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THESIS

DEVELOPING A SHARED SERVICE UNMANNED AERIAL VEHICLE CAPABILITY FOR REGIONAL EMERGENCY SERVICES

by

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September 2016

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At the scenes of emergencies across the nation, unmanned aerial vehicles (UAVs) have proven their worth to rescue crews; however, this expensive asset is not necessarily a tool that every emergency service would use routinely. This research explored three shared service models, determined their best attributes, and then applied those characteristics to the development of a regional UAV asset that would avoid duplication of resources. The study addressed relevant issues including assumption of risk and liability, public privacy concerns, and federal legislation. Findings led to the following recommendations in the creation of a regional UAV asset: 1) conduct a response evaluation to support a shared service UAV; 2) organize the asset under local government nonprofit oversight; 3) take advantage of grant funding for initial asset purchase; 4) define sustainable funding for maintenance and repair; 5) investigate further revenue generation, housing at least one asset within a large organization; 6) research applicable state law for managing risk; 7) develop privacy and organizational policy consistent with community standards; and 8) define the roles and responsibilities of the organization and the administration.

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DEVELOPING A SHARED SERVICE UNMANNED AERIAL VEHICLE CAPABILITY FOR REGIONAL EMERGENCY SERVICES

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ABSTRACT

At the scenes of emergencies across the nation, unmanned aerial vehicles (UAVs) have proven their worth to rescue crews; however, this expensive asset is not necessarily a tool that every emergency service would use routinely. This research explored three shared service models, determined their best attributes, and then applied those characteristics to the development of a regional UAV asset that would avoid duplication of resources. The study addressed relevant issues including assumption of risk and liability, public privacy concerns, and federal legislation. Findings led to the following recommendations in the creation of a regional UAV asset: 1) conduct a response evaluation to support a shared service UAV; 2) organize the asset under local government nonprofit oversight; 3) take advantage of grant funding for initial asset purchase; 4) define sustainable funding for maintenance and repair; 5) investigate further revenue generation, housing at least one asset within a large organization; 6) research applicable state law for managing risk; 7) develop privacy and organizational policy consistent with community standards; and 8) define the roles and responsibilities of the organization and the administration.

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LIST OF ACRONYMS AND ABBREVIATIONS

ACLU	American Civil Liberties Union
AMBUS	Ambulance Bus
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFD	Cincinnati Fire Department
CFR	Code of Federal Regulations
COA	Certificate of Authorization or Waiver
CRS	Congressional Research Service
DAPTA	Drone Aircraft Privacy and Transparency Act
DECON	Decontamination
EMS	Emergency Medical Service
EMT	Emergency Medical Technician
EMTF	Emergency Medical Task Force
EOD	Explosive Ordnance Disposal
FAA	Federal Aviation Administration
FLIR	forward looking infrared
FMRA	Federal Aviation Administration Modernization and Reform Act
Hazmat	hazardous materials
HCCC	Hamilton County Communications Center
HCFCA	Hamilton County Fire Chief's Association
HCUSAR	Hamilton County Urban Search and Rescue
HFD	Houston Fire Department
IAFC	International Association of Fire Chiefs
LMA	labor management agreement
MCI	mass casualty incident
MOA	Memorandum of Agreement
MOU	Memorandum of Understanding
MPV	multiple patient vehicle
NAS	national air space
OEMA	Ohio Emergency Management Agency
PFD	personal floatation device

RNA	rapid needs assessment
RSC	regional steering committee
SAR	Synthetic Aperture Radar
SETRAC	Southeast Texas Regional Advisory Council
SOSINK	Southwestern Ohio Southeastern Indiana Northern Kentucky
UASI	Urban Area Security Initiative
UAV	unmanned aerial vehicle
USAR	Urban Search and Rescue

EXECUTIVE SUMMARY

Unmanned aerial vehicles (UAVs) have evolved over the last century from rudimentary tethered balloons to electronically advanced aircraft that can be piloted using a cellular telephone. As a result of this evolution, the UAV has found its way into the field of emergency services and has proven itself as an advantageous tool in the first responder's toolbox.

UAVs have been utilized experimentally during a variety of emergency responses, providing situational awareness for incident commanders on large-scale scenes and conducting reconnaissance at hazardous materials responses. Equipped with optical and infrared cameras, UAVs can search a wide area on land or over water for missing victims and can scan fire scenes for lingering hot spots. They also can provide video for real-time rapid needs assessments during large-scale natural disasters. In other emergencies, hazardous materials sensors have been attached to UAVs to measure the presence of toxic gases. Eventually, UAVs could be used to establish safety zones at hazardous materials scenes or to verify plume modeling for potential exposure. UAV applications will continue to develop as the technology improves.

While a UAV provides a range of uses, not every fire department needs to own a UAV asset. This research supported the creation of a shared service model for a UAV asset to avoid duplication of resources. Answering the following question was crucial: "Why shouldn't every emergency service organization develop a UAV asset?" To assess the demand for the development of a shared service model, the author conducted a needs assessment. The author examined fire department responses for Hamilton County, Ohio, over a three-year period to assess the need for a UAV. The parameters of the study included fires over one hour of on-scene time, hazardous materials responses, and water emergencies. In addition to the city of Cincinnati Fire Department, which is the largest department in the county, only five of the 40 other fire departments would have met the criteria to use the UAV more than once a month.

Once the need for the creation of the shared service model was established, the research focused on the question: Do shared service models exist that can be identified and applied to develop a regional unmanned aerial vehicle asset? Additional issues addressed through the research include the management of risk and liability, the management of the public’s expectation of privacy, and the legislation and policies required for a shared service UAV asset.

Three emergency shared-service models were identified, and a policy analysis was conducted. The three models were the Southeast Texas Regional Advisory Council (SETRAC) Ambulance Bus (AMBUS), the Hamilton County Urban Search and Rescue (HCUSAR) Task Force, and the Southwestern Ohio Northern Kentucky Southeast Indiana (SOSINK) decontamination trailers and mass casualty trailers. The SETRAC AMBUS is a regional asset that provides transportation of patients from scenes of mass casualties to the hospital, and it can function as a stand-alone medical facility during a disaster. The HCUSAR Task Force provides technical rescue and search capabilities to Hamilton County and the surrounding region. HCUSAR is also the state of Ohio Region 6 collapse and rescue team. The SOSINK decontamination and mass casualty trailers serve the 12-county region and the city of Cincinnati.

The criteria for the policy analysis evaluation focused on five categories: structure of the organization, ownership and funding of the asset, unit staffing, the response of the asset, and risk and liability management. Each one of the five categories was further divided into subcategories to determine how they affect the shared service model. The models were ranked using a low, medium, and high scale, and received one, five or 10 points, respectively. Using the evaluation of the three shared service models, an analysis was conducted to select and apply the characteristics identified in the evaluation criteria to form recommendations for creating a shared service UAV asset. While none of the three models studied was optimal, a model can be created based on the recommendations of the evaluation.

The findings showed a need to identify a local governmental organization to provide responsive oversight to the asset. Nonprofit status for the organizing entity would also be beneficial to take full advantage of public and private donations.

Once a local governmental organization has been selected, a funding mechanism must be identified. The research showed the benefit of utilizing grant funding for the initial purchase of the asset; however, relying on grant funding for the maintenance and future sustainability of the asset can be tenuous.

Furthermore, it was determined that the UAV asset needs to be located with an emergency service to facilitate rapid response to the scene. Housing at least one of the assets in a large organization, such as a large municipal fire department, would be beneficial for resiliency, tactical reserve and consistency of the response of a UAV asset.

Flying a UAV comes with inherent risks. The management of risk and liability varied from each shared service model examined, but the research revealed sovereign immunity laws differ from state to state and that the ownership of the asset can also affect the applicability of sovereign immunity legislation. As such, organizations should research state laws where the UAV will be utilized to determine whether sovereign immunity will apply. In addition, a UAV asset can stir privacy concerns within a community. Therefore, it is recommended that privacy policies be developed that address the collection, retention, and the definition of approved users that is consistent with the expectations of privacy within the community. These policies must be in place prior to the creation of the asset.

Throughout the research, organizational policy of the shared service models was not always reduced to writing. The research recommended the development of policies that delineate the structure of the shared service and define the roles and responsibilities of the organization and administration as well as the expectations of the host agency. These policies must be documented and shared with all partners within the shared service agreement.

This research has demonstrated the need for a shared service UAV asset within Hamilton County, Ohio. By employing a shared service model with five UAVs, the county could save more than $1.5 million.

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I. INTRODUCTION

A. PROBLEM STATEMENT

Over the last 150 years, the technology behind unmanned aerial vehicles (UAV) has undergone many transformations—from balloons floating over Venice in the 1850s, to highly sophisticated military aircraft guided by pilots many miles away, to drones flown for entertainment by enthusiasts all over the world.[1] During this evolution, emergency services found a niche for UAV use in emergency response.

Today, UAVs have proven their effectiveness as tools in emergency response environments across the nation. For instance, UAVs equipped with optical sensors were successful in locating missing persons in Saskatoon, Canada, after a vehicle accident in freezing temperatures,[2] and in Virginia, a man who was missing for three days was found within 20 minutes of UAV deployment by a civilian hobbyist.[3] In both of these rescue situations, the technology proved to be lifesaving.

UAVs have also been utilized to provide situational awareness[4] and conduct damage assessments,[5] providing incident commanders and emergency managers with larger perspectives of the emergency in real time. This technology has also opened doors to data collection, allowing leaders to make better-informed decisions regarding the deployment of resources and the magnitude of the emergency.

The utility of UAV technology in emergency response is undeniable, but it is not a technology that fire departments and emergency services would use all the time. Most

[1] Ian G. R. Shaw, "The Rise of the Predator Empire: Tracing the History of U.S. Drones," Understanding Empire, accessed May 20, 2015, https://understandingempire.wordpress.com/2-0-a-brief-history-of-u-s-drones/.

[2] Ben Coxworth, "Canadian Police Save Man's Life Using a Drone," *Gizmag*, May 13, 2013, http://www.gizmag.com/rcmp-quadcopter-locate-victim/27488/.

[3] "Drones for Disaster Response and Relief Operations," American Red Cross, April 2015, http://www.issuelab.org/resources/21683/21683.pdf.

[4] Jesse Roman, "Rise of the Machines," *NFPA Journal*, July-August 2015, http://www.nfpa.org/newsandpublications/nfpa-journal/2015/july-august-2015/features/drones.

[5] Jean Lang, "Officials See Local Role for Drones, with Limits," *Boston Globe*, May 31, 2015, http://search.proquest.com/docview/1684258735.

incidents handled by fire departments do not warrant UAV use, and as a result, not every fire department or emergency service needs to own and maintain a UAV. However, many service providers would support a collaborative resource, or shared service model, that would allow them to request access to a UAV when the need arises. For the purposes of this thesis, a shared service model is defined as a resource provided by a single organization and used collectively throughout a region, thus saving funding and resources. This shared services concept would reduce operating costs by limiting the total number of UAVs, producing a pool of experienced operators with more flight time at emergencies, and distributing the operating and maintenance costs throughout the region.

Shared service models do have some inherent drawbacks. Response time to arrive on scene may be greater than it would be if the asset were owned by the local department because the asset may be responding from a regional, rather than a nearby, location. Another challenge is that the asset may not be available for response if it already is deployed by another agency within the region. In addition to these negative aspects, the shared service will also have to maneuver through myriad regulations imposed by the Federal Aviation Administration.

