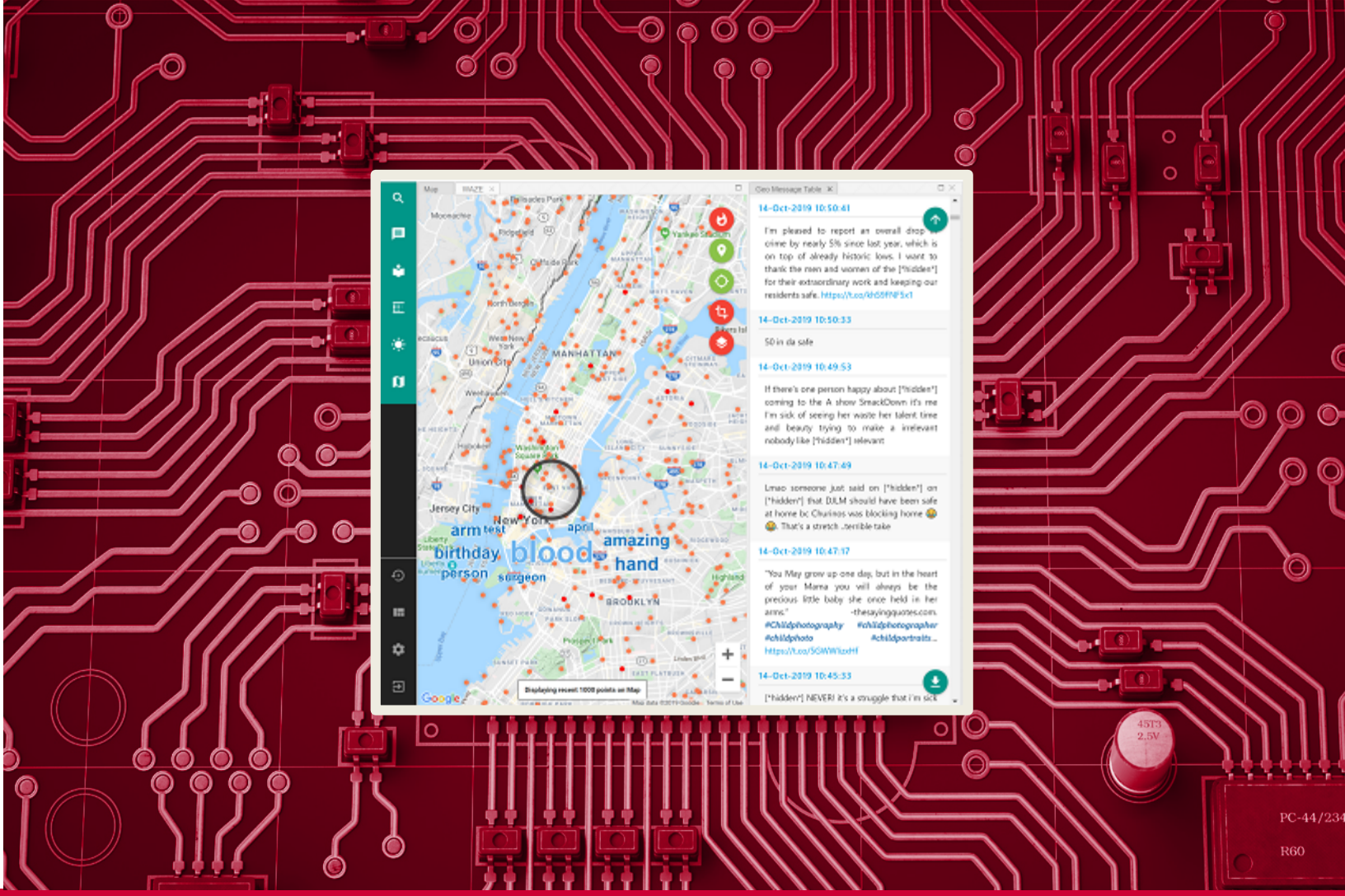

SMART: Social Media Analytics and Reporting Toolkit

Data Collection Report

May 2020

Homeland Security
Science and Technology

NUSTL®
NATIONAL URBAN SECURITY TECHNOLOGY LABORATORY

Approved for Public Release

RT-T-R-14

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FOREWORD

The National Urban Security Technology Laboratory (NUSTL) is a federal laboratory organized within the U.S. Department of Homeland Security (DHS) Science and Technology Directorate (S&T). Located in New York City, NUSTL is the only national laboratory focused exclusively on supporting the capabilities of state and local first responders to address the homeland security mission. The laboratory provides first responders with the necessary services, products, and tools to prevent, protect against, mitigate, respond to, and recover from homeland security threats and events.

DHS S&T works closely with the nation's emergency response community to identify and prioritize mission capability gaps, and to facilitate the rapid development of critical solutions to address responders' everyday technology needs. DHS S&T gathers input from local, tribal, territorial, state, and federal first responders, and engages them in all stages of research and development—from building prototypes to operational testing, to transitioning tools that enhance safety and performance in the field. The goal is to advance technologies that address mission capability gaps in a rapid timeframe, and then promote a quick transition of the technologies to the commercial marketplace for use by the nation's first responder community.

As projects near completion, NUSTL typically conducts an operational field assessment (OFA) of the technology's capabilities and operational suitability to verify and document that project goals were achieved. Based on technology specifications or limitations, a technology demonstration or data collection effort may be conducted in lieu of an operational field assessment (OFA).

Publicly released OFA reports are available at www.dhs.gov/science-and-technology/frg-publications.

For information on other projects relevant to first responders, visit the DHS S&T website, www.dhs.gov/science-and-technology/first-responder-technologies.

For more information on NUSTL programs and projects, visit the NUSTL website, https://www.dhs.gov/science-and-technology/national-urban-security-technology-laboratory.

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EXECUTIVE SUMMARY

Advances in technology have made it possible for social media platforms to export real-time data feeds. These feeds capture location- and time-stamped information that can increase situational awareness of local events. Every day up to 500 million tweets are sent on the Twitter platform, sharing a tremendous amount of publicly available data. The frequency with which tweets are generated often increases during emergencies or major incidents, representing an external source of information that could be tapped by responders, provided that decision-makers can locate meaningful and actionable information in the data feed in a timely manner. First responders require new methods to monitor topics of interest, identify trends and anomalies and deal with the data volume and its dynamic nature.

To address this technology gap, the U.S. Department of Homeland Security (DHS) Science and Technology Directorate (S&T) funded the development of the Social Media Analytics and Reporting Toolkit (SMART) software. SMART was developed by Davista Technologies and Purdue University, to provide an interactive web-accessible system that provides users with aggregated social media data for analysis and visualization to help first responders gain improved situational awareness from Twitter feeds without the persistent attention of the user.

DHS S&T's National Urban Security Technology Laboratory (NUSTL) conducted a technology demonstration of the SMART software on October 16, 2019, at the DHS S&T NUSTL facility located in New York, New York. Seven emergency responders from law enforcement, fire services, emergency management agencies and members of the uniformed services from across the United States served as evaluators and provided feedback on the tool's usability, interface and overall usefulness to First Responders.

At the technology demonstration, the developers presented the SMART software using historical data that had been previously captured. The historical data was scrubbed for personally identifiable information (PII) and aged at least a month to meet the requirements of the DHS S&T Privacy Office.

Throughout the technology demonstration, evaluators expressed that SMART could be a valuable addition to their existing workflow by providing the ability to gain insight into events unfolding in real time. The evaluators proposed that SMART could be useful during large events and would likely be used 24 hours per day to monitor an event as it unfolds. Evaluators also commented that they felt the notification and alerting capabilities within SMART were able to "separate the signal from the noise" for large events, and this could be a key advantage over traditional manual observation techniques.

Evaluators also provided valuable feedback to the SMART developers, suggesting new features, widgets and usability changes that would improve SMART, including that SMART incorporate visual media such as pictures or video that have been posted to social media feeds.

Lastly, changes to the Twitter Developer Application Programming Interface have reduced the number of Twitter tweets that provide geo-tags. Twitter has changed to an opt-in model that requires users to specifically tag their location or explicitly share their location data.

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1.0 INTRODUCTION

Advances in technology have made it possible for social media platforms to export real-time data feeds. These feeds capture location- and time-stamped information that can increase situational awareness of local events. With the massive number of messages generated and diffused through social media platforms, locating meaningful, actionable information in a timely manner is crucial for decision makers. Currently, there is no way to integrate relevant data feeds from multiple social media sources and provide interactive, easily understood information to first responders through one seamless interface. First responders require new methods to monitor topics of interest, identify trends and anomalies and deal with the data volume and its dynamic nature.

To address this technology gap, the U.S. Department of Homeland Security's (DHS's) Science and Technology Directorate (S&T) funded Purdue University and Davista Technologies to develop the Social Media Analytics and Reporting Toolkit (SMART) software for first responders. The National Urban Security Technology Laboratory (NUSTL) received a request to conduct an operational field assessment (OFA) to evaluate and determine if the project requirements were met.

1.1 PURPOSE

The purpose of the technology demonstration was for first responders to assess and provide feedback on the functionality and usefulness of the DHS S&T-funded SMART software for social media analytics.

1.2 OBJECTIVES

The objectives of this demonstration were to:

- Assess the overall concept of the system
- Assess the functionality of the application for first responders
- Determine the usability of SMART by first responders for field operations
- Evaluate the features and functions of SMART as stated in the contract

1.3 PARTICIPANTS

Table 1-1 lists the technology demonstration participants. Seven evaluators from six different organizations participated, along with DHS staff members, the technology developers and observers.

Table 1-1 Technology Demonstration Participants

Role	Organization
Evaluators	• San Diego Fire and Rescue Department (California) • U.S. Coast Guard Intelligence Operations (Kentucky) • U.S. Coast Guard Intelligence Operations (Missouri) • Huntingdon County Deputy Sheriff (Pennsylvania) • New York City Emergency Management • New York City Police Department Cyber Intelligence Unit
Venue Host	DHS S&T NUSTL
Program Managers and Support Staff	DHS S&T
OFA Test Director and Data Collectors	DHS S&T NUSTL
Technology Developer	• Davista Technologies • Purdue University
Observers	U.S. Coast Guard Research & Development

1.4 Statement of Work

The description and requirements for the SMART software are documented in the, *Integration of Public Data Feeds Statement of Objectives (SOO), (Department of Homeland Security - Science and Technology Directorate, 2017)*. The document states that the purpose of a proposed solution for integrating public feeds, "is to allow for the use of both authoritative and informational application feeds and select publicly shared social media in a variety of typical, standards-based common operating pictures (COP) already in use (e.g., Next Generation Incident Command System (NICS), geographic information systems (GIS), Google Earth, etc.). Furthermore, it should include the ability to provide automated alerts based on specified, tailorable triggers and thresholds to inform incident commanders and emergency responders of potential or emerging threats for increased situational awareness."

Section 5.1 of the *Integration of Public Data Feeds Statement of Objectives (SOO), (Department of Homeland Security - Science and Technology Directorate, 2017)* provides a list of the "must have requirements." These requirements are listed in Table 1-2.

Table 1-2 SMART Requirements

Statement of Objectives Requirements
Seamlessly integrate with a variety of common operating pictures (COPs) and communications platforms (smartphone, tablet, laptop, etc.) and their associated operating systems without negatively affecting functionality or response time.
Provide user-defined triggers, warnings and alerts (such as an increase in particular hashtags, social media “check-ins” at particular locations, etc.) in multiple formats (visual text, voice alerts, vibration, etc.) selected based on user conditions that can be changed from the application interface by the user during an event.
Be able to display data in multiple formats (images, text, etc.), allowing user control over icons, spatial and temporal filtering, etc.
Be open source, open standards-based (National Information Exchange Model compliant) to support platform interoperability, allowing it to augment local COPS with all-source data or otherwise easily interface with various local emergency management COPS systems to include Next Generation Incident Command System, geographic information system, Google Earth and WebEOC.
Provide an intuitive graphical user interface that requires no additional programming.
Provide the ability for users to toggle which social media feeds to pull data from.
Provide the ability for users to easily include newly acquired information feeds into the system.
Offer command-level triggered alerts that can override individually pre-set user-defined triggers.
Allow development of user profiles, including customized tags, triggers and searches.
Be scalable to work with technology as the common operating system and hardware systems upgrade.
Be capable of providing an output summary as defined by the user such as data relating to an incident, timeframe or location. The format should be one that is easily assimilated in common office productivity software such as Word, Outlook and Excel and will be more specifically defined by first responder subject matter experts during development.
Integrate social media sharing so elements of triggered alerts can be integrated into emergency alert and SMS/MMS (short message service/multimedia message service) messages.
Ability to perform basic data analysis to validate sources and identify trends.
Mechanism to use orthogonal data to validate data stream (may be done using percentage or scoring mechanism).
Software must have the capability to selectively filter data sources deemed inaccurate or questionable.

Table 1-3 SMART Statement of Work Requirements

Statement of Work Requirements
Ingest data from at least one social media source. The prototype shall read in social media postings from a Twitter feed (live or pre-downloaded).
Assess ingested data for relevance, using pre-set parameters. The prototype shall filter ingested Twitter postings for hashtags (pre-selected and pre-loaded).
Assess ingested data for relevance, using in-situ, user-defined parameters. The prototype shall filter ingested Twitter postings for hashtags selected and entered by a user.
Generate a relevance measure for human consumption. The prototype shall produce some visualization of relevance to a first responder mission need.
Recognize personally identifiable information (PII) that may be present in ingested data. The prototype shall internally note content in live Twitter postings that contains PII.
Remove/replace PII that may be present in ingested data. The prototype shall remove noted PII from ingested live Twitter postings.

1.5 System Description

SMART software provides real-time monitoring of social media channels, extraction of trending and user-defined topics, topic clustering and message categorization. These components can be displayed in a customizable interface intended to provide users with additional information. Users also have access to web and news sources that are incorporated into the system. Additionally, SMART provides optional automatic e-mail alerts and summary services related to user-defined topics.

The primary interface to the SMART software is a web-based graphical user interface (GUI), shown in Figure 1-1, which can be used within either the Chrome or Firefox web browsers on a desktop computer. There is currently no mobile version of SMART. The SMART GUI has a modular design that provides the capability to customize the interface and move modules around the screen, allowing each individual user to customize the dashboard to their own specific mission requirements.

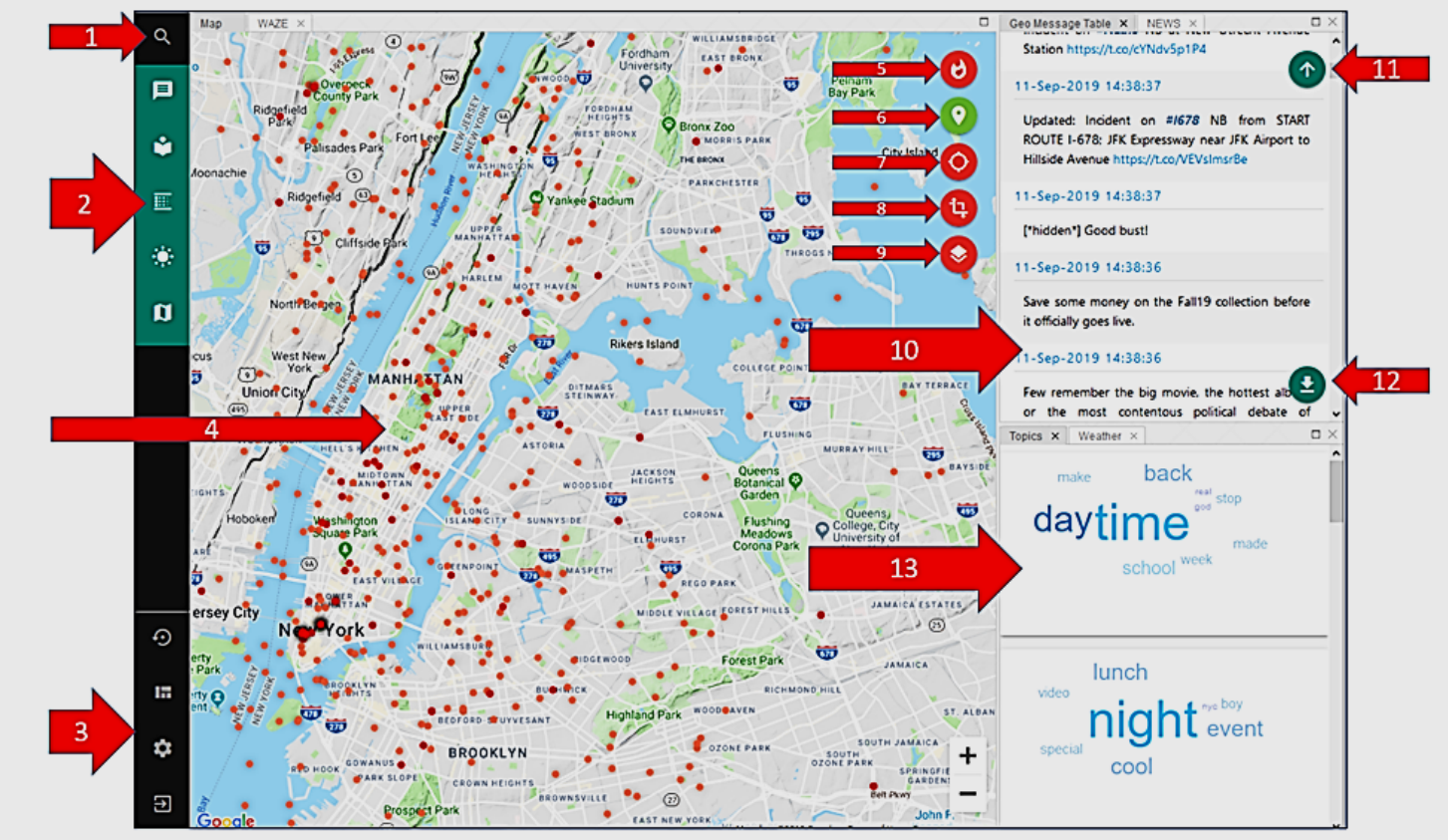

Figure 1-1 SMART Browser-based GUI

The default layout of the SMART GUI (Figure 1-1) is separated into three distinct sections:

Left

Used to select modules and control the interface

See Arrows 1, 2, 3

Middle

The map in the middle is overlaid with geo-located data.

See Arrow 4

The map includes several features on the right-hand side to manipulate the map view.

See Arrows 5, 6, 7, 8, 9

Right

The geo message table is a default module.

See Arrow 10

The topics word cloud is a second default module.

See Arrow 13

Once a user starts to scroll down into historical data, a button appears, allowing the user to go back up to the latest live tweet.

See Arrow 11

There is also a feature that allows export of the current SMART message table to comma-separated value (CSV) format.

See Arrow 12

Table 1-4 SMART Browser-based GUI Features and Descriptions

Arrow	Feature	Description
Arrow 1	Search Classifiers	Filter tweets by specific words or hashtags. SMART can filter on a single keyword or a group of keywords known as “team classifiers” that are defined within the configuration settings control panel.
Arrow 2	Non-default Modules	Other available non-default modules such as news, weather or traffic can be selected.
Arrow 3	Default Settings	Users can reset the interface back to the default settings or modify their team settings by selecting the gear and other icons.
Arrow 4	Tweet Location Data	The map is overlaid with tweet location data. Each tweet is represented by a red or orange dot on the map. A red dot represents a tweet that includes specific location data and an orange dot represents a tweet that SMART has received as a bounding box instead of an accurate latitude/longitude, so the location is approximate.
Arrow 5	Areal Locations of Hazardous Atmospheres (ALOHA)	SMART provides several additional tools such as ALOHA, which allows users to apply a chemical dispersion model to the map interface that can estimate the downwind dispersion of a chemical cloud based on the toxicological and physical characteristics of the released chemical.
Arrow 6	Geo-coded Points	Geo-coded points allow users to remove the dots on the map to clean up the content.
Arrow 7	Context Lens	The context lens tool provides word cloud generation within the map interface that enables SMART users to focus on a specific location without having to zoom in.
Arrow 8	Custom Bounds	Custom bounds let users draw a custom bounding box of a specific area on the map. This enables users to focus on a specific geographic area. By default, SMART shows a limited number of messages within the map boundary due to browser constraints. It automatically pulls the most recent messages for the bounded region.
Arrow 9	Heat Map	The heat map feature provides a graphical representation of data where the individual values contained in a matrix are represented as colors.
Arrow 10	Geo Message Table	On the right side of the layout is the “geo message table,” which lists the tweets within the current map view chronologically. A user can scroll down and review historical tweets, if desired.
Arrow 13	Topics Box	The “topics box” creates a word cloud or heat map of the most used words within the displayed tweets. The size of the word within the box is proportionate to the amount of times it is found within the tweets on the map.

2.0 TECHNOLOGY DEMONSTRATION

2.1 Event Design

On October 16, 2019, the developers from Davista Technologies and Purdue University conducted a technology demonstration of the SMART software. The SMART technology demonstration was designed as a one-day event bringing together seven emergency response subject matter experts from six different agencies to evaluate SMART. Evaluators were encouraged to ask questions and provide feedback throughout the technology demonstration.

The demonstration was conducted at NUSTL, where the developers performed two activities, summarized in Table 2-1. The data collectors from NUSTL recorded observations and comments during each activity and utilized a questionnaire to gather feedback from each evaluator following the demonstration. One data collector was assigned to each group of evaluators. Observers from federal agencies attended the demonstration and provided feedback. The data collection demonstration plan contains complete details of the technology demonstration.

2.2 Activities

The technology demonstration consisted of the following components.

Operational Set-up and Training

The technology demonstration began with the technology developers giving an overview of the capabilities and features of SMART, providing evaluators an introduction and general overview of the SMART software.

Technology Demonstration

Following the operational set-up and training session, the technology developers demonstrated the activities listed in Table 2-1.

Table 2-1 Technology Demonstration Activities

Activity Title	Description	Purpose
Data Search	Developer conducted several keyword searches on historical data to demonstrate the SMART software	To assess system functionality of how the system produces results
Feature Exploration Activity	Developer provided a thorough demonstration and explanation of each feature and tool within the SMART software	To test and evaluate the functionality and capability of the system's features, individually

Debrief

A debrief session was conducted with all of the evaluators at the conclusion of the technology demonstration. During the demonstration throughout each of the activities, evaluators were given the opportunity to provide constant verbal feedback. This feedback was captured by the NUSTL data collectors and is presented in Section 3.0 of this report.

Figure 2-1 NUSTL Data Collectors Gathering Feedback from Evaluators

2.3 Limitations

As stated in the foreword, typically an OFA would be conducted to provide evaluators with hands-on experience with the technology under evaluation; however, based upon guidance from the DHS S&T Office of General Council in regard to maintaining compliance with Twitter's terms of service, the scope of the event was narrowed from a conventional hands-on assessment to a vendor-led technology demonstration using only historical data. The SMART developers operated the web-based system using Davista-owned hardware and user accounts. NUSTL gathered feedback from the evaluators based upon their impressions of the capabilities demonstrated.

3.0 RESULTS

This section contains feedback from the evaluators' responses to questionnaires and group discussions. This includes evaluator suggestions for modifications to the software that may improve functionality. The questionnaire was structured so that evaluators selected a response of strongly agree, agree, disagree or strongly disagree to a statement, and provided comments to explain their response. In some cases, evaluators provided a neutral response to the statement; a neutral response was given when the evaluator did not have a strong opinion about the given statement. The results of the technology demonstration are depicted in Sections 3.1 through 3.6 with the statements posed to the evaluators appearing above the pie charts.

3.1 User Interface and Display

As shown in Figure 3-1, two evaluators strongly agreed that the SMART software's user interface seemed intuitive and easy to use, while three evaluators agreed, and two were neutral. Evaluators suggested that description bubbles to explain how each feature within SMART works would be helpful to new users.

Additionally, all seven evaluators agreed that SMART's display was easy to read and appropriate for their use. Evaluators valued the iFrame feature and thought it would be helpful for users with multiple displays. The iFrame feature allows users to take any of the unique interface features described Section 1.5 and use them in a separate browser tab or browser window. Evaluators also suggested that a night mode—that reduced brightness—would be useful in reducing eye strain.

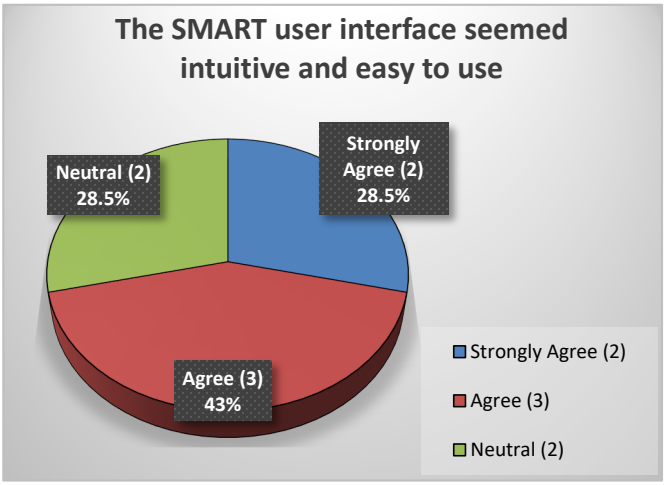

Figure 3-1 Evaluator Feedback on User Interface

3.2 Tweet Review

As shown in Figure 3-2, two evaluators strongly agreed that the tweet review appeared easy to interact with and understand, while four evaluators agreed, and one was neutral. Evaluators believed the context lens feature was useful but recommended improvements such as the ability to sort data based on existing images in order to prioritize emergency situations and possibly including the ability to show thumbnail images.

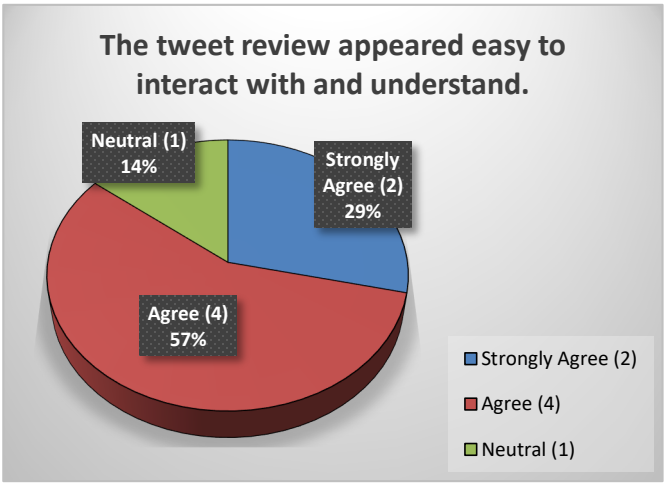

Figure 3-2 Evaluator Feedback on Tweet Review

3.3 Features and Events

As shown in Figure 3-3, two evaluators strongly agreed that the features available in SMART were intuitive to use and would help with their daily tasks, while five evaluators agreed. Evaluators also noted that the SMART software would complement existing strategies such as other software or tools currently in use. Evaluators believed that the built-in ALOHA feature could be useful for chemical dispersion events as well as the ability to filter content, which could be critical to ensuring important information is identified. Additionally, one evaluator described the heat map feature as, "the most useful data to me."

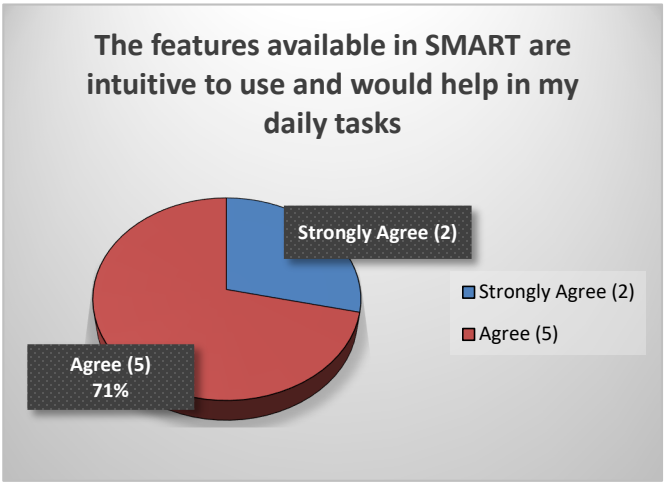

Figure 3-3 Evaluator Feedback on SMART's Features

As shown in Figure 3-4, two evaluators agreed that it was intuitive to confirm a real-time event, such as a protest or an emergency while five evaluators were neutral. The evaluators said SMART would likely be used for medium- and large-scale events as not enough people would be tweeting about a small-scale event, making it difficult to validate activity. Evaluators believed hands-on experience using the tool was necessary to provide additional feedback, but they recommended having preloaded words based on event type to enhance searches.

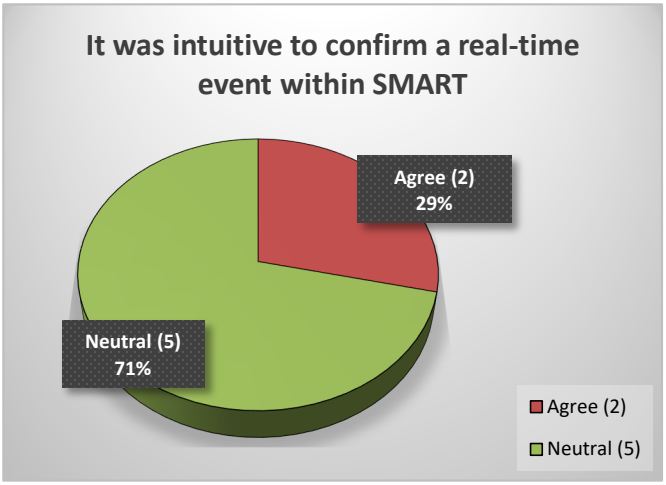

Figure 3-4 Evaluator Feedback on Confirming Events

3.4 SMART Alerts

As shown in Figure 3-5, most evaluators were neutral on the configuration as they were unable to configure alerts due to the restriction of using historical data.

Additionally, the evaluators inquired about the potential of receiving alerts via a text message or push notification. The technology developer indicated that this would require additional configuration.

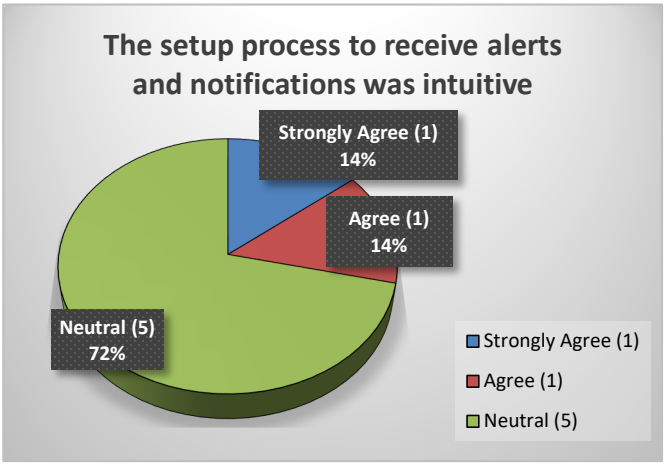

Figure 3-5 Evaluators' Satisfaction of Capabilities

3.5 Capabilities and Usage

As shown in Figure 3-6, four evaluators were neutral about their satisfaction with the SMART capabilities. Two other evaluators strongly agreed and one agreed. Evaluators commented that without hands-on experience with the tool, they were not able to fully assess the tool's capabilities.

The evaluators found SMART to be a tool that could be useful during large-scale events. As such, six evaluators strongly agreed and one agreed that they would actively use SMART if it were available to their organization.

Additionally, four evaluators strongly agreed that they would recommend SMART for acquisition while two agreed and one evaluator was neutral as shown in Figure 3-7. Evaluators had several concerns, such as understanding price points and scalability, and being able to compare it to other existing products before committing. Additionally, evaluators were interested in enhancing the tool, having recommendations that included refining the user interface to make it more user-friendly, providing additional descriptions using information bubbles, introducing language translation capabilities and incorporating data from additional social media platforms.

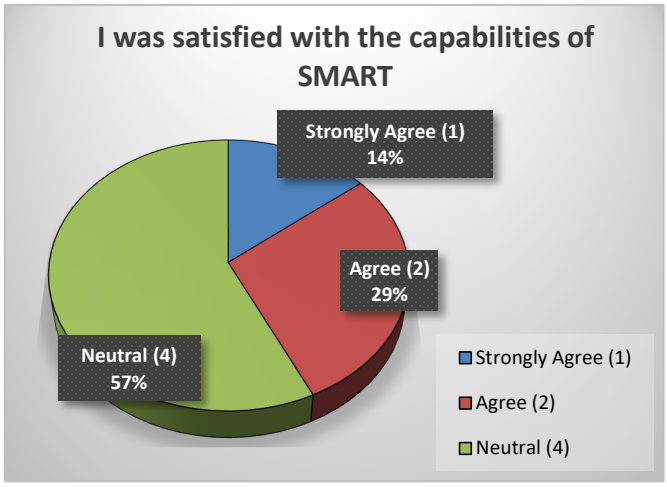

Figure 3-6 Evaluators' Satisfaction of Capabilities

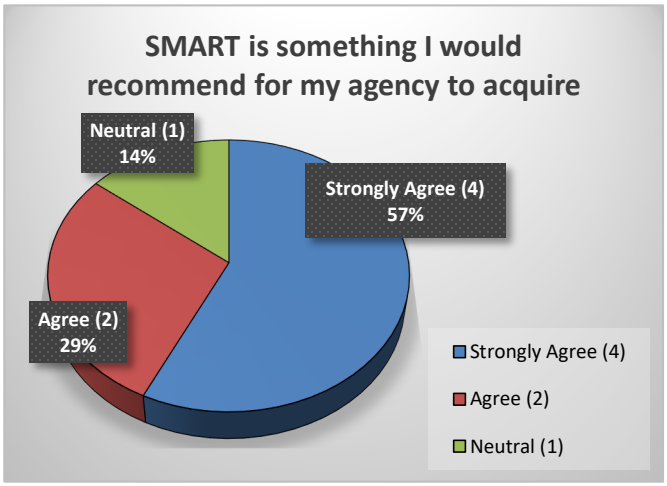

Figure 3-7 Evaluators' Recommendation for Acquisition

3.6 Training for SMART

All seven evaluators agreed that the duration and detail of the training and set up for SMART was sufficient. While the developers provided approximately one hour of training, evaluators noted that it was dependent upon the user's experience and training to make the most of the tool. They also noted that while the design was easy to understand, it still had a reasonable learning curve. Evaluators again suggested that information bubbles would be helpful for each specific feature to explain its use, along with a demonstration or introduction video for each feature to help new users.

4.0 DEMONSTRATION DEBRIEF

After the demonstration, a debrief session was held with the evaluators to capture additional input. The evaluators provided the following information in a free form environment that was captured by the NUSTL data collectors. The following questions were asked of the evaluators as a group:

How do you think the SMART software would affect your ability to complete your duties?

- Evaluators believed SMART would aid in their overall situational awareness and decision-making process by helping with information coordination both internally to the organization and externally when collaborating with partners. Additionally, evaluators believed it could provide an indication of the tone of events they were monitoring.

What features of the SMART software did you or did you not find advantageous?

- Advantages
  - Waze: A traffic overlay within the SMART software is useful for urban environments to determine if an event has had an impact on travel times.
  - ALOHA: This capability of mapping chemical dispersion events within SMART allows first responders to better understand the impact a dispersion event may have on a specific area.
  - Heat map: The heat map allows SMART users to quickly determine the most active areas within the geographical map. This was described by one evaluator as providing, "the most useful data to me."
  - Display customization: The capability within SMART to completely customize the interface allows the software to serve individual levels of sophistication.
  - Context lens: This capability allows users to quickly drill down to a specific location without zooming in on the overall map, letting users maintain their high-level situational awareness while still being able to obtain detailed information.
  - iFrame support: This capability displays data on multiple monitors, providing SMART users with additional flexibility for observation.
- Disadvantages
  - Additional data sources: SMART currently only supports Twitter as a data feed.
  - Twitter API access: The free Twitter developer API account has restrictions on the volume of Twitter data. Additional paid tiers of access exist, but pricing is unclear.
  - Standards compliance: The Federal Emergency Management Agency released the refreshed National Incident Management System (NIMS) doctrine on October 17, 2017. NIMS provides a common, nationwide approach to enable the whole community to work together to manage all threats and hazards. NIMS applies to all incidents, regardless of cause, size, location or complexity. SMART is not compliant with NIMS doctrine.

What changes would you recommend to the SMART software?

- Throughout the technology demonstration, evaluators provided suggestions for expanded capabilities and enhancements to the user experience, including:
    - Automated language translation: The ability to translate multiple languages within SMART would be a helpful addition for users in diverse communities.
    - Data sources: Evaluators suggested that SMART ingest additional social media feeds, such as Facebook or open data sources.
    - Night mode: Adding a night mode feature that reduces brightness would be a useful in reducing eye strain.
    - Weather layer: The ability to overlay the current weather within the SMART software.
    - Polygon bounding box: The ability to use a polygon shape as a bounding box.
    - Spell check: Incorporate spell check in order to capture misspelled words.
    - Display images: Currently, SMART only displays the textual content of Twitter posts. Evaluators suggested the capability to display a thumbnail image of media associated with a post would be helpful.
    - Sort tweets: Ability to sort tweets based on specific criteria, such as having an image associated with a tweet.
    - Adjustable contrast: The ability to modify the contrast on the heat map to prioritize unusual activity.
    - Alerts: Add a chime or distinct alert sound for new trends.

How would you conduct social media analysis without the SMART software?

- Several evaluators currently use other commercial tools that are similar to SMART and would like the opportunity to compare them side-by-side.

5.0 CONCLUSION

Overall, the evaluators were very receptive to the SMART software and believed that the demonstration provided several examples of how they could use the tool on a day-to-day basis. Most evaluators would recommend SMART to their respective agencies and were very interested in obtaining hands-on experience with the software.

The evaluators found that several tools provided within SMART such as ALOHA and Waze could be useful on a daily basis and improve their overall workflow. Evaluators also valued the context lens feature and the ability to display data in a separate window frame to support users with multiple monitors.

Evaluators expressed interest in other social media feeds other than Twitter. Facebook was mentioned frequently but is not currently supported by SMART. Additional social media feeds are in development but were not part of the SMART technology demonstration.

Lastly, the evaluators provided valuable feedback to the developers of SMART to help improve the product for operational use by first responders and support their ever-evolving mission. This included suggestions for ways to improve the software for new users to ease the introduction of new features and tools. Users also suggested that a training video or a series of videos may be helpful for new users to learn the tool.