

Fire Department Use of Small Unmanned Aircraft Systems

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Certification Statement

I hereby certify that this paper constitutes my own product, that where the language of others is set forth, quotation marks so indicate, and that appropriate credit is given where I have used the language, ideas, expressions, or writings of another.

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Abstract

The problem is that the Ridgefield fire department has not identified the utility of using small unmanned aircraft systems (sUAS) in fire department operations. The purpose of this research is to determine the utility of incorporating sUAS in Ridgefield fire department operations.

Descriptive methodology guided the following research questions: (a) How can sUAS be used to enhance emergency and non-emergency fire department operations? (b) How do federal, state, and local laws and regulations impact fire department use of sUAS? (c) What are the potential costs of using sUASs in fire department operations? (d) What are the political, social, and other non-regulatory considerations of using sUAS in fire department operations? The data collection procedures included a survey made available to fire departments nationwide to obtain quantitative data. In addition, subject matter expert interviews were used to obtain qualitative data to facilitate interpretation of the quantitative data and determine applicability to the Ridgefield fire department. Interview subjects were current subject matter experts in fire department sUAS operations selected based on their familiarity with or similarity to the Ridgefield fire department operations. The results showed the potential benefits were significant enough for Ridgefield to warrant managing the barriers, costs, and concerns of an sUAS program.

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Introduction

Situational awareness is a crucial component of every phase of emergency management (Pagan, 2019, para. 2). Small unmanned aircraft systems (sUAS) provide an elevated platform that can significantly improve a fire department's real-time situational awareness in prevention, mitigation, preparedness, response, and recovery operations (City of St. Louis, Missouri, 2022; Kedia et al., 2020). Emergency service organizations worldwide currently employ sUAS technology (Kedia et al., 2020). However, this is not necessarily an optimal use of resources for every fire department in the United States (Avsec, 2018; Dugan, 2016; Hatt, 2021; Jones et al., 2015).

The Ridgefield Fire Department RFD) is an all-hazards fire department serving the Town of Ridgefield, Connecticut (Aarons & Marconi, 2019, p. 48). The Chief of the RFD is tasked with exploring emerging tools, techniques, and technologies that may help the RFD better serve their community (*Job Description: Position of Fire Chief*, 2014). The problem is that the Ridgefield fire department has not identified the utility of using small unmanned aircraft systems (sUAS) in fire department operations. This research aims to determine the feasibility of incorporating sUAS in Ridgefield Fire Department operations.

The Chief of the Ridgefield fire department determined a need to investigate the utility of fire service small unmanned aircraft systems (sUAS) specific to the operations of the RFD (J. Myers, personal communication, October 13, 2021). The hypothesis was that the benefits of an sUAS program in the Ridgefield fire department would be worth the investment. It was determined that a cost-benefit analysis specific to the Ridgefield fire department was necessary to assess the utility of sUAS and confirm or refute the hypothesis. If the research proved the

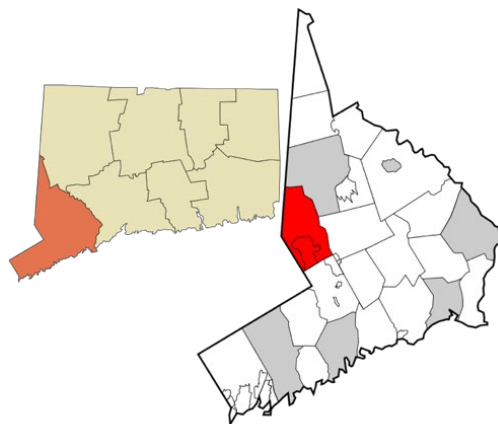
hypothesis true, then the RFD may improve the scope or efficiency of the emergency services they provide. If the investigation confirmed the hypothesis false, the Ridgefield fire department might invest resources in other tools, techniques, and emerging technologies to improve the scope or efficiency of emergency services. The purpose of this research is to determine the utility of incorporating sUAS in RFD operations.

Descriptive methodology guided the following research questions: (a) How can sUAS be used to enhance emergency and non-emergency fire department operations? (b) How do federal, state, and local laws and regulations impact fire department use of sUAS? (c) What are the potential costs of using SUASs in fire department operations? (d) What are the political, social, and other non-regulatory considerations of using sUAS in fire department operations?

Background and Significance

The Town of Ridgefield is in Fairfield County on the Western side of the state of Connecticut. Ridgefield is primarily a bedroom community of approximately 35 square miles serving an estimated population of 25,000 residents (United States Census Bureau, 2021).

Figure 1: Map of the Town of Ridgefield, Connecticut within Fairfield County



Note: Image courtesy of United States Census Bureau, 2020, (<https://mtgis->

portal.geo.census.gov/arcgis/apps/MapSeries/index.html?appid=2566121a73de463995ed2b2fd7ff6eb7)

The Ridgefield Fire Department administrative staffing consists of a full-time career fire chief, full-time career assistant chief, department administrator, and fire marshal (Burford, 2011). The department provides all-hazards emergency services, including emergency medical transport services at a paramedic level, hazardous materials and rescue response, and public assistance (Burford, 2011; Marconi & Burford, 2009).

The fire chief is responsible for the maintenance and administration of the department and the oversight of all departmental functions (International Fire Service Training Association, 2014 p. 1; Town of Ridgefield Human Resources Department, 2014). The department maintains four shifts of eight to nine full-time career firefighters, all certified at a minimum of EMT level, eighteen of whom are paramedics (Burford, 2011). Each shift has two officers, one captain who acts as a shift commander at headquarters, and one lieutenant who supervises the Ridgebury Fire Station and serves as an acting shift commander at headquarters in the absence of the captain (Burford, 2011; Town of Ridgefield Human Resources Department, 2014). The department also maintains a volunteer component of approximately fifty firefighters who work under the career chief and assistant chief but maintain their internal leadership structure (Burford, 2011). These firefighters and officers have a variety of qualifications but primarily serve in a support role (Burford, 2011).

Over the past twenty-five years, the Town of Ridgefield has undergone significant growth and change (Town of Ridgefield Planning and Zoning Commission, 2020, pp. 3–4). To meet the increasing demands placed on emergency services, the RFD has evolved from a

primarily volunteer fire department with career firefighters supplementing dispatch, first response, and EMS to a department with full-time civilian public safety telecommunicators dispatching firefighters with multiple engines and EMS companies (J. Myers, personal communication, January 15, 2022). An increase in the number and scope of calls for emergency response requires the RFD to continuously evaluate new tools, techniques, and technologies to serve the public better (J. Myers, personal communication, January 15, 2022). Some, like compressed air systems (CAFS), have been evaluated and not adopted, while others, including mechanical CPR (mCPR) devices, have been adopted with success (J. Myers, personal communication, January 15, 2022). With the recent implementation of sUAS in the Danbury Fire Department, a career fire department bordering Ridgefield to the north, the question of the RFD adopting sUAS has become a priority (J. Myers, personal communication, January 15, 2022).

This research relates directly to the National Fire Academy Executive Fire Officer Program course: Executive Analysis of Fire Service Operations in Emergency Management (R306). The Executive Fire Officer Program Handbook (National Fire Academy, 2018) states this course is “designed to help senior staff officers better prepare their communities for large scale, multiagency, all-hazards incidents” (p. 13). This course also covers risk assessment, incident documentation, and damage assessment, all aspects of incident management in the RFD with which sUAS may potentially assist (Dugan, 2016; Hatt, 2021; Kedia et al., 2020; National Fire Academy, 2018). This research also aligns with goal two of the United States Fire Administration Strategic Plan (Bryant, 2019), “to ready the nation’s fire and emergency medical services for all hazards” (p. 1).

Literature Review

This review of the related literature includes peer-reviewed published research, government and private entity reports, fire service trade magazine and website articles, and resources from national and international public safety organizations. To provide context, this review first presents a background on the utility of sUAS in public service. This is followed by a review of related literature within the framework of the four primary areas of concern regarding sUAS and the United States fire service. These are the benefits, barriers, costs, and concerns of fire department use of sUAS.

Background

Modern sUAS are typically associated with military uses, from observation of enemy positions and movements to delivery of weapon payloads (Dormehl, 2018). While the military has used forms of sUAS from the 19th century to the 21st, the first civilian use ready-to-fly quadcopter was introduced at the 2010 Consumer Electronics Show (CESS) (Dormehl, 2018). By 2022, even relatively low-cost sUAS can be purchased by civilians with various features, including hi-resolution photography, thermal imaging, and even the ability to deliver small payloads, all characteristics that make modern sUAS appealing to the fire service (Fisher, 2022).

Current sUAS vary significantly in capabilities and cost (Fisher, 2022), just as fire departments in the United States differ considerably in their capacity and needs (Evarts & Stein, 2020, p. 1). However, the elevated observation platform that sUAS provides can increase responder situational awareness in a wide enough variety of circumstances to benefit virtually all emergency agencies in North America (Dugan, 2016). A 2015 report from the National Fire Protection Association (NFPA) (Jones et al., 2015) concludes, “The Unmanned Aircraft System

UASS) is going to change how we view the fire or accident scene today” (p. 4). The NFPA (Jones et al., 2015) further concludes that sUAS can enhance functions such as size up, situational awareness, search and rescue, investigations, pre-planning, and training that are universal to virtually all fire departments in the United States (pp. 11–13). Chief Robert Avsec (2018) agrees, foreseeing the use of sUAS rapidly increasing for fire departments of all types. Analytics firm Levitate Capital (Constantine, 2020) predicts that the market for sUAS will grow from 700 million dollars in 2020 to over 5 billion dollars by 2030 in the public safety sector alone (p. 5).

Benefits

Da-Jiang Innovations (DJI) is the largest manufacturer of consumer sUAS, commanding approximately 70% of the market, while no other company accounts for more than 5% (Insider Intelligence Staff, 2020). DJI consumer drones have saved 133 lives between 2017 and 2018 (Middleton, 2018). This demonstrates that relatively low-cost non-military-grade sUAS can enable fire departments and other public safety agencies to accomplish life-saving tasks (Middleton, 2018).

The National Public Safety Telecommunications Council (NPSTC) (2017) has developed a list of primary public safety missions that may be served by sUAS Telecommunications (pp. 1–2). The potential sUAS missions outlined in this NPSTC report are broadly applicable to public safety organizations, including fire departments, search and rescue teams, law enforcement, emergency management agencies, emergency medical service (EMS) providers, disaster recovery groups, environmental agencies, agricultural agencies, and other similar entities (NPSTC, 2017). Categories include public safety, local emergency management, traffic

management, geographic information systems, infrastructure inspection, public buildings, facilities and asset management, environmental and natural resources, cultural, and agricultural operations (NPSTC, 2017, pp. 1–3). These missions are not fire-service-specific and may not apply to individual fire departments in the United States.

The International Association of Fire Chiefs (IAFC) (2018a) has developed a toolkit that includes a fire-service-specific section on sUAS operational abilities. These include structural firefighting, wildland fire fighting, rescue, hazardous materials, EMS, disaster response, and other operations (IAFC, 2018b). In addition, individual experts in the fire service have assembled their list of operational uses and benefits of sUAS in their fire agencies. These include Chief Otto Drozd III of the Orange County Florida Fire-Rescue Department, who lists scene size up, structure fire overview, hazardous materials response, air monitoring, wide area search, technical rescue, pre-incident planning, and special event planning as only scratching the surface of ways fire department may be able to use sUAS to enhance their operations (Hatt, 2021).

Locally, other fire departments in Connecticut have demonstrated the benefits of their sUAS platforms. Danbury fire department, immediately to the north of Ridgefield, established an sUAS program beginning in 2018 after a search for a missing person required the use of a state police K9 tracker and a helicopter costing more than \$6,000 per hour to operate (Perrefort & Attanasio, 2018, paras. 1–2). Danbury has since deployed their sUAS at structure fires, large-scale incidents, and other missing person emergencies (B. Meehan, personal correspondence, January 19, 2022). Other Connecticut fire departments such as Branford (Ball, 2014), Putnam (Spires, 2020), Norwich (Penney, 2020), and West Hartford (FOX News 61, 2020) have all deployed sUAS to aid in public safety operations.

Barriers

Wakeham and Griffith (2015) report that unclear regulatory requirements have confounded the fire service since the early days of sUAS operations (pp. 2-3). Federal regulations governing the operation of these devices were clarified in 2016 with the release of the updated Federal Aviation Administration (FAA) regulations for small unmanned aircraft systems (Small Unmanned Aircraft Systems, 14CFR. § 107, 2016). This document outlines what is needed to operate sUAS for non-recreational purposes, defining the requirements for pilots, aircraft, and operations (Small Unmanned Aircraft Systems, 14CFR. § 107, 2016). A summary of the major provisions of these regulations can be found in Table 1.

Table 1: Summary of Major Provisions of 14CFR. Part 107

Operational Limitations	<p>Unmanned aircraft must weigh less than 55 lbs. (25 kg).</p> <p>Visual line-of-sight (VLOS) only.</p> <p>sUAS may not operate over any persons not directly participating in the operation, not under a covered structure, or inside a covered stationary vehicle.</p> <p>Daylight-only operations or civil twilight with appropriate anti-collision lighting.</p> <p>Must yield right of way to other aircraft.</p> <p>May use visual observer (VO) but not required.</p> <p>Maximum groundspeed of 100 mph (87 knots).</p> <p>Maximum altitude of 400 feet above ground level (AGL) or, if higher than 400 feet AGL, remain within 400 feet of a structure.</p> <p>Minimum weather visibility of 3 miles from the control station.</p>
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	<p>Operations in Class B, C, D, and E airspace are allowed with the required ATC permission.</p> <p>Operations in Class G airspace are allowed without ATC permission.</p> <p>No person may act as a remote pilot in command (RPIC) or VO for more than one unmanned aircraft operation at one time.</p> <p>No operations from a moving aircraft.</p> <p>No operations from a moving vehicle unless the operation is over a sparsely populated area.</p> <p>External load operations are allowed if the object being carried by the unmanned aircraft is securely attached and does not adversely affect the flight characteristics or controllability of the aircraft.</p> <p>Most of the restrictions discussed above are waivable if the applicant demonstrates that their operation can safely be conducted under the terms of a certificate of waiver.</p>
Remote Pilot in Command (RPIC) Qualifications & Responsibilities	<p>To qualify for a remote pilot certificate, a person must demonstrate aeronautical knowledge by passing an initial aeronautical knowledge test at an FAA-approved knowledge testing center, or they must hold a part 61 pilot certificate other than student pilot, complete a flight review within the previous 24 months, and complete an sUAS online training course provided by the FAA.</p> <p>The Transportation Security Administration (TSA) must vet RPIC candidates.</p> <p>A person operating a small UAS must either hold a remote pilot airman certificate with a small UAS rating or be under the direct supervision of a person who does have a remote pilot certificate.</p> <p>A remote pilot in command must report to the FAA within ten days of any operation that results in at least serious injury, loss of consciousness, or property damage of at least \$500.</p> <p>Conduct a preflight inspection.</p>

Note. Adapted from “Small unmanned aircraft systems, 14CFR. § 107” by the Federal Aviation Authority (FAA), 2016. (<https://www.ecfr.gov/current/title-14/chapter-I/subchapter-F/part-107>)

The FAA gives government entities two paths for the public safety operation of sUAS. The first is to follow all the rules and requirements of the FAA part 107 regulations. Unfortunately, these regulations may hinder some fire department operations with restrictions such as only flying during daylight hours, not operating over people, and not operating within five miles of a towered airport (Martinez, 2019). This last of these would prohibit sUAS operations in virtually all the Ridgefield fire department's response area due to the proximity of Danbury airport.