UAV technology for emergency services requires compliance with the regulations administered by the Federal Aviation Administration (FAA) and Congress. The FAA established a December 31, 2015, deadline to provide guidelines for UAV training for public operations,[6] but it missed this deadline. Organizations looking to add UAVs to their emergency response toolkits still lack a legal framework to follow. In addition to navigating federal regulations, collaborative UAV resources face questions regarding the framework and structure of the regional capability: For example, under whose auspices will the asset be formed? How will liability be managed in order to take full advantage of sovereign immunity? How should societal privacy issues be handled?

By studying and applying aspects of collaborative and shared service, this research develops a model for a regional unmanned aerial vehicle. Hamilton County, Ohio, a region with many separate and distinct municipalities, is used as the case

[6] Comm. on Conference, FAA Modernization and Reform Act of 2012, H.R. Rep. No 112-381 (2012), https://www.gpo.gov/fdsys/pkg/CRPT-112hrpt381/pdf/CRPT-112hrpt381.pdf.

example. This research explores both the positive and negative implications of collaborative models. Special attention is given to the concept of sovereign immunity, liability, and potential privacy concerns to pre-emptively address potential opposition to development of the asset.

B. LITERATURE REVIEW

This literature review consists of an examination of relevant literature pertaining to the research of the viability of unmanned aerial vehicle (UAV) use for emergency services and how to use UAV capability as a regional concept to avoid duplication of resources. The review addresses UAV use in emergency services, training, legal and policy considerations and civilian privacy and safety concerns.

1. Emergency Services

The implementation of unmanned aerial vehicles in emergency services has the potential to improve the capabilities and efficiency of emergency responders and to increase responder safety. Recognizing this potential, the Congressional Unmanned Systems Caucus believes there is an urgent need to deploy more UAVs in support of civil operations.[7] A report by Karen Vance et al. suggests that UAV platforms could provide imagery for situational awareness and damage assessment when responding to natural disasters and major emergencies and scenarios where utilizing manned vehicles or human operators may be too dangerous.[8] G.S. Mani, professor emeritus from the JS College of Engineering in India, agrees that utilizing UAVs will make it safer for responders to handle hazardous tasks by not requiring responders to enter the hazard zone.[9]

In addition to protecting responders from entering the hazard zone, UAVs may present the advantage of increased situational awareness by providing the incident commander with a “birds-eye” view of the incident and an opportunity to see the

[7] Karen Vance et al., “Unmanned Aircraft Systems: Security and Regulatory Challenges in U.S. Domestic Airspace,” IC Analyst Private Sector Program (2014), https://www.hsdl.org/?view&did=759945.

[8] Ibid., 6.

[9] G. S. Mani, “Mapping Contaminated Clouds using UAV—A Simulation Study,” *2013 Annual IEEE India Conference* 12 (2013): 1–6, http://dx.doi.org/10.1109/INDCON.2013.6725993.

magnitude of the problem. Charles Werner, a fire chief from Virginia and a member of the International Association of Fire Chiefs (IAFC) Technology Council,[10] believes a UAV in the air at the scene of a building fire may permit the incident commander to see the progression of the fire throughout the building, the construction, and attributes of the roof; victims presenting from windows not visible from the front of the building; and any potential exposure problems where the fire may extend.[11] The Oklahoma State University and the Tulsa Fire Department tested this use of a UAV in Tulsa, Oklahoma. The result of the test corroborated the use of a UAV on emergency incidents and that a UAV equipped with a camera provides real time situational awareness.[12]

UAVs also could potentially make the response to natural disasters more efficient with the redirection of resources in a more thoughtful manner. UAVs could be utilized to survey the area devastated by a flood, earthquake, tornado or hurricane to conduct rapid needs assessments in order to prioritize search efforts and to determine the magnitude of the damage to buildings and infrastructure.[13] By utilizing GPS-enabled UAVs, the University of Oklahoma demonstrated the ability to pinpoint exact locations of structures when conducting damage evaluations after natural disasters.[14] Utilizing UAVs in emergency services has been an ongoing experiment for several years; however, until recently, the idea of utilizing UAVs for damage assessment during natural disasters has mainly been a theory of emergency responders or an academic demonstration under non-emergent conditions. Then in 2015, catastrophic earthquakes in Nepal devastated the city. Aeryon Labs, a Canadian company that manufactures UAVs, deployed three unmanned aerial vehicles to the disaster, mapped the terrain, and searched for survivors. The UAVs generated 3-D maps that detected the structural instability of a building that was leaning about three inches. In addition to the 3-D structural mapping, the Aeryon UAVs were

[10] The IAFC Technology Council evaluates and distributes technological advancements within the fire service to promote early adoption.

[11] Charles Werner, “Using Drones in the Fire Service,” *Firehouse* 40 (2015): 82–86, http://search.proquest.com/docview/1685183092.

[12] Marshall Kendrick, “Tulsa Firefighters Get Demonstration on Use of Drones in Rescue Situations,” McClatchy-Tribune Business News, Nov. 14, 2013.

[13] Werner, “Using Drones in the Fire Service,” 82–86.

[14] Kendrick, “Tulsa Firefighters.”

able to produce real-time mapping and tested the efficacy of rotary wing versus fixed wing UAVs in disaster response.[15]

Also in 2015, the Plymouth Massachusetts Fire Department corroborated the use of UAVs in natural disasters by operating a UAV in inspections of homes along the waterfront that had been isolated by a massive snowstorm. The inspections conducted by the UAV took one hour to complete as compared to similar inspections in the past, which had taken days.[16] The literature has demonstrated that utilizing UAVs to assess damage in natural disasters is not only possible, but it also improves efficiency in emergency responses.

While utilizing UAVs equipped with cameras for damage assessment has been helpful during natural disasters, using UAVs with forward looking infrared (FLIR) can benefit search and rescue operations. The premise is that a UAV will reduce the amount of time needed to search an area as well as reduce the size of the area that needs to be searched on foot or by a vehicle.[17] In order for a drone to be useful in search and rescue operations, it has to be properly equipped with imaging equipment. UAVs utilized for search operations should have a high-end digital camera equipped with digital stabilization, gyro-stabilized gimbals, and object detection capability.[18] Bart Elias, a specialist in aviation policy for the Congressional Research Service, states that combining the high-end camera with infrared capability provides images beyond the capabilities of the human eye and allows for visualization of a victim based on temperature difference compared to the environment.[19] The University of North Dakota corroborated this by conducting training missions at night that were able to locate simulated victims using the

[15] Chris Herhalt, "Waterloo Firm Lends Drones to Aid Nepal's Earthquake Recovery," *Waterloo Region Record*, April 28, 2015.

[16] Lang, "Officials See Local Role for Drones."

[17] Kendrick, "Tulsa Firefighters."

[18] Bart Elias, *Pilotless Drones: Background and Considerations for Congress Regarding Unmanned Aircraft Operations in the National Airspace System* (CRS Report No. R42718) (Washington, DC: Congressional Research Service, 2012).

[19] Ibid.,17–18.

infrared technology.[20] Elias also discusses Synthetic Aperture Radar (SAR) as an emerging technology for UAV imaging that allows the camera to provide imaging in poor environmental conditions, such as rain, fog, or smoke. This technology could replace or augment the existing infrared sensor.[21]

UAVs have proven their value during active searches. For example, in 2014, a UAV was utilized to search waterways and inaccessible areas for a missing University of Virginia student. The UAV did not locate the victim; however, it directed searchers to areas unable to be searched by the UAV.[22] A UAV was also used in Austin, Texas, during the floods of 2015, and Austin officials stated the UAV could access areas that manned aircraft could not. UAVs also have been successful in assisting search and rescue efforts that involve several victims. In Saskatoon, Saskatchewan, Canada, the police launched a UAV equipped with electro-optical and IR sensors after a motor vehicle accident in an attempt to locate the driver, who had wandered off in freezing temperatures. The driver was injured, called 911 on his cell phone, and stated that he did not know where he was. Using the cellphone location information, the UAV quickly identified three heat signatures in the infrared sensor, one of which was the injured driver who was rescued within minutes. The driver was two miles from the accident scene.[23] Another search team turned to technology in July 2014, when an elderly man went missing in Virginia. The man was missing for three days, and police, search dogs and volunteers searched the heavily wooded areas around the man's home. Using electro-optical sensors with first-person view controls, the UAV located the man within 20 minutes of takeoff.[24] It also has been documented that a UAV was used to provide a personal floatation device (PFD) to a teenager stranded on a rock in the middle of a

[20] Matthew L. Wald, "The Drones Next Door; No Longer Just for the Military, Unmanned Aerial Vehicles Are Quickly Becoming Ubiquitous," *National Post*, March 19, 2013.

[21] Elias, *Pilotless Drones*.

[22] Werner, "Using Drones in the Fire Service," 82–86.

[23] Coxworth, "Canadian Police Save Man's Life."

[24] "Drones for Disaster Response and Relief Operations," American Red Cross, April 2015, 27, http://www.issuelab.org/resources/21683/21683.pdf.

rushing waterway. In July 2015, an Auburn, Maine, fire chief employed his personal UAV to fly a PFD to the stranded teenager before his rescue by boat.[25]

Hazardous materials emergencies are another type of emergency where UAVs have proved to be effective tools. Fire Chief Charles Werner of the Charlottesville Fire Department in Virginia states that UAVs can be equipped with remote monitoring devices for hazardous materials detection.[26] Circle Group Holdings, developers of the Mini-Raman Lidar System, claim that their sensor can be attached to a UAV, and it will detect trace contaminants and bulk quantities of chemicals or weapons agents that may be present in the air during chemical spills or a terrorist attacks.[27] In addition, G.S. Mani, professor emeritus at the College of Engineering in Pune, India, claims that ion mobility spectrometers can be affixed to a UAV and used for rapid real-time chemical detection, identification and quantification.[28] While these technologies show promise, there is no evidence in the research that a UAV has been successfully utilized to monitor the atmosphere during a hazardous materials emergency. However, the Department of Homeland Security in cooperation with the Los Angeles County Fire Department successfully utilized a UAV to detect low-grade radiation dispersed in the desert.[29] In situations involving radiation, such as a dirty bomb attack or a nuclear reactor accident, UAVs offer emergency responders a tool for safe monitoring.[30]

2. Legal and Policy Considerations

Unmanned aerial vehicles comprise a dynamic growth sector, and their prominence in the United States is only expected to increase. According to the Federal Aviation Administration (FAA), by the year 2020, seven million UAVs will travel the

[25] Matt McFarland, “This Fire Chief Used His Drone to Help Deliver a Life Vest to a Stranded Kid,” *Washington Post*, July 2, 2015.

[26] Werner, “Using Drones in the Fire Service,” 82–86.

[27] “Circle Group Holdings, Inc. Announces Its Plan to Develop the Mini Raman Lidar System for Unmanned Aerial Vehicle Applications in the Defense Industry,” PR Newswire, April 27, 2005, http://search.proquest.com/docview/447132847.

[28] Mani, “Mapping Contaminated Clouds,” 1–6.

[29] Brian Bennett, “Police, Fire Departments Testing Drones for Local Use,” McClatchy-Tribune News Service, Aug. 6, 2012, http://search.proquest.com/docview/1031204464.

[30] Werner, “Using Drones in the Fire Service,” 82–86.

nation's skies.[31] Legislation and regulatory mechanisms have struggled to keep up with the emerging technology. Congress was aware of the potential increase in UAV proliferation as far back as 2003, when it included language in the "Vision 100—The Century of Aviation Reauthorization Act," specifying that the Next Generation Air Transportation System for air traffic control would include unmanned aerial vehicles.[32] In 2012, Congress enacted the FAA Modernization and Reform Act (FMRA), which directed the FAA to integrate unmanned aerial vehicles into the national air space (NAS) by September 30, 2015.[33] The FMRA divides UAV operations into three distinct categories: public or governmental, civilian or commercial, and model or hobbyist.[34] A comparison between public UAVs and hobbyist UAVs relates to the maximum allowable weight permitted in the original legislation. Public UAVs were initially restricted to no more than 4.4 pounds, while hobbyist drones could weigh up to 55 pounds.[35] According to the FAA website, the maximum weight for a publicly operated UAV is now 25 pounds[36]—still 30 pounds less than a hobbyist drone.

