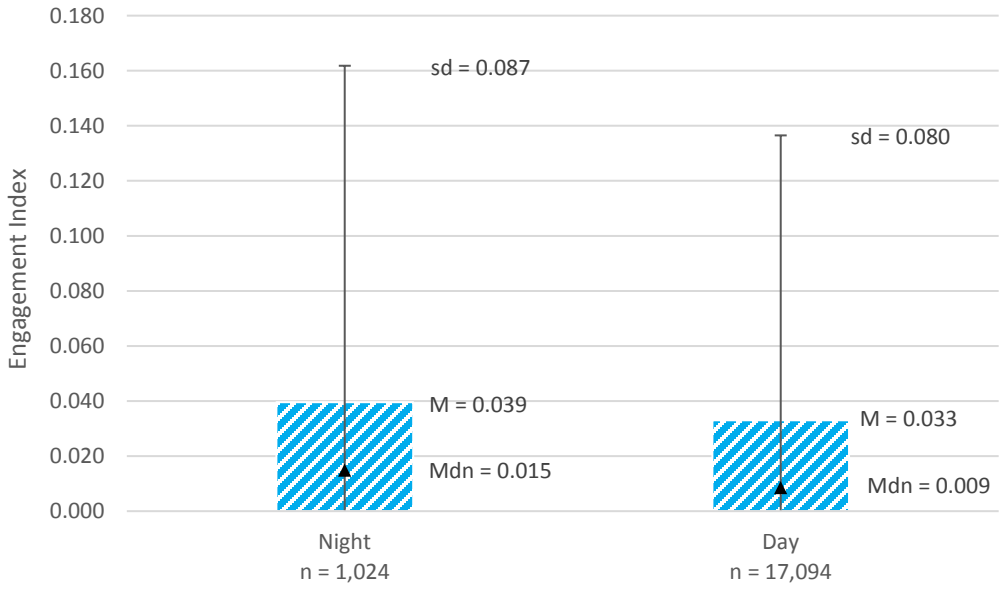

Figure 38: Bar chart of mean and standard deviation of engagement index and day versus night on Facebook.

On both Facebook and Twitter, the volume of safety content varies throughout the year with peaks centered on national and local campaigns. The volume of overall safety content on both platforms across the year appears to match up with national and local campaigns. For example, Facebook shows spikes around holidays with impaired driving events—such as Saint Patrick's Day and Cinco de Mayo—and months that contain focused safety weeks—such as work zone awareness week and child passenger safety week (Figure 39). Twitter exhibits similar trends. The largest peak appears for April, which is distracted driving month and includes work zone awareness week.

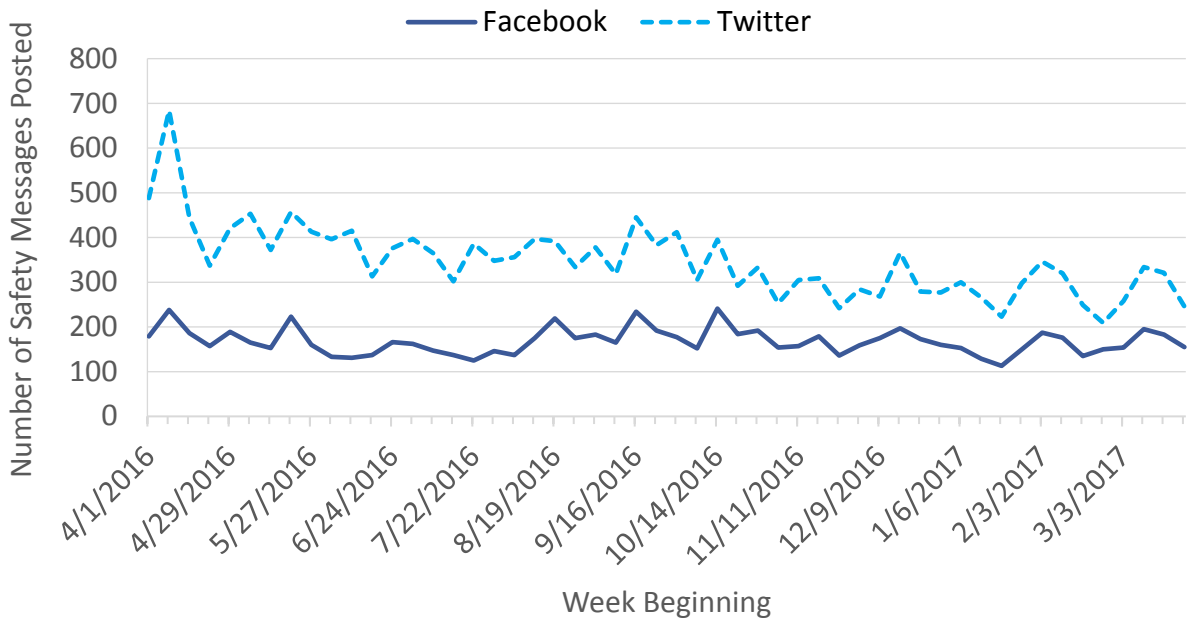

Figure 39. Line graph of volume of safety content posted by week on Facebook and Twitter.

5.2 Qualitative

This section describes the results of the qualitative data collection and analysis, including the literature review and interviews with the 10 NHTSA Regional Offices and 9 State Highway Safety Offices.

5.2.1 Literature Review

As part of the qualitative research, a literature review was conducted early in the project to help identify social media practices, trends, and challenges being featured in communication-related resources. Articles were identified that could serve as a resource for SHSOs seeking to advance their social media practices. The original list of over 50 articles was re-visited in the later stages of the project to further down-select articles that were most relevant given the analysis throughout the lifetime of the project. Because of this, Appendix A provides an abbreviated list of resources that can serve as useful information to SHSOs interested in learning more about social media administration and operations. This list includes information on the key topic, article title, and direct link to the information

5.2.2 Interviews

The interviews conducted with the 10 NHTSA Regions helped to build a foundation of understanding on how SHSOs use social media for traffic safety. While the Regional Offices do not directly engage with SHSO social media, the interviews resulted in the identification of several common themes: measuring the impact of social media is difficult, SHSOs use a limited set of social media platforms, and law enforcement is an important partner in social media safety campaigns. Additionally, consistent with the SHSO social media inventory completed at the onset of the project, the interviews confirmed that the most common social media platforms used by SHSOs are Facebook and Twitter. In some cases, the NHTSA staff were also able to provide opinions on States' different levels of use of social media for safety messaging. Four Regions (Regions 3, 4, 7, and 9) mentioned that they host knowledge sharing events with their SHSOs to foster collaboration and awareness of what others in the region are doing for safety campaigns and media outreach.

The SHSO interviews also identified several themes in how SHSOs plan for and implement social media. The 9 SHSO interviews, coupled with the data analysis described above, identified the role that message sentiment and timing can play when delivering social media. The SHSO interviewees shared their opinions on what they perceived to be successful messaging, along with related challenges in implementing a social media strategy. While this analysis does not quantify the successes discussed, the qualitative information identified some common themes regarding message sentiment and timing.

5.2.2.1 Message Sentiment

All the SHSO interviews identified unique messages or campaigns that they considered successful largely due to the creative tone that message portrayed. For some, they noted that emphasizing danger can help enhance reported engagement when appropriate. For example, one SHSO reported posting a video on national puppy day showing how an animal can inadvertently become a projectile in a crash when not properly restrained in a car.

Additionally, States reported the importance of having relatable and accessible content in achieving higher engagement levels. They noted that efforts to use localized or personalized content tend to improve engagement. More specifically, some successful campaigns focus on authenticity and present real-life scenarios. Tapping into social trends and sports culture further enhances engagement.

5.2.2.2 Timing

Because social media accounts are managed as part of a regular 40-hour workweek, interviews with SHSOs found that most of the messages posted or tweeted during the week are done at times when people are working. Even within a 40-hour work week, there are lots of possibilities on when to post a message. The 9 SHSOs interviewed each use a different strategy for deciding what day, what time, and how frequently to post as part of a strategic decision to inform an overall social media strategy. For example, some SHSOs interviewed chose to post on a specific day of the week, and others include a specific time that they regularly post.

Table 11 provides examples of approaches taken by the SHSOs interviewed.

Schedule	Rationale
Variable Days, 8 – 10 a.m.	Reach morning commuters
Weekdays after 5 p.m.	Reach evening commuters and keep posts at top of feed for evening viewing
In the evening	Post "jarring" content
Every Tuesday at 10 a.m.	Establish a routine to ensure reliability
Every Friday Morning	Encourage ride planning for evening/weekend to reduce drunk driving

Table 11. Example SHSO social media posting schedules.

These decisions often come down to knowing the target audience. For example, the 9 SHSOs interviewed broadly agree that understanding the intended audience improves engagement. At the same time, SHSOs also recognize there is no "one size fits all" approach to successfully craft, implement, and track safety-related social media strategies.

6. Discussion

Both the quantitative and qualitative results informed six promising practices and SHSO mini-case studies. These practices are general enough that they can be added to existing operations or used to enhance current practices. While many of these practices are informed by the quantitative social media data analyses, they are also supported by the qualitative SHSO interviews. The interviews found that each SHSO tracks the success of its social media differently. Metrics include engagement, impressions, and comments, and some of this is based on organic posts (done through the SHSO or account owner) while other posts may gain increased visibility using paid social media. In many of these cases, the project team did not have access to this data, and it was not requested as part of the interviews. Therefore, the observations shared below from SHSOs regarding their approaches and successes are based on their independent assessment of their own social media through their own assessment.

The results and examples described in this report also show the variability that exists across SHSO social media. This variability helps demonstrate the importance of tailoring social media so that the messaging, how and when it is received, and its potential engagement are optimized. Regardless of the variability, however, the social media data analysis and interviews show that successful campaigns have several common goals.

- Setting the right tone for your audience
- Knowing how to measure "success" at a low-cost
- Having the right skill set to design engaging content
- Keeping content fresh and relatable to audiences
- Mimicking successes without appearing repetitive

These goals—and often challenges at the same time—were introduced in different ways during interviews and data analysis. This information was then used to identify six promising practices to serve as guides for implementing the goals above.

6.1 Promising Practices

The promising practices are described in detail below.

- Reuse safety messaging on multiple platforms
- Consider the tone of your safety messages
- Use pictures, videos, and links strategically
- Use hashtags selectively
- Time the posting of content to meet stakeholders' needs
- Collaborate with other State and local accounts to increase visibility of safety messaging

6.1.1 Safety messaging can be reused on multiple platforms

Tools exist to cross-post messages on multiple platforms simultaneously (e.g., Hootsuite, Sendible, SocialPilot). Analysis of the character lengths of safety messages posted on Twitter and Facebook generally suggests that the same safety messages may be posted on both with no negative effect. Individual account managers may experiment with this approach to reuse content, save time and resources, and reach target audiences on multiple platforms.

6.1.2 Consider the tone of safety messages

The goal of striking the right tone for the right message can be an ongoing challenge. All the SHSO interviews identified unique messages or campaigns that they considered successful largely due to the creative tone that message portrayed. For some, they noted that danger–e.g., featuring the consequences of distracted driving or leaving children in a hot car–can help enhance engagement when appropriate. Some SHSOs shared in the interviews that they always need to be aware of "sensitivities" to jarring material and tend to consider posts on a case-by-case basis. One State noted it will remove a post if complaints around sensitivities surface. The quantitative results support this finding; positive messages typically had higher engagement indices than neutral messages on Facebook.

While many of the SHSOs interviewed acknowledged that a negative message could result in engagement, they also shared many examples of messages with a positive tone that they considered to be some of their most successful campaigns or messages. For example, it was noted that comedic twists—and entertaining posts more generally—tend to be perceived as some of the most successful posts. One SHSO also noted that a light-hearted tone can also help "ease any anxiety of government posts," while another noted that a humorous tone can also "generate buzz in a positive/supportive way." At the same time, interviewees also reported that it is important to "toe the line" between using humor to catch people's attention and not appearing to make light of the dangers of these safety concerns.

6.1.3 Be strategic about using pictures, videos, and links in your messaging

As seen in the results, adding a picture, video, or links to a social media post can often increase its engagement and therefore increase its reach and impact. However, analysis of the safety messaging across Facebook and Twitter found that this increase depends on the platform. On Facebook, text only safety messages generate higher engagement than those that include links, photos, or videos. The opposite was true for Twitter. Relatively few text-only messages produce very high engagement while most other messages produce no engagement. Given this variability, "getting the words right" matters considerably in prompting people to engage, especially for text-only messaging.

6.1.4 Be selective about the usage of hashtags

In this report, hashtags were used on both platforms with differing levels of success. Specific hashtags stood out as effective, even within a single platform, and usage patterns were analyzed for several specific campaigns. The popularity of a hashtag can vary depending on how it is used, when it is used, and for what it is used. For example, hashtags can gain in popularity based on the specific social media campaign or who it is being shared with (e.g., partner organizations or celebrities). Overuse of hashtags on Facebook can result in diminishing returns resulting in little or no increase in engagement. However, on Twitter, messages with one to four hashtags have higher engagement indices than those with none. Like the other promising practices, the use of hashtags should be considered in an overall strategy outlining how that specific message is intended to be used.

6.1.5 Customize the timing for posting content to meet audience needs

Because social media accounts are managed as part of a regular 40-hour workweek, most messages are posted or tweeted during the week at times when people are working. Even within a 40-hour work week, there are many opportunities to post messages, but the data revealed that

overall messages posted at night had higher engagement indices. Deciding what day, what time, and how frequently to post is a strategic decision to inform an overall social media strategy.

These decisions often come down to knowing the target audience. For example, though approaches to social media account management vary, the 9 SHSOs interviewed broadly agree that understanding the audience improves engagement. At the same time, SHSOs also recognize there is no "one size fits all" approach to successfully craft, implement, and track safety-related social media strategies.

6.1.6 Collaborate with State and local agencies to increase safety message visibility

The number of followers for a given account can vary based on the type of agency and how they use the social media platform. DOTs typically have more followers than other account types, thus other account types may seek to share and retweet messages with their DOT counterparts to increase the reach of these messages. This strategy can be especially helpful when planning to rollout specific campaigns and match the topic with appropriate organizations—government and non-government—that have an active following.

SHSOs also identified successful partnering arrangements in the interviews. The following examples illustrate these partnerships or collaboration.

- New York's SHSO has a contract with the New York State Broadcaster's Association that increases the reach of their messaging. The grantee shares the SHSO's messaging via broadcast stations throughout the State. Operationally, when the SHSO sends a post out, the association reaches out to their stations to ask them to share a post. As part of this arrangement, the association has shared which types of content they would be more apt to share, and the SHSO has been trying to align their content with what the association would want to share.
- Tennessee's SHSO has partnered with the State's Bureau of Health and other agencies as part of the launch for their Stop Drugged Driving campaign. This partnership is a joint effort to help address opioid abuse and drugged driving.
- South Carolina's SHSO partners with their Community Relations Officers who each have their own trooper account specific to their assigned area. The SHSO has seen an increase in Twitter engagement and attributes that partly to the Community Relations Officers who often retweet or repeat what is shared on the SHSO account.

6.2 SHSO Case Studies

This section provides examples of social media practices used to convey safety messaging by one or more of the 9 SHSOs selected for interviews. These SHSO case studies include popular campaigns and describe some of the ways SHSOs think they are beneficial.

6.2.1 Case Study Practice: Tap into the social and sports culture of the State

The idea: Taking advantage of the strong sports focus in Kansas, the Kansas SHSO developed a March Madness bracket composed of KSDOT safety campaigns. The public was asked to vote via Twitter at each bracket stage to determine a winner for their favorite campaign. The March Madness Twitter safety bracket reached 54,000 people with more than 1,400 engagements during the three-week campaign (Figure 40).

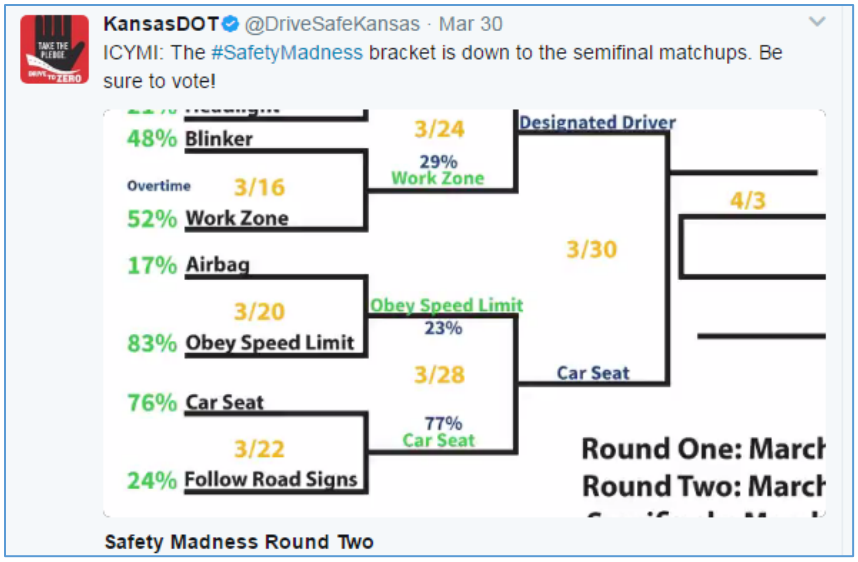

Figure 40: Kansas' "Safety Madness Bracket" campaign.

The rationale: The SHSO viewed this example as beneficial because it played off the sports energy of the State to promote social media engagement. Focusing on populations interested in large sporting events also allows Kansas to geo-fence safety messaging around specific sports venues by programming certain messages to reach certain geographic areas and/or demographics. Using geo-fencing is an especially helpful strategy when there are certain location-based events that can benefit from specific messaging (e.g., messaging promoting designated drivers focused on areas with night life).

6.2.2 Case Study Practice: Use emojis to capture attention, interest, and recall

The idea: South Carolina SHSO's Trooper Bob emoji campaign originally began with one South Carolina State trooper, Trooper Bob, illustrating the dangers of a 1,000-year flood on Twitter using emojis. This one tweet concept evolved into a full emoji campaign, including emoji-only depictions of what happens during a DUI arrest. The campaign was lauded on national news (Figure 41).

Figure 41: Trooper Bob's emoji-filled safety tweets.

The rationale: Emojis incorporate simple yet creative humor into safety messaging, lighten the often-serious mood around the topic, and reduce any monotony or habituation around safety messaging where people do not really "hear" the message even when they see it. The SHSO viewed this approach as beneficial because it leveraged a law enforcement officer's social media handle; the SHSO estimates that this helped "double the impact" of their safety messaging.

6.2.3 Case Study Practice: Share personal stories to engage audience empathy and sharing

The idea: The Pennsylvania SHSO solicited quotes from construction workers across the region regarding their personal identity within the community. Stories were highlighted on Facebook and Twitter to help emphasize the "person" side of construction workers in an effort to reduce speeding in work zones (Figure 42).

Figure 42: Pennsylvania's personalized work zone safety campaign.

The rationale: The SHSO viewed the work zone safety campaign, #Slow4Zone, as a good example because it reminded drivers that construction workers are also parents, little league coaches, etc., and important members of the community. By attaching personal stories to the group most in danger from work zone speeding, the SHSO hopes drivers will start to be more likely to empathize and show caution when driving through these areas.

6.2.4 Case Study Practice: Position tickets as poor choices drivers make with their money

The idea: The Maryland SHSO's "Would You Rather" social media campaign offers choices to drivers on what they would rather do or experience instead of receiving punishment for highway safety infractions (Figure 43). For example, "would you rather spend money on a concert ticket or a speeding ticket?"

Figure 43: Maryland's "Would You Rather" campaign.

The rationale: The SHSO viewed this technique as beneficial because it frames speeding warnings on the more day-to-day monetary losses incurred when receiving a speeding ticket. This introduces an additional comparison to consider before committing an infraction. In doing so, the idea finds a compelling near-term consequence for the driver to reflect on. The SHSO hopes that the campaign will use relatability to potentially connect with audiences through the idea of losing money on a speeding ticket when they could spend it elsewhere.

6.2.5 Case Study Practice: Incorporate pop culture to reach young audiences

The idea: Several SHSOs took advantage of the recent Pokémon Go craze and the safety concerns surrounding it, employing a Facebook and Twitter campaign to reach people in key demographic groups (i.e., 18 to 34 years old). Two examples are the Texas campaign called Don't Pokémon and Drive #WeShouldntHaveToTellYouThis and Tennessee's campaign #PikachuCanWait (Figure 44). This example of using the momentum from pop culture can be engaging and attract attention. One SHSO cautions, however, that agencies should also be aware of intellectual property when using logos or marketing from pop culture trends and recommends agencies enlist a legal advisor in the process for guidance.

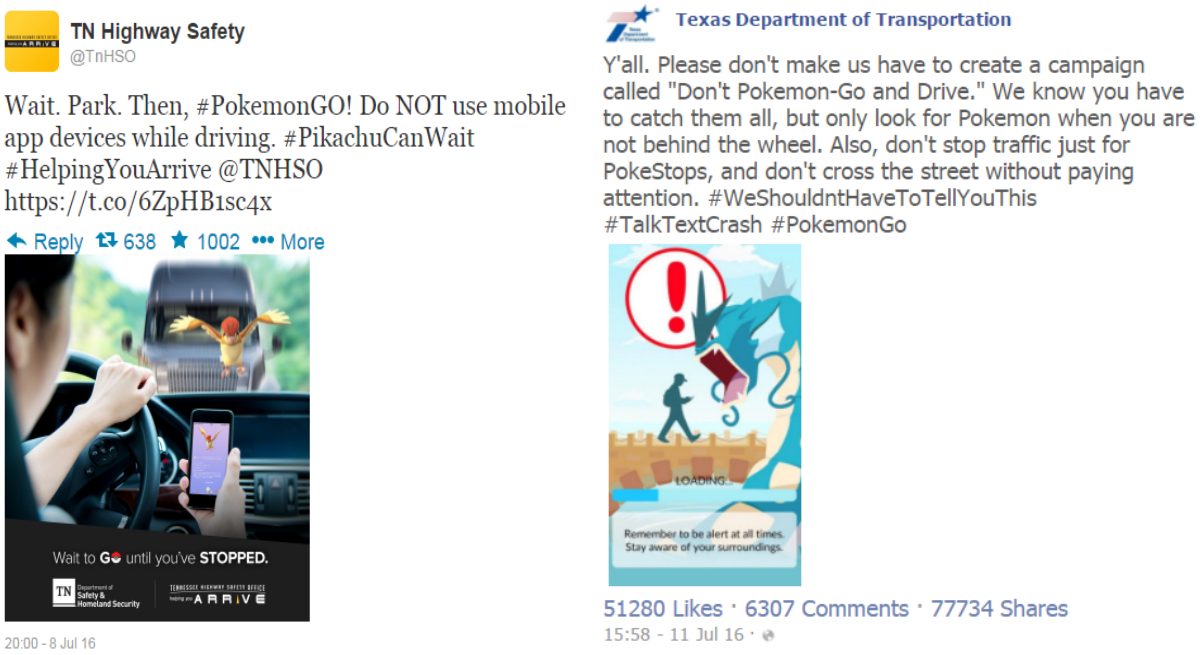

Figure 44: Sample Pokémon Go campaigns, from Tennessee and Texas.

The rationale: This campaign is viewed as a beneficial practice by SHSOs because it uses both humor and creative graphics to attract attention on the dangers of playing the game while driving. These hashtags are particularly effective as a slogan that both creates attention and engagement. **Error! Reference source not found.** shows that #PokemonGo had the highest engagement index for the study period despite it not having a high frequency rating. Although the different Pokémon campaigns are condemning a bad practice of driving while distracted, it does not come across as stern. And that's the point— SHSOs believe this light-hearted approach is a novel way to try to raise awareness.

6.2.6 Case Study Practice: Use jarring content to create a visceral, real-life response

The idea: In Texas, a video was used on Facebook to show a real-world example of distracted driving by sharing a message from a parent of a popular local athlete. The New Mexico SHSO developed a video campaign titled "The Things I've Seen" for Facebook, YouTube, and Twitter, with videos running from 30 seconds to almost 2 minutes. These were produced to support prevention efforts targeting statewide Labor Day driving while intoxicated (DWI) (Figure 45).

Figure 45: Examples of campaigns featuring intentionally jarring content from TxDOT and New Mexico.

The role: The SHSO believes this technique is a good example because it incites fear about the dangers of DWI and distracted driving. In the case of New Mexico's video, it should be noted that to employ this technique well, the New Mexico SHSO stressed the importance of being authentic in their content. Its video series follows somebody through the entire process of a DWI arrest, conviction, and release. In addition, this social media campaign uses a somewhat unique approach in that contractors launch the videos from non-government sites (e.g., sites ending in .com) to minimize the government "feel." The SHSO also found that producing videos of varying length captured from the same file also improves efficiency and distribution return on investment.

7. Limitations

Limitations existed in the collection of both quantitative and qualitative data.

7.1 Quantitative

The Twitter application programming interface (API) imposes a limitation on the available tweets that can be retrieved retrospectively. The maximum number of tweets able to be retrieved in this manner is 3,200. It's theoretically possible to retrieve all a user's tweets, but only if they have tweeted fewer than 3,200 tweets during the year of data collection.

The Twitter API retrieval limit of 3,200 tweets required periodic data retrieval throughout the project timeline, as some agencies posted tweets at a rate of nearly 30 per day, which would have left gaps in the data if only retrieved at the end of the analysis period. The beginning date of the analysis period was governed primarily by the rate limit. At the beginning of the analysis, only the previous 3,200 tweets from each account were available, which for at least one account only included tweets through the beginning of April. This was likely due to some SHSO Twitter accounts posting large volumes of messages via automated intelligent transportation systems (ITS) for traffic monitoring purposes.

Additionally, there are also significant data and statistics that are only made available to Facebook account owners and were not available for this study. For this reason, the project team limited the data analysis to focus on engagement and was not able to investigate impressions or other engagement metrics used by account owners.

7.2 Qualitative

Qualitative limitations existed with the interview phase of this project. While the group of 9 interviewees represents a diverse set of SHSOs—by account type, geographic location, population, etc. —the project team recognizes that the information collected from the interviews cannot be used to identify larger trends or themes representative of all SHSOs. Further, to minimize any burden on the SHSOs interviewed, the project team did not request additional data (i.e., engagement measures) on any mentioned successes they may have highlighted. As a result, the case studies featured in this report are based on SHSO observations and perceptions. While the SHSOs likely have the data to help quantify the engagement, the project team does not have the data and therefore was unable to include that.

8. Conclusion

The state of the practice of SHSO social media varies widely as seen by many of the findings and examples discussed in this report. While no one approach is the same, SHSOs continuously work to evolve their social media approach to reach more people and deliver engaging safety messages. The variability, however, is important to recognize. Many factors can be adapted to achieve different results, such as timing, tone, and partnering. Other influencing factors, such as which agency operates the SHSO, may be less likely to change but are still important to consider in order to identify other strategies to incorporate and address any gaps.

With social media rapidly evolving, SHSOs will need to continue to innovate, share ideas, and be strategic in how they use data and roll out campaigns to deliver an engaging social media program. The network of social media expertise is vast, and SHSOs are in a prime position to learn from each other's successes and challenges.

This report describes some of the factors that play a role in how social media messaging is created, delivered, and measured. Figure 46 for example, shows the relationship among these different components and the role each play in informing a different aspect of social media, from building blocks like staffing and stakeholders to how social media is measured.

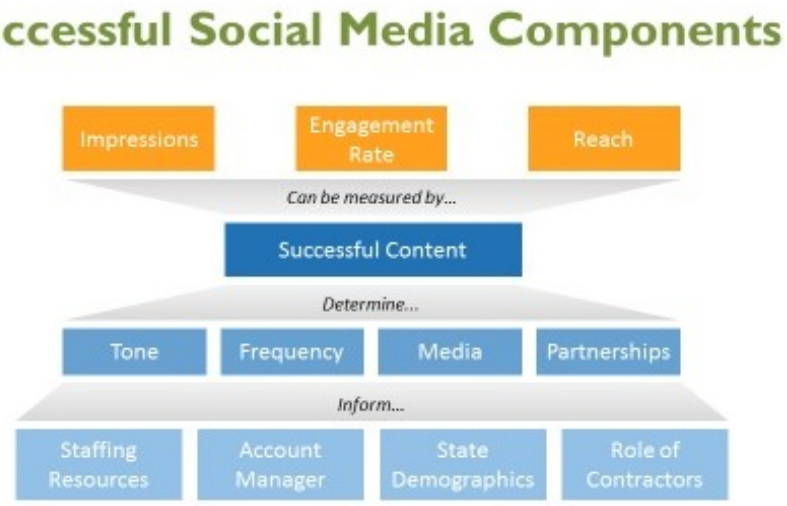

Figure 46: Components of a successful social media program.

Defining how these elements and others contribute to a social media strategy is critical when striving to effectively communicate safety messages to target audiences. The analysis and results described in this report provide a snapshot of national trends, varying approaches, and promising practices that can all be used to help inform future decision-making when planning social media.

Last, while the scope of this project was focused on the state of the practice of SHSO social media for safety messaging, several other knowledge gaps also arose during the project. These gaps—both quantitative and qualitative—are described below.

Using data to understand engagement trends. A challenging question remains: "What is the unit of analysis?" Even if just focusing on "engagement," definitions and efforts to measure this term

vary considerably within and across several stakeholders, including agency operated social media at the national, account management (e.g., DOT, versus SHSO versus Law Enforcement) and individual State levels. SHSOs may benefit from having a more consistent or common understanding of what engagement is, how to track it, and how to apply the information to inform future planning.

Additionally, most SHSOs report that currently data is typically stored in the format provided when downloaded from the social media account software and not yet transformed into metrics that could be useful for future analysis, such as engagement, impressions, or reach. The SHSOs interviewed broadly expressed an interest in learning more about social media data capture and practices to identify which data would be most helpful for analysis and guidance.

***Understanding paid social media across all channels*.** While SHSO account managers can create posts and tweets for free, these messages will only be seen by their followers, along with messages from the other accounts these users follow. To increase the number of people who see their messages, account managers can choose to boost their social media posts by using paid options. These options include making their posts appear higher up in their current followers' message streams, or even making their posts appear in the message streams of users who don't currently follow the SHSO account. This project did not explore paid media.

Learning more about emerging platforms. While quantitative data was only collected for Facebook and Twitter handles, SHSO interviews identified other social media platforms emerging as outlets for safety messaging, including:

- Snapchat to create safety related filters at recreational events (e.g., sports games, concerts);
- Pinterest to share educational ideas for organizations focused on older drivers; and
- Instagram to readily integrate with Facebook operations given the recent Facebook acquisition.

Existing and emerging platforms are rapidly transforming. SHSOs can benefit from being aware of the opportunities and challenges associated with each to help them better focus their messaging to the right audiences.

Gaining a deeper understanding of safety messages and safety impact. Combining natural language processing, machine learning techniques, and more advanced statistical methods such as structural equation modeling, safety messages can be analyzed on a deeper content level. For example, natural language processing and advanced machine learning models—such as neural nets—can discover trends within message content that may otherwise go unobserved. This may include looking at sentence structure, whether messages are advising against a bad action or are promoting a good one, or whether the message contains any "calls to action."

Building on natural language processing and machine learning techniques, structural equation modeling (SEM) can further fit networks of various concepts, traits, or dimensions (constructs) to the data. This well-used approach helps to significantly better understand relationships between observed variables—such as engagement rates—and unobserved variables, including critical steps linking engagement to actual safety data, while taking into account other variables that may also impact safety results.

Together these next-steps aim to enhance the traffic safety community's understanding of the relationship between social media safety messaging and safe behavior. Such next-step studies could explore how posting and engagement rates, along with other measurable indices, function to impact thinking, behavioral change, safety risk, and ultimately downstream safety results including crashes, injuries, and deaths.

9. Appendices

9.1 Appendix A: Relevant Literature Review Articles (retrieved as of August 29, 2016)

Topic	Summary	Reference
Facebook	Tips on how to use Facebook to prioritize and highlight information	Chawla, A. (2016, July 19). *Govtech: What government agencies can do now that facebook is prioritizing people over page*. Retrieved from www.govtech.com/social/What-Government-Agencies-Can-Do-Now-that-Facebook-is-Prioritizing-People-Over-Pages.html
Facebook	Guidance for building a more effective Facebook page	Kolowich, L. (2016, June 2). *How to use Facebook for business: 25 Facebook marketing tips and tricks*. Retrieved from http://blog.hubspot.com/blog/tabid/6307/bid/24422/The-Ultimate-Facebook-Marketing-Cheat-Sheet.aspx#sm.000016cbvgn30afl1qj7pbwsam9jy
Facebook	Information about videos on Facebook and the necessity of audio or not	Vellla, Z. (2016, June 14). *Facebook content and brand strategies that win in a silent autoplay world*. Retrieved from https://techcrunch.com/2016/06/14/facebook-content-and-brand-strategies-that-win-in-a-silent-auto-play-world/
Instagram	Information on how government agencies can engage on Instagram using content that is interesting and sincere	Olander, A. (2015, November 10). Creating content with Instagram. Retrieved from wwwwww.digitalgov.gov/2015/11/10/creating-connection-with-instagram/
Instagram	Tips for developing best practice for Instagram	Chan, N. (2015, December 28). How to build your brand with Instagram: 4 tried-and-true tips. Retrieved from http://blog.hubspot.com/marketing/instagram-build-business-brand#sm.001xnix8rq1ocy2110d1qzs2t5mzg
Instagram	Ideas for content to post on Instagram	Kolowich, L. (2016, April 16). What to post on Instagram: 18 photo & video ideas to spark inspiration. Retrieved from http://blog.hubspot.com/marketing/what-to-post-on-instagram#sm.001xnix8rq1ocy2110d1qzs2t5mzg
Manage-ment	Tips on defining the qualities needed for the person or team managing the social media campaign and community	Chowdhury, A. (2016, June 21). How to become a great online community manager [Infographic]. Retrieved from http://blog.hubspot.com/marketing/online-community-management-tips#sm.001xnix8rq1ocy2110d1qzs2t5mzg
Social Media Comparison s	An overview for determining how/when/why to use different social media platforms	Kolowich, L. (2015, April 30). The pros & cons of Facebook, Twitter, Instagram & other social networks [Infographic]. Retrieved from http://blog.hubspot.com/marketing/pros-cons-facebook-twitter-instagram-social-media#sm.001xnix8rq1ocy2110d1qzs2t5mzg
Snapchat	Outline of the top three reasons for the creation of a snapchat site and how to measure success	Milcetich, J. (2016, April 1). *Why we launched a snapchat account and how we'll measure success*. Retrieved from www.digitalgov.gov/2016/04/01/why-we-launched-a-snapchat-account-and-how-well-measure-success/

Topic	Summary	Reference
Strategy	Tutorial on what to consider when planning a social media strategy	Peters, E. (2016, June 15). Solving for the future of social media: How to keep your strategy ahead of the curve [Free Master Class]. Retrieved from http://blog.hubspot.com/marketing/social-media-strategy-master-class#sm.000016cbvgn30afl1qj7pbwsam9jy
Tactics	Strategies for incorporating social media into emergency management	Canton, L. G. (2016, November 25). Is it time for a standard social media strategy? Retrieved from www.emergencymgmt.com/emergency-blogs/managing-crisis/is-it-time-for-a-standard-social-media-strategy.html
Tactics	Tips describing effective ways to use social media	Feldman, B. (2016, July 14). 30 effective social media tactics worth testing for yourself (Infographic). *HubSpot.* Retrieved from http://blog.hubspot.com/marketing/effective-social-media-tactics#sm.000016cbvgn30afl1qj7pbwsam9jy
Trends	Description of how FirstNet is using Facebook to engage with emergency response agencies	Hilliard, A. (2016, July 7). Connecting with the public safety community through social media. Retrieved from www.digitalgov.gov/2016/07/07/connecting-with-the-public-safety-community-through-social-media/
Trends	Description of how social media is being used to deliver better public services and to create more open policy processes	Mickoleit, A. (2014). Social media use by governments: A policy primer to discuss trends, identify policy opportunities and guide decision makers. Retrieved from. http://dx.doi.org/10.1787/5jxrcmghmk0s-en
Twitter	Ways to maximize recent changes in Twitter that expand the 140 character count	Stewart, L. (2016, June 30). Twitter's evolution and what it means for your government account. Retrieved from www.digitalgov.gov/2016/06/30/twitters-evolution-and-what-it-means-for-your-government-account/
Twitter	Statistics about why Twitter works	Devaney, E. (2016, May 13). A visual guide to the science of Twitter success [Infographic]. Retrieved from http://blog.hubspot.com/marketing/science-of-twitter-success#sm.001xnix8rq1ocy2110d1qzs2t5mzg
Usage	Information on how social media is used that may inform best practices.	Mitchell. A., Gottfried, J., Barthel, M., & Shearer E. (2016, July 7). Social engagement. Retrieved from www.journalism.org/2016/07/07/social-engagement/
Users	Examples of how local governments are using social media to communicate and engage with their citizens.	CivicPlus. (2016, January 4). 7 ways local government can use social media. Retrieved from www.civicplus.com/blog/ce/seven-ways-local-government-can-use-social-media
Video	Information on the use of video in social media and other social media trends	Walters, K. (2015, November 30). Why video is the social media trend to watch in 2016. Retrieved from https://blog.hootsuite.com/video-social-media-trend-2016/

9.2 Appendix B: SHSO Pre-Interview Questionnaire

The Volpe Center is supporting NHTSA and GHSA in their efforts to understand social media's evolving role in highway safety through an informative review that is both qualitative (interviews) and quantitative (analysis of Twitter and Facebook activity). The information gathered from this study will be used to describe the current state of the practice in how SHSOs use social media for safety messaging, as well as highlights of trends and best practices.

For the purpose of our study, we are defining "safety messaging" as a message that does one or more of the following.

- Includes a "call to action" to influence transportation user (motorists, cyclists, pedestrians, passengers) behavior to reduce risk to self and/or others
- Raises awareness of transportation-related risks to persons or property
- Raises awareness of transportation safety-related offices, programs, activities, or events

Thank you in advance for your participation!

Q1: Please provide the following information:

- State
- Name
- Title
- Agency
- Email

Q2: What is your role in managing the SHSO social media? (select all that apply)

- Social Media Account Administrator
- Content Developer/Designer
- Safety Specialist or Program Manager
- Other (please specify)

Q3: What social media platform(s) are used by your SHSO for safety messaging?

- Facebook
- Twitter
- YouTube
- Instagram
- Snapchat
- Other (please specify)

Q4: Which of the following factors is your safety-focused social media designed to address? (select all that apply)

- Social media engagement overall
- Inclusion among diverse groups
- Behavioral change
- Partnerships with law enforcement
- Partnerships with non-safety stakeholders (e.g., sports and entertainment, higher education, etc.)
- Other (please specify)

Q5: Are contractors employed to support social media for your SHSO?

- Yes - they administer our social media on behalf of the SHSO
- Yes - they support the SHSO in developing content, administering or monitoring activity, etc.
- No - we do not use contractors

Q6: Which data is being collected or calculated to measure the use of social media? (select all that apply)

- Followers
- Engagement Rate
- Content Type (video, picture, text, etc.)
- Content topic (e.g., distracted driving, seatbelt use, etc.)
- Other (please specify)

Q7: If you selected "engagement rate" above, please describe the formula you use to calculate the engagement rate.

Q8: Please provide one or two examples of safety-messaging successes that we could share with other SHSOs. Describe what platform was used and why you consider the example to be a success. We can discuss these further during the phone interviews.

9.3 Appendix C: SHSO Interview Guide

The National Transportation Systems Center

Advancing transportation innovation for the public good

NHTSA/GHSA National Cooperative Research & Evaluation Program

Scan of Social Media for Highway Safety

Project Overview

The Volpe Center is supporting NHTSA and the Governor's Highway Safety Association (GHSA) in their efforts to understand social media's evolving role in highway safety through an informative review that is qualitative and quantitative, and understandable by the lay person. The information will be used by States to better understand: how social media functions across State Highway Safety Offices (SHSOs); the evolving opportunities and challenges that social media poses; and ways to improve safety messaging and related activities tied to safety programming. The information gathered from this study also will be used to further analytical research and quantitative analysis on the effectiveness of social media engagement and include a summary on the current state of the practice used by SHSOs as well as highlights of trends and best practices.

Note, for the purpose of our study, we are defining "*safety messaging*" as a message that does one or more of the following:

- Includes a "call to action" to influence transportation user (motorists, cyclists, pedestrians, passengers) behavior to reduce risk to self and/or others.
- Raises awareness of transportation-related risks to persons or property.
- Raises awareness of transportation safety-related offices, programs, activities, or events.

Discussion Guide

Below is a set of sample questions to be used for each SHSO interview. Not all questions may be asked, depending on the questionnaire responses and/or data previously gathered by earlier tasks.

I. Staffing and Financial Resources

Staffing and Experience:

1. What is your current role at the State Highway Safety Office (SHSO)?
2. How is your SHSO's social media program staffed and how was that decision made?
    a. Is there a single social media program leader or do multiple people share leadership roles?
    b. Are safety messages, in particular, managed by the same group or different people?
3. How would you describe the relevant skills and experience of employees directly involved in this SHSO's social media program? Who else from SHSO is involved in the social media safety program and what are their roles?

Support:

1. What if any specific social media training is provided or supported for social media staff?
2. How does the SHSO safety program "fit" into the overall social media strategy? For example, if your social media platform is administered by another agency, how is your safety messaging shared, prioritized, captured, etc.?

II. Planning, Design, and Operations

Planning:

1. What prompted your SHSO's entre into social media?
2. Is there a focus on sustaining/increasing the number of followers?
    a. How so, and what specific steps are taken if any?
    b. Is there an ongoing process to track and improve this measure?
3. Is there a focus on creating interactive messaging, and if so, how? (e.g., video embedding, map embedding, audio captions, auto play, etc.)?

Design:

1. Are efforts made to personalize safety messaging to target audiences (e.g., urban versus rural, students, elderly, etc.)?
    a. How so and how successful have any such efforts been?
    b. Were specific measures taken to gauge success, and if so, can you describe the results?
2. Please discuss your social media safety program's interest and focus on each of the below as you plan, execute, measure, and/or evaluate campaigns:

a. **Campaign Topics:** (e.g., seatbelt use, speeding, distracted driving, drugged driving/drunk driving, fatigued driving, teen driving, elder driving, night driving, etc.). Are campaign selections data-driven, and if so how?
b. **Media Platforms:** (e.g., Twitter, Facebook, Instagram, YouTube, and/or others):
    i. Any notable differences among platform, such as Twitter versus Facebook, in generating and sustaining followers, engagement, and any other measures you might track?
c. Media Content and Type:
    i. What media types (text, link, pictures, video, etc.) do you use and how do you determine the media mix?
    ii. Is content designed to attract specific audiences? If so, what approaches have you found to be most successful?

Operations:

1. Overall, what is the distribution of social media versus traditional media being used? Are distribution targets set, and have they changed?
2. How, if at all, do you consider engagement rate goals when planning safety-focused social media messaging, including design, implementation, measurement, and evaluation as applicable?

III. Trends and Best Practices

1. Broadly, what are your social media programs' greatest strengths, and how can they be further leveraged to support safety initiatives and safety education and engagement? What areas can be further strengthened?
2. Please describe some of your SHSOs social media safety initiatives.
    a. What seem to be some of the more successful social media safety initiatives being implemented by your SHSO? Why?
    b. What seem to be some of the less successful social media safety initiatives being implemented by your SHSO? What did you learn from that experience?
3. What other practices are considered when planning social media deployment, for example:
    a. Message layout, such as placement and number of buttons to retweet or share in Twitter or Facebook, for example?
    b. Timing and frequency of messaging?
    c. Other considerations?
4. Are there notable trends or best practices you can share that you have been applying, or would like to implement? How did you discover these? How do they appear to impact your safety-focused social media?
    a. What lessons learned have been most helpful from these trends and best practices?
    b. Have you noticed any trends that have seemed to negatively impact your social media safety campaigns? Any workarounds you can suggest?

   c. Any significant obstacles in implementing successful trends and best practices, or paths of least resistance you have found especially helpful?
   d. Do you currently share trends and best practices with other SHSOs in your region or other organizations within your State?

IV. Data Collection/Analysis/Evaluation

1. Does your SHSO use a standard definition of "engagement rate" and if so, what is it and how is it tracked? Is there another metric used?
2. Does the SHSO track its social media, and what if any data do you collect and/or review to evaluate social media success, generally or specifically for safety messaging?
   a. What challenges have you encountered in tracking social media campaigns targeted at driver safety issues?
   b. Do you currently measure social media engagement rate, and if so, how? Are you aware of any notable differences among SHSOs regarding their determination and use of an engagement rate?
   c. Does your SHSO report back to the NHTSA Region on costs, activities, impacts, and lessons learned tied to your social media safety initiatives?
3. How and by whom is data collected, and how frequently is dynamic data updated?
4. What analyses are performed on the qualitative and/or quantitative data sets?

V. Future Direction

1. Are any significant changes in your SHSO social media use, reporting, and/or resources/budgeting anticipated for 2017? At what level and by whom are these decisions made?
2. Are there plans to review/improve the current social media strategy? If so, what are the goals and what staff functions and/or vendors are expected to be involved?
   a. What current campaigns will continue? Are these decisions data-driven, and if so, how are decisions made?
   b. What new campaigns, safety messages and materials, if any, are currently targeted for rollout in FY17?
   c. Any plans to integrate additional data, tracking, analysis, and evaluation into your social media safety program?

9.4 Appendix D: Box and Whisker Plots Value Repository

The following tables present the value of key box and whisker plot elements not labeled in the figures featured throughout the report. These elements include the first quartile and third quartile, as well as the upper adjacent value (UAV) and lower adjacent value (LAV). Please note that the UAV/LAV values reported in this appendix are the *fences* used for determining which observations constitute the UAV/LAV: for the UAV, the upper fence is the third quartile plus 1.5 * interquartile range (IQR), and for the LAV, the lower fence is the first quartile plus 1.5*IQR. In instances where the calculated lower fence was negative, the value was rounded up to zero. The UAV included in the plots themselves is the largest observation that is less than or equal to the upper fence, while the LAV is the smallest observation that is greater than or equal to the lower fence.

Figure 8: Box and whisker plot of account types and safety posts per day on Facebook.

	SHSO	DOT	LE	Other
First quartile	0.31	0.28	0.13	0.13
Third quartile	1.58	0.75	0.84	0.51
UAV (upper fence)	3.49	1.44	1.91	1.07
LAV (lower fence)	0	0	0	0

Figure 9: Box and whisker plot of account types and safety tweets per day on Twitter.

	SHSO	DOT	LE	Other
First quartile	0.80	0.51	0.03	0.17
Third quartile	1.96	1.83	1.22	3.66
UAV (upper fence)	3.71	3.81	3.01	8.91
LAV (lower fence)	0	0	0	0

Figure 13: Box and whisker plot of account types and engagement rates on Twitter.

	SHSO	DOT	LE	Other
First quartile	0.0004	0.0001	0.0002	0.0003
Third quartile	0.0067	0.0007	0.0021	0.0019
UAV (upper fence)	0.0160	0.0016	0.0051	0.0041
LAV (lower fence)	0.0000	0.0000	0.0000	0.0000

Figure 14: Box and whisker plot of account types and engagement rates on Facebook.

	SHSO	DOT	LE	Other
First quartile	0.0001	0.0003	0.0004	0.0010
Third quartile	0.0018	0.0018	0.0031	0.0040
UAV (upper fence)	0.0044	0.0041	0.0072	0.0084
LAV (lower fence)	0.0000	0.0000	0.0000	0.0000

Figure 15: Box and whisker plot of message length quintiles and engagement indices on Twitter

	20th	40th	60th	80th	100th
First quartile	0.000	0.001	0.001	0.001	0.002
Third quartile	0.008	0.015	0.016	0.022	0.028
UAV (upper fence)	0.019	0.036	0.039	0.052	0.067
LAV (lower fence)	0.000	0.000	0.000	0.000	0.000

Figure 16: Box and whisker plot of message length quintiles and engagement indices on Facebook

	20th	40th	60th	80th	100th
First quartile	0.001	0.001	0.002	0.001	0.003
Third quartile	0.028	0.028	0.028	0.027	0.047
UAV (upper fence)	0.070	0.069	0.067	0.066	0.114
LAV (lower fence)	0.000	0.000	0.000	0.000	0.000

Figure 19: Box and whisker plot of sentiment and engagement indices on Facebook

	Positive	Neutral	Negative
First quartile	0.001	0.000	0.001
Third quartile	0.013	0.015	0.016
UAV (upper fence)	0.033	0.037	0.038
LAV (lower fence)	0.000	0.000	0.000

Figure 20: Box and whisker plot of sentiment and engagement indices on Twitter.

	Positive	Neutral	Negative
First quartile	0.001	0.000	0.000
Third quartile	0.019	0.020	0.022
UAV (upper fence)	0.047	0.050	0.055
LAV (lower fence)	0.000	0.000	0.000

Figure 21: Box and whisker plot of media type and engagement indices on Facebook.

	Text	Link	Photo	Video
First quartile	0.001	0.001	0.001	0.001
Third quartile	0.072	0.028	0.026	0.021
UAV (upper fence)	0.179	0.069	0.063	0.051
LAV (lower fence)	0.000	0.000	0.000	0.000

Figure 22: Box and whisker plot of media type and engagement indices on Twitter.

	Text	Link	Photo	Video
First quartile	0.001	0.001	0.003	0.004
Third quartile	0.026	0.028	0.048	0.044
UAV (upper fence)	0.062	0.069	0.115	0.104
LAV (lower fence)	0.000	0.000	0.000	0.000

Figure 23: Box and whisker plot of hashtag counts and engagement indices on Twitter.

	0	1	2	3	4	5	6	7
First quartile	0.001	0.002	0.002	0.002	0.003	0.002	0.002	0.003
Third quartile	0.029	0.031	0.033	0.030	0.038	0.042	0.016	0.046
UAV (upper fence)	0.072	0.073	0.078	0.073	0.091	0.102	0.037	0.111
LAV (lower fence)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Figure 24: Box and whisker plot of hashtag counts and engagement rates on Facebook.

	0	1	2	3	4	5	6	7	8	9	10	11
First quartile	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.001
Third quartile	0.043	0.026	0.018	0.014	0.009	0.005	0.008	0.009	0.005	0.007	0.024	0.004
UAV (upper fence)	0.107	0.064	0.043	0.033	0.021	0.012	0.018	0.021	0.011	0.015	0.058	0.008
LAV (lower fence)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Figure 25: Box and whisker plot of hashtag frequency quintiles and engagement indices on Facebook.

	20th	40th	60th	80th	100th
First quartile	0.002	0.006	0.008	0.009	0.014
Third quartile	0.020	0.045	0.031	0.040	0.036
UAV (upper fence)	0.047	0.102	0.066	0.088	0.068
LAV (lower fence)	0.000	0.000	0.000	0.000	0.000

Figure 26: Box and whisker plot of hashtag frequency quintiles and engagement indices on Twitter.

	20th	**40th**	**60th**	**80th**	**100th**
First quartile	0.005	0.009	0.010	0.009	0.025
Third quartile	0.030	0.029	0.034	0.024	0.046
UAV (upper fence)	0.068	0.060	0.069	0.047	0.076
LAV (lower fence)	0.000	0.000	0.000	0.000	0.000

Figure 34: Box and whisker plot of day of week and engagement index on Facebook.

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
First quartile	0.003	0.001	0.002	0.001	0.001	0.001	0.003
Third quartile	0.037	0.031	0.032	0.029	0.027	0.030	0.033
UAV (upper fence)	0.088	0.075	0.077	0.071	0.065	0.074	0.080
LAV (lower fence)	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Figure 35: Box and whisker plot of day of week and engagement index on Twitter.

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
First quartile	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Third quartile	0.029	0.031	0.028	0.030	0.028	0.029	0.026
UAV (upper fence)	0.071	0.076	0.069	0.073	0.069	0.071	0.063
LAV (lower fence)	0.000	0.000	0.000	0.000	0.000	0.000	0.000

DOT HS 812 673
May 2019

U.S. Department of Transportation
National Highway Traffic Safety Administration

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14024-050719-v6