Figure 2: Five Mile Radius of Danbury Regional Airport



Note: Image courtesy of VFRMAP, 2022, VFRMAP

(http://vfrmap.com/?type=vfr&lat=41.372&lon=-73.482&zoom=10&api_key=763xxE1MJHyhr48DlAP2qQ)

However, the FAA also allows government entities to apply for a blanket public Certificate of Waiver or Authorization (COA) that lifts many of these restrictions (UAV Coach,

2022). Other restrictions may be lifted by additional waivers available only to public safety organizations operating with a COA (Roman, 2017). The downside of obtaining a COA is that even with recent streamlining by the FAA, the process remains relatively complex, expensive, and takes many months (Roman, 2017).

Some departments may choose to comply with the FAA Part 107 regulations and obtain a COA. Effectively, the FAA Part 107 regulations put the responsibility and liability on the individual pilot, whereas the COA put the responsibility and liability on the organization (Roman, 2017). In addition to the FAA regulations, fire department sUAS operators must also comply with or receive a waiver of state and local regulations (Martinez, 2019). While complying with both FAA Part 107 and obtaining a COA and waivers can be the most costly, it provides individuals and organizations with the greatest safety, flexibility, and ability to provide service to the public (Roman, 2017).

According to Rupprecht (2021, para. 4), FAA regulations are a form of administrative law rather than criminal law. This means that no criminal penalties are directly associated with the violation of Federal Aviation Regulations (FAR) (Rupprecht, 2021, paras. 4–6). Consequences for FAR violations can include certificate action, where the FAA revokes or suspend operating certificates, certificates of authorization, or waivers (Rupprecht, 2021, para. 6). Civil penalties in the form of fines can also be levied against those who violate FAR (Rupprecht, 2021, para. 5). Fines for FAR violations can number in the hundreds of thousands of dollars (National Law Review Staff, 2020). In addition, criminal penalties can apply if a FAR violation breaks other laws (Graves, 2021, paras. 5–11). In one case from 2015, a pilot using sUAS to film a parade lost control of his drone resulting in a bystander getting knocked

unconscious (Graves, 2021, para. 6). This resulted in the charge of reckless endangerment. The pilot was sentenced to 30 days in jail and received an additional \$500 fine (Graves, 2021, para. 6).

In Connecticut, the only current laws governing sUAS beyond the federal regulations restrict sUAS flights over state parks and recreation areas (UAV Coach, 2022). Some local entities, including the Town of Ridgefield, post certain schools as “no-fly zones” for sUAS. Many state and local regulations further restricting non-public safety recreational sUAS operators have been proposed but have yet to be enacted (UAV Coach, 2022). It remains to be seen how such regulations might affect public safety sUAS operations.

Costs

A report by the European Emergency Number Association (EENA) and DJI outlined essential costs facing agencies seeking to integrate sUAS into their regular emergency and safety operations (O’Brien et al., 2016, pp. 7–8). These include the hardware platform, including the aircraft, initial and ongoing training, staffing for operational deployment, maintenance, and liability (O’Brien et al., 2016, pp. 7–8). These costs apply to virtually all properly constructed public safety sUAS programs (O’Brien et al., 2016).

Platform Costs

One of the primary costs of integrating sUAS into firefighting operations is, of course, the sUAS platform itself (Jones et al., 2015, p. 14). These platforms typically consist of a radio-controlled, battery-operated multi-rotor or quadcopter device with a camera (International Association of Fire Chiefs, 2018c). Basic commercial sUAS platforms can cost anywhere from \$500 to \$10,000 and up (Fisher, 2022; PropelRCC Staff, 2021). Prices then vary based on

improvements in battery capacity (effectively flight time and range), camera quality and features including infrared capabilities, GPS features, build quality and robustness, weight and size, speed of deployment, speed of slight, stability, and control features (PropelRCC Staff, 2021).

Training Costs

An appropriate training program is recommended for all pilots who operate the department's sUAS platform (Jonkey, 2016, p. 66). Although pilots operating under an FAA COA do not necessarily need to pass an FAA written exam, pilots operating under the FAA Small Unmanned Aircraft Systems regulations do (Small Unmanned Aircraft Systems, 2016). The FAA provides free training to prepare department personnel to pass the written FAA sUAS pilot exam. The application fee for the exam is \$150 (Federal Aviation Administration, 2021). However, this training only covers initial qualifications for pilots. Continuing education and skills maintenance are necessary considerations for any public safety sUAS program (Jonkey, 2016, p. 48).

In 2021 the National Aeronautics and Space Administration (NASA) and ESRI entered into a joint venture to form DRONERESPONDERS, a global public safety sUAS directory and resource center (Werner, 2021). At the same time, the Airborne International Response Team (AIRT), a nonprofit, non-governmental organization that hosts DRONERESPONDERS, established a Global Emergency Remote Pilot Directory to coordinate and share pilot emergency pilot resources around the world (Werner, 2021). These resources are free and open to emergency services worldwide and are intended to lower the cost and ease the path for agencies to obtain and train sUAS pilots (Werner, 2021).

Staffing Costs

Integrating an sUAS into fire department operations requires more staffing considerations than simply training one or more existing firefighters to fly the machine (NPSTC, 2017, pp. 3–4). Not only will the ability of the department to operate their sUAS depend on the availability of a qualified pilot, depending on the mission, but appropriate staffing might also include a pilot, observer, and an officer or liaison to manage communication and coordination (NPSTC, 2017, pp. 3–4). Furthermore, a department with an in-house sUAS program must consider including a mechanic who qualifies to maintain and repair the sUAS (NPSTC, 2017, pp. 3–4). Because of the complexities of appropriate staffing for sUAS missions, smaller departments may consider a program where the platform is shared between departments or subcontract it out to a commercial operator (NPSTC 2017, pp. 4–5).

Maintenance Costs

sUAS maintenance needs and costs are likely to vary significantly from program to program (Jones et al., 2015, p. 14). Costs should be projected based on estimated use and manufacturers' recommendations (Werner, 2016). Maintenance records, along with training records, flight plans, and other records related to sUAS operations, should be carefully documented with other department records (Werner, 2016).

Liability Costs

System failures, malfunctions, and operator errors are an inevitable part of any sUAS program. While preventative maintenance will minimize many of these issues, and FAA regulations and restrictions may mitigate the impact of falling drones, these do not eliminate

danger, cost, and liability (IAFC, 2018a). In addition, consideration must be given to intentional and malicious interference with fire department sUAS operations (Werner, 2018).

The Volunteer Firemen's Insurance Service (VFIS) has published recommendations to minimize liability, along with liability insurance costs, for public safety organizations operating sUAS platforms (Volunteer Firemen's Insurance Service, 2021). These recommendations include compliance with FAA regulations and restrictions, establishing standard operating procedures, maintaining a training program, using proper flight planning and logging procedures, and performing and documenting maintenance as recommended (VFIS, 2021). VFIS emphasizes establishing the appropriate framework for an effective sUAS program before the first flight takes place (VFIS, 2021).

Cost Mitigation

Funding alternatives exist to mitigate the cost of sUAS programs (United States Fire Administration [USFA], 2012). Options include government grants, private grants, sales and fundraising events, corporate donations, private donations, fee for service, special taxes, development impact fees, and seized assets, among others (USFA, 2012). Minimizing the financial burden of a new program on the local tax base may facilitate government approval of an sUAS program (USFA, 2012). Ridgefield Fire Department has a history of successfully acquiring grants and donations (Himes, 2012). Other fire departments in Connecticut have received donations to support sUAS programs, including Danbury (Perrefort & Attanasio, 2018), Branford (Ball, 2014), Putnam (Spires, 2020), Norwich (Penney, 2020), and West Hartford (FOX News 61, 2020).

Concerns

The literature review quickly revealed that the most significant public concern outside of program cost and safety regulations is personal privacy. In 2015 President Obama charged the US. Department of Commerce's National Telecommunications Information Administration (NTIA) to gather stakeholders to develop and publish best practices for privacy, transparency, and accountability, promoting the use of sUAS in a way that did not diminish the rights and freedoms of US citizens (National Telecommunications Information Administration, 2016). The NTIA report recommends informing others of use of sUAS were practical and reasonable, being responsible when collecting and storing data gathered by sUAS, limiting the benefit in sharing of this data, securing the data, and monitoring apply with evolving federal, state, and local laws governing the operation of sUAS (NTIA, 2016, pp. 5–6).

To assist public safety entities in addressing these concerns, DRONERESPONDERS (2020) published a guide to principles on responsible use of sUAS. DRONERESPONDERS (2020) guide outlined the Five C's of community engagement and transparency, civil liberties and privacy protection, common operating procedures, clear oversight and accountability, and cybersecurity (p. 1). These five principles are based on guidance from the Police Executive Research Forum (PERF), the International Association of Chiefs of Police (IACP), the National Institute of Justice (NIJ), and the US Department of Justice DOJ) (DroneResponders, 2020, p. 1). These recommendations were developed primarily with law-enforcement sUAS programs in mind but are explicitly applicable to sUAS programs of all branches of public safety (DroneResponders, 2020, p. 1).

In addition to concerns about privacy, the literature revealed potential concerns about drones being used as a potential weapon (Paganini, 2021). Although no evidence was found in the literature to suggest that public safety sUAS platforms might be coopted to take part in an attack on the public, there have been documented uses of drones used to carry out attacks with improvised explosive devices (IEDs) outside of the United States (Harkins, 2021), leading some countries to ban the use of drones (ABC News, 2022). The potential, therefore, exists that weaponized drones may be a potential concern for the public.

Summary

National Fire Protection Association (NFPA) 2400 (2019) is the fire service standard for small unmanned aircraft systems used for public safety operations. This standard builds on much of the work of other individuals, national groups, and committees mentioned in the literature review addressing the benefits, barriers, costs, and concerns related to fire service deployment of sUAS. As with many other aspects of fire department operations, the tremendous variety in size, structure, and mission priorities in the various fire departments across the United States means that NFPA 2400 make an excellent reference along with resources from the FAA, NTIA, NPSTC, IAFC, and other organizations, but should not be considered a comprehensive and universally accepted document that outlines the single way that sUAS programs must be structured. The literature search makes it clear that there is a need for individual departments to collect and interpret data specific to their department's resources, needs, and mission priorities.

Procedures

Sample Selection

The collection of quantitative and qualitative data was needed to complete the cost-benefit analysis at the heart of this research. Quantitative data was collected via a convenience sample of responses to an online survey. The target audience for respondents for the online quantitative survey was persons knowledgeable of an emergency services sUAS program. No specific rank or knowledge set was required beyond the ability to answer most of the quantitative survey questions regarding their sUAS program. Qualitative data was collected from interviews of both local and national subject matter experts. Interviewees were identified as subject matter experts (SME) in fire department sUAS operations, each having the qualifications of having developed their sUAS programs and provided guidance for the development of sUAS programs for other agencies. Of the ten SMEs contacted for interviews for this research, four replied with responses to all interview questions.

Data Collection Procedures

A nineteen-question survey was used to obtain quantitative data for this research. The survey accepted responses between January 1, 2021, through February 28, 2022. This survey was created on the Survey Monkey web platform (www.surveymonkey.com) with an estimated completion time of 7 minutes and an ease-of-use rating of “perfect.” A list of all survey questions and responses can be found in Appendix B.

The source for respondents for the quantitative survey was derived from communication channels known to be used by fire service chiefs and officers associated with sUAS programs, including Facebook (<https://www.facebook.com/>), Twitter (<https://twitter.com/>), Instagram

(<https://www.instagram.com/>), the State of Connecticut Commission On Fire Prevention And Control listserv, and the International Association of Fire Chiefs (IAFC) KnowledgeNet Forums (<https://knowledge.iafc.org/home>). Communications soliciting the quantitative survey can be found in Appendix A.

Interview questions were developed to obtain qualitative data from SMEs on fire service sUAS programs to provide context and meaning for the quantitative data. The primary source for sUAS SMEs was the social media site for professionals, LinkedIn (www.Linkedin.com). Each interview consisted of seven open-ended questions conducted via email correspondence in writing. Email communications soliciting the quantitative survey can be found in Appendix C. The qualitative interview questions and a detailed breakdown of responses can be found in Appendix D.

Data Analysis Procedures

The quantitative survey results were tabulated within the Survey Monkey platform (www.surveymonkey.com), which presented numerical and graphical breakdowns of response results for each question. Write-in responses in the open-ended “other” response in some questions were re-categorized where applicable. For example, several respondents wrote in answers that their programs were run entirely in-house to question number one. These were counted as equivalent responses to that question’s selection “run entirely in-house.”

The qualitative e-email interviews were collected manually and summarized for analysis. Responses to the questions in the qualitative interview were then compared with responses from other SME interviewees and answers from comparable questions in the quantitative survey. Where differences were significant, greater weight was given to responses in the qualitative

survey based on the SME experience in developing sUAS programs. Further weight was given where multiple SMEs responded similarly and where SMEs were directly familiar with the context and operations of the Ridgefield fire department.

Assumptions and Limitations

The author made certain assumptions about this research. The assumption was made that all participants in the surveys and interviews were honest in their answers and understood the questions as presented. The author did not attach qualifiers to any questions to avoid influencing answers. A further assumption was that each respondent would submit only one survey response. While the Survey Monkey platform (www.surveymonkey.com) has controls to prevent this, individuals can bypass these controls. It did not appear that any respondents submitted more than one response. Limitations of this research included a low number of responses to both the surveys and the interviews. A limitation of this research is that the surveys will use a sample of convenience and will not represent a comprehensive view of sUAS globally. These surveys did not meet the 95% confidence level desired for surveys, reducing the confidence in any data derived from the surveys. The length of the surveys and interviews may have discouraged participation and complete and honest responses from those who did choose to participate. The exclusive use of the internet and the Survey Monkey platform (www.surveymonkey.com) may have limited responses from potential survey participants either unable or unwilling to access the internet.

A significant statistical limitation of this research is the use of a convenience sample. It would be impractical to obtain survey responses from people in authority over fire department sUAS programs across the country. Furthermore, the literature review revealed no reliable

sources for the total number of public safety sUAS programs currently deployed in the United States. Because a convenience sample was used to obtain 67 responses from an unknown number of sUAS programs, while the responses are likely to provide useful and actionable data, they will not reflect the state of all public safety sUAS programs in the United States with a high level of accuracy.

Results

Four research questions were developed based on the literature review to perform the cost-benefit analysis. How can sUAS enhance emergency and non-emergency fire department functions? How do federal, state, and local laws and regulations impact the fire department's use of sUAS? What are the costs of using sUAS in fire department operations? What are the political, social, and other non-regulatory considerations of using sUAS in fire department operations? These questions established the framework of identifying the benefits, barriers, costs, and concerns related to using sUAS by the Ridgefield (CT) fire department.

Quantitative Survey

A total of 67 responses to the quantitative survey were received. The first four questions of the quantitative survey provided demographic information on the respondents' programs. Questions five and six of the quantitative survey provided information on the benefits of the respondents' programs. Questions seven through fourteen of the quantitative survey provided information on the barriers to developing and operating the respondents' programs. Questions fifteen through eighteen of the quantitative survey provided information on the development and operation costs of the respondents' programs. Question nineteen of the quantitative survey

provided information on the public concerns related to the respondents' programs. The quantitative survey questions and detailed breakdown of results can be found in Appendix B.

Quantitative Survey Results Question 1

The first question was, "how was your sUAS program structured?" Almost two-thirds of respondents (60.61%) indicated that their sUAS programs were run entirely in-house in their departments. Approximately one-third (31.82%) run their sUAS programs collaboratively with other agencies. Either of these frameworks is a possibility for the Ridgefield fire department.

Quantitative Survey Results Question 2

The second question was, "approximately what size population does your department currently serve?" A graph of the responses presents a bell curve with a peak in the 25,000 to 50,000 population range. This is the population range of the response area served by the Ridgefield fire department. Including the response ranges immediately above and below the mode shows 59.09% of respondents' programs have a similar population range to the Ridgefield fire department. Responses from respondents outside this range may still apply to the Ridgefield fire department's context.

Quantitative Survey Results Question 3

The third question was, "approximately what size in square miles serves as your agency's primary response area?" A graph of the responses generally presents a bell curve with a 31 to 40 square mile range peak. This is the size range of the response area served by the Ridgefield fire department. Including the response ranges immediately above and below the mode shows 49.25% of respondents' programs serve a similar area range to the Ridgefield fire department. Responses from respondents outside this range may still apply to the Ridgefield fire

department's context. However, this response area data may provide useful information for a more detailed breakdown of responses. It is useful to note that a large percentage (25.37%) of respondents' agencies have response areas of greater than 100 square miles.

Quantitative Survey Results Question 4

The fourth question was, "what type of demographic area does your agency primarily serve?" A graph of the responses generally presents a bell curve with a peak in the "suburban" range. This is the demographic of the response area served by the Ridgefield fire department. Responses from respondents outside this range may still apply to the context in which the Ridgefield fire department operates. However, this demographic data may provide useful information for a more detailed breakdown of responses. It is useful to note that most respondents' agencies (65.15%) serve a suburban response area. Similarity to the demographics of the response area served by the Ridgefield fire department contributes to the validity of the quantitative data obtained by this survey.

Quantitative Survey Results Question 5

The fifth question was, "how often do you employ sUAS for the following mission types?" Responses included inspection, pre-planning, training, incident overview, significant incident situational awareness, damage assessment, search, deliveries, and an open-ended "other" category. This was a matrix multiple choice question where each response could be categorized as "often," "seldom," or "never." Respondents indicated the most frequent uses for fire department sUAS were immediate incident overview (e.g., structure fire) (90.91% combined seldom and often). A close second was disaster damage assessment with 87.87% combined "seldom" and "often" plus one "other" response. This was followed closely by fire department

training, situational awareness (e.g., brushfire or wildfire), and search/locating victims, each with 87.69% combined seldom and often. Notably, 90.77% of respondents indicated that delivering equipment or supplies was never employed in their sUAS programs.

Quantitative Survey Results Question 6

The sixth question was, “which of the following sUAS functions provides the greatest value to your agency?” Response categories included inspection, pre-planning, training, incident overview, large incident situational awareness, damage assessment, search, deliveries, and an open-ended “other” category. Respondents indicated the most valuable use for fire department sUAS (31.75%) was “search/locating victims.” This was followed by “situational awareness on large incidents” with 23.81% and “immediate area incident overview” with 22.22% of responses. Inspection/investigations received 11.11% of responses.

Despite being the second most often cited use for an sUAS program, “disaster assessment” provided the greatest value to only 6.35% of respondents, and all other responses received less than 5% each. This information aligns closely with the data obtained through the qualitative interviews.

Quantitative Survey Results Question 7

The seventh question was, “what is the composition of your sUAS team when deployed?” This was a checkbox-type response where respondents could select all applicable answers. Response categories included pilot/operator, observer, officer, liaison, maintenance/repair, logistics, and an open-ended “other” category. Respondents indicated that a pilot/operator was the most frequent (93.94%) team member for fire department sUAS programs. This was followed by “observer” with 77.27% and “officer” with 27.27% of responses, respectively. All

other categories received approximately 5% or fewer responses each. Of note, “Liaison” was the “other” response for 0.06% of respondents. This information aligns closely with the data obtained through the qualitative interviews, aligning with staffing possible for the Ridgefield fire department.

Quantitative Survey Results Question 8

The eighth question was, “do you require pilots to complete the FAA remote pilot in charge airman knowledge test?” This was a simple yes, no, I don’t know style survey question. The vast majority (85.07%) of respondents indicated yes. This was followed by “no” and “I don’t know,” with 7.46% of responses each. This presents a clear “barrier” or requirement for developing and operating an sUAS program for the Ridgefield fire department.

Quantitative Survey Results Question 9

The ninth question was, “does your organization have a Certificate of Authorization (COA) from the Federal Aviation Authority (FAA)?” This was a simple yes, no, I don’t know style survey question. The majority (50.00%) of respondents indicated yes. This was followed by “no” with 33.33% and “I don’t know “ with 16.67% of responses, respectively. This presents a need for further clarification on the applicability and utility of this “barrier” or requirement for developing and operating an sUAS program for the Ridgefield fire department. Responses to the qualitative interview questions provide further clarification on this point.

Quantitative Survey Results Question 10

The tenth question was, “if our organization has a COA from the FAA, what, if any, waiver do you have?” This was an open-ended question with “N/A” and “unknown” as available null responses. Eleven respondents indicated they had waivers for night operations. Several

respondents noted that this waiver, along with others, was no longer applicable under a recent revision of FAA Part 107 rules. Five respondents indicated they had waivers for operations of sUAS beyond the line of sight. This would be necessary for many Ridgefield fire department sUAS operations due to the terrain in most of the response area. Seven respondents indicated they had waivers for sUAS operations in or around restricted airspace. This would be necessary for many Ridgefield fire department sUAS operations due to Danbury Municipal Airport's (DXR) proximity to the Ridgebury section of the Ridgefield fire department response area. See Figure 1

Quantitative Survey Results Question 11

The eleventh question was, "must your organization comply with any additional state sUAS requirements?" This was a simple yes, no, I don't know style survey question. The vast majority (57.58%) of respondents indicated no. This was followed by "I don't know" and "yes," respectively, with 22.73% and 19.07% of responses. While most respondents indicated that they do not comply with any additional sUAS requirements within their state, the question remains on answered as to why. Potential reasons may be that they are unaware of requirements, unwilling to comply with requirements, exempt from requirements, or willing to accept penalties and liabilities of noncompliance. The exact reasons are not explored further in the quantitative portion of this research. However, additional information is provided through question twelve and the qualitative interviews. Furthermore, this question invites further review and study specific to the Ridgefield fire department of state requirements as a barrier for developing and operating an sUAS program for the Ridgefield fire department.

Quantitative Survey Results Question 12

The eleventh question was, “what are the additional state requirements with which your agency must comply?” This was an open-ended question with “N/A” and “unknown” as available null responses. One respondent indicated they required an annual report of sUAS use. One respondent suggested that law enforcement was not allowed by state law to fly over an area to observe any illegal activities. Six respondents indicated state restrictions on no-fly zones, including restricted airspace. These results invite further investigation into methods of compliance for State of Connecticut regulations and restrictions as barriers to the operation of a Ridgefield fire department sUAS program.

Quantitative Survey Results Question 13

The thirteenth question was, “must your organization comply with any additional local sUAS requirements?” This was a simple yes, no, I don’t know style survey question. The vast majority (72.73%) of respondents indicated no. This was followed by “I don’t know” with 15.15% and 12.12% responses, respectively. While most respondents indicated that they do not comply with any additional local sUAS requirements, the question again remains unanswered. As with state restrictions and requirements, the exact reasons are not explored further in the quantitative portion of this research. However, additional information is provided through question fourteen and the qualitative interviews. Furthermore, this question invites further review and research specific to the Ridgefield fire department of local requirements as a barrier for developing and operating an sUAS program for the Ridgefield fire department.

Quantitative Survey Results Question 14

The fourteenth question was, “what are the additional local requirements with which your agency must comply?” This was an open-ended survey question with “N/A” and “unknown” as available null responses. One respondent indicated they were required to comply with posted local no-fly zones, and all other respondents indicated either unknown or N/A or repeated state or federal requirements. Two respondents indicated additional restrictions were stated in their department procedures but did not specify those restrictions. These results invite further investigation into methods of compliance for State of Connecticut regulations and restrictions as barriers to the operation of a Ridgefield fire department sUAS program.

Quantitative Survey Results Question 15

The fifteenth question was, “regardless of funding source, what were the approximate startup costs for your sUAS program?” A graph of the responses generally presents a bell curve with a peak in the \$10,000 to \$25,000 range. Including the response ranges immediately above and below the mode shows 66.66% of respondents’ programs have initial startup costs between \$5,001 and \$50,000. Although this is a very broad range, it provides a valid initial estimate of startup costs for a Ridgefield fire department sUAS program. It must be noted that responses from respondents outside this range may still apply to the context in which the Ridgefield fire department operates.

Quantitative Survey Results Question 16

The sixteenth question was, “regardless of funding source, what is the approximate annual budget for your sUAS program?” A graph of the responses generally presents a bell curve with a peak in the \$1,000 to \$5,000 range. Including the response ranges immediately above and

below the mode shows 56.06% of respondents' programs have annual operating budgets between \$501 and \$10,000. This provides a valid initial estimate of annual costs for a Ridgefield fire department sUAS program. A complete 15.15% of respondents indicated that they did not know the annual operating budget of their agency's program. In addition, responses from outside this range may still apply to the context in which the Ridgefield fire department operates.

Quantitative Survey Results Question 17

The seventeenth question was, "what, if any, funding sources were used to defer the startup of your sUAS program?" This was a checkbox style multiple choice question with possible responses of government grants, private grants, sales and fundraising events, corporate donations, private donations, fee-for-service, special taxes, development impact fees, seized assets, "none of the above," "I don't know," and an open-ended option of "other." The top three additional funding sources included government grants (27.27%), private donations (25.76%), and corporate donations (12.12%). These results are significant as the Ridgefield fire department has successfully used all three alternative funding sources for other programs. Approximately one-third of respondents (30.30%) indicated no additional funding sources. Of the responses written under the category of "other," the only option potentially available to the Ridgefield fire department program was a vendor partnership.

Quantitative Survey Results Question 18

The eighteenth question was, "what, if any, funding sources were used to defer the annual budget of your sUAS program?" This was a checkbox style multiple choice questions with possible responses of government grants, private grants, sales and fundraising events, corporate donations, private donations, fee-for-service, special taxes, development impact fees, seized

assets, “none of the above,” “I don’t know” and an open-ended option of “other.” By far, the top response (62.12%) was that no additional funding sources deferred the annual cost of respondents’ program. However, 20.12% of respondents selected government grants as alternative funding sources, including those writing in government grants under the section of “other.” This provides a potential alternative funding source to defer annual operating costs for a Ridgefield fire department sUAS program.

Quantitative Survey Results Question 19

The nineteenth question was, “what non-regulatory political or social concerns have been expressed about your sUAS program?” This was an open-ended question in the survey based on the numerous non-specific mentions of public concerns of sUAS programs found in the literature review. Privacy was the top answer worded in various ways, as mentioned in 25 out of 67 (37.88%) responses. Other concerns mentioned by respondents included data retention and recovery and liability (physical danger posed by sUAS to the public). Of particular note is that three of the responses noted that effective communication with the public about the sUAS program is critical. Two other respondents replied that there was significant public support for their programs.

Qualitative Interviews

Interview questions were developed to obtain qualitative data from SMEs on fire service sUAS programs to provide context and meaning for the quantitative data. Each interview consisted of seven open-ended questions conducted via email correspondence in writing. The qualitative interview questions and a detailed breakdown of responses can be found in Appendix D.

Qualitative Interview Responses Question 1

The first question of the qualitative interview was, “how have sUAS helped your organization operate more effectively or efficiently?” Two SMEs noted the cost savings of sUAS versus other mobile aerial platforms, specifically helicopters. Both cited search and rescue as a prime example which ties in with the quantitative survey results showing search and rescue as the most significant value sUAS provides for fire department operations.

The other two SMEs cited an increase in situational awareness with sUAS contributing to improved ability to perform functions such as suppression and ventilation and an increased level of safety. These same SMEs noted the utility of sUAS platforms contributing to situational awareness for both police and fire operations. These SMEs made it clear that sUAS provided value in this way for public safety professionals from the patrol officer and line firefighter up to commanders of large and complex incidents.

Qualitative Interview Responses Question 2

The second question of the qualitative interview was, “what do you think is the biggest practical benefit of an sUAS program?” Aligning with quantitative survey question six results, one SME responded that search and rescue was the most significant practical benefit. The other SMEs noted that an sUAS delivers substantial value across various missions, including a safe and relatively inexpensive platform for mobile aerial observation of incidents. Three of the SMEs mentioned the benefit of maximizing resources, especially for smaller departments, that an sUAS provides.

Qualitative Interview Responses Question 3

The third question of the qualitative interview was, “what do you think is the biggest barrier to establishing an sUAS program?” Both SMEs identified personnel as the most significant barrier, and SME number one identified a lack of leadership or knowledge. In contrast, SME number two specified the challenge of finding the right personnel willing to commit to initial and ongoing sUAS training. This is extremely valuable information as neither of these points were found in the literature review. The literature review identified numerous other barriers, including regulatory, technical, and financial concerns. It appears from this interview that those may remain significant challenges but are relatively straightforward to deal with, whereas personnel issues are more complex.

Qualitative Interview Responses Question 4

The fourth question of the qualitative interview was, “what do you think is the biggest barrier to maintaining an sUAS program?” Two SMEs identified the most significant barrier as the cost of purchase and maintenance of more extensive and more expensive drones. One SME recognized that less expensive drones often provide the same operational value with lower operating costs. Two other SMEs reiterated the personnel issue as the most significant barrier to maintaining an ongoing sUAS program. Personnel-related barriers identified explicitly by the SMEs included developing individuals with the necessary knowledge, skills, and attitudes to be a part of the sUAS team and fighting departmental resistance to change, and adopting new technology. Again, the qualitative interview results vary significantly from information obtained in the literature review.

Qualitative Interview Responses Question 5

The fifth question of the qualitative interview was, “what are the most significant costs in your program?” All four SMEs identified equipment costs as the most significant expense in their programs. SMEs noted the very wide range of equipment costs, which aligned closely with information discovered in the literature review. In addition, three SMEs mentioned that personnel was the highest cost after the initial outlay for the equipment. However, these SMEs noted that this cost was extremely flexible, generally based on the desired frequency of use of the sUAS program.

Qualitative Interview Responses Question 6

The sixth question of the qualitative interview was, “what do you think is the biggest public concern of a fire department sUAS program?” Three SMEs identified privacy as the most significant public concern, noting that citizens involved in illegal activities will be most concerned about an aerial observation platform operating in their area. Also mentioned were related concerns about operational transparency and data retention.

After mentioning privacy, the SMEs varied in their answers far more than in response to any other question. One SME stated that the public might have an unrealistic expectation of the abilities of an sUAS platform or program. This SME used the specific example of the expectation that an sUAS equipped with an infrared camera or “night vision” would see through buildings or a forest canopy to identify dangers or lost persons. SME number two states the public should be made aware of the operational capabilities of the sUAS program. This aligns closely with the results of question 19 of the quantitative survey.

Qualitative Interview Responses Question 7

The seventh question of the qualitative interview was, “do you have any other recommendations for a small suburban combination fire department interested in establishing an sUAS program?”

All SMEs provided numerous recommendations. A paraphrased and summarized list of these recommendations follows:

- Start small
- Allow adequate time for program development
- Ensure support from leadership
- Develop clear sUAS mission goals
- Identify desired sUAS capabilities
- Identify the anticipated frequency of use
- Identify program stakeholders
- Get membership buy-in
- Clarify community benefit and return on investment
- Develop a funding plan early
- Develop written policies that support a framework for the program
- Develop a training strategy and written training program with minimum monthly training sessions
- Be prepared to cut operational capabilities for significant cost savings
- Infrared camera capabilities should be an early add-on
- Ensure compliance with federal, state, and local regulations

- Have a program lead and champion
- Cross-train with law enforcement even if you don't anticipate flying law enforcement missions

Summary

The data from the quantitative surveys were generally consistent with the expectations set by the literature review. Within the context provided by the qualitative interviews, the quantitative data appeared to be relevant and applicable to the Ridgefield fire department. Pertinent conclusions should be able to be drawn from this data

Discussion

These findings imply that the town of Ridgefield would realize a significant return on investment with the integration of an sUAS program into fire department operations. The quantitative data make it clear that even a basic sUAS platform will increase the safety and efficiency of current fire department operations such as search and rescue, inspections, and disaster reconnaissance. In addition, the qualitative data provides a framework of recommendations to begin adoption of an sUAS program.

Quantitative survey questions 1-4: Demographics

Data from the quantitative survey may be further analyzed by isolating responses from only those sUAS programs with a demographic profile similar to the Ridgefield fire department. A comparative analysis that separates responses in this way is possible but beyond the scope of this research. All responses were included to get the most precise possible picture of how an sUAS program might benefit the RFD.

Quantitative survey questions 5-6: Benefits

RFD operations include the potential sUAS missions listed in questions five and six, derived from the literature review. Of note is that the sUAS missions respondents reported as most frequent may be performed by basic, less expensive SUS platforms with minimal training, logistic support, and operational waivers. This raises the possibility of a Ridgefield fire department sUAS program that begins small and expands as opportunities arise.

Quantitative survey questions 7-14: Barriers

The results from these questions point to the need for an RFD sUAS program to operate under an FAA Certificate of Authorization (COA). Results indicate that obtaining a COA, along with additional qualification of pilots under FAA part 107, is likely the most efficient path to a robust sUAS program that complies with federal, state, and local regulations and minimizes individual, organizational, and municipal liability. This is especially true given the impact of the recent revision of FAA part 107 to make operational waivers for night-time operations unnecessary.

Quantitative survey questions 15-18: Costs

Based on prior Town of Ridgefield, Connecticut budgets (Town of Ridgefield, 2021), the startup budget for a fire department sUAS program is likely to be heavily based on available alternative funding sources. However, an operating budget within the range of \$1,000 to \$5,000, as indicated by the peak of the bell curve in question 16, is within the capacity of the RFD to absorb.

Quantitative survey question 19: Concerns

The top non-regulatory political or social concern identified by responses to question 19 was privacy. A separate but connected concern identified was data retention and recovery. Important to note that several responses recognized the importance of effective communication with the public about the parameters and benefits of a public safety sUAS program in allaying political and social concerns. The other significant concern identified was a liability in the physical danger posed by unmanned aircraft to the general public. This concern supports the need for a robust program of proper preventative maintenance, logistics, and a minimum crew of one pilot and one observer to maximize operational effectiveness and minimize safety issues. This aligned with the literature review.

Qualitative interview questions 1-2: Benefits

The SMEs cited search and rescue as a prime benefit of an sUAS program, especially considering the cost savings over other approaches with similar capabilities such as manned helicopters. This is pertinent as the RFD responds to approximately 6 to 12 lost or missing persons and search and rescue missions per year (J. Myers, personal communication, February 16, 2022).

Qualitative interview questions 3-4: Barriers

The SMEs identified issues related to personnel as the most significant barrier. This aligns with the quantitative survey findings, which identified proper training and staffing as essential factors to an effective sUAS program. However, the qualitative answers highlight the complexity of personnel issues, including the challenges of getting buy-in from both leadership and line personnel. An additional barrier relevant to the RFD includes the cost of the platform.

Of note is that compliance with federal regulations, while highlighted in the quantitative survey, was clarified by the SMEs as a necessary but relatively straightforward issue. These were items not identified in the literature review.

Qualitative interview question 5: Costs

The SMEs focused on the most significant cost being equipment and supplies, which strengthens the findings of the qualitative survey. This is particularly beneficial to Ridgefield, which has a history of obtaining grants and donations for equipment and supplies with demonstrable public safety benefits. In short, donations in Ridgefield are relatively easy to come by if they are used to obtain a physical object. The SMEs mention personnel as a significant cost outlay after the equipment and are likely to be a barrier to developing an sUAS program in Ridgefield. The deployment of personnel is highly flexible and scalable around available funding and desired budgets.

Qualitative interview question 6: Concerns

Although privacy was reiterated as the most significant public concern, reinforcing what was found in the quantitative survey, one SME brought up an issue not identified in either the literature review or the survey responses. This concern was that the public might have an unrealistic expectation of the abilities of the sUAS platform. While not previously articulated through other data, this finding still points to the solution identified in the quantitative survey, namely that an sUAS program should have an effective public communication component to manage expectations. This was not specified in the literature review.

Qualitative interview question 7: Recommendations

Several recommendations were made by the SMEs, which amounted to a blueprint for developing an sUAS program. These recommendations were reinforced or supported by the literature review and data acquired in the quantitative survey. Specifically, an sUAS program should be formed with written policies, procedures, and an operational plan. Also, an sUAS program may begin with focused missions using inexpensive devices and, if found to be valuable, may expand their mission profile with increased platform and operational capabilities. Many of these points aligned with the literature review but were made more specifically relevant to the RFD in the qualitative interviews.

Summary

The quantitative and qualitative results successfully answered the four research questions. The results showed that sUAS could be used to enhance emergency and non-emergency fire department operations in a variety of ways. Federal, state, and local laws and regulations impact fire department use of sUAS but do not significantly hinder the startup or continued operation of an sUAS program. The potential costs of using sUASs are well within the ability of the Ridgefield fire department to pay. The political, social, and other non-regulatory considerations of using sUAS in fire department operations are primarily privacy, which, along with other concerns, can be mitigated with effective policies and practices along with an effective public communication campaign.

Recommendations

This research directly addresses the problem that the Ridgefield fire department has not previously identified the utility of using small unmanned aircraft systems (sUAS) in fire

department operations. Based on this research, the recommendation is for the Ridgefield fire department to develop an sUAS program. While the cost-benefit ratio is challenging to quantify at this stage, this research clarifies that an sUAS program would significantly benefit a public safety agency with the Ridgefield fire department's mission, size, and structure. The startup costs of these sUAS benefits are likely to be significantly reduced by alternative, non-tax funded sources, including private and corporate grants and donations. Private grants and donations may also offset the operating costs of the program. Additional cost savings may be realized through fee-for-service inspections, public/private partnerships, and the regionalization of the sUAS program. Furthermore, the sUAS program is highly scalable and adaptable with relatively low initial costs, but the option of expanding the scope and frequency of use of the program as additional opportunities to capture benefits arise.

Given the relatively low cost to initiate an sUAS program, combined with the Ridgefield fire department's history of successful use of alternative funding sources, and considering the context of current fire department operations in which an sUAS platform could add value, it becomes clear the fire department should move forward in adopting an sUAS program. Furthermore, the data acquired through this research provides a roadmap for implementing an sUAS program. While many questions remain to be answered, including the type of platform, personnel who wish to be trained, specific sources of funding, and more, the conclusion of this research leaves little doubt that an sUAS program is a worthwhile investment for the Ridgefield fire department.

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Appendix A: Quantitative Survey Solicitations

The following solicitation for responses to the quantitative survey was posted to the State of Connecticut Commission on Fire Prevention and Control's (CFPC) listserv and the International Association of Fire Chiefs' (IAFC) KnowledgeNet.

Capt. Rom Duckworth from the Ridgefield (CT) fire department requests that anyone in a department with any form of small unmanned aerial system (drone) program in your organization, please consider answering a few questions on this survey for an Executive Fire Officer Program applied research project.

<https://bit.ly/RFDSUAS>

Please consider sharing or forwarding this survey if you know of someone who may be able to assist.

Thank you very much.

--

Capt. Rommie L. Duckworth

Ridgefield fire department

6 Catoonah St.

Ridgefield, CT 06877

(203) 431-2725

rfdrduckworth@ridgefieldct.org

The following solicitation for responses to the quantitative survey was posted twice each on the Twitter, Instagram, and Facebook social media networks.

“If you’re involved in a public safety “drone” program, please answer a few questions

HERE: <https://bit.ly/RFDSUAS> #Firefighter #EMS #sUAS”

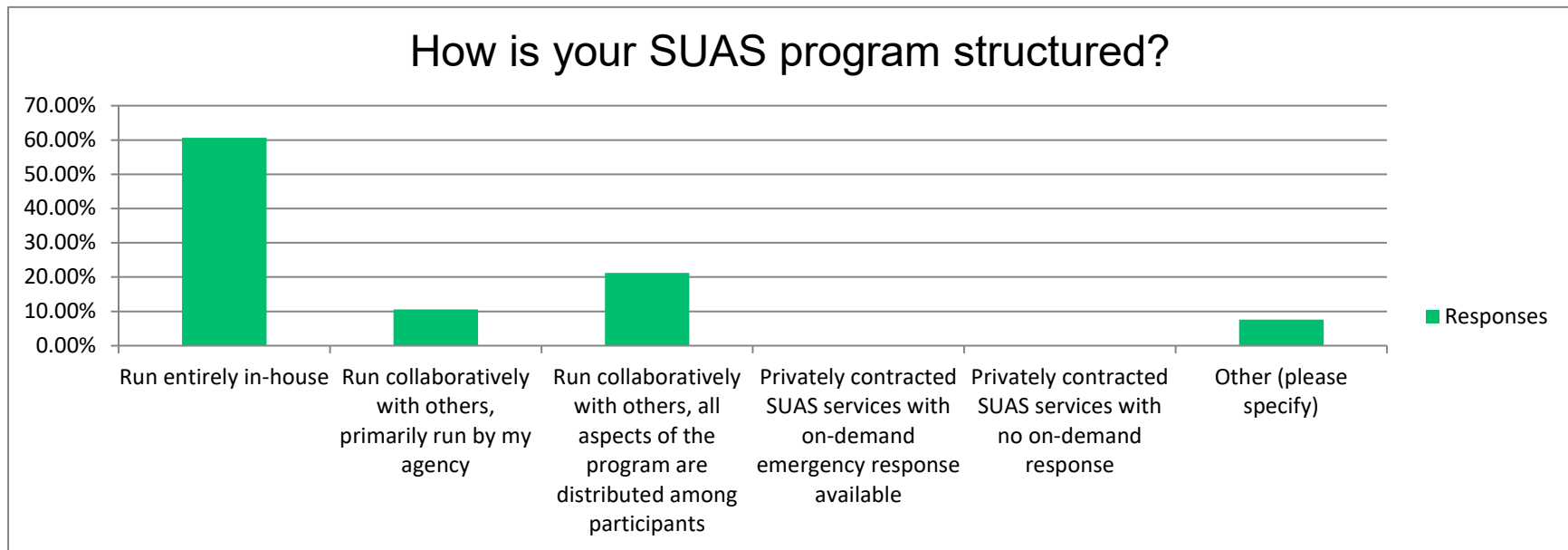
Appendix B: Quantitative Survey Results

Quantitative Survey Results: Question 1

Ridgefield Fire Department Small Unmanned Aerial System Survey

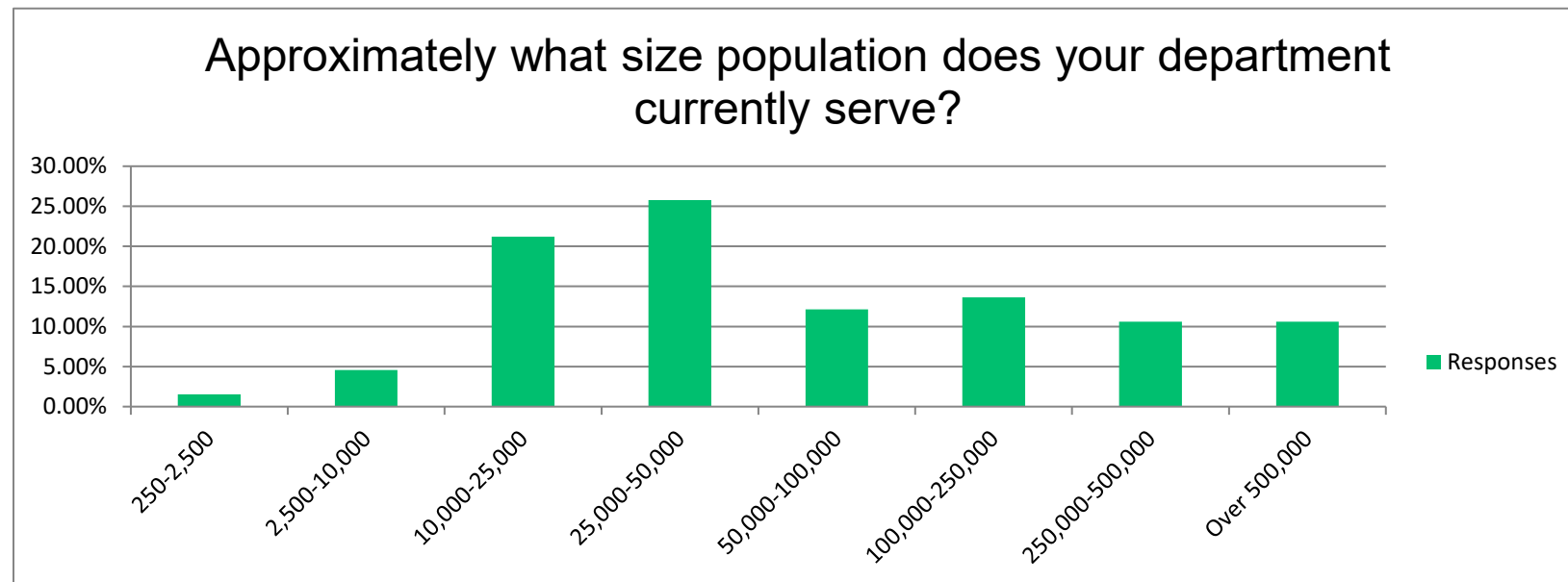
How is your SUAS program structured?

Answer Choices	Responses	
Run entirely in-house	60.61%	40
Run collaboratively with others, primarily run by my agency	10.61%	7
Run collaboratively with others, all aspects of the program are distributed among participants	21.21%	14
Privately contracted SUAS services with on-demand emergency response available	0.00%	0
Privately contracted SUAS services with no on-demand response	0.00%	0
Other (please specify)	7.58%	5
Answered		66
Skipped		1



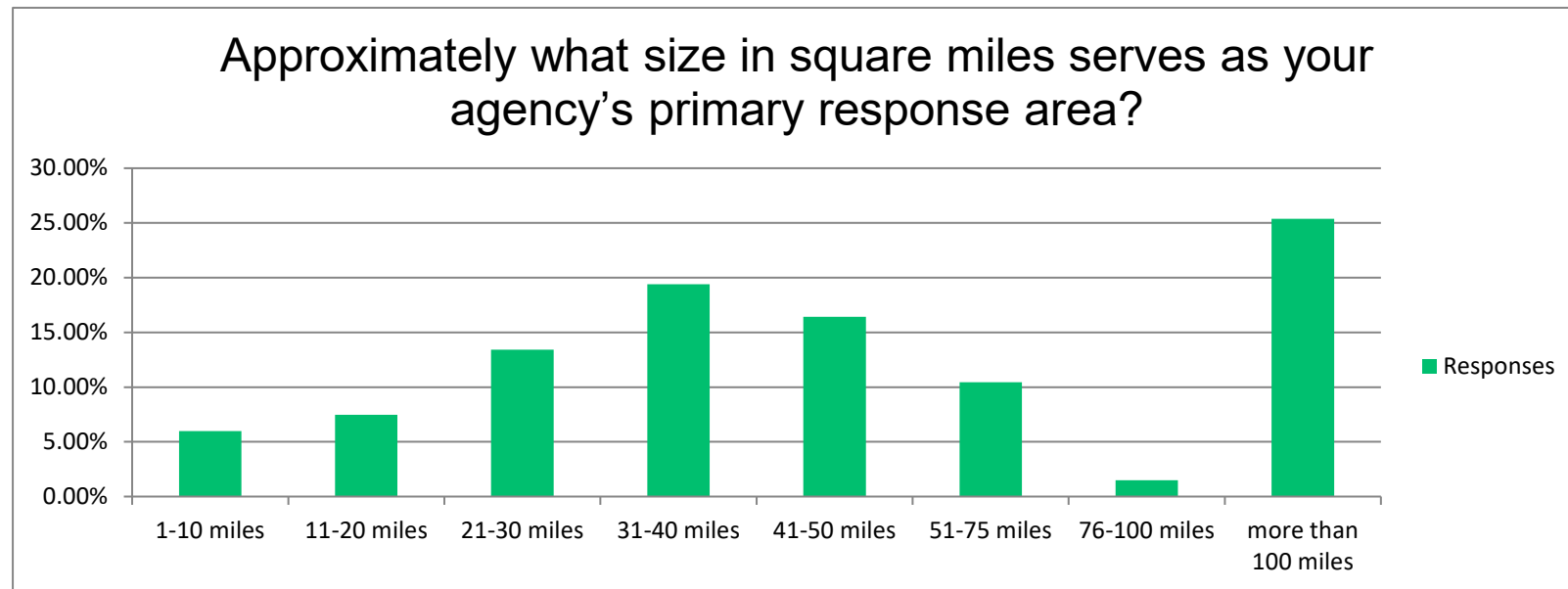
Quantitative Survey Results: Question 2**Ridgefield Fire Department Small Unmanned Aerial System Survey****Approximately what size population does your department currently serve?**

Answer Choices	Responses	
250-2,500	1.52%	1
2,500-10,000	4.55%	3
10,000-25,000	21.21%	14
25,000-50,000	25.76%	17
50,000-100,000	12.12%	8
100,000-250,000	13.64%	9
250,000-500,000	10.61%	7
Over 500,000	10.61%	7
Answered		66
Skipped		1



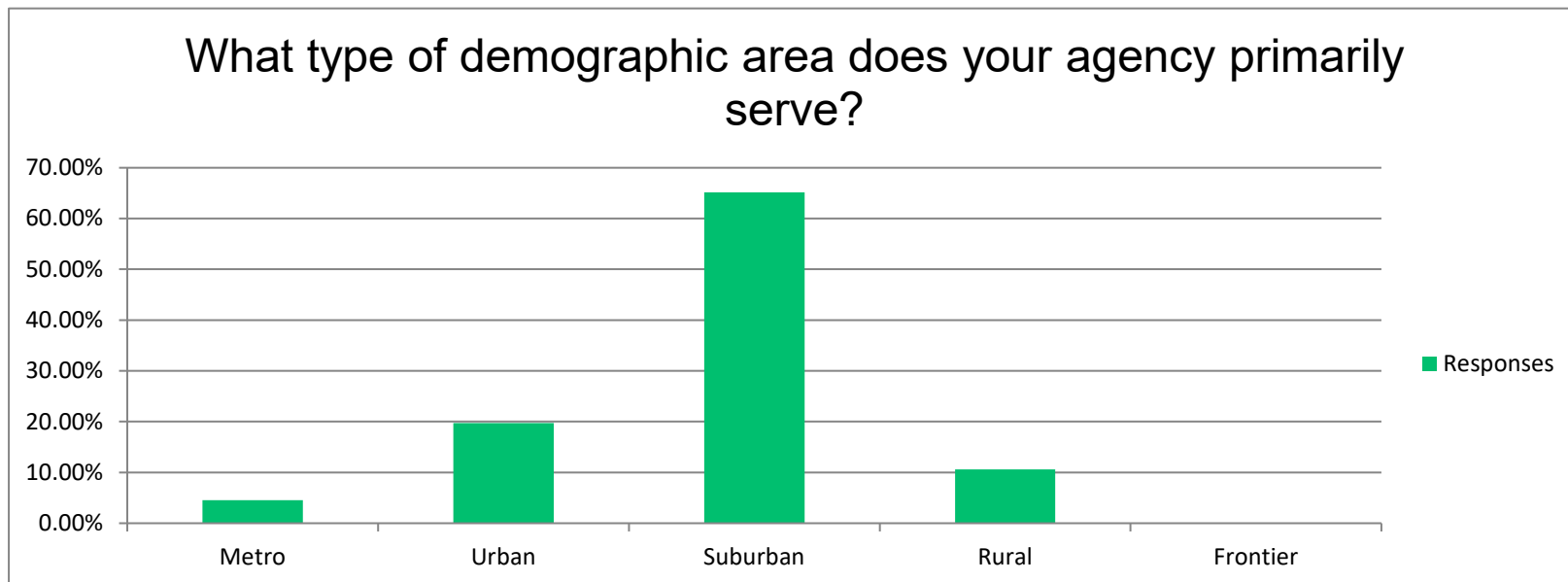
Quantitative Survey Results: Question 3**Ridgefield Fire Department Small Unmanned Aerial System Survey****Approximately what size in square miles serves as your agency's primary response area?**

Answer Choices	Responses	
1-10 miles	5.97%	4
11-20 miles	7.46%	5
21-30 miles	13.43%	9
31-40 miles	19.40%	13
41-50 miles	16.42%	11
51-75 miles	10.45%	7
76-100 miles	1.49%	1
more than 100 miles	25.37%	17
Answered		67
Skipped		0



Quantitative Survey Results: Question 4**Ridgefield Fire Department Small Unmanned Aerial System Survey****What type of demographic area does your agency primarily serve?**

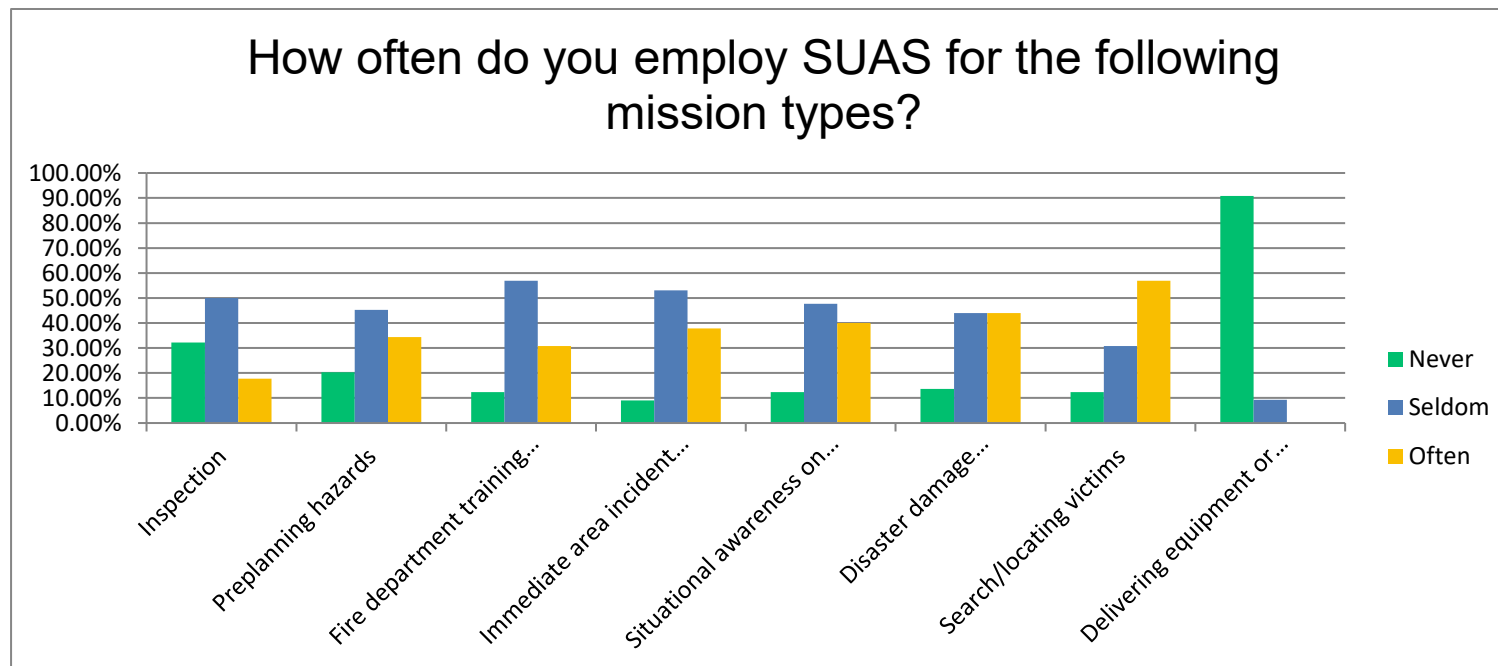
Answer Choices	Responses	
Metro	4.55%	3
Urban	19.70%	13
Suburban	65.15%	43
Rural	10.61%	7
Frontier	0.00%	0
Answered		66
Skipped		1



Quantitative Survey Results: Question 5**Ridgefield Fire Department Small Unmanned Aerial System Survey****How often do you employ SUAS for the following mission types?**

	Never	Seldom	Often	Used	Total
Inspection	32.26% 20	50.00% 31	17.74% 11	67.74%	62
Preplanning hazards	20.31% 13	45.31% 29	34.38% 22	79.69%	64
Fire department training (not SUAS training)	12.31% 8	56.92% 37	30.77% 20	87.69%	65
Immediate area incident overview (e.g. structure fire)	9.09% 6	53.03% 35	37.88% 25	90.91%	66
Situational awareness on large incidents (e.g. brush fire or wildfire)	12.31% 8	47.69% 31	40.00% 26	87.69%	65
Disaster damage assessment (e.g. hard to reach areas)	13.64% 9	43.94% 29	43.93% 29	87.87%	66
Search/locating victims	12.31% 8	30.77% 20	56.92% 37	87.69%	65
Delivering equipment or supplies	90.77% 59	9.23% 6	0.00% 0	9.23%	65
Other (please specify)					12
Other (Investigations)	64	3	0.05%	0.05%	67
Other (Law Enforcement support)	64	3	0.05%	0.05%	67

Answered **66**
Skipped **1**

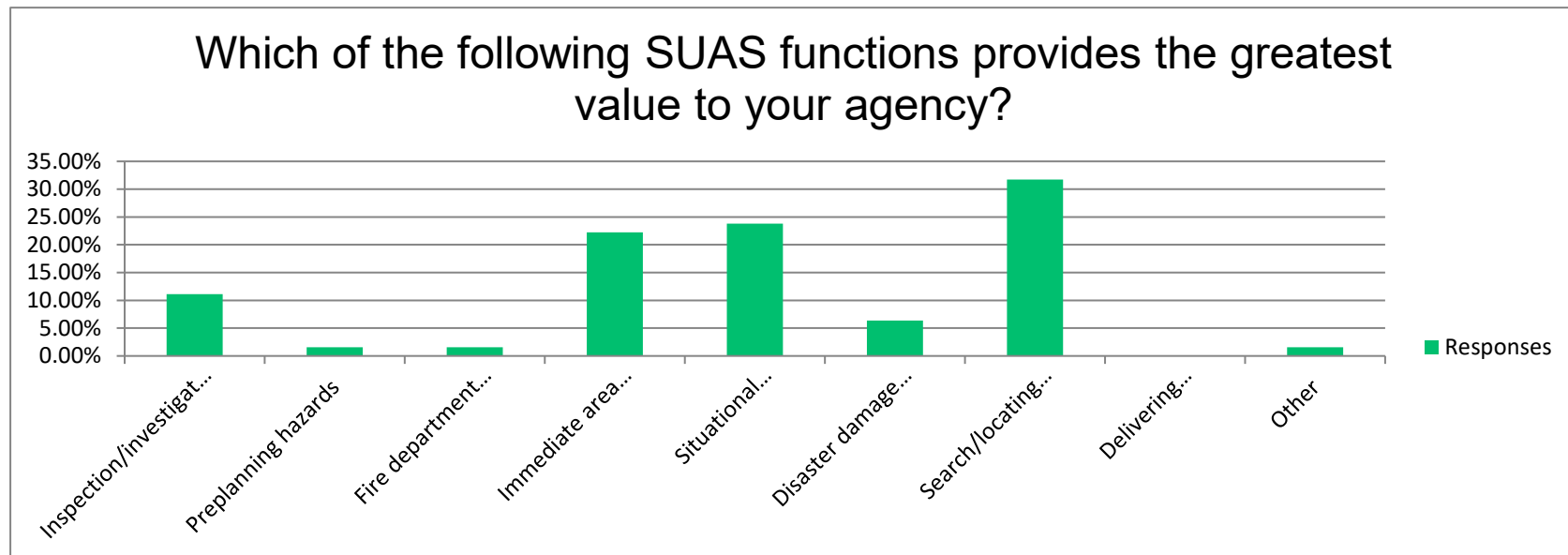


“Other” responses:

- Criminal Activity, SWAT, K-9, Bomb, general Police activity
- DEMHS Region 5 support and LE training
- We have a barrier beach and a sea wall. We use the drone to capture before a storm, then fly the exact same route post storm.
- Fire Investigations, seldom. ocean rescue seldom. Even though we don't deploy our uavs often when we do its important.
- Support of law enforcement options.
- post incident/investigations
- Since the program is still in development, we plan on using it for all of the above, with the exception of delivering supplies or equipment
- Our Drone Program runs hand-in-hand with our Canine Search Dogs.
- Overwatch for SWAT and pre planned events
- As needed on incidents, low volume however
- Investigations
- FLIR/Heat Intensity/Temp of working structure fires

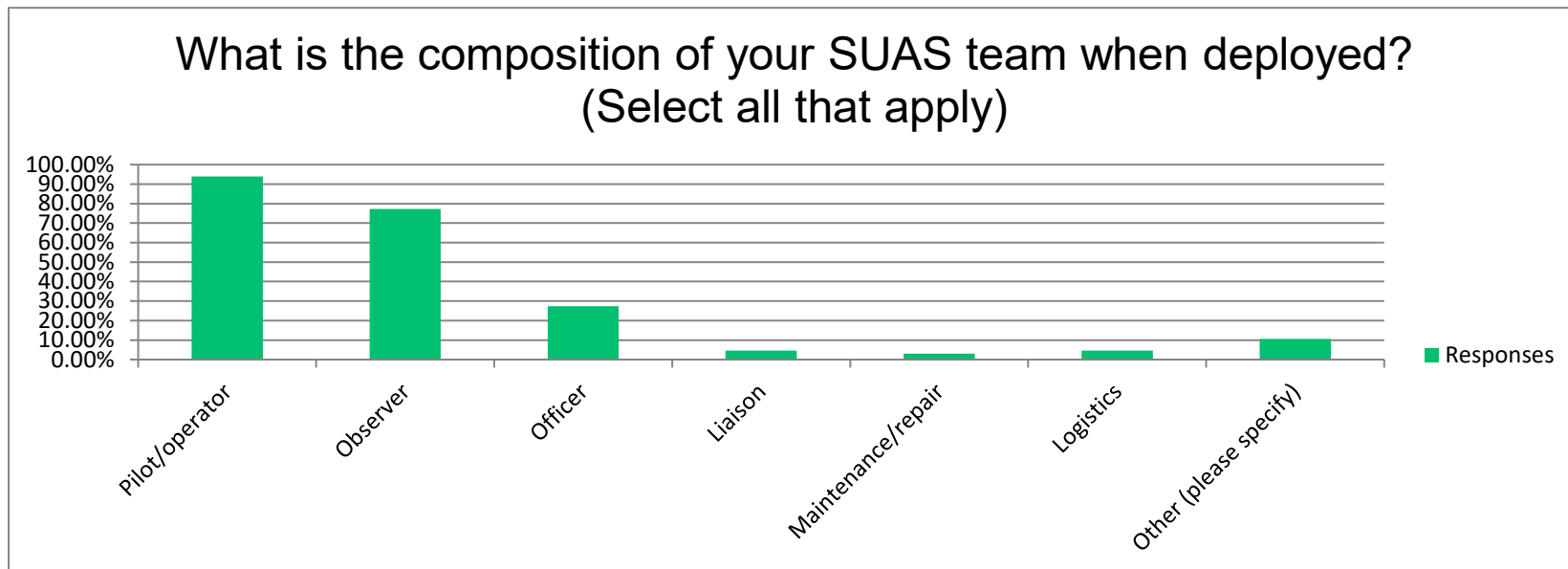
Quantitative Survey Results: Question 6**Ridgefield Fire Department Small Unmanned Aerial System Survey****Which of the following SUAS functions provides the greatest value to your agency?**

Answer Choices	Responses	
Inspection/investigations	11.11%	7
Preplanning hazards	1.59%	1
Fire department training (not SUAS training)	1.59%	1
Immediate area incident overview (e.g. structure fire)	22.22%	14
Situational awareness on large incidents (e.g. brush fire or wildfire)	23.81%	15
Disaster damage assessment (e.g. hard to reach areas)	6.35%	4
Search/locating victims	31.75%	20
Delivering equipment or supplies	0.00%	0
Other	1.59%	1
Answered		63
Skipped		4



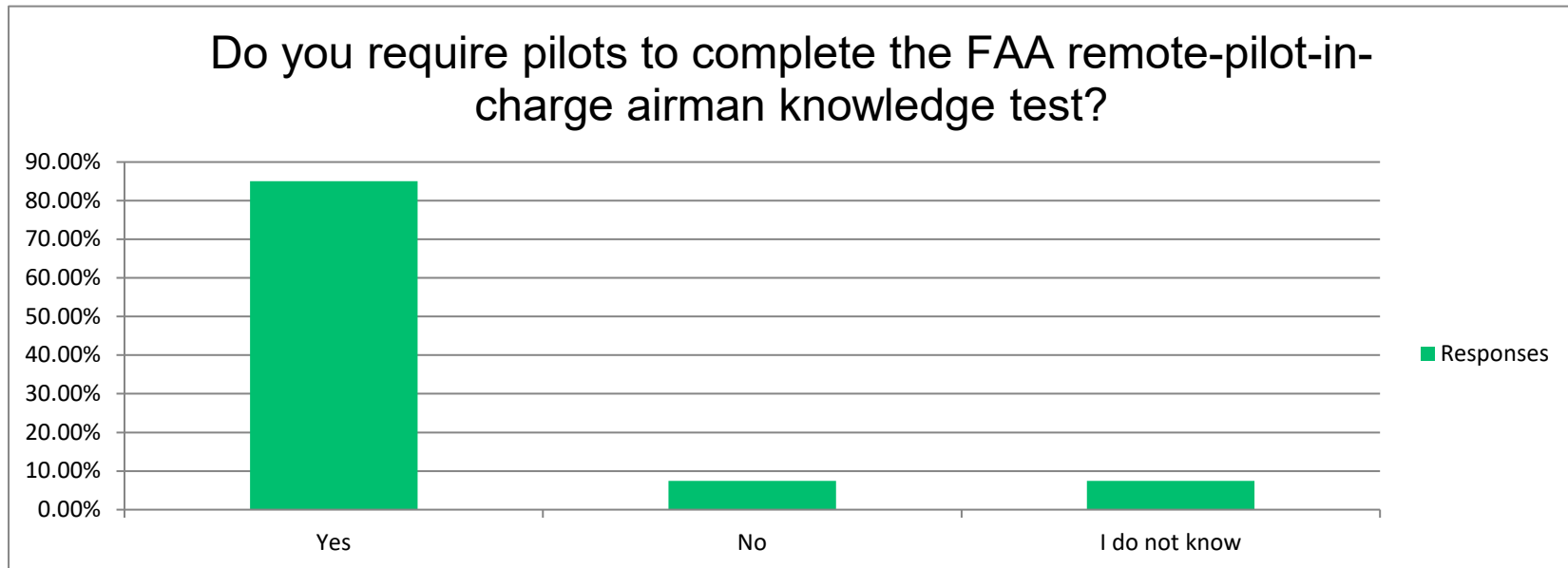
Quantitative Survey Results: Question 7**Ridgefield Fire Department Small Unmanned Aerial System Survey****What is the composition of your SUAS team when deployed? (Select all that apply)**

Answer Choices	Responses	
Pilot/operator	93.94%	62
Observer	77.27%	51
Officer	27.27%	18
Liaison	4.55%	3
Maintenance/repair	3.03%	2
Logistics	4.55%	3
Other (please specify)	10.61%	7
Answered		66
Skipped		1



Quantitative Survey Results: Question 8**Ridgefield Fire Department Small Unmanned Aerial System Survey****Do you require pilots to complete the FAA remote-pilot-in-charge airman knowledge test?**

Answer Choices	Responses	
Yes	85.07%	57
No	7.46%	5
I do not know	7.46%	5
Answered		67
Skipped		0



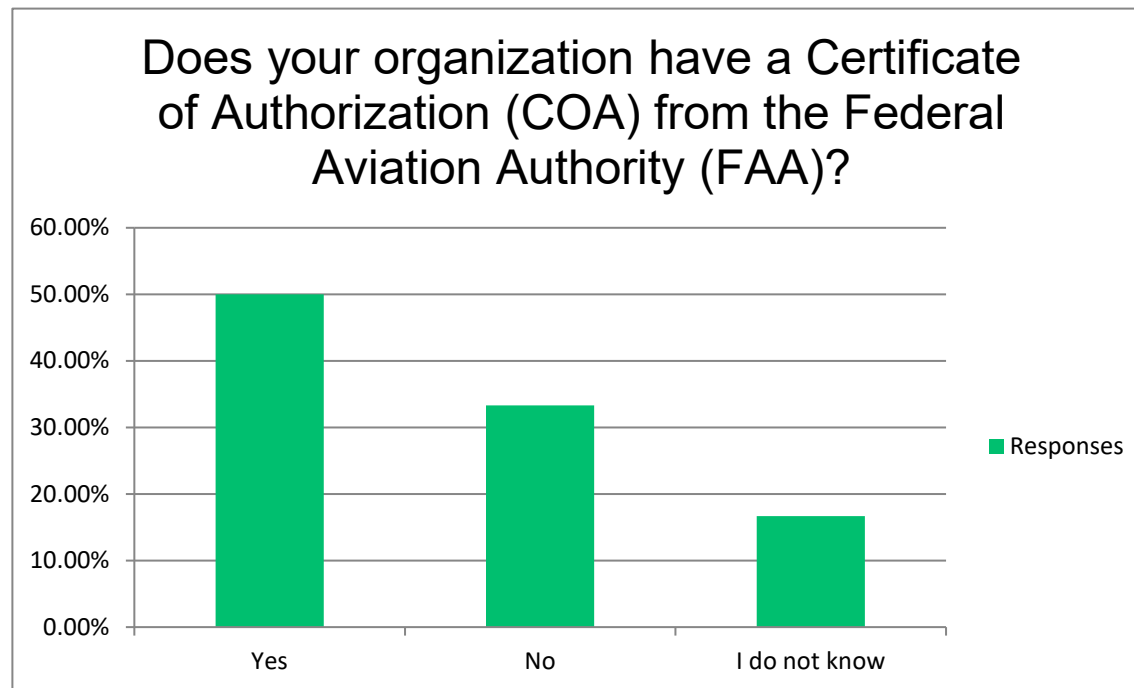
Quantitative Survey Results: Question 9

Ridgefield Fire Department Small Unmanned Aerial System Survey

Does your organization have a Certificate of Authorization (COA) from the Federal Aviation Authority (FAA)?

Answer Choices	Responses	
Yes	50.00%	33
No	33.33%	22
I do not know	16.67%	11
Answered		66

1



Quantitative Survey Results: Question 10**Ridgefield Fire Department Small Unmanned Aerial System Survey**

If your organization has a COA from the FAA, what, if any, waivers do you have? (enter “N/A” or “Unknown” if applicable)

- N/A
- Na
- N/a
- Night, various airspace waivers
- Unknown
- Unknown
- na
- Gave up COA in favor of all 107 with the new flight rules.
- BVLS and Daylight
- N/A
- NA
- Unknown
- Night waiver but not needed anymore under new Part 107 rules

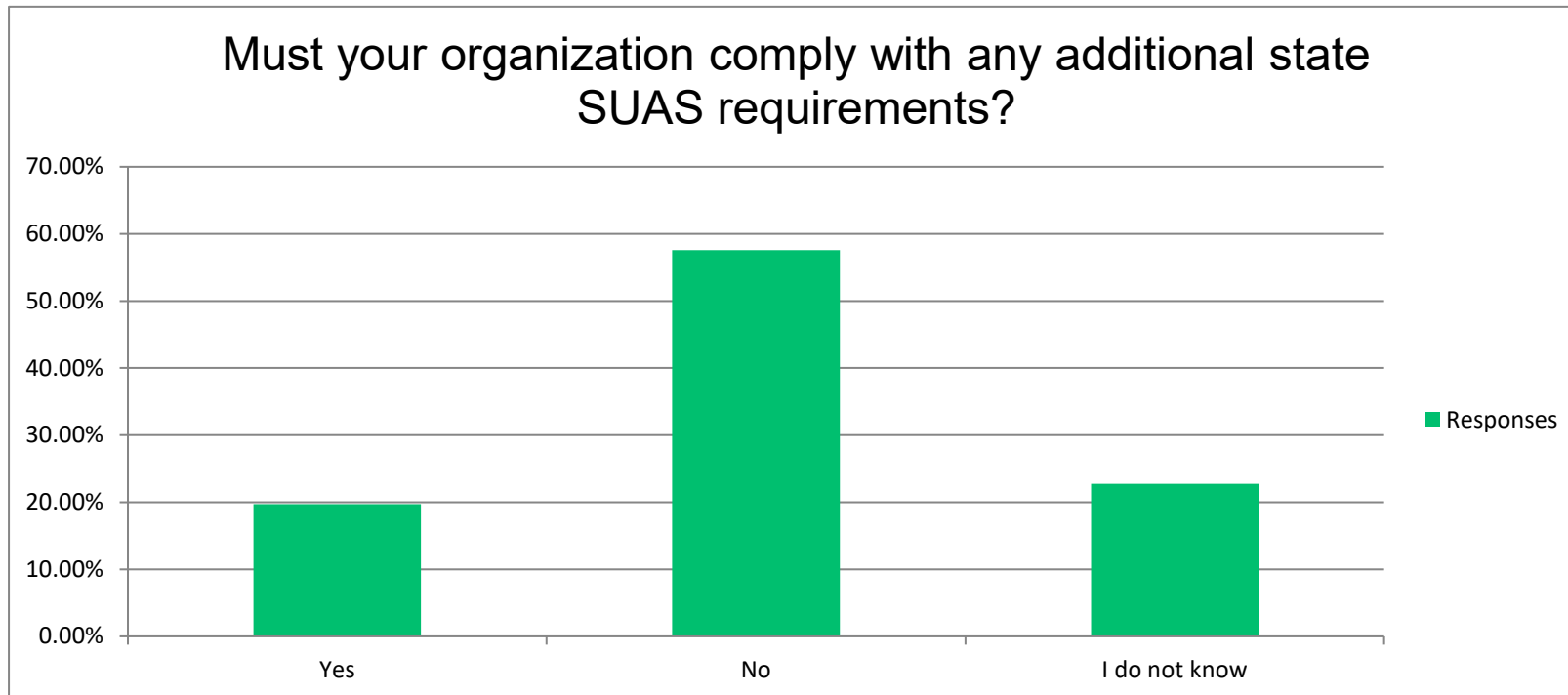
- Unknown
- N/A
- n/a
- N/A
- N/A
- unk
- beyond visual line of sight Nite time flight
- Unknown
- Unknown
- Night ops
- N/A
- Not my specialty, but I know we have night flying, flying over people, and operating within a restricted airspace.
- Unknown
- N/A
- N/A
- night operations

- N/A
- N/A
- N/A
- N/A
- Unknown
- unknow
- We do not currently have the drone in hand as it is being ordered. As soon as we have it we will obtain a COA from the FAA
- Blanket, Jurisdictional COA, with Night time flight and Beyond line of Sight
- n/a
- For our County Airport.
- Night Operations
- Night Wavier, Restricted Space due USAF BASE within area
- Unknown
- Night, BVLOS, over people.
- Jurisdictional & Tactical Beyond Line of Sight

- Na
- N/A
- Na
- Unknown
- Unk
- Unknown
- Canadian: Have Transport Canada non-line of sight pilot license, restricted aerodrome licenses.
- Unknown
- Unknown
- Daylight and airspace (DXR)
- N/a

Quantitative Survey Results: Question 11**Ridgefield Fire Department Small Unmanned Aerial System Survey****Must your organization comply with any additional state SUAS requirements?**

Answer Choices	Responses	
Yes	19.70%	13
No	57.58%	38
I do not know	22.73%	15
Answered		66
Skipped		1



Quantitative Survey Results: Question 12

Ridgefield Fire Department Small Unmanned Aerial System Survey

If YES, what are the additional STATE requirements with which your agency must comply? (enter “N/A” or “Unknown” if applicable)

- N/A
- Tx
- N/a
- We usually operate under Part 107
- Unknown
- No Chinese uas. limited use for law enforcement activities
- N/a
- N/A
- Annual report of use
- Unknown
- Unknown
- N/A

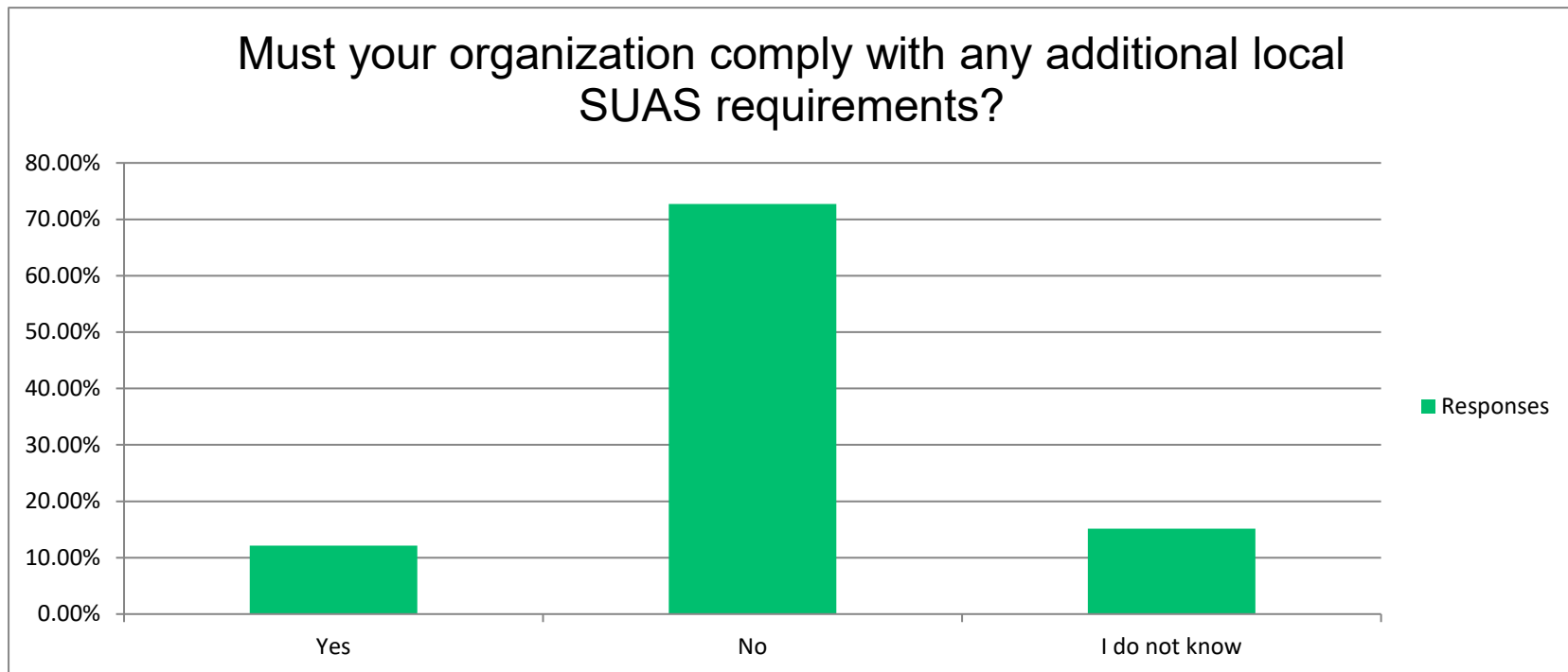
- n/a
- N/A
- N/A
- na
- N/A
- Unknown
- Unknown
- Na
- Brainard Airport Class Delta Airspace
- Photo/video capture and release
- None
- N/A
- N/A
- N/A
- N/A
- N/A

- NC DOT
- N/A
- N/A
- Cannot be used by law enforcement to just see what they can find. For example law cannot just fly around and see what they can find growing in an area
- Unsure at this time
- N/A
- n/a
- There are state of Colorado restrictions for all UAS operators, but as a special district, we may be able to operate during an emergency
- N/A
- Delaware SUAS agreements
- No-fly zones over many public areas including state parks
- If on state mission must have DroneSense.
- Na

- N/A
- Nc state permit
- Unknown
- Naval air space
- N/A
- N/a
- N/a

Quantitative Survey Results: Question 13**Ridgefield Fire Department Small Unmanned Aerial System Survey****Must your organization comply with any additional local SUAS requirements?**

Answer Choices	Responses	
Yes	12.12%	8
No	72.73%	48
I do not know	15.15%	10
Answered		66
Skipped		1



Quantitative Survey Results: Question 14

Ridgefield Fire Department Small Unmanned Aerial System Survey

What are the additional LOCAL requirements with which your agency must comply? (enter “N/A” or “Unknown” if applicable)

- N/A
- Internal SOP requirements
- Na
- N/a
- N/A
- None
- SOG's
- City and Department Policy
- nA
- Unknown
- None
- We are next to an airport so there are FAA no-fly zone area in half our district

- N/A
- N/A
- n/a
- N/A
- We require all the RPIC's to be the one actually manipulating the controls.
- na
- Exempt from City laws
- Unknown
- N/A
- Na
- Brainard Airport Class Delta Airspace
- None
- N/A
- N/A
- N/A
- N/A

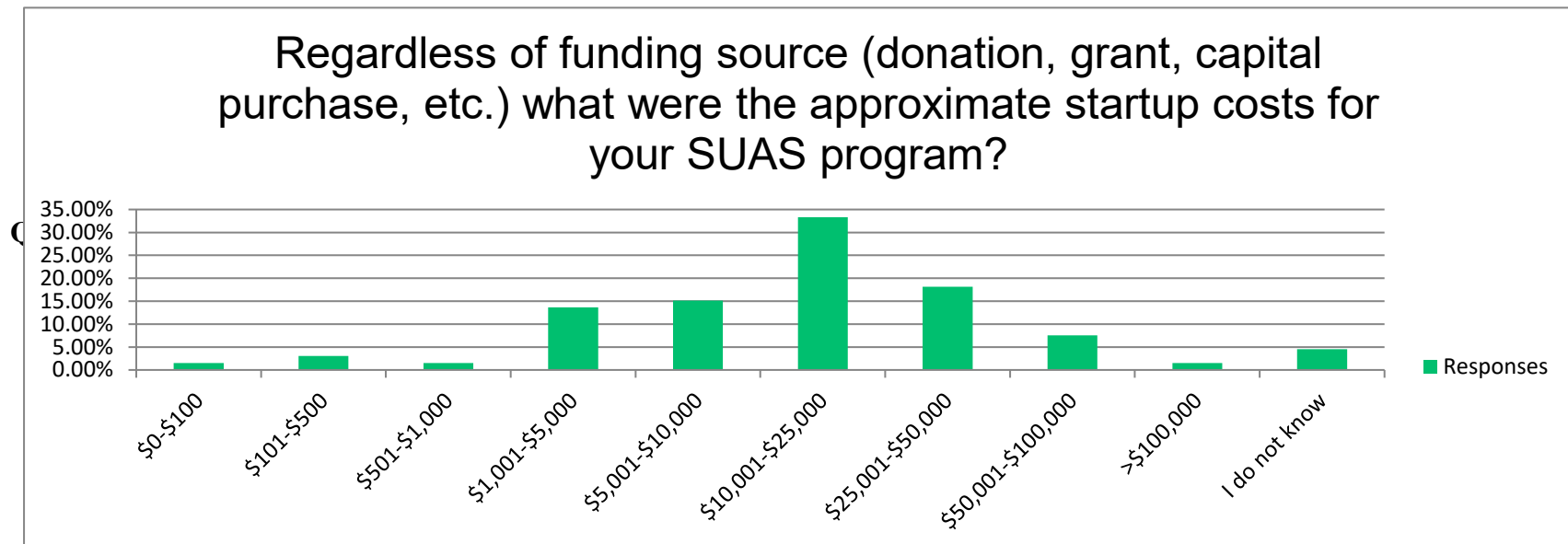
- N/A
- N/A
- N/A
- N/A
- n/a
- Unsure at this time
- N/A
- n/a
- There are local restrictions for all UAS operators, but as a special district, we may be able to operate during an emergency
- N/A
- Posted no-fly zones over schools and public parks.
- N/A
- Na
- N/A
- Na

- Unknown
- Unk
- N/A
- N/a
- N/a

Quantitative Survey Results: Question 15**Ridgefield Fire Department Small Unmanned Aerial System Survey**

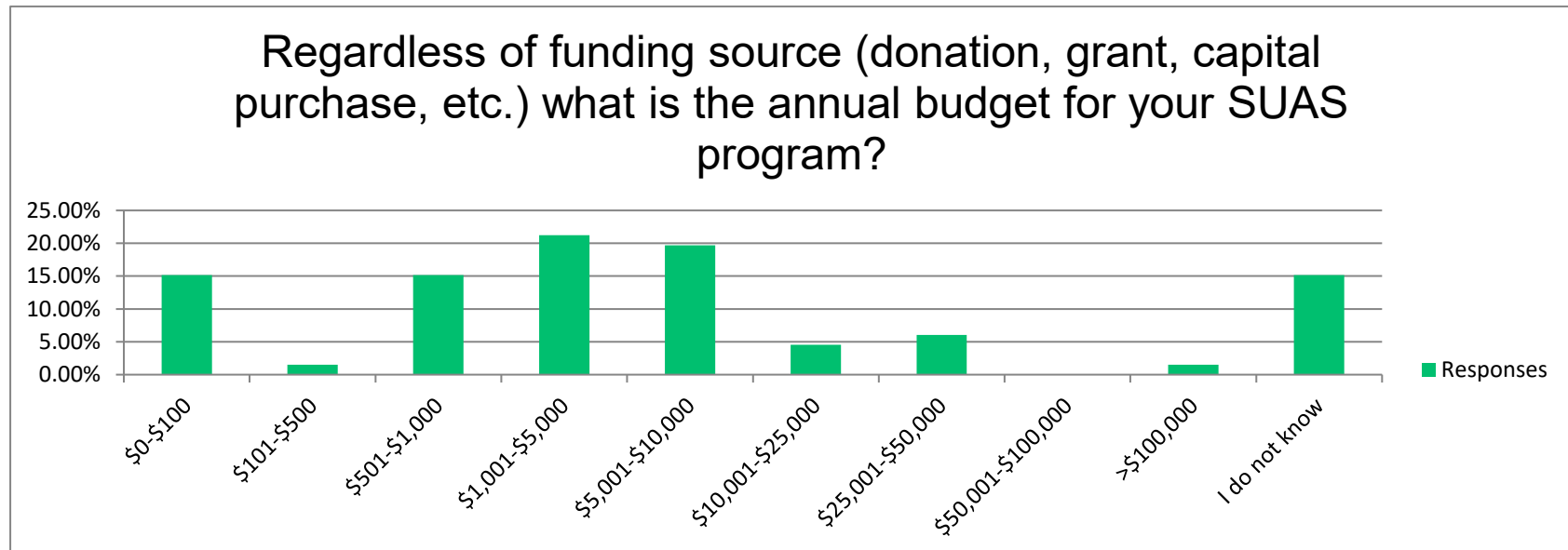
Regardless of funding source (donation, grant, capital purchase, etc.) what were the approximate startup costs for your SUAS program?

Answer Choices	Responses	
\$0-\$100	1.52%	1
\$101-\$500	3.03%	2
\$501-\$1,000	1.52%	1
\$1,001-\$5,000	13.64%	9
\$5,001-\$10,000	15.15%	10
\$10,001-\$25,000	33.33%	22
\$25,001-\$50,000	18.18%	12
\$50,001-\$100,000	7.58%	5
>\$100,000	1.52%	1
I do not know	4.55%	3
Answered		66
Skipped		1



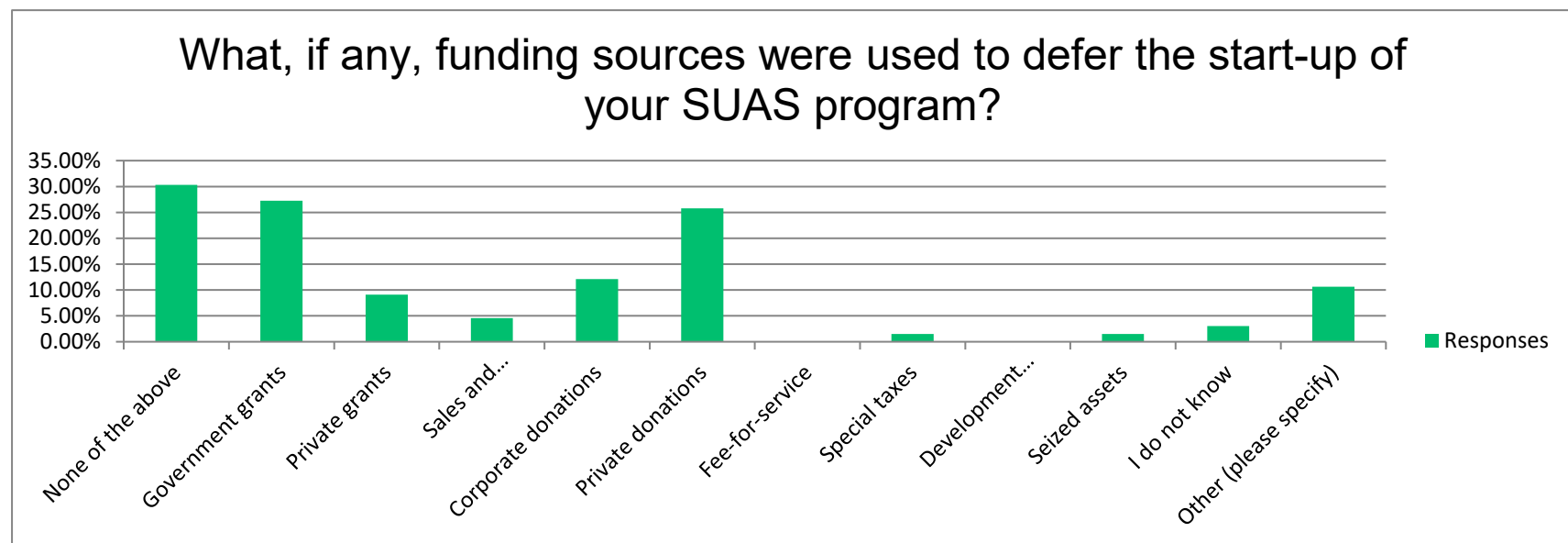
Quantitative Survey Results: Question 16**Ridgefield Fire Department Small Unmanned Aerial System Survey****Regardless of funding source (donation, grant, capital purchase, etc.) what is the annual budget for your SUAS program?**

Answer Choices	Responses	
\$0-\$100	15.15%	10
\$101-\$500	1.52%	1
\$501-\$1,000	15.15%	10
\$1,001-\$5,000	21.21%	14
\$5,001-\$10,000	19.70%	13
\$10,001-\$25,000	4.55%	3
\$25,001-\$50,000	6.06%	4
\$50,001-\$100,000	0.00%	0
>\$100,000	1.52%	1
I do not know	15.15%	10
Answered		66
Skipped		1



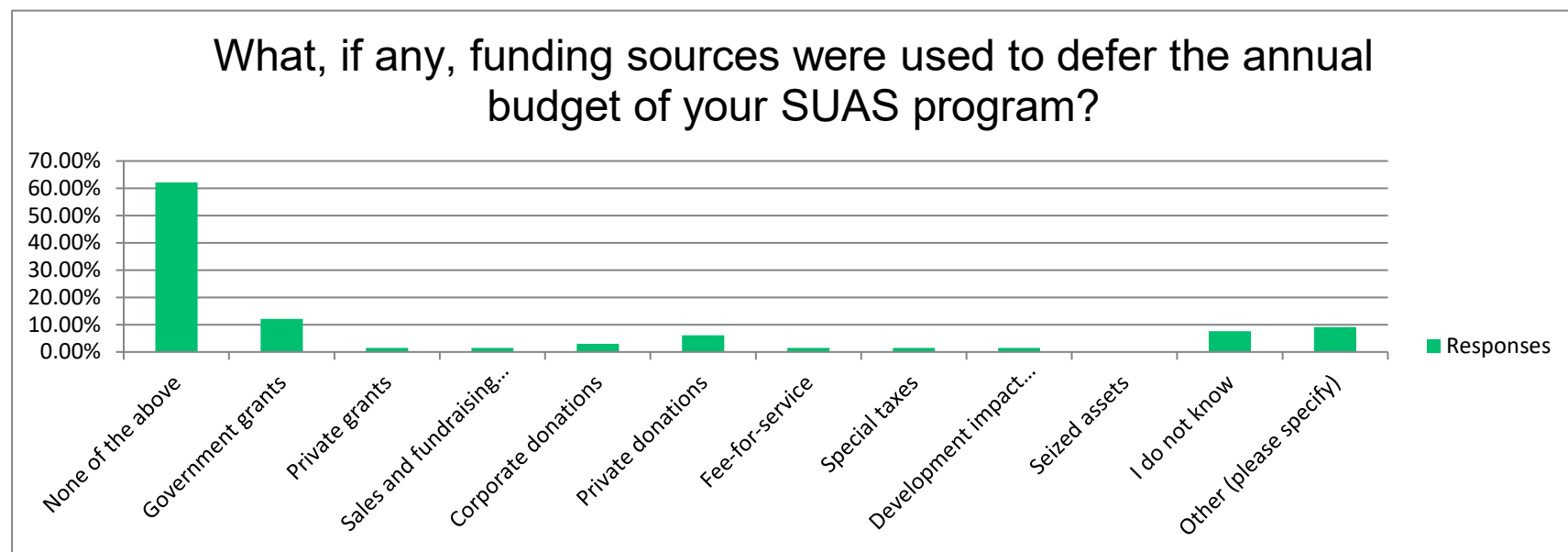
Quantitative Survey Results: Question 17**Ridgefield Fire Department Small Unmanned Aerial System Survey****What, if any, funding sources were used to defer the start-up of your SUAS program?**

Answer Choices	Responses	
None of the above	30.30%	20
Government grants	27.27%	18
Private grants	9.09%	6
Sales and fundraising events	4.55%	3
Corporate donations	12.12%	8
Private donations	25.76%	17
Fee-for-service	0.00%	0
Special taxes	1.52%	1
Development impact fees	0.00%	0
Seized assets	1.52%	1
I do not know	3.03%	2
Other (please specify)	10.61%	7
Answered		66
Skipped		1



Quantitative Survey Results: Question 18**Ridgefield Fire Department Small Unmanned Aerial System Survey****What, if any, funding sources were used to defer the annual budget of your SUAS program?**

Answer Choices	Responses	
None of the above	62.12%	41
Government grants	12.12%	8
Private grants	1.52%	1
Sales and fundraising events	1.52%	1
Corporate donations	3.03%	2
Private donations	6.06%	4
Fee-for-service	1.52%	1
Special taxes	1.52%	1
Development impact fees	1.52%	1
Seized assets	0.00%	0
I do not know	7.58%	5
Other (please specify)	9.09%	6
Answered		66
Skipped		1



Quantitative Survey Results: Question 19**Ridgefield Fire Department Small Unmanned Aerial System Survey**

What non-regulatory political or social concerns have been expressed about your SUAS program? For example, privacy.

- None
- Being that our program both police and fire, Privacy is the biggest
- Privacy
- Privacy
- Common sense.
- No issues so far.
- Privacy is the big one. Additionally the area we cover is so large having enough uas to be quickly available has been cost prohibitive, but with new technology we are exploring getting more smaller inexpensive equipment to make the program for useful.
- Privacy concern near training areas. Using in conjunction with law enforcement.
- Privacy and cost of replacement equipment
- Verbiage used to describe mission types. Use “situational awareness” as a term instead of “surveillance”.

- None
- Unknown
- None
- When flying over a neighborhood during a training exercise someone tried to shoot the drone. We are no longer allowed to fly over residential areas during training
- Liability for in-flight incidents. Addition insurance had to be obtained to satisfy legal council.
- Privacy
- There are people that believe that we are going to be prying through their windows.
- None at this time
- Privacy
- Public safety use regarding privacy, public safety use in prohibited area's such as above preserve land. (City law prohibits use within 0.5 miles and within the preserve boundaries.
- None

- None as of now
- Council had some initial concerns about privacy, but after the program was explained in detail they were on board
- None have been expressed at this time, all feedback from the town government and citizens has been positive this far. Residents are excited about the new capability
- Overflight Privacy
- We operate our UAS system with the Police Department. The Police have received a few concerns regarding privacy but the UAS is only used for Search & Rescue and situational awareness for the Police Department. The Fire Department uses the UAS for additional programs like pre-planning.
- None
- None at this point that I am aware of.
- privacy when drone is in use.
- Invasion of privacy
- privacy

- Privacy was brought up however we were specific on mission in our SOPs and eliminated some areas of concern through that. For instance, we cannot perform surveillance or LE type missions with FD sUAS.
- Privacy, allowing police to use the devices
- Data retention & security
- None
- Mostly privacy issues
- None So Far
- Privacy was the biggest issue, as the Sheriff's Office is the one managing the program. However, the main focus of all presentations has been on Fire/HazMat team usage. With that being the main focus we had very little push back from the public.
- None yet, too early to tell
- On July 28th, 2021 Florida Governor DeSantis signed into law Senate Bill 44, Use of Drones by Government Agencies. Language that was attached to the bill before it passed the senate states that an "approved drone equipment" list will be published on Jan. 1, 2022. The list is will contain approved drones/vendors that will be approved for use in the state of

Florida. Current programs that are using equipment not on the list will have to stop using that equipment by Jan. 1, 2023. From the research and networking that we have undertaken it appears that DJI drones will not be on the approved list. Thus we would have to replace our entire fleet by Jan. 1, 2023. Once you have started your program have your PIO involved to get the word out on the benefits i.e.(Structure fires, bush fires, pre storm, and even the ability to drop needed items during a search and rescue from water, cell phone, EpiPen).

- privacy complaints from citizens. Mitigated by using AirData.com to show exactly where are drones have gone
- None. Yet..
- Our drone program is a citywide program with police, fire and public works. We thought four years ago when we rolled out the program there would be push back from PD use. However, there has been very few community issues around the operation. PD flies the most, the PW, then fire a few times a year. Most of our operational flights are to support water rescue.

- Have not encountered those issues during emergencies, Citizens are always inquiring about our missions,
- Personal privacy. Safety over personal property. Personal and organization (Town) liability. Safety operating near the adjacent local airport.
- None, lots of transparency and public education for program.
- None to date
- Our Chief is concerned about privacy
- None
- None as of now
- Unk
- None so far
- None
- None. We are struggling with Feds and availability of A450 course to fly on fed wildland fires
- None
- None
- Being that our program both police and fire, Privacy is the biggest

- Privacy
- Privacy
- Common sense.
- No issues so far.
- Privacy is the big one. Additionally the area we cover is so large having enough uas to be quickly available has been cost prohibitive, but with new technology we are exploring getting more smaller inexpensive equipment to make the program for useful.
- Privacy concern near training areas. Using in conjunction with law enforcement.
- Privacy and cost of replacement equipment
- Verbiage used to describe mission types. Use “situational awareness” as a term instead of “surveillance”.
- None

Appendix C: Qualitative Interview Email Solicitation

The following solicitations for responses to the quantitative survey were made to Danbury fire department Assistant Chief, sUAS pilot and program developer Bernard Meehan, North Carolina Office of the Fire Marshal, sUAS pilot and program developer Wayne Bailey, Pelham, New York fire department Lieutenant, sUAS pilot and program developer Frank Bellantoni, and Madison County, Alabama Deputy Director of the Huntsville-Madison County Rescue Squad sUAS pilot and program developer Chad Tillman. Additional solicitations were made to six other subject matter experts who did not respond.

I am requesting your assistance with an applied research project on the cost-benefit of a fire service program for small unmanned aerial systems (sUAS), commonly referred to as “drones.”

As a subject matter expert, I am hoping that you will answer a few questions to help identify the benefits, barriers, costs, and concerns related to sUAS programs in the fire service. If so, please let me know your answers to the seven questions below. You can simply e-mail a reply. My research time frame is approximately two weeks from when you receive the e-mail. I hope you can assist me with this research. I greatly appreciate it and look forward to hearing from you.

--

Capt. Rommie L. Duckworth

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Appendix D: Qualitative Interview Results

Qualitative Interview Results: Question 1

How have small unmanned aerial systems (sUAS), commonly referred to as “drones”, helped your organization operate more effectively or efficiently?

Danbury fire department Assistant Chief Bernard Meehan

The largest impact with public safety UAS programs have been search and rescue and aerial observation. We can cover a fairly large area quickly and more efficiently with a UAS, if the conditions are right for the mission. On larger scale incidents such as structure fires, brush fires, we can get an aerial view of things without putting people in danger like in a helicopter.

North Carolina Office of the Fire Marshal Wayne Bailey

Cost is the first thing. Typical drone cost \$25 an hour to operate versus a helicopter that cost \$300 plus an hour.

For searches, less manpower is needed when you can use a drone to cover an area much quicker.

Pelham, New York fire department Lieutenant Frank Bellantoni

The sUAS system has increased situational awareness at major incidents in town and on mutual aid. Having an overall image of an incident is a major help. As well as increases safety of FFs performing roof operations. Being able to keep an eye on the roof units increases safety of members operating. The sUAS unit is mutual aid available to FDs and PDs.

Deputy Director of the Huntsville-Madison County Rescue Squad Chad Tillman

LE - The biggest benefit has been the ability to “see before confront” Our UAS are attached to our fusion center and as such, we look at them as intelligence gathering tools. We can give the patrol officer to the IC a better picture of the operation and assist in planning.

FIRE – The ability to manage fire events more intelligently. The aerial view from various sensors can provide suppression with critical hot spot and other info. From investigations, differing viewpoints and overhead view of patterns for suspected arson. For HAZMAT, better standoff data collection. Rapid deployment helps everyone Pre planning is a big one

Qualitative Interview Results: Question 2

What do you think is the biggest practical benefit of a sUAS program?

Danbury fire department Assistant Chief Bernard Meehan

The biggest practical benefit is a rapidly deployable aerial observation platform. Most places do not have access to a rapid response from a helicopter for aerial observation, so a easily deployed, and relative low cost drone can fill that need. Drones can also provide a safe platform to observe details of an incident, such as wildfires, large structure fires, hazmat calls, shooters, riots, demonstrations, etc.

North Carolina Office of the Fire Marshal Wayne Bailey

Search and rescue for people that have wandered (sic) away from assisted-living or a small child that is lost.

For searches, less manpower is needed when you can use a drone to cover an area much quicker.

Pelham, New York fire department Lieutenant Frank Bellantoni

The biggest practical benefit to our smaller dept is being able to deploy the unit with 1 to 2 people. As a smaller department having the sUAS helps us bring something to the table to offer to specialized operations such as HazMat (over view of scene and eye on members going down range), High Angle rescue can fly directly to the victim and view the incident/rescue up close, Trench over view of the operation and if we had mapping capabilities (software and

training is expensive) a 3D rendering of the trench with accurate measurements could be beneficial to the operation and for post incident analysis. Along with mapping the sUAS could be used to map and create 3D renderings for accident reconstruction teams.

Deputy Director of the Huntsville-Madison County Rescue Squad Chad Tillman

Safety.. Maximization of resources, and intel

Qualitative Interview Results: Question 3

What do you think is the biggest barrier to establishing a sUAS program?

Danbury fire department Assistant Chief Bernard Meehan

The biggest barrier is finding the right personnel who are willing to be trained and maintain proficiency with the UAS program .

North Carolina Office of the Fire Marshal Wayne Bailey

Lack of leadership or knowledge about drones

Pelham, New York fire department Lieutenant Frank Bellantoni

Biggest barrier for start up is cost (grants for DJI (the leader in drone tech) are for the most part unavailable. Cost of the unit and spare batteries, outfitting a vehicle for a drone operation (TV monitor Wifi Etc), and getting members certified as Part 107 operators. Getting members to accept the technology can also be an uphill battle.

Deputy Director of the Huntsville-Madison County Rescue Squad Chad Tillman

Public awareness of the benefits. Internal aversion to change. Lack of a defined program

Qualitative Interview Results: Question 4

What do you think is the biggest barrier to maintaining a sUAS program?

Danbury fire department Assistant Chief Bernard Meehan

Personnel issues. see #3

North Carolina Office of the Fire Marshal Wayne Bailey

Purchasing the most expensive drone and the bigger cost that goes along with it and not needing A less expensive drone could work just as well with lower cost to operate.

Pelham, New York fire department Lieutenant Frank Bellantoni

Barrier of maintaining a program is the evolution in technology and to keep up with it. New better and more capable units keep coming to the market.

Deputy Director of the Huntsville-Madison County Rescue Squad Chad Tillman

Lack of a defined program. Inconsistent training. Lack of mission definitions. Lack of leadership buy in. Sticker shock

Qualitative Interview Results: Question 5

What are the most significant costs in your program?

Danbury fire department Assistant Chief Bernard Meehan

Depending on the level of service you want to provide. If you want a simple UAS, they range about \$2000, if you want advanced systems, those can go upward of \$25,000. Add to the initial cost outlay, the cost of personnel. In a career system, you have to pay your people to operate, and that cost is up to the agency.

North Carolina Office of the Fire Marshal Wayne Bailey

The drone itself. They can cost anywhere between \$1000 and \$30,000. Some of the fixed wing (vertical takeoff and lift) drones are costing up to \$150,000

The insurance to cover your drone is usually part of your inventory in your department. In most cases, there is no an additional cost.

Pelham, New York fire department Lieutenant Frank Bellantoni

Significant costs of our program is OT when it gets called out. (The way we operate currently until everyone is totally trained) Members who can operate the unit if they aren't working are recalled in. On going training costs as well (monthly training and yearly qualifiers)

Deputy Director of the Huntsville-Madison County Rescue Squad Chad Tillman

Hard Costs - Infrastructure and Hardware. Soft Costs – Lack of SOPS, and program definition.

Qualitative Interview Results: Question 6

What do you think is the biggest public concern of a fire department sUAS program?

Danbury fire department Assistant Chief Bernard Meehan

The public may have an unrealistic expectation of what a UAS program can provide. The drone cameras, even Infra-Red cannot see through the forest canopy, so expecting to put a drone up to find a lost child instantly is not possible. The public may also think these drones are play toys. The best practice would be to be transparent with the public and involve them as much as possible in the program with press releases and such.

North Carolina Office of the Fire Marshal Wayne Bailey

Privacy. Someone doing something illegal doesn't want a drone flying over the backyard to know what they're doing.

Pelham, New York fire department Lieutenant Frank Bellantoni

The biggest public concern is surveillance and the use of the word Drone (sounds ominous). When promoting the program show its uses (thermal) and how it is good for firefighter safety and for possibly assisting in locating missing persons.

Deputy Director of the Huntsville-Madison County Rescue Squad Chad Tillman

I am going to give you two answers here. Public and departmental

Public – Fire departments are a little less under scrutiny than PD. Lack of privacy is the big one. This one can be mitigated by having internal rules in place that minimize the opportunity for misperception. This comes back to SOPS and program. Having a good data

management program is critical. There are some out there that are very expensive. Other that will do just a well with a little for much less. A good PR plan is critical.

Departmental - For me, it is lack of system ownership and maintenance. The pilots need to function as a K-9 team. They are responsible for the aircraft, it's maintenance, storage and their skill development. You cannot put the aircraft on an engine, or ladder, or rescue truck, or HAZMAT without having dedicated pilots that will exercise the aircraft regularly. I have seen depts put \$35k drones on a truck, only for the batteries to go bad and the aircraft fall into disrepair because on one "own's the aircraft.

Qualitative Interview Results: Question 7

Do you have any other recommendations for a small suburban combination fire department interested in establishing a sUAS program?

Danbury fire department Assistant Chief Bernard Meehan

Start small. Purchase an entry level drone in the \$1500 range, practice with it, set up some realistic scenarios and see if it fits within your op

North Carolina Office of the Fire Marshal Wayne Bailey

Develop policies and procedures.

Get buy in from senior management

Get buy in from your community

Have a plan on where the drone will be placed and who will be the pilots.

Make sure you have pilots for all shifts.

Training should be done weekly and or monthly using NIST props.

When you're viewing, the image should be streamed to a TV screen for visual observers to help search or critique whatever you're observing.

Have a drone with a FLIR. Not all calls happen in the day and this payload will help find people lost or walked away from a rest home.

Pelham, New York fire department Lieutenant Frank Bellantoni

It is a slow process. Get the membership to buy in first then work on a plan to fund it. From there work on its uses in the dept and how locally it can benefit the community you serve and the members of your dept.

Deputy Director of the Huntsville-Madison County Rescue Squad Chad Tillman

Don't buy a drone first and don't buy the biggest best coolest. Start with your mission goals.

What do you want to fly for?

What will the UAS add capabilities to?

How often would you fly?

Who are the stakeholders? Suppression, Investigations, Pre Fire Planning, SAR, HAZMAT? How would each of those missions benefit from UAS?

Do not look at disaster support as a major pin in your program. You will not fly that many and if you wrap your program around that, you will miss the good that UAS can do for day to day operations.

Write your SOPs

Develop a training strategy. What type, how often, training goals. Talk to others who have programs and ask them about their success and more importantly, the failures. There is no sense in repeating mistakes.

Look for internal funding or non-governmental grants. You will have a lot more flexibility.

Then look at aircraft. Compare capabilities to your mission goals. If you can accomplish 95% of the goal with an aircraft that costs 80% less. Consider it.

The biggest and coolest are not necessarily the best answers.

Consider the pros and cons, for your dept. of embedded (aircraft assigned to individuals)teams, (A team of on call pilots) and vehicle mounted. (My opinion the hardest to maintain)

Follow the FAA rules. I recommend Part 107 pilots and a COA. Gives you much more flexibility, especially in a mixed department.

Have a program lead.

Cross train with your police force if they are flying UAS. Sometimes, A firefighter needs to be fighting fire, not flying. A cross trained police officer can fill in.

Have open conversations with others that have programs. There is a wealth of information to had. And.... Small missteps can have huge consequences.