While the FMRA hardly restricts hobbyist UAV operators, public operators must first file for a Certificate of Authorization or Waiver (COA) in order to operate a UAV. The FMRA does state that the FAA will simplify the process for applying for a Certificate of Authorization or Waiver and that a decision will be rendered for approval or denial within 60 business days.[37] Although the FMRA states that the process for obtaining a COA will be simplified and expedited, the UAV director for the Mesa County Arizona Sheriff's Office told the *Toronto Star* that the "process is beyond cumbersome"

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[31] "FAA Aerospace Forecast: Fiscal Years 2016–2036," Federal Aviation Administration, accessed July 19, 2016, http://www.faa.gov/data_research/aviation/aerospace_forecasts/media/FY2016-36_FAA_Aerospace_Forecast.pdf.

[32] Elias. *Pilotless Drones*.

[33] H.R. Rep. No 112-381 (2012) (Conf. Rep.).

[34] Ibid.

[35] Ibid.

[36] "Unmanned Aircraft Systems," Federal Aviation Administration, last modified May 6, 2015, http://www.faa.gov/uas/.

[37] H.R. Rep. No 112-381 (2012) (Conf. Rep.).

and that it is “difficult obtaining a user name and password.”[38] The FAA website outlines further requirements to obtaining a COA, for example, that the agency must provide a declaration from the municipality that it is recognized as a political subdivision and that it will be operating the UAV for public purposes. The determinate factors of public operations are the aircraft ownership, the operator and the purpose of the flight.[39] The COA will then be issued for a particular purpose, in a particular airspace, for up to a two-year period.[40] As of June 2016, there have been 5,538 certificates of authorization issued,[41] and Vance et al. believe the FAA will likely license many more UAVs, including many public UAVs, within the next few years.[42]

The FMRA further regulates public use of a UAV to the following:[43]

- Within line of sight of the operator
- Less than 400 feet above the ground
- During daylight hours
- Within Class G airspace[44]
- Outside of 5 statute miles from any airport, heliport, seaplane base, spaceport, or other location with aviation activities.

It also states that the FAA will allow expansion of the public UAV operation within the NAS as the technology matures, and that the FAA would develop operational and certification requirements for public UAVs by December 31, 2015.[45] This deadline passed without the development of these requirements. The FAA has issued “The Operation and Certification of Small Unmanned Aircraft Systems; Final Rule” within the

[38] Rick Westhead, “Balancing Drone Rules in U.S. Proving Tough,” *Toronto Star*, Feb. 7, 2013, http://search.proquest.com/docview/1284744944.

[39] “Public Operations (Governmental),” Federal Aviation Administration, last modified Feb. 10, 2015, http://www.faa.gov/documentLibrary/media/Advisory_Circular/AC_00-1_1A.pdf.

[40] Ibid.

[41] “Section 333,” Federal Aviation Administration, last modified May 6, 2015, https://www.faa.gov/uas/getting_started/fly_for_work_business/beyond_the_basics/section_333/.

[42] Vance et al., “Unmanned Aircraft Systems.”

[43] H.R. Rep. No 112-381 (2012) (Conf. Rep.).

[44] Class G airspace is below 1200 feet and is not otherwise controlled.

[45] H.R. Rep. No 112-381 (2012) (Conf. Rep.).

Federal Code of Regulations, which outlines civilian, non-hobbyist use of UAVs; however, this regulation does not apply to public operation.[46] This regulation was effective August 29, 2016.

Although the FAA is charged with the responsibility of enforcing the regulations of the FMRA and adherence to the terms of the COA, FAA aviation safety inspectors are often unable to immediately travel to the location of a reported incident.[47] Regardless of the FAA capability to enforce the regulations, public UAV operators will not only need to ensure compliance with the federal regulations, they will also need to develop internal operational policies and guidelines to utilize the UAV. Monica Manzella and Gregory Favre offer model policy guidelines in their 2015 paper for the Naval Postgraduate School. Manzella and Favre contend that public UAV policies should comply with all COA application requirements and also include an air-worthiness statement that addresses training and continuing education requirements for pilots, planned maintenance in accordance with the manufacturer's recommendations, and a data collection and storage policy.[48] Vance et al. also believe that each public entity should develop standard operating procedures and policies at the regional and local level.[49]

Public UAVs will not only have to comply with the FMRA, and develop internal operating policies and procedures, but the entities will also have to research liability concerns related to UAV flight. These issues may get more complicated when developing a regional UAV capability. Further research will need to be undertaken to include the application of sovereign immunity to regional UAV operation.

3. Training

Piloting a UAV for public use will require some form of proficiency training. However, the exact training requirements are not clear and probably will not be until the

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46 "Department of Transportation," *Federal Register*, 81, June 28, 2016, https://www.gpo.gov/fdsys/pkg/FR-2016-06-28/pdf/2016-15079.pdf.

47 "Law Enforcement Guidance For Suspected Unauthorized UAS Operations."

48 Monica Manzella and Gregory Favre, *Through the Looking Glass: Public Safety Agency Drone Policies and The Fourth Amendment* (Monterey, CA: Naval Postgraduate School, 2015).

49 Vance et al., "Unmanned Aircraft Systems."

FAA develops and releases its response to the FMRA. Currently, a public operator can obtain a COA for training, and when the entity has demonstrated proficiency operating the UAV, it will be issued a jurisdictional COA to fly within its boundaries.[50] While the recent Final Rule Part 107 regulations contain training requirements for remote pilots, the Part 107 regulations exempt public operations leaving public operators without clear training direction.

The term "unmanned" aerial vehicle is misleading, as each UAV must have a trained pilot to operate it. The human performance factor must be taken into consideration and the FAA has been tasked to develop the basic training and certification standards.[51] Making matters more complicated is the fact that the FMRA prohibited training institutions from actually flying UAVs, and treated these institutions as commercial UAVs that were not approved for flight.[52] The CFR Part 107 Rules has addressed this issue and will now permit UAV training flights utilizing an instructor who holds a remote pilot in command certificate.[53] Further investigation into the applicable training requirements will need to be conducted prior to establishing policies for public UAV implementation.

4. Regional Collaboration

The integration of drones into emergency services response is an opportunity to develop regional collaboration between municipalities. However, regional collaboration is a learned behavior that must be constructed and nurtured among the participants, according to Ovidiu Noran, an Australian engineer.[54] Noran believes that for regional collaboration to be successful, it must be a voluntary commitment and not forced on the

[50] "Fact Sheet - Unmanned Aircraft Systems," Federal Aviation Administration, February 15, 2015, https://www.faa.gov/news/fact_sheets/news_story.cfm?newsId=18297.

[51] Elias, *Pilotless Drones*.

[52] Jack Nicas and Andrea Gallo, "U.S. News: Schools for Drone Pilots Hamstrung by FAA Rule," *Wall Street Journal,* July 29, 2014.

[53] "Department of Transportation," *Federal Register*.

[54] Ovidiu Noran, "Collaborative Disaster Management: An Interdisciplinary Approach," *Computers in Industry* 65 (2014): 1032–1040.

participants.[55] Sharon Caudle, author of "Basic Practices for Homeland Security Regional Partnerships" agrees that voluntary participation in the collaborative effort is essential and adds that the members must obligate the resources expected of the organization for the collaboration to succeed.[56]

Collaboration has been embraced by municipalities as a means to make capital purchases since the early 2000s.[57] Financially burdened local governments, looking to create more efficient and effective operations, have turned to regional collaboration and partnerships to acquire additional services for less cost.[58] Through these partnerships, the governments enjoy the savings gained by widening the pool of taxpayers sharing the economic burden of the service.[59]

The Homeland Security Policy Institute Task Force has determined that regional collaboration is essential for the integration of local assets into effective disaster preparedness and response and critical in eliminating the duplication of resources.[60] Regional collaborative partnerships must be organized and structured in a manner that shares the authority, responsibility, resources, and accountability in an equitable manner in order to achieve mutually beneficial goals and outcomes.[61] There are several different frameworks to organize a regional partnership. Susan MacManus and Kiki Caruson outline three forms of inter-local agreements as follows:

1. Formal contract: This is a contract between two parties where one entity agrees to provide service for the other for an agreed upon fee.

2. Joint Service Agreement: An agreement where two or more entities agree to join resources to plan, deliver and fund a resource within the boundaries of their combined jurisdictions.

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55 Ibid.

56 Sharon Caudle, "Basic Practices for Homeland Security Regional Partnerships," *Public Manager* 36 (Summer, 2007): 40–44.

57 Susan A. MacManus and Kiki Caruson, "Financing Homeland Security and Emergency Preparedness: Use of Interlocal Cost-Sharing," *Public Budgeting and Finance* 28 (2008): 48–68.

58 Ibid.

59 Ibid.

60 Caudle, "Basic Practices for Homeland Security," 40–44.

61 Ibid.

3. Service exchange: An agreement where each entity offers up a service for the good of the partnership where no money is exchanged between the participants.[62]

In addition, Caudle describes several practices necessary for success:

1. The partnership needs a leader that will champion the cause and lead the charge to secure commitments from the collaborative entities.
2. The organizational infrastructure must be in place in order for the collaboration to perform effectively.
3. The goals, objectives and desired outcomes must be decided on collectively and that the outcomes must be conveyed realistically to those entities involved in order to determine that the return on investment is worth the resources committed.[63]

Caudle also delineates several challenges for establishing regional partnerships. Those challenges include establishing the networks and relationships necessary for the partnership to be successful, aligning competing interests between the entities, overcoming legal hurdles and requirements, and determining the risks associated with the partnership.[64] Despite challenges, there are definitive benefits to regional collaboration for disaster and emergency response. By combining resources and knowledge, regional partnerships provide disaster management organizations the tools necessary to achieve capability beyond their individual resources.[65] Regional collaboration is crucial to building effective community response, providing a resource that is better equipped to address and resolve a problem.[66]

The literature largely focuses on local regional partnerships. Former Rhode Island Governor Lincoln Chafee attempted to foster local-to-local partnerships by forming a panel to help municipalities achieve efficiency through shared service agreements.[67]

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[62] MacManus and Caruson, "Financing Homeland Security," 48–68.

[63] Caudle, "Basic Practices for Homeland Security," 40–44.

[64] Ibid.

[65] Noran, "Collaborative Disaster Management," 1032–1040.

[66] Adenike Bitto, "Say What? Who? Me? Right Here in the Trenches? Collaborate on What? Seeking Common Ground in Regional All-Hazards Preparedness Training," *Journal of Environmental Health,* 69 (Jan. 2007): 28–33.

[67] "Governor Creates, through Executive Order, Shared Municipal Services Task Force," Targeted News Service, June 28, 2012, http://search.proquest.com/docview/1022575666.

MacManus and Caruson have found that local governments have more faith in horizontal (local-to-local) partnerships than vertical (local to state/federal) partnerships. Local officials tend to have more confidence in partnerships with their counterparts in neighboring jurisdictions than state and federal government entities, which they view as less responsive to local needs and more distant.[68]

5. Conclusion

The literature review suggests that UAV use in emergency situations has the potential to enhance emergency services by making operations more efficient and safer for responders. The literature also shows promising applications for UAVs to improve situational awareness and damage assessments during natural disasters. The use of UAVs in search and rescue operations has already been documented, and while air monitoring during hazardous materials emergencies has not been proven advantageous at this point, it still holds potential.

As a result of the emerging potential for UAV use by public entities, municipalities must address an assortment of legal, policy, and privacy concerns. UAV use by public operators raises privacy and civil liberty issues; however, the research has shown that the majority of the public does not oppose UAV use for search and rescue,[69] and that early involvement of the public helps to allay those concerns. Regional collaboration by municipalities may also be beneficial to establish a UAV asset.[70]

C. RESEARCH QUESTION

Do shared service models exist that can be identified and applied to the development of a regional unmanned aerial vehicle (UAV) asset?

This thesis will include research of existing shared service models in the United States as well as existing collaborative services within the region in order to develop the UAV asset.

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[68] MacManus and Caruson, "Financing Homeland Security," 48–68.

[69] "Drones' Good Flies Hand in Hand with Bad, Experts Fear," Gannett News Service, July 8, 2012, http://search.proquest.com/docview/1024154281.

[70] Karen Vance et al., "Unmanned Aircraft Systems."

Additional research questions to be answered are

- How will the assumption of risk and liability of the shared service be managed, and will the concept of sovereign immunity apply to a regional asset?
- What are the privacy concerns of public service unmanned aerial vehicles within the community?
- What legislation and policies are required to support a shared service UAV?

D. RESEARCH DESIGN

The purpose of this study is to develop a policy approach to support an unmanned aerial vehicle capability for Hamilton County, Ohio. Hamilton County is a conglomeration of more than 40 municipalities, each with its own emergency services, which results in an abundance of fire apparatus and equipment. Following the status quo model for Hamilton County could lead to a duplication of UAV resources as well. This problem of duplication and abundance of emergency equipment is not confined to the Hamilton County region; it occurs throughout the country. By establishing the framework for a regional UAV asset in Hamilton County that addresses the potential for duplication of resources, recommendations could be applied not only to the local operation but also to other regions struggling with similar issues across the United States.

A policy options analysis was conducted to compare organizational models for developing a shared service. The outcomes of this research are specific recommendations for the development of an unmanned aerial vehicle asset for the Hamilton County, Ohio, region. However, the analysis and results are also useful to other entities looking to share a common asset throughout a geographic region.

This study focused on assets owned and operated by a single municipality or regional sponsoring agency up to the county level for local response; the scope does not include assets owned by the state or federal government to be deployed throughout the state or throughout the country in order to focus on a local, rapid response asset. The scope was limited to the formation of a regional asset for use by fire departments or other emergency services for situational awareness, search and rescue, explosive ordnance or hazardous materials responses. The use by law enforcement would be outside the scope of this research, as the use by law enforcement has inherent legal issues associated with its use.

The data sources used for this research were documents and policies of the shared service organizations within the United States. State and federal law regarding sovereign immunity was also studied to determine liability coverage based on the parent organization of the shared service model. Response data was also utilized to analyze the formation of a regional asset.

Eugene Bardach's policy options analysis method will be used to evaluate the data. It consists of the following eight steps:

1. Defining the problem
2. Assembling the evidence—gathering data
3. Constructing the alternative solutions to the problem
4. Selecting the criteria for evaluation—Will the selected policy outcome solve the problem to an acceptable degree?
5. Projecting potential outcomes from the alternative solutions
6. Confronting the tradeoffs between the potential outcomes
7. Deciding on the best course of action
8. Telling the story—explain the recommendations[71]

The organizational models for study include the following:

- Staffing and management of the Hamilton County Urban Search and Rescue (HCUSAR) team. This shared service asset provides technical rescue and urban search capability to the region and utilizes a shared staffing model from organizations throughout the county. This asset is a locally organized, (county level) successful, shared service model within the region.
- State of Texas Multiple Patient Vehicle (MPV). The State of Texas MPV assigned to the Houston Fire Department provides a multiple patient transport capability at the scene of a mass casualty incident or imminent

[71] Eugene Bardach, *A Practical Guide for Policy Analysis: The Eightfold Path to More Effective Problem Solving* (Los Angeles: CQ Press, 2012).

disaster emergency. The MPV has demonstrated success in the Houston, Texas region and while housed as a regional asset, it is organized at the state level of government.

- The Southeastern Ohio Southwestern Indiana Northern Kentucky (SOSINK) mass decontamination and mass casualty trailers. These trailers are provided through the SOSINK, multi-county tri state Urban Area Security Initiative grant program designed for regional utilization.

These models will be applied for a shared UAV service. The following criteria will be used in the analysis:

- The organization of the asset and how the organization affects the oversight of the asset.
- The ownership and funding of the asset including initial funding mechanisms, funding for sustainment and maintenance and potential for billing for service.
- The staffing component of the asset and the availability of staffing to immediately respond, the operational burden to the host agency, and the cost efficiency to the host agency to staff the asset.
- The reduction of the duplication of assets within a region.
- The response configuration of the model to include response time, resiliency, redundancy, and consistency.
- The assumption of risk or liability: The organizational documents will also be compared to the sovereign immunity laws within the state of Ohio to determine which model provides the most liability protection for the sponsoring organization and the personnel and whether the sponsoring agency would be protected by sovereign immunity or would need to purchase additional liability coverage.

The use of unmanned aerial vehicles in emergency services will continue to increase as the federal regulations become less restrictive and permit flight in more populated areas. Similarly, the capabilities and potential applications of the unmanned aerial vehicle will continue to expand, but not every municipality will need—or be able to afford—its own UAV asset. The creation of an organizational structure for a regional unmanned aerial vehicle would create a framework for municipalities to share an asset in a defined region. The finished product will be a framework for organizing a regional UAV asset based on different organizational models.

E. OVERVIEW OF CHAPTERS

The next chapter discusses the background of the Hamilton County, Ohio, region, including an analysis regarding the frequency of application of a UAV asset within the current emergency services and the necessity of the shared service model. Chapter III describes the evaluation criteria utilized to analyze the three shared service models. Chapter IV compares the advantages and disadvantages of the projected outcomes of each of the shared service models. Finally, Chapter V synthesizes those outcomes into recommendations for the creation of a regional UAV asset and addresses implementation concerns.

II. BACKGROUND

The overarching goal of this research is to produce an unmanned aerial vehicle asset for Hamilton County, Ohio. This chapter identifies organizational frameworks that exist for other shared service assets that may be adapted for a UAV asset.

A. UNITED STATES PERSPECTIVES OF UAV USE

The utilization of UAVs in the hobbyist market within the United States has increased dramatically over the last several years. The implementation of the Part 107 regulations will create an inundation of small commercial UAVs into the nation's air space. Safely integrating the UAVs has been the task of the FAA, and the intent of the FAA Modernization and Reform Act of 2012 and subsequent related legislation. The FAA has faced many challenges along the way. Bart Elias, a specialist in aviation policy for the CRS mentioned in the previous chapter, has identified several safety concerns posed by the integration of UAVs into the airspace. Elias cites incidences of incursions between commercial aircraft and small UAVs, reports of UAVs flying too close to wildfires, concern for UAVs flying over public events, and the potential to utilize UAVs in a terroristic manner.[72]

Richard Thompson, a legislative attorney also with the CRS, is concerned with the privacy issues presented with increased utilization of UAVs within the United States, and the lack of judicial precedence regarding the privacy impacts of UAV flight.[73] A study conducted by the University of Nevada in Las Vegas surveyed U.S. adult citizens regarding their opinion regarding aerial drone activities. While many respondents indicated they are "very concerned" about privacy issues of UAV use around their homes

[72] Bart Elias, *Unmanned Aircraft Operations in Domestic Airspace: U.S. Policy Perspectives and the Regulatory Landscape* (CRS Report R44352) (Washington, DC: Congressional Research Service, 2016), https://www.fas.org/sgp/crs/misc/R44352.pdf.

[73] Richard Thompson, *Domestic Drones and Privacy: A Primer* (CRS Report R43965) (Washington, DC: Congressional Research Service, 2015), http://fas.org/sgp/crs/misc/R43965.pdf.

they overwhelmingly supported (93%) the use of UAVs for search and rescue operations by emergency services.[74]

B. UAV MISSION WITHIN THE REGIONAL EMERGENCY SERVICES

Hamilton County, Ohio, is located in the southwest corner of the state, bounded by Indiana to the west, Kentucky to the south, and Butler, Warren, and Clermont Counties in Ohio to the north and east. Established as a county in 1790, Hamilton County now covers 407 square miles and has a population of 802,000 people.[75] Hamilton County is made up of 49 cities, villages and townships.[76] The county seat is the city of Cincinnati, which makes up most of the southern border of the county and is adjacent to the Ohio River. Cincinnati has a population of 297,000 and covers 77.2 square miles.[77] It is by far the largest municipality within the county. Of the 49 municipalities within Hamilton County, 40 provide fire departments for their citizens. Municipalities that do not have their own autonomous services usually contract with an adjacent community or have formed a fire protection district.

Unmanned aerial vehicles have been demonstrated to be effective in various aspects of emergency response including hazardous materials, search for missing persons, equipment transport, and situational awareness on the scene of structure fires. Within Hamilton County, there are primarily two resources to provide hazardous materials response: The Cincinnati Fire Department (CFD), which responds to incidents within the city limits, and the Greater Cincinnati Hazardous Materials Unit, which responds in the rest of the county.

A UAV asset available to each of these entities would be beneficial. Currently, on a hazardous materials scene, the responders would potentially have to enter the hazardous

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[74] Terance D. Miethe et al., "Public Attitudes About Aerial Drone Activities: Results of a National Survey," *UNLV Center for Crime and Justice Policy*, July 2014, http://www.unlv.edu/sites/default/files/page_files/27/CCJP-PublicAttitudesAboutAerialDrones-2014.pdf.

[75] "Hamilton County – 2014 By the Numbers," Hamilton County, accessed April 14, 2016, http://www.hamiltoncountyohio.gov/hc/videoseries/bythenumbers.asp.

[76] "Homepage," Hamilton County, Ohio, accessed April 14, 2016, http://www.hamiltoncountyohio.gov/hc/default.asp.

[77] "General Information," Cincinnati USA Convention and Visitors Bureau, accessed April 16, 2014, http://www.cincyusa.com/cincinnati/info/.

zone at least two times. The first entry would be to size up the situation and identify the product, and the second entry would be to mitigate the spill or leak. Using an onboard camera to gather information from the container, vehicle, or placard, an unmanned aerial vehicle can fly into the hot zone to size up and identify a potentially hazardous substance. The UAV would reduce the risk and exposure to responders by allowing them to remain in a safe area and eliminating an entry. Furthermore, a UAV can also be equipped with sensor technology to identify and determine the presence of gases.

The Cincinnati Fire Department and the Hamilton County Sheriff's Office both maintain an explosive ordnance disposal (EOD) team. The use of a UAV for reconnaissance during a response to a suspicious package could be invaluable by saving time and reducing risks to responders. The EOD team could rapidly deploy the UAV to recon the package and determine the safest manner of approach. A UAV would save time and provide a larger situational awareness picture than those provided with the limited scope and slower speed of an EOD robot.

Searches present their own challenges. Searches for missing individuals within the region traditionally has started with the local emergency service, and then transitioned to the regional urban search and rescue team. Overland search is time-consuming, tedious work and requires a large contingent of emergency personnel. The utilization of an unmanned aerial vehicle has the potential to shorten the time required to search a vast area as well as reduce the number of personnel needed to conduct that search. UAVs equipped with optical cameras and forward looking infrared (FLIR) have been utilized in searches of large areas of terrain where they were able to detect and direct the team to the victim, or reduce the area needed to be searched by emergency personnel. Over the past several years, emergency services in the region have been asked to search local rivers to find drowning victims. In these kinds of emergencies, a UAV with FLIR could be deployed to find a swimmer who was struggling to stay afloat or one incapacitated on a bank. It can identify the victim's location based on the temperature difference between the body heat and the surface temperature of the water. The UAV could also search the river and banks for many miles without tiring and examine locations that are difficult, or even impossible, to traverse by foot. The information gathered by the UAV could be transmitted in real time back to an operations center and stored onboard the UAV for examination upon return. A UAV was recently used in a search in Colorado where a horse had been missing on an 800-acre ranch. Searchers looked for the horse for three days before locating the animal with a UAV that was equipped with FLIR.[78] Similarly, two postgraduate students at Newman University utilized a UAV equipped with an optical camera to find a rescue mannequin during a search exercise at the Kansas Emergency Management Training Center. Under similar circumstances in the real world, it would have taken much longer to locate the victim using traditional search means.[79]

For a commander arriving at an emergency scene, situational awareness is critical but perspective can be a challenge, especially when an incident involves a large area. The ability to place a UAV in the air to give the incident commander perspective of the emergency can be invaluable for strategic decision making. When a fire threatens to engulf nearby buildings, an incident commander on the ground has no way of knowing the path of the fire relative to the salvageable areas of the structures. UAVs equipped with FLIR and optical cameras can provide this kind of information to the incident commander. Then the incident commander can make informed decisions regarding the fire's progression and where to place resources to engage a firefight. If the building is beyond salvage, then the incident commander can pursue a defensive strategy. This information can be useful in determining the location of firefighting streams both inside and outside the building. In fact, the Fire Department in Lincoln County, Missouri, employed a UAV during a fire in a 9,000 square foot high school field house, and the incident commander was able to use the information provided by the UAV for situational awareness and to keep firefighters safe around the structure.[80]

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[78] "Drone Brings Happy Ending in Search for Missing Horse," Unmanned Aerial, Oct. 20, 2015, http://unmanned-aerial.com/drone-brings-happy-ending-in-search-for-missing-horse/?utm_medium=email&utm_source=LNH+10-21-2015&utm_campaign=UAO+Latest+News+Headlines.

[79] Clark Shafer, "Newman Grad Students' Drone Research to Help Local Fire Departments," *Newman Today*, August 13, 2015, http://news.newmanu.edu/newman-grad-students-drone-research-to-help-local-fire-departments/#.VgicK8h8cI0.email.

[80] Jason Reagan, "New UAV Tech Can Save Firefighter Lives," Dronelife, March 16, 2016, http://dronelife.com/2016/03/16/new-uav-tech-can-save-firefighter-lives/.

The UAV also provides information to assess large areas affected by natural or man-made disasters. For the Hamilton County region, natural disasters mean tornadoes and flooding. Table 1 presents the county's tornados history from 1954–2014. Since 1950, 64 tornadoes have struck Hamilton County on ten separate dates (multiple tornados occurred on the same date).[81] These tornados occurred over a wide area, and by utilizing a UAV, the Emergency Management Agency could collect valuable information to conduct rapid needs assessment (RNAs) to make decisions regarding deployment of search and rescue teams.

Table 1. Tornado Occurrences 1954–2014, Hamilton County, Ohio[82]

Date	Fujita	Fatalities	Injuries
5/2/54	1	0	0
2/25/56	2	0	0
7/11/58	2	0	8
7/11/58	2	0	0
7/11/58	2	0	8
8/9/69	3	4	247
4/3/74	5	3	210
4/3/74	5	0	0
4/3/74	5	0	20
4/3/74	5	3	190
4/3/74	4	2	39
9/11/75	1	0	0
10/1/77	3	0	17
10/1/77	1	0	0
6/2/80	1	0	15
6/2/90	4	0	37
6/2/90	4	0	21
6/2/90	4	0	16
4/9/99	1	0	0
4/9/99	4	4	65
6/4/08	0	0	0

81 "Tornadoes in Hamilton County, Ohio," TornadoHistoryProject.com, accessed April 16, 2016, http://www.tornadohistoryproject.com/tornado/Ohio/Hamilton.

82 Ibid.

Unlike the abrupt tornado, flooding is considered a more predictable visitor, and many consider it an annual occurrence within Hamilton County. The county has multiple waterways within its borders, including 37 miles of the Ohio River, the Great Miami River, The Little Miami River, The Whitewater River, the Mill Creek and the Duck Creek. From 1993 to 2009, Hamilton County has experienced 88 flood and flash flooding events.[83] The waterways traverse many municipalities throughout Hamilton County, and a UAV asset could provide real-time situational awareness to determine locations of residents in need of rescue during a flood, as well as provide confirmation of the inundation models and information for evacuation orders. During a disaster, the UAV is faster to deploy than manned aircraft and more reliable than satellite imagery that has to orbit the Earth and can fly below cloud cover. In addition, the University of New Mexico and San Diego State University have developed software platforms for UAVs that can detect minute damage to transportation infrastructure for use by emergency coordinators in flooding and other natural disasters.[84]

C. REGIONAL RESPONSE ASSETS AND STATISTICS

Within Hamilton County, there are 40 separate fire departments, or fire protection districts.[85] Each department provides and manages its own fire apparatus, personnel and command staff. Within the county, there are more than 80 engines and over 30 ladder companies. Arguably, there is duplication of resources within the Hamilton County fire services. Most of this equipment is utilized daily while responding to routine fire and emergency medical incidents within the community.

1. Hamilton County

Table 2 was created using statistics provided by the Hamilton County Communications Center (HCCC) and the Cincinnati Fire Dispatch Center. It shows the

[83] The Polis Center at IUPUI, Dept. of Geography at University of Cincinnati, and Hamilton County EMA, *2013 Hamilton County Multi-Hazard Mitigation Plan* (Cincinnati, OH: Hamilton County Emergency Management Agency, 2013), 53, http://www.hamiltoncountyohioema.org/wp-content/uploads/2015/09/2013-Hamilton-County-Mitigaiton-Plan-Complete.pdf.

[84] "Drones for Disaster Response and Relief Operations."

[85] "Hamilton County Fire Departments," Hamilton County Fire Chief's Association, accessed April 14, 2016, http://www.hamiltoncountyfirechiefs.com/hamilton-county-fire-departments.html.

number of responses within Hamilton County, excluding the city of Cincinnati, for structure fires that lasted longer than one hour in duration, hazardous materials responses, and water responses from 2013–2015. All of these responses could have the potential for the use of a UAV. The structure fire dispatch data that resulted in an on-scene time of greater than 1 hour was utilized as an opportunity to deploy a UAV asset. (HCCC does not capture data on actual working fires just the initial dispatch code.) The one-hour time frame suggested an incident of significance where a UAV could be utilized. It allows for arrival and set up of the UAV within 30 minutes of receipt of call, which will be dependent on the location and staffing model of the UAV. A locally owned UAV asset could be deployed in a shorter amount of time but would require personnel to operate from the initial arriving entity and would negatively impact the firefighting operations due to the reduction of personnel.

In reality, many of these responses were resolved within 10 to 15 minutes of arrival of the fire department; however, the one-hour benchmark captured the largest number of incidents for comparison. The table shows that within Hamilton County that only some of the departments would have the potential to deploy a UAV more than once a month (highlighted in yellow). Most fire departments calculate responses based on monthly totals and compile those results for a comprehensive annual report.

Table 2. Hamilton County Response Data from 2013 to 2015[86]

	2013				2014				2015			
Department	St. Fires	Hazmat	Water	Total	St. Fires	Hazmat	Water	Total	St. Fires	Hazmat	Water	Total
Amberly				0	0			0	0			0
Anderson	16		6	22	11		4	15	16		6	22
Blue Ash	5	1		6	5		1	6	1			1
Cheviot	6			6	2			2	4			4
Colerain	18			18	31		2	33	40			40
Crosby Twp.	2			2	2	2		4	1			1
Deer Park - Silverton	6			6	2			2	0	1		1
Delhi	4			4	8		1	9	2			2

86 Data received from Shawn Cruze, Hamilton County Communications Center interim director, in an email to the author, May 3, 2016.

	2013				2014				2015			
Elmwood	2	1		3	3			3	1			1
Evendale	1			1	3			3	4	1		5
Forest Park	12	1		13	11			11	9			9
Glendale	1			1	2			2	2			2
Golf Manor	5			5	1			1	0			0
Green Twp.	11	1	1	13	14			14	16	1		17
Greenhills	2			2	3			3	5			5
Harrison	7		2	9	8			8	9		3	12
Lincoln Heights	2			2	1			1	2			2
Little Miami	4		2	6	3			3	2			2
Lockland	4			4	6			6	3			3
Loveland/ Symmes				0			1	1				0
Madeira/ Indian Hill	6			6	7			7	1			1
Mariemont	1			1	2			2	1			1
Miami Twp.	9		2	11	15	2	1	18	11	1	2	14
Milford	6		1	7	7	1	2	10	9		1	10
Montgomery	4			4	0			0	6			6
Mount Healthy	5			5	5			5	5			5
North College Hill	5			5	10			10	8			8
Norwood				0				0				0
Reading	10			10	5			5	7		1	8
Sharonville	11	2		13	9	2		11	4			4
Springdale	7			7	3			3	7			7
Springfield Twp.	19			19	17		2	19	8	1	2	11
St. Bernard	3			3	2			2	6			6
Sycamore Twp.	9	1		10	10			10	6			6
Terrace Park	1			1	1		1	2	1			1
Whitewater Twp.	5		2	7	4		6	10	7		2	9
Woodlawn	5			5	5			5	4			4
Wyoming	5			5	2			2	2			2
No Dept. AVL	8	2	0	10	8	3		11	7	2		9
	227	9	16	252	228	10	21	259	217	7	17	241

2. City of Cincinnati Response Data

The city of Cincinnati response data depicted in Table 3 includes extra alarm fires, explosive ordinance device (EOD), hazardous materials (Hazmat) and river responses for the period from 2013 to 2015. The response data reveals the Cincinnati Fire Department would have the potential to utilize a UAV asset multiple times per month and could justify hosting one of the regional assets.

Table 3. Cincinnati Fire Response Data 2013 to 2015

	2013					2014					2015				
Department	Extra Alarms	EOD	Hazmat	River	Total	Extra Alarms	EOD	Hazmat	River	Total	Extra Alarms	EOD	Hazmat	River	Total
Cincinnati	8	52	11	20	91	3	39	7	24	73	11	49	7	25	92

The data in Table 2 reveals that an unmanned aerial vehicle asset would not be utilized every day by each fire department, and it would be an egregious duplication of resources for each fire department to purchase and maintain a UAV. Developing a UAV asset for a department would cost approximately $44,274.00 per UAV. This figure includes purchasing the airframe and optical camera, an infrared camera, the necessary electronics to transmit the images to the incident commander, the emergency operations center, and initial training for five operators per aircraft. The extended cost over 40 fire departments would be $1,770,960.[87] These figures do not include the costs of training to maintain currency and proficiency, or maintenance and repair of the vehicles.

An additional consideration would be the diversion of a firefighter from fighting the fire in situations where departments do not have the discretionary personnel to implement the UAV on scene. This cost will continue into perpetuity, even if the cost of ownership of a UAV asset drops drastically. The loss of a single firefighter from a fire company to deploy the UAV can greatly affect the firefighting ability of smaller

[87] See Appendix A for cost breakdown.

departments. The shared service model would provide an operator from a department not involved in initial firefighting operations.

D. BARRIERS TO THE UAV MISSION

1. Regulation and Legislation

The benefits of a public service UAV asset continue to evolve with improvements in technology; however, there are significant barriers to utilizing unmanned aerial vehicles for emergency operations. Federal regulations governing the national airspace have not kept pace with the evolving technology and restrict the use of UAVs by public emergency services. Under the current legislation, public entities must submit for a Certificate of Waiver or Authorization (COA) and await its processing. The COA is usually effective for two years but restricts the UAV to a particular geographical airspace.[88] Without a shared service model, each individual entity would be required to apply for a separate COA, and it would not be valid outside of its designated flight area.

The United States adopted the "Operation and Certification of Small Unmanned Aircraft Systems; Final Rule" on June 21, 2016.[89] The new legislation FAA proposed is codified under Part 107 of the Federal Aviation Regulations.[90] This reform allows a small UAV weighing less than 55 pounds to operate without requiring an airworthiness certificate, exemption, or a COA for civilian operation. The new Part 107 regulations allow for crop monitoring and inspection, research and development of UAV technology, educational and academic uses, powerline and pipeline inspection, antenna inspection, in search and rescue operation assistance, bridge inspections, aerial photography, and wildlife nesting area evaluations.

While these amended regulations are a sign of progress for civilian UAV operation, the Part 107 regulations do not apply to public operation of unmanned aerial vehicles. Public operation of a UAV is still regulated under the COA process.[91] In

[88] H.R. Rep. No 112-381 (2012) (Conf. Rep.).

[89] "Department of Transportation," *Federal Register*.

[90] Ibid.

[91] Ibid.

contrast, current Canadian UAV regulations classify their UAVs by inherent risk rather than intended use, acknowledging that lighter UAVs pose a smaller danger to both people and property on the ground.[92] Newly proposed amendments to the Canadian regulations would permit flight of a small UAV in urban areas and night flight, while still not permitting flight beyond visual line of sight.[93] Permitting flight beyond the visual line of sight has become dependent on the development of sense and avoid technology[94] that can be installed on a UAV. Restricting the use of a UAV to line of sight limits the capability of the asset to search areas well within the potential of the aircraft and makes the search less efficient. Development of sense and avoid technology that is small enough to be installed on small UAVs is not yet available.

2. Operator Training

The proposed amendments to the Code of Federal Regulation (CFR) Part 107 will require a small UAV operator to pass a knowledge exam to obtain an unmanned system operator's certificate from the FAA.[95] These exams will be created by the FAA and administered by currently approved knowledge centers. Operators will need to pass a knowledge exam every 24 months to maintain a current operator's certificate.[96] Operators will need to become proficient with the aircraft. While there is no flight proficiency exam associated with the proposed CFR Part 107 regulations,[97] training will be required to operate the aircraft efficiently and safely under emergency conditions. Operator training can be obtained from the UAV manufacturer and will have to be included in the budget for creating the UAV asset.

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[92] "CARAC Activity Reporting Notice 2015–012," Transport Canada, May 28, 2015, http://wwwapps.tc.gc.ca/Saf-Sec-Sur/2/npa-apm/doc.aspx?id=10288.

[93] Ibid.

[94] UAVs are not equipped with the capability to autonomously detect, sense, and avoid obstacles or other aircraft. Until that technology is developed for small UAVs, the ability to fly beyond the line of sight will be restricted.

[95] "Department of Transportation," *Federal Register*.

[96] Ibid.

[97] Ibid.

To become a proficient UAV operator will require hours of flight time and practice. In addition to training, the operator will need to log hours of flying during emergency scenarios to develop experience. Continual training and flight time will be required to maintain currency of the operator's skills.

3. Privacy Concerns

The proliferation of UAVs in the United States has fueled debate regarding the expectation of privacy. Bart Elias, the aforementioned specialist in aviation policy for Congressional Research Service, contends that cameras and imaging sensors are the biggest concern among privacy advocates. Elias also makes the point that the proponents of UAV technology maintain that the sensor technology affixed to UAVs is no different from the technology attached to manned aircraft, cellular phone towers, telephone poles or tall buildings.[98] Senator Patrick Leahy, the chairman of the Senate Judiciary Committee, stated in the *National Post* that UAVs are a fast-emerging technology that "could pose a significant threat to the privacy and civil liberties of millions of Americans."[99] Attorney Saurabh Anand[100] believes the negative public perception of UAVs may pose one of the largest obstacles for implementation by public entities.[101] Anand's contention may be true for law enforcement, but in 2013, researchers from Monmouth University conducted a survey that determined the majority of the public support using UAVs for search and rescue.[102] A similar poll conducted by Reuters in 2015 revealed that a majority of the public support public-service UAV use, including use by law enforcement to solve crimes.[103] However, The American Civil Liberties Union (ACLU) has been outspoken regarding privacy issues and UAV use by law

98 Elias, *Pilotless Drones*.

99 Wald, "The Drones Next Door."

100 Saurabh Anand is an attorney for the University of Southern California and holds a bachelor of science degree in mechanical and aerospace engineering.

101 Saurabh Anand, "Hovering on the Horizon: Civilian Unmanned Aircraft," *The Air and Space Lawyer* 26 (2013): 9–13.

102 "Drones' Good Flies Hand in Hand with Bad."

103 Scott Alwyn, "Americans OK With Police Drones–Private Ownership, Not So Much: Poll," Reuters, February 5, 2015. http://www.reuters.com/article/2015/02/05/us-usa-drones-poll-idUSKBN0L91EE20150205.

enforcement, stating it believes law enforcement will be more tempted to use UAVs without a warrant,[104] and the ACLU of Massachusetts supports a "Drone Privacy Policy" that would set limits regarding the government's use of UAVs.[105]

The University of North Dakota has been a pioneer in UAV research and training over the past several years and has developed a compliance committee to address public concern related to UAV integration into the national airspace system.[106] In order to overcome the possible negative community reaction to instituting a public UAV program, the University of North Dakota recommends holding meetings where local businesses and concerned individuals are free to voice their concerns regarding the UAV program and address the ethical issues. The ACLU has endorsed the University of North Dakota's model as an "excellent vehicle for providing education and transparency" regarding UAV use by public operators.[107]

Unmanned aerial vehicles can collect a large amount of data, which includes images, data and patterns of unsuspecting and uninvolved citizens. Congress has held hearings concerning the privacy issues presented by the emerging UAV industry; however, there has not been any federal legislation passed.[108] There have been bills introduced that have not yet been ratified. The Drone Aircraft Privacy and Transparency Act (DAPTA) of 2015 has been proposed in the Senate to address UAV privacy issues as they relate to commercial and governmental use of unmanned aerial vehicles.[109] As of March 2016, this bill was under consideration by the Committee on Small Business& Entrepreneurship.[110] DAPTA charges the Secretary of Transportation to require UAV

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[104]"Drones' Good Flies Hand in Hand with Bad."

[105] Lang, "Officials See Local Role for Drones."

[106] Karen Vance et al., "Unmanned Aircraft Systems," 10.

[107] Ibid.

[108] Hilary Farber, "Sensing and Surveillance; Constitutional Privacy Issues of Unmanned Aircraft," *Unmanned Aircraft in the National Airspace,* ed. Donna A. Dulo (Chicago: American Bar Association, 2015), 230.

[109] "S.635 Drone Aircraft Privacy and Transparency Act of 2015," Congress.gov, accessed June 23, 2016, https://www.congress.gov/bill/114th-congress/senate-bill/635/text.

[110] "All Actions – S.635 – 114th Congress (2014–2015)," Congress.gov, accessed June 9, 2016, https://www.congress.gov/bill/114th-congress/senate-bill/635/all-actions?overview=closed#tabs.

operators to provide data collection policies that operate under “privacy principles” and that governmental use of UAVs follows the rule of law for privacy concerns—especially for use in law enforcement.[111] DAPTA does not apply to hobbyist UAV operators.

The literature has shown that privacy concerns of the community related to data collection during the course of emergency operations need to be addressed when implementing a UAV program and that including law enforcement in an emergency response program may create additional public concern. The regional asset would need to comply and develop privacy policies that conform to community expectations. Involving the public early in the process has shown to have positive results.[112]

E. BENEFIT OF SHARED SERVICE MODEL

Examining the information presented in this chapter leads to the conclusion that a shared service model would be the most effective and efficient for the Hamilton County region. If every fire department within the county developed a UAV asset, it would result in over 40 separate UAV assets. Each asset would require multiple operators to be trained, certified and available for response. The response data for the region shows that departments would not utilize their asset frequently on an emergency scene, and as a result, the operator would not gain the experience necessary for UAV flight under emergency conditions. Each department would need to develop a set of operating procedures and privacy policies to govern the use of the asset, potentially resulting in over 40 different policies within the county regarding UAV use. Each department would also be required to submit an application for a COA to the FAA, also resulting in 40 applications for processing and approval.

Creating a shared service UAV asset for the county would avoid the duplication of resources and determine the number of assets to be provided. A geographic information system (GIS could be utilized to strategically position the assets throughout the county for the most efficient response configuration. A shared service would coalesce the asset into one entity and require one COA, privacy policy, and procedure for

[111] “S.635 Drone Aircraft Privacy and Transparency Act of 2015.”

[112] Ibid.

operations. The collaborative would reduce the number of operators as well as increase the experience level of operators by not diluting the number of flight opportunities among the 40 departments. It would also reduce the training costs to produce certified operators.

The initial creation of the shared service UAV asset for the county must determine the best model for the shared service. Chapter III addresses the evaluation criteria for each of the shared service models discussed in Chapter IV.

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III. EVALUATION CRITERIA

The shared service models presented in the next chapter will be evaluated on their effectiveness. The evaluation will focus on five categories: the organizational structure of the organization, the ownership and funding of the asset, how the unit is staffed, the response of the asset, and how the asset manages risk and liability. The evaluation of the organizational structure of the shared service models was necessary in order to apply the results to the governance of the regional UAV asset. The shared service UAV asset will require a funding mechanism, thus the ownership and funding of the shared service models were studied to identify sustainable funding for the asset. The UAV asset will require personnel to operate the aircraft, thus the shared service models were evaluated to identify the benefits of each staffing model and apply them to the UAV asset. The management of risk and liability of the shared service was also evaluated, as a UAV asset poses an inherent risk when flying. Each of the five categories was further divided into subcategories to assess specific components within the category and how they affect the shared service model.

A. EVALUATION MATRIX

Each of the shared service models was evaluated using the same metrics. The subcategories were scored using a low, medium, high scale and were given a point value based on this evaluation. A low score received one point, a medium score received five points, and a high score received 10 points. Scoring each subcategory individually allows for the creation of a hybrid shared service model by selecting the best subcategory from each main category to build the most effective model.

The points for each subcategory will be totaled and divided by the number of subcategories evaluated to determine an average for the category. The average score for the category will be compared to the other shared service models.

B. EVALUATION CRITERIA

The evaluation criteria were organized by the category of the shared service model evaluated.

1. Organization

The organization of the asset refers to what body ultimately governs the asset. The organization of shared services under a larger parent organization provides the opportunity for diverse management and oversight of the asset and ensures that the asset is available to all entities in the region. The larger organizational structure establishes the agreement for all parties within the region and the parameters for the use of the asset. It also influences the remaining evaluation characteristics.

The more removed the organization is from local control could translate into less responsiveness and oversight from the organizational body to the needs of the asset within the region. The perceived access to oversight of the organization is based on the status of reporting frequency or how often the asset interacts with the organizational structure. Scoring for how the organizational structure provides oversight of the asset is shown in Table 4:

- High – Organizational structure provides direct oversight of the asset including frequent status reports (monthly)
- Medium – Organizational structure provides some oversight with occasional but scheduled status reports (quarterly).
- Low – Organizational structure provides minimal or no oversight with no scheduled status reports.

Table 4. Oversight and Organizational Structure

Organizational Structure Scoring Matrix			
	Low (1)	Medium (5)	High (10)
Oversight			

2. Ownership and Funding

The ownership and funding category evaluated the initial purchase to establish the asset and the funding mechanisms for sustainment and maintenance utilized by each shared service. It also assessed impact on the host agency's budget.

The **initial purchase** includes the acquisition all of the hardware, software and training of personnel to establish the asset as a shared service within the region. Scoring for the funding mechanism utilized for purchasing the initial asset and its impact on the host agency's budget is as follows:

- High – No impact on the host budget for initial purchase.
- Medium – Some impact on the host budget for initial purchase.
- Low – Initial purchase completely dependent on host agency funding.

Sustainment and maintenance funding allows for the continued replacement of consumable items (fuel, batteries, supplies, etc.), preventative maintenance, and repair of damaged or inoperable equipment to keep the asset available for deployment within the region. Scoring for the funding mechanism utilized for sustainment and maintenance of the asset and the impact on the host agency budget will be as follows:

- High – No maintenance and sustainment relies on the host agency budget.
- Medium – Some maintenance and sustainment relies on the host agency budget
- High – All maintenance and sustainment relies on the host agency budget.

Some shared service models have the capability to bill the user for the utilization of the resource. **Billing for service** can be a controversial topic and can be applied only in certain response instances. Scoring for the asset's potential funding from bill for service will be as follows:

- High – Can bill for almost every response.
- Medium – Can bill for service depending on the nature of the emergency.
- Low – Cannot bill for service or has not investigated or historically levied fee for service.

The following scoring matrix shown in Table 5 will be used to compile the evaluation data regarding the ownership and funding of each shared service studied.

Table 5. Ownership and Funding

Ownership and Funding Scoring Matrix			
	Low (1)	Medium (5)	High (10)
Initial Purchase			
Sustainment and Maintenance			
Bill for service fees			

3. Staffing

The staffing component of the asset was evaluated based on the **availability of personnel** where the asset is housed, the operational burden of staffing the asset, and the financial burden to the host agency to staff the asset.

The availability of personnel where the asset is housed to transport and operate the asset at the emergency scene results in a reduced response time and affects the resiliency and consistency of the asset. Scoring for the asset's potential funding from bill for service will be as follows:

- High – Asset responds immediately upon receipt of call with sufficient staffing to operate the asset upon arrival.
- Medium – Asset responds immediately and must wait for personnel to arrive on scene to operate the asset.
- Low – Asset must wait to respond until personnel arrive to transport the asset and must wait for personnel to arrive on scene to operate the asset.

The **operational burden** is the effect on the host department to absorb the loss of personnel that deploy with the shared service asset and are no longer available to respond to emergencies within the host community. The operational burden to the host department was evaluated and scored as follows:

- High – Host agency can still provide service to community using existing resources

- Medium – Host agency can sustain services to the community but must backfill the personnel.

- Low – Host agency cannot absorb the loss of personnel and continue to provide services to the community.

The **financial burden** of staffing is the cost incurred by the host agency as the result of personnel deployment and is interdependent with the operational burden. While a department may be able to continue to provide service to the community as the result of the asset deployment, the personnel utilized for that deployment presents a cost to the host organization in the form of lost services. The financial burden will be evaluated and scored as follows:

- High – Personnel are essentially volunteers and the host does not incur any cost for staffing

- Medium – Personnel are lost from service to the community but the organization can absorb the loss without incurring backfill overtime.

- Low – Personnel are lost from service to the community and must be backfilled with overtime to provide services.

The scoring matrix shown in Table 6 was utilized for compiling the evaluation data regarding the staffing of each shared service studied.

Table 6. Staffing Conditions

Staffing Scoring Matrix			
	Low (1)	Medium (5)	High (10)
Availability of personnel			
Operational burden			
Financial burden			

4. Response

The response component of the asset was evaluated based on the response time, redundancy of the asset for availability or response to multiple incidents and for the consistency of the response.

The **response time** is the length of time required for the asset to arrive on the scene of the emergency and be operational within its region. Response time was evaluated and scored based on the following criteria:

- High – Respond and operational within thirty minutes
- Medium – Response and operational greater than thirty minutes but less than one hour
- Low – Response and operational greater than one hour.

The **resiliency** of the asset is its ability to respond if the primary host agency (or fire company) is unavailable. Resiliency was evaluated and scored based on the following criteria:

- High – Multiple personnel available and on duty on a daily basis that can transport and operate the asset independent of the primary host.
- Medium – Multiple personnel available but must be recalled from home to respond with the asset.
- Low – No additional personnel available to respond with the asset if the primary agency is unavailable.

The **tactical reserve** of the asset is its ability to respond to multiple incidents occurring at the same time. Tactical reserve was evaluated and scored based on the following criteria:

- High – Multiple assets available to respond independently.
- Medium – Ability to respond to no more than two incidents simultaneously.
- Low – Can only respond to one incident at a time.

The **consistency** of the response is the level of assurance that the asset will provide for every request for service. Consistency was evaluated and scored based on the following criteria:

- High – Asset is staffed and available at all times.
- Medium – Asset staffing is dependent on the staffing levels of the host department and may or may not respond based on that staffing.

- Low – Asset dependent on the availability of members with no guaranteed personnel.

The scoring matrix shown in Table 7 was used to compile the evaluation data regarding the staffing of each shared service studied.

Table 7. Response and Consistency

Response Scoring Matrix			
	Low (1)	Medium (5)	High (10)
Response time			
Resiliency			
Tactical Reserve			
Consistency			

5. Risk and Liability

The risk and liability is dependent on state and federal law and ownership of the asset. The risk and liability component is evaluated on the ability of the asset to claim **sovereign immunity** in response to any damages incurred. The risk and liability component was evaluated and scored based on the following criteria, as seen in Table 8:

- High – Sovereign immunity can be claimed.
- Medium – No sovereign immunity due to nature of the asset; however, liability limits set. (This is state dependent.)
- Low – Cannot claim sovereign immunity.

Table 8. Risk and Liability

Risk and Liability Scoring Matrix			
	Low (1)	Medium (5)	High (10)
Sovereign Immunity			

C. COMPILING THE DATA

All of the evaluation data was compiled into a single table. Assembling the data by shared service model permits a side-by-side comparison over all of the evaluation criteria. The average scores of each subcategory determined the scores for each category. The scores for each shared service were compiled using the framework in Table 9 with a maximum score of 50 (10 possible points for each of the five categories).

Table 9. Shared Service Compiled Scoring

	Shared Service Model Scoring Matrix		
Category	SETRAC	HCUSAR	SOSINK
Organizational Structure			
Ownership & Funding			
Staffing			
Response			
Risk & Liability			

IV. SHARED SERVICE MODELS

This chapter provides an overview of three distinct shared service models. The advantages and disadvantages of each of these models are presented and analyzed using the scoring criteria. Then the results will be evaluated further in Chapter V.

A. SOUTHEAST TEXAS REGIONAL ADVISORY COUNCIL MULTIPLE PATIENT VEHICLE – AMBULANCE BUS

The Southeast Texas Regional Advisory Council (SETRAC) multiple patient vehicle (MPV) – Ambulance Bus (AMBUS) provides the capability to respond to a mass casualty emergency and provide transportation for up to 20 patients to the hospital. It also can be used for hospital evacuation. The AMBUS looks similar to a large coach but is equipped with provisions for cots and has pre-piped oxygen for administration to the patients. Four paramedics, a driver and a supervisor staff the unit. The asset, which is available for no-notice local and regional response, may also be dispatched to statewide emergencies.[113]

1. Organization

The AMBUS is organized under the Southeast Texas Regional Advisory Council. SETRAC is one of eight Emergency Medical Task Forces (EMTFs) within Texas, and it is organized under the Texas Department of State Health Service. SETRAC manages EMTF-6, which is located in southeast Texas and encompasses nine counties and the city of Houston.[114] SETRAC is a nonprofit corporation organized under the Texas nonprofit corporation act.[115] SETRAC is organized under the Texas Department of Health as one of the 22 regional advisory councils as a nonprofit, tax-exempt organization. The primary function of SETRAC is to provide support to its stakeholders within the region and to

[113] "Emergency Medical Task Force," SETRAC, accessed April 21, 2016, http://www.emtf-6.org/EMTF_6_website/MPV.html.

[114] "Emergency Task Force Region 6," SETRAC, accessed April 21, 2016, http://www.setrac.org/go/doc/4207/1760539/.

[115] "Agreement for Housing and Storage of SETRAC MPV 602," SETRAC, Houston, TX, May 7, 2013, personal communication to author.

function as the administrator for state and federal grant programs.[116] SETRAC is governed by an executive committee composed of a chairman, two vice chairmen, a treasurer, a secretary and one officer at large.[117] Below the executive committee is the Board of Directors. The Board of Directors is composed of 10 Emergency Medical Service representatives—one from each of the nine counties and the city of Houston, seven hospital representatives, two at large representatives, and a representative from each of six committees (Preparedness, Cardiac, Pre-hospital, Stroke, Trauma and Injury Prevention). There are 25 members on the Board of Directors.[118] SETRAC is a large state organization and conducts quarterly meetings to address issues. The AMBUS is organized under SETRAC and contracted via Memorandum of Agreement (MOA) to the city of Houston.[119] Table 10 depicts the scoring structure for the SETRAC AMBUS.

Table 10. SETRAC Organizational Structure

Organizational Structure			
	Low (1)	Medium (5)	High 10
Oversight		5	

2. Ownership and Funding

SETRAC retains ownership of the asset and signs MOAs between SETRAC, the Texas Department of State Health Services, and the entity that assumes responsibility for the asset. Within EMTF 6, there are two AMBUSes for response to large emergencies.[120] The Houston Fire Department (HFD) and the Atascocita Volunteer Fire Department operate the AMBUS within SETRAC.

116 "Southeast Texas Regional Advisory Council," SETRAC, accessed May 8, 2016, http://www.setrac.org/go/doc/4207/1709667/.

117 "Executive Committee – Board of Directors," SETRAC, accessed May 8, 2016, http://www.setrac.org/go/doc/4207/1594491/.

118 "Board of Directors," SETRAC, accessed May 8, 2016, http://www.setrac.org/go/doc/4207/1594495/.

119 "Texas Emergency Medical Task Force Memorandum of Agreement," Houston, TX, Sept. 25, 2012, personal communication to author.

120 "Emergency Medical Task Force," SETRAC, accessed April 21, 2016, http://www.emtf-6.org/EMTF_6_website/MPV.html.

The initial purchase for the asset was facilitated through SETRAC. The AMBUS program is funded through a federal program of the Assistant Secretary of Preparedness and Response. The grant is distributed regionally through the EMTF system, and SETRAC manages the grant for EMTF-6. HFD houses and deploys the asset within Houston and the region. The initial purchase of the AMBUS was made possible through this federal grant program and did not affect the Houston Fire Department budget. The ownership and funding initial purchase category for the SETRAC AMBUS model is outlined in Table 11.

Table 11. SETRAC Ownership and Funding–Initial Purchase

SETRAC Ownership and funding			
	Low (1)	Medium (5)	High (10)
Initial Purchase			10

SETRAC agrees through the housing and storage agreement to pay for all approved repairs and maintenance to the AMBUS. Sustainment and maintenance funding is through the grant program. Since the grant program also provides sustainment and maintenance funding, the HFD does not incur additional costs to provide the asset. Table 12 shows the ownership, funding, sustainment and maintenance category for the SETRAC AMBUS.

Table 12. SETRAC Ownership and Funding—Sustainment and Maintenance

SETRAC Ownership and funding			
	Low (1)	Medium (5)	High (10)
Sustainment and Maintenance			10

HFD also has the ability to bill patients' medical insurance for service to recover costs. When a patient is transported to the hospital using the SETRAC AMBUS, patient medical insurance information is collected, and the insurance provider is billed for service.

The proceeds from medical insurance billing are required to be placed back into the sustainment of the AMBUS program. The bill for services category is depicted in Table 13.

Table 13. SETRAC Ownership and Funding—Bill for Services

SETRAC Ownership and funding			
	Low (1)	Medium (5)	High (10)
Bill for service fees			10

SETRAC also seeks donations from corporations and individuals, and offers tax-exempt donation opportunities. SETRAC delineates donors by corporate, major (>$1000) and personal (< $1000).[121] There is a membership fee to belong to SETRAC. The fee structure is divided up between hospitals and EMS providers. The EMS providers are further divided based on the number of emergency transports annually.[122] There is no fee for service when a municipality utilizes the asset; however, the HFD will bill the patients insurance for the medical treatment and transport. Table 14 summarizes the subcategories for the ownership category for the SETRAC AMBUS model.

Table 14. SETRAC Ownership and Funding—Compiled Data

SETRAC Ownership and Funding			
	Low (1)	Medium (5)	High (10)
Initial Purchase			10
Sustainment and Maintenance			10
Bill for service fees			10

3. Staffing

The asset is staffed with on-duty resources within the Houston Fire Department. The AMBUS must be staffed by a licensed driver, a crew chief, two paramedics and two emergency medical technicians (EMT), for a total of six personnel for deployment. All

[121] "Giving Options," SETRAC, accessed May 8, 2016, http://www.setrac.org/go/doc/4207/2178430/.

[122] "Membership Dues," SETRAC, accessed May 8, 2016, http://www.setrac.org/go/doc/4207/1596223/.

six positions require certified personnel. The MOA between SETRAC and HFD states that HFD "must develop and maintain a Local, Regional and State response plan … on a 24/7/365 basis."[123] This staffing model is very reliable, as the HFD is staffed 24/7/365 for response. More than 4,000 firefighters work for the Houston Fire Department, the third largest fire department in the United States.[124] The AMBUS is staffed by on-duty HFD personnel. The primary response would be the engine company assigned where the AMBUS is stored and supplemented with a medic unit (two paramedics) and supervisory personnel.[125] This firehouse is staffed at all times, and as a result, does not cause an additional staffing burden to HFD. Table 15 depicts the subcategory for the staffing availability of personnel for the SETRAC AMBUS.

Table 15. SETRAC Staffing—Availability of Personnel

SETRAC Staffing			
	Low (1)	Medium (5)	High (10)
Availability of personnel			10

Outlined within the MOA, HFD agrees to train personnel provided by other agencies to staff the AMBUS as a secondary resource.[126] The HFD asset is staffed by a fully paid fire department. The Atascocita Volunteer Fire Department also staffs the unit daily but does not have the redundancy in staffing available to HFD. The HFD is a large enough fire department to absorb the deployment of six personnel with the AMBUS and the deployment will not affect the service delivery to the community. Table 16 shows the subcategory for the staffing operational burden for the SETRAC AMBUS.

123 "Agreement for Housing and Storage of SETRAC MPV 602," Houston, TX, May 7, 2013, Section 1 (B), personal communication to author.

124 "About the Houston Fire Department," Houston, TX, accessed May 8, 2016, http://houstontx.gov/fire/about/index.html.

125 "Multiple Patient Vehicle Operations AMBUS (MPV 602)," Houston Fire Department, Vol. 2, July 2013, COMMAND, EMS, Reference No. II-46, Sections 1.01-11.05.

126 "Agreement for Housing and Storage of SETRAC MPV 602," Houston, TX, May 7, 2013, Section 1 (D), personal communication to author.

Table 16. SETRAC Staffing—Operational Burden

SETRAC Staffing			
	Low (1)	Medium (5)	High (10)
Operational burden			10

The Houston Fire Department does incur the loss of the personnel that are no longer available to serve the community as a result of the asset deployment. While there is reimbursement available for state activations for the personnel staffing, the unit, as well as their backfill overtime, most responses are not eligible. The subcategory for the financial burden of staffing the SETRAC AMBUS model is depicted in Table 17.

Table 17. SETRAC Staffing—Financial Burden

SETRAC Staffing			
	Low (1)	Medium (5)	High (10)
Financial burden		5	

Table 18 presents the staffing subcategories for the SETRAC AMBUS model.

Table 18. SETRAC Staffing—Compiled Data

SETRAC Staffing			
	Low (1)	Medium (5)	High (10)
Availability of personnel			10
Operational burden			10
Financial burden		5	

4. Duplication of Resources

As part of a regional organization, SETRAC has provided two assets within the region. As a result, it has reduced the duplication of equipment for a low-frequency, high-impact asset and increased capability within the region while maximizing resources.

5. Response

The AMBUS could take up to 30 minutes for response within the city of Houston, depending on the time of day and potential for traffic delays. Responses outside the city of Houston could take up to 1½ hours, depending upon the location of the emergency. The AMBUS is a state resource and could be dispatched anywhere in the state, which would take even longer. The response time subcategory for the SETRAC AMBUS model is depicted in Table 19.

Table 19. SETRAC Response—Response Time

SETRAC Response			
	Low (1)	Medium (5)	High (10)
Response time			10

The response model established by HFD provides for an engine (four firefighters) and a medic unit to respond (two paramedics). This meets the minimum number required by SETRAC for response. In addition, HFD dispatches a medical supervisor along with the EMS district chief to serve as a liaison to command or the medical branch director if needed. If the host company is unavailable, all Houston companies have AMBUS training and can respond with the asset, a distinct advantage that provides overall resiliency. The subcategory for the response resiliency for the SETRAC AMBUS model is depicted in Table 20.

Table 20. SETRAC Response—Resiliency

SETRAC Response			
	Low (1)	Medium (5)	High (10)
Resiliency			10

There are two assets available within SETRAC: The Houston Fire Department and the Atascocita Volunteer Fire Department. Both assets are located within Harris County, which is centrally located within SETRAC. Having more than one asset available provides a moderate level of tactical reserve for the asset. Table 21 presents the subcategory for the tactical reserve of response for the SETRAC AMBUS model.

Table 21. SETRAC Response—Tactical Reserve

SETRAC Response			
	Low (1)	Medium (5)	High (10)
Tactical Reserve		5	

Houston Fire is staffed 24 hours a day, 365 days a year and provides that staffing for the response of the AMBUS. As a result, the response of the AMBUS is highly consistent providing the asset and a trained crew for every response. The subcategory for the consistency of the response for the SETRAC AMBUS model is depicted in Table 22.

Table 22. SETRAC Response—Consistency

SETRAC Response			
	Low (1)	Medium (5)	High (10)
Consistency			10

Table 23 presents the subcategories for the SETRAC AMBUS model response classification.

Table 23. SETRAC Response—Compiled Data

SETRAC Response			
	Low (1)	Medium (5)	High (10)
Response time			10
Resiliency			10
Tactical Reserve		5	
Consistency			10

6. Risk and Liability

The concept of sovereign immunity is designed to protect governmental entities from lawsuits and monetary damages.[127] Protecting the government from fraudulent or frivolous litigation has been the intended design of sovereign immunity legislation.[128] While sovereign immunity would apply for most governmental actions, it would not apply for motor vehicle accidents involving the AMBUS. The Texas Tort Claims Act of 1969 has waived sovereign immunity for certain situations.[129] Sovereign immunity has been eliminated if the acts are due to "negligence of an employee acting within the scope of employment" and operating "a motor-driven vehicle or motor-driven equipment."[130] While the Tort Claims Act has waived sovereign immunity for incidents involving motor-driven vehicles and equipment, it has limited the liability of the government to $250,000 for each person and $500,000 for each single occurrence for bodily injury or death, and $100,000 for an incident of property damage.[131] Although the sovereign immunity has been waived in these cases, the limit of liability greatly reduces the potential damages a government entity could incur. Risk and liability for the SETRAC AMBUS are depicted in Table 24.

Table 24. SETRAC Risk and Liability

SETRAC Risk and Liability			
	Low (1)	Medium (5)	High (10)
Sovereign Immunity		5	

[127] "Texas Supreme Court Addresses Sovereign Immunity," Sedgwick Law, accessed June 11, 2016, http://www.sedgwicklaw.com/Publications/detail.aspx?pub=4451.

[128] "What Is the Texas Tort Claims Act?," Texas Municipal League, accessed June 11, 2016, http://www.tml.org/legal-qna/2005February.pdf.

[129] Ibid.

[130] Marilyn Phelan, "A Synopsis of Texas and Federal Sovereign Immunity Principles: Are Recent Sovereign Immunity Decisions Protecting Wrongful Governmental Decisions?," *St Mary's Law Journal* 42 (2011): 725–792, http://www.stmaryslawjournal.org/pdfs/Phelan_II.pdf.

[131] "What Is the Texas Tort Claims Act?"

As a result of the liability imposed by the Tort Claims Act, in the SETRAC Agreement for Housing and Storage with the city of Houston, SETRAC agrees to honor the insurance coverage provided through the city of Houston. Houston provides auto liability and physical damage insurance through the Texas Municipal League Intergovernmental Risk Pool. Houston Fire may use the asset as deemed necessary, and HFD will be responsible for any damages incurred.[132] Outlined in the MOA with Houston Fire, HFD assumes responsibility for all liability claims and assumes responsibility for acts of negligence. Table 25 presents a compilation of scores for the evaluation categories.

Table 25. SETRAC Compiled Evaluation Matrix for All Categories

SETRAC		
Category	Total Score	AVG
Organizational Structure	5	5.0
Ownership & Funding	30	10.0
Staffing	25	8.3
Response	35	8.8
Risk & Liability	5	5.0

B. HAMILTON COUNTY URBAN SEARCH AND RESCUE TASK FORCE

Hamilton County Urban Search and Rescue (HCUSAR) provides technical rescue capabilities to Hamilton County, Ohio, and structural collapse capability to Ohio's Emergency Management Agency (OEMA) Region 6, which covers the southwest corner of the state of Ohio. HCUSAR provides trench rescue, confined space rescue, structural collapse, machinery extrication, high angle rescue, and wide area search capability to the 45 departments within Hamilton County. HCUSAR will also respond outside of the county on a mutual aid request basis.

1. Organization

The Hamilton County Fire Chief's Association (HCFCA) is an organization consisting of the fire chiefs within Hamilton County. Each fire department within the

[132] "Agreement for Housing and Storage of SETRAC MPV 602," Section 1 (D).

county pays annual dues to be a member of the HCFCA. HCFCA is a not-for-profit corporation (501C3) formed under the state of Ohio. Hamilton County USAR is a permanent committee formed under the direction of the HCFCA Board of Trustees.[133]

An executive board consisting of president, vice president, secretary and treasurer governs HCFCA. The Board of Trustees shall include the executive board, the immediate past president and five additional trustees.[134] The Board of Trustees appoints the management of HCUSAR. A commissioner, senior advisor and four deputy commissioners form the executive management of HCUSAR. Eight team managers and 12 squad officers complete the management of HCUSAR.[135]

The local organizational control of HCUSAR from the HCFCA provides direct oversight of the asset, and the HCFCA receives monthly briefings from the commissioner of the team. The local oversight can address immediate issues and provide direction for the management team. Examples of oversight provided by HCFCA are approval and audit of the budget and expenditures, member participation, and management evaluation. The budgetary oversight has brought transparency to the organization regarding the financial stability of the asset and provided political support for sustainment grant requests. While HCUSAR is considered a regional state asset, the state does not have any organizational oversight to the asset. Table 26 depicts the organizational structure scoring for HCUSAR.

Table 26. HCUSAR Organizational Structure

Organizational Structure			
	Low (1)	Medium (5)	High 10
Oversight			10

133 "Constitution and Articles of Incorporation," