# DRONES AND TRAFFIC SAFETY: PRELIMINARY RISK ASSESSMENT


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**ABSTRACT**

The use of UAS (Unmanned Aircraft Systems) or “drones” for different commercial, industrial, agricultural and environmental management applications has increased greatly. There are millions of hobbyists and civilian recreational users. While the Federal Aviation Administration (FAA) regulates drone use near airports, there are increased concerns about other potential hazards associated with increased drone use. With the decreased costs and increased development of UAS applications, there will be increased interactions between drones and roadway users. The key findings from a national survey of transportation, law enforcement, and emergency management personnel are presented as well as discussion of approaches to regulating and managing the risks. A total of 435 professionals from 98 different cities, 45 states, and all U.S. territories responded to the survey. A majority perceived an increase in drone use in their communities and 21.38% reported drones operating in close proximity to traffic. Approximately 6% heard of instances where drones have caused crashes, while 17.66% heard of near misses. An overwhelming majority, more than 85%, believe that drones should be regulated over roadways. More than a quarter of respondents were unaware of FAA regulations on drone registration, flying height and location restrictions. Nearly 14%of the respondents come from communities which have adopted “no drone fly zones.” In addition to capturing attitudes towards restricting UAS use over different types of roadways and vehicles, the key approaches to regulating UAS use in urban and rural areas are described.

## INTRODUCTION

Unmanned Aircraft Systems (UAS), commonly referred to as "drones" are an emerging technology. UAS consist of a flight vehicle, ground station, and command and control radio linkages between the two (*1*). Various sensors, cameras, and other payload may also be part of the system. Although historically the development of UAS has focused on military applications, recent advances in technology make UAS affordable and easy to operate, enabling UAS to go "mainstream." In the United States and worldwide, governments and civilians are finding new and exciting ways to use UAS for non-military applications. Clarke (*2*) refers to the "drone epidemic" because of the tremendous growth in non-military drone use for business, commercial, industrial, agriculture and disaster management and surveillance applications. As reported in the 2016 Congressional Research Service report (*1*), UAS use has increased for homeland security, border protection, and law enforcement, forest firefighting, storm monitoring, disaster response, highway traffic monitoring, pipeline and transmission line inspection, applications of pesticides, surveying and geospatial imaging, atmospheric and environmental science, wildlife and natural resources management and scientific data collection. There has also been interest in using unmanned aircraft for transporting commercial cargo (*3*, *4*). Kim and Davidson *(3)* summarize the uses of UAS in disaster management. UAS are also being widely used for recreational purposes.

Federal Aviation Administration (FAA) forecasts potential annual sales of 1.9 million UAS units for hobbyists (less than 0.55 pounds) in 2016 which is expected to reach 4.3 million annually by 2020. The non-hobbyist UAS (those more than 0.55 pounds and less than 55 pounds) forecasted potential annual sales is 0.6 million in 2016 with the expectation to reach 2.7 million annually by 2020. In total, the potential UAS sale in 2016 is 2.5 million with the projection of 7 million annually by 2020 (*5*). In 2015, the global UAS market was valued at US$ 10.1 Billion and was projected to increase at an 8.12% compound annual growth rate (CAGR) and reach US$ 14.9 Billion by 2020 (*6*). The FAA requires registration of all non-hobbyist UAS and by mid-March, 2016 over 408,000 have already been registered (*5*).

In the transportation sector, UAS use has been growing. It has been used to manage traffic (*7*), provide information to help clear traffic accidents (*8*), monitor road conditions (*9*), monitor traffic speeds, guide emergency vehicles (*10*), manage other traffic system disruptions (*11*) and assist in search and rescue missions *(12)*. UAS technology has become more affordable and transportation agencies are exploring it for many monitoring and surveillance tasks (*11*). UAS is also used for security purposes. The Michigan State Police Department uses it for investigation and law enforcement (*13*).

There are also risks and hazards with the use of drones. There are a number of reported UAV (Unmanned Aerial Vehicle) collisions with motor vehicles in France, Belgium, Switzerland (*14*), Australia (*15*) and several U.S. cities. During the 2015 Seattle Parade, a drone hit a woman knocking her unconscious (*16*). A drone crashed in the Commonwealth Stadium of Kentucky before a college football game in 2015 (*17*). In December 2015, a drone crashed with a moving motor vehicle in Belleville, Ontario, Canada (*18*). Another crashed on to a car's roof in June 2015 in Tampa Bay, Florida *(19)*.

"No Fly Zones" are being implemented where drones are banned from flying over critical infrastructure or buildings, such as capital buildings (*20*). Recently declassified military information has shown thousands of UAS crashes around the world since 2001 (*14*). Previous studies have documented different causes of crashes, including human error *(21)*, technical failure *(2*), and weather *(21)*. Electromagnetic transmission disruption, hijacking of devices, hacking of software used by the UAV and pilot, and limited safety features in low cost drones are other causes related to UAS failures *(21)*.

The research described in this paper was conducted by the National Disaster Preparedness Training Center (NDPTC), funded by the U.S. Department of Homeland Security, Federal Emergency Management Agency (FEMA) housed at the University of Hawaii. As a member of the National Domestic Preparedness Consortium (ndpc.us), the NDPTC (ndptc.hawaii.edu) focuses on natural hazards, coastal communities, and islands and territories. The mission of the Center is to "build resilient communities through training." To date, the NDPTC has trained more than 30,000 first responders and emergency managers across 260 communities in the United States and its flag and trust territories. The NDPTC has been developing UAS courses for disaster management *(3)* focusing on its use for damage assessment, communications, and other applications to support emergency managers and first responders.

In 2014, NDPTC decided to create a training course because there was a need to provide training on the use and application of UAS technologies, guidance on FAA rules and regulations, and the handling of external UAS interference during disaster situations. The training course was built on research conducted at the University of Hawaii that examined UAS in disaster management and transportation, as well as FAA regulations (*3*). On June 16, 2016, FEMA certified the course as AWR- 345, Unmanned Aircraft Systems in Disaster Management. This course reviews UAS applications for disaster management, from mitigation and preparedness to response and recovery, while describing different UAS capabilities and applications for situational awareness, threat and damage assessment, and other data collection activities. The course also explains the current FAA regulations of UAS operations and how to apply for authorization. Final rules and guidance from the FAA will be in effect on August 29, 2016 (*22*). Besides using UAS technologies for situational awareness, search and rescue, and damage assessment during and after disasters (*23*, *24*), there is also much interest in the use of UAS and their sensors to replace traditional large format sensors from more expensive aircraft (*25*). Collection, processing, storing and analyzing such remotely sensed data is part of the "Big Data" movement because it allows for data capture and integration with other massive databases (*26*).

The AWR-345 training course is intended to be an introductory awareness level course in the use of UAS in disaster management, including all phases of the disaster cycle. It is intended to allow participants to gain a basic understanding of UAS, learn the general concepts to build a successful UAS program, understand the FAA regulations, and identify the importance of engaging the local community by addressing the need to ensure that privacy issues, civil rights, and civil liberties are thoroughly addressed. The course also discusses how the use of UAS technology could enhance the disaster mission, and how the different types of payloads and sensors can be used on a UAS mission. The course provides the first steps to determining whether the use of UAS technology is right for the work being conducted.

While the NDPTC uses drones for assessing risks and vulnerabilities from natural hazards and integrates sensor technology into building resilience, improper or malevolent use could potentially create safety hazards and threats. The primary research question of this study is: do drones pose a threat to traffic safety?

The paper is structured as follows: First, the approach, methods and data are described. Next, survey results are presented, and potential drone impacts on communities, motorists, traffic, as well as other users, are described. Finally, to minimize adverse traffic safety impacts, drone related regulatory provisions and approaches are presented.

## REGULATORY CONTEXT OF UAS

On June 21, 2016, the FAA released the final version of its rules for UAS operations, entitled Operation and Certification of Small Unmanned Aircraft Systems, which will be in effect on August 29, 2016 (*22*). The rules are intended to provide for the "safe and efficient operation" of small UAS (defined by statute as weighing less than 55 pounds) for "non-hobby and non-recreational purposes," including, for example, "crop monitoring/inspection, research and development, educational/academic uses, power-line/pipeline inspection in hilly or mountainous terrain, antenna inspections, aiding certain rescue operations, bridge inspections; aerial photography, and wildlife nesting area evaluations" (*1*) and are intended to integrate small UAS operations into the National Air Space (NAS). These final rules were called for by the FAA Modernization and Reform Act of 2012. Earlier federal rules included certificates of waiver or authorization and exemptions under which small UAS had been operating for several years.

Local governments have responded to increasing calls for tighter control of UAS by issuing their own rules and regulations, despite some uncertainty over the extent to which those rules may overlap and conflict with federal rules (*1*) and disagreement over which level of government is best suited to regulate UAS (*27*). Local regulations of UAS often cite the need to protect public health, safety, and welfare and address concerns in areas such as privacy, nuisance, and trespassing. In general, local governments have targeted the regulation of land use activities (such as launching, operating, and recovering UAS) rather than their actual flight, given the FAA's jurisdiction over airspace. To date, no efforts to modify state and local traffic codes and ordinances have been located. Private landowners have attempted to control UAS use in the airspace above their land, which raises similar issues over authority to regulate airspace outside of FAA involvement (*1*). State and local involvement in UAS control has also extended to assisting the FAA in assisting the agency with the difficult task of enforcement amidst rapid proliferation of UAS use and violations (*1*).

The rapid rise of novel and aggressive UAS uses, public concerns over threats to safety and privacy, and what has been a fluid regulatory environment, have raised concerns among those in emergency response, public safety, and related fields regarding their ability to test and use UAS technology to meet needs in several key areas (*28*). UAS use in emergencies to gather information, reduce risk, and facilitate response has been documented (*29*). Threats posed by UAS to emergency responders have also generated concern, such as when manned firefighting aerial vehicles have been grounded to avoid collision with UAS (*29, 30*). Continued innovation and development of UAS applications for emergency response will need a regulatory environment that facilitates use and safety as well as increased public awareness of its benefits. With UAS, tolerance for expanded adoption of new technologies in the face of unanticipated and disruptive uses (privacy invasions, hacking, weaponizing, etc.), often well-publicized in the media (*28*) present further challenges to the industry and user community. Transparency and openness by public agencies who are testing and using UAS technologies is also needed to ensure that the public remains aware and informed of its significant benefits to reduce risk and save lives.

## APPROACH, METHODS AND DATA

To address the basic research questions, an online survey instrument was developed and pre-tested. The survey included questions on:

1) Observations of UAS use and accidents in the community.
2) Perceptions of UAS threats to traffic safety.
3) Attitudes towards the regulation of UAS use over roadways and vehicles.
4) Background characteristics of the respondents.

The electronic link of the online survey was sent via email and social media platforms, including Twitter, Facebook, and LinkedIn, to notify and reach knowledgeable individuals. Recipients include a list of over 5,000 email addresses of emergency managers, transportation planners, engineers, law enforcement and others involved in the planning, management, and operation of transportation resources. The list was developed from the training programs of the NDPTC which included subject matter experts, instructors, and participants; principally from state and local government but also private companies and non-governmental agencies. These contacts were also supplemented with lists from state and local transportation agencies and others from the engineering, planning, and logistics communities. The questionnaire was circulated for approximately three weeks. The survey instrument and research protocol was approved by the Committee on Human Subjects, Institutional Review Board, of the University of Hawaii.

After receiving, compiling, and cleaning the data, 435 responses were available for analysis. Figure 1, "Spatial Distribution of Sampling Locations within the United States," shows the geographic distribution of the responses which came from 98 cities, 45 states and all US territories. This provides wide coverage of communities across the nation.

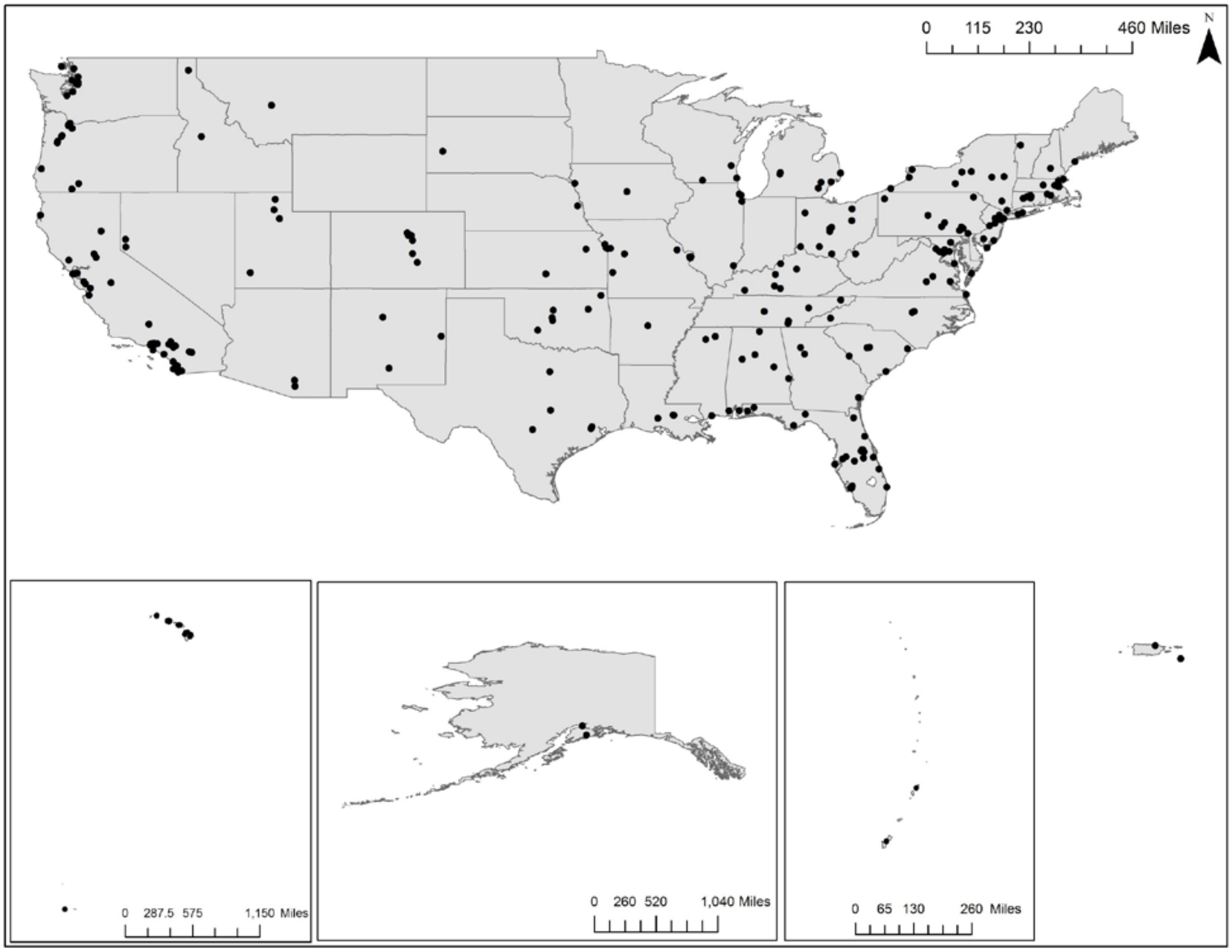


**FIGURE 1 Spatial Distribution of Sampling Locations within the United States**

Table 1, "Summary of the Respondent Characteristics," contains the demographic, organizational affiliation and work responsibilities of the respondents. The majority of respondents were male (77.6 percent). The mean age of respondents was 49.4 years. The primary responsibility of the respondents in their organization included training/education (21.8 percent), enforcement (14.79 percent), research (9.27 percent), public information (8.02 percent) and engineering (5.76%). While the majority (57.9 percent) of respondents were from government agencies, there were responses from the private sector (18.5 percent), universities (9 percent) and non-profits (5.2 percent). The responses included people from across the country and included a wide mix of professionals with broad responsibilities including planning, engineering, enforcement, public information, education and research.

**TABLE 1: Summary of the Respondent Characteristics**

| Description | Mean | Std Dev | Minimum | Maximum |
|---|---|---|---|---|
| **Age** | 49.4 | 12.2 | 18 | 76 |
| **Description** | **Frequency** | **Percent** | **Cumulative Frequency** | **Cumulative Percent** |
| **Gender** | | | | |
| Male | 298 | 77.6 | 298 | 77.6 |
| Female | 86 | 22.4 | 384 | 100 |
| **Primary responsibility in the organization** | | | | |
| Engineering | 23 | 5.76 | 23 | 5.8 |
| Public information | 32 | 8.02 | 55 | 13.8 |
| Research | 37 | 9.27 | 92 | 23.1 |
| Enforcement | 59 | 14.79 | 151 | 37.8 |
| Training/education | 87 | 21.8 | 238 | 59.6 |
| Other | 161 | 40.35 | 399 | 100 |
| **Organization type** | | | | |
| Government | 235 | 57.9 | 235 | 57.9 |
| Non-profit | 21 | 5.2 | 256 | 63.1 |
| University | 55 | 13.6 | 311 | 76.6 |
| Private sector | 75 | 18.5 | 386 | 95.1 |
| Other | 20 | 4.9 | 406.0 | 100.0 |

## FINDINGS

The key findings are summarized in Table 2, "Key Survey Findings: Observed UAV Use, Threats and Regulations." Out of the total of 434 individuals who answered the question: "Have you seen drones (unmanned aerial vehicles) operating in the community?" 73.73% answered in the affirmative. A little more than 79% of those 320 responding agreed that they have seen an increase in drone use in their community. While 21.38 % have seen UAV operating in close proximity to motor vehicles, only 5.81% have heard of instances where drones have caused crashes and 17.66% have heard about "near misses." A majority (85.42 %) agrees that UAV use over roadways should be regulated. Respondents are mostly (73.19 %) aware of the FAA regulations on drone registration, flying height and location restrictions, but are not that well informed on the community "no drone fly zones." About 41 percent replied "I don't know," while 13.73 % answered that their communities have adopted "no drone fly zones." The remaining 45.3% indicated that there was no such zones in their communities.

**TABLE 2. Key Survey Findings: Observed UAV use, Threats and Regulations**

| Description | Frequency | Percent | Cumulative Frequency | Cumulative Percent |
|---|---|---|---|---|
| Have seen drones (unmanned aerial vehicles) operating in the community | | | | |
| Yes | 320 | 73.73 | 320 | 73.73 |
| No | 114 | 26.27 | 434 | 100 |
| Have seen an increase in drone use in your community | | | | |
| Yes | 253 | 79.06 | 253 | 79.06 |
| No | 67 | 20.94 | 320 | 100 |
| Have seen drones flying in close proximity to motor vehicles | | | | |
| Yes | 93 | 21.38 | 93 | 21.38 |
| No | 342 | 78.62 | 435 | 100 |
| Have heard of instances where drones have caused crashes | | | | |
| Yes | 24 | 5.81 | 24 | 5.81 |
| No | 389 | 94.19 | 413 | 100 |
| Have heard of about "near misses" | | | | |
| Yes | 68 | 17.66 | 68 | 17.66 |
| No | 317 | 82.34 | 385 | 100 |
| Agrees that drone use over roadways should be regulated | | | | |
| Yes | 353 | 85.47 | 353 | 85.47 |
| No | 60 | 14.53 | 413 | 100 |
| Aware of the Federal Aviation Administration (FAA) regulations on drone registration, flying height and location restrictions | | | | |
| Yes | 303 | 73.19 | 303 | 73.19 |
| No | 111 | 26.81 | 414 | 100 |
| Community has adopted "no drone fly zones" | | | | |
| Yes | 57 | 13.73 | 57 | 13.73 |
| No | 188 | 45.3 | 245 | 59.04 |
| I don't know | 170 | 40.96 | 415 | 100 |

The observations by the respondents indicated that UAV use is on the rise and is consistent with the exponential “lower S curve” increase projected in the Volpe report (*31*). Even though the incidence of accidents being caused by drones is small, there is widespread recognition of the potential threat.

Table 3, “UAV Hazards and Operation Restrictions,” summarizes the hazard perception on traffic and the preferred restrictions by the respondents. A majority (92.5%) surveyed indicated distraction to drivers as a UAV hazard followed by causing visual obstruction (46.8%)

and falling on motorist (45.9%). Increasing congestion was indicated as a hazard by only a few (16.2%) of the respondents.

**TABLE 3. UAV Hazards and Operation Restrictions**

| Description | Frequency | Percent |
|---|---|---|
| **Hazard Perception** | | |
| Distracting drivers | 393 | 92.5% |
| Increasing congestion | 69 | 16.2% |
| Falling on motorists | 195 | 45.9% |
| Causing visual obstructions | 199 | 46.8% |
| Other effects | 58 | 13.6% |
| Total responses | 425 | |
| **Preferred Restriction on roadways** | | |
| Interstate highways | 306 | 79.7% |
| Rural highways | 173 | 45.1% |
| Major arterials | 279 | 72.7% |
| Secondary roadways | 149 | 38.8% |
| Residential streets | 177 | 46.1% |
| Parking lots | 92 | 24.0% |
| Intersections | 205 | 53.4% |
| Bike lanes | 118 | 30.7% |
| Pedestrian paths | 101 | 26.3% |
| Other | 67 | 17.4% |
| Total responses | 384 | |
| **Preferred Restriction on Vehicle** | | |
| Large trucks | 239 | 69.3% |
| Public transit vehicles (Buses, light/heavy rails) | 241 | 69.9% |
| Tour buses | 217 | 62.9% |
| School buses | 260 | 75.4% |
| Personal vehicles (car, van, pickup, SUV, etc.) | 232 | 67.2% |
| Motorcycles | 231 | 67.0% |
| Total responses | 345 | |

The middle section of Table 4 shows attitudes towards UAV operation restrictions on roadways. Respondents preferred restrictions of UAV use on primary roadways. Restrictions on

UAS operation over interstate highways (79.7 percent) and major arterials (75.7%) received higher support than restrictions on intersections (53.4 percent), residential streets (46.1 percent), rural highways (45.1 percent) and secondary roadways (38.8 percent). There was less support for restrictions over bike lanes (30.7 percent), pedestrian paths (26.3 percent) and parking lots (24 percent). Overall, respondents preferred restrictions over roadways with higher volumes and operating speeds.

The last section of Table 3 shows preferred UAV restrictions over vehicles. Support for restrictions of UAV over school buses was highest (75.4 percent), followed by public transit vehicles (69.9 percent), large trucks (69.3 percent), personal vehicles (car, van, pickup, SUV, etc.) (67.2 percent) and motorcycles (67 percent). Compared to UAV operation restrictions support on other modes, tour buses had comparably less (62.9 percent) restriction support.

## DISCUSSION

In this section, approaches to regulating UAS are described, and FAA regulations, as well as state and local ordinances, are summarized.

### FAA Regulations

On August 29, 2016, the FAA will be putting into effect its final guidance on the use of UAS, called Small UAS Rule, Part 107. In summary, this new rule lays out the operational limitations and the remote pilot in command certification process and responsibilities for operation of unmanned aircraft drones weighing less than 55 pounds that are conducting non-hobbyist operations (*22*). Table 4, "Summary of FAA Small UAS Rule, Part 107," summarizes the new guidance. The Small UAS Rule, Part 107 only governs commercial UAS use. Model aircraft and those UAS hobbyists must continue to satisfy all criteria specified in Section 336 of Public Law 112-95 (*22*).

**TABLE 4 Summary of FAA Small UAS Rule, Part 107**

| | **Operational Limitations** |
|---|---|
| 1 | Must weigh less than 55 lbs |
| 2 | Must remain within visual line of sight (VLOS) |
| 3 | May not be operated over any persons not directly participating in the operation, not under a covered structure, and not inside a covered stationary vehicle |
| 4 | Only daylight operations allowed |
| 5 | Must yield right of way to other aircraft |
| 6 | Maximum ground speed of 100 mph |
| 7 | Maximum altitude of 400 feet |
| 8 | Minimum weather visibility 3 miles |
| 9 | Operations within Class B, C, D, E, and G airspace allowed with required ATC permission |
| 10 | No person may act as a remote pilot in command for more than one UAS at a time. |
| 11 | No operations from a moving a vehicle |
| 12 | No operations from a moving aircraft |
| | **Remote Pilot in Command Certification and Responsibilities** |
| 1 | Establish a remote pilot in command position |
| 2 | Must hold a remote pilot airman certificate |
| 3 | To qualify for a remote pilot certificate must demonstrate aeronautical knowledge by passing the initial aeronautical knowledge test at the FAA approved testing center or hold a part 61 pilot certificate, complete a flight review within 24 months, and complete a FAA small UAS training course. |
| 4 | Make available to the FAA, upon request, the small UAS for inspection or testing, and any associated documents/records required to be kept under the rule. |

5 Report to the FAA within 10 days of any operation that results in at least serious injury, loss of consciousness, or property damage of at least $500.

6 Conduct a preflight inspection, to include specific aircraft and control station systems checks, to ensure the small UAS is in a condition for safe operation.

7 Ensure that the small unmanned aircraft complies with the existing registration requirements specified in § 91.203(a) (2).

8 FAA airworthiness certification is not required. However, the remote pilot in command must conduct a preflight check of the small UAS to ensure that it is in a condition for safe operation.

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**State and Local Regulations**

The FAA rules and regulations are broad usage rules, and as such are more geared towards ensuring safety of flight, and safety of people and property on the ground. States and local jurisdictions have been enacting their own legislation and rules relating to UAS operations. According to the National Conference of State Legislatures (NCSL), state legislatures across the country are debating if and how UAS technology should be regulated considering their benefits, privacy concerns and potential economic impact (*32*). According to the NCSL, 32 states have enacted laws addressing UAS issues and an additional five states have adopted resolutions (*32*). In 2016, at least 41 states have considered legislation related to UAS. Fourteen states, including Alaska, Arizona, Idaho, Indiana, Kansas, Louisiana, Oklahoma, Oregon, Rhode Island, Tennessee, Utah, Vermont, Virginia, and Wisconsin have passed 26 pieces of legislation either for or against UAS activities (*32*). The Institute for National Security and Counterterrorism (INSCT) at Syracuse University, has compiled ordinances on the use of UAS from approximately 40 cities (*33*). Laws traditionally related to state and local police power, including land use, zoning, privacy, trespassing, and law enforcement operations are normally not subject to federal regulation (*34*). The issues with local jurisdictions establishing their own rules, bills, or ordinances on the use of UAS is that there are no consistent standards across jurisdictions.

As an emerging technology, UAS are difficult to regulate. The technology itself is only beginning to show its potential. It is a disruptive technology because it will only get cheaper, and smaller, yet providing more capabilities for more applications. Already, researchers are examining smart and autonomous drones, the microscopic and swarms, improved sensors and connectivity to the internet, and advances in battery life to allow UAS to fly for longer periods of time without landing. In the future, losing drones won’t matter because another hundred could easily and cheaply replace what was lost. Technical challenges aside, the nation will need to address social and political challenges before UAS uses can be advanced. The concerns over privacy, interference, safety, noise, and other aspects need to be resolved.

In reviewing UAS legislation at the state and local level, there are a number of approaches for regulating this technology. Some state and local governments reinforce many of the FAA restrictions and guidelines such as restricting UAS use near critical facilities or imposing height and flight. Others emphasize the importance of drone operator credentials or require permits or licenses or special use permits. Bans on drone use in locations such as stadiums or public spaces have also started to emerge. Some localities also restrict the surveillance of persons or property to protect privacy. There are bans on taking photographs or videos of people without consent. In addition to restrictions on use, other municipalities have specified the situations for which drones can be used, especially by law enforcement for applications such as pursuing suspects, implementing search warrants, and other applications. Regulations on different types of sensors (thermal, infrared, etc.) are also being adopted.

Traffic safety researchers concerns regarding driver and pedestrian distraction, associated with technologies such as cell phone use have been identified *(35, 36)*, but the disruptive nature of UAS presents a much larger problem as cheaper, smaller and more autonomous drones take to the skies. The traffic safety and distraction research may be particularly relevant to understanding the safety hazards associated with UAS. Yet to date, there has been little effort to include drone operations in state and local traffic ordinances. Future research will focus on: 1) additional follow-up on the survey conducted for this research, with interviews of respondents to gain more information about traffic safety incidents and “near misses”; 2) tracking state and local ordinances and legislation, and systematically identifying the different approaches to regulating drones; 3) creation of a drone near miss or accident reporting system; and 4) developing best practices in the use of UAS as it pertains to traffic safety.

## CONCLUSIONS

This research has shown a clear emerging need to better understand the threats and hazards associated with drones and traffic safety. While the reported number of cases is still quite small, with increased proliferation of drones, greater interactions, more traffic conflicts, accidents and collisions between drones and motor vehicles, pedestrians, and other roadway users can be expected. There is an urgent need to focus on drones and traffic safety. It is time to bring together a taskforce, perhaps through the Transportation Research Board to address these issues and concerns regarding safety as more drones are used for business, recreational, and public safety applications. A more comprehensive survey of DOTs and transportation agencies use of UAS is also needed. More effort in identifying stakeholders beyond transportation researchers is needed. In addition to traffic engineers, law enforcement and, those involved in using UAS and their products must be consulted in order to better assess the threats and hazards. Successful management will require a systems view, taking into account drone users (hobbyists, students, government, and industry) as well as the system size, weight, payload, operating speeds, performance to better understand the risks and exposure to drones collisions. In addition, it is important to track emerging technologies such as collision avoidance, drone blocking systems, registration and vehicle ID in flight. It is not hard to envision that in addition to the many drones used by industry and hobbyists, UAS could be used not only for routine enforcement activities on the ground, but also in the skies above.

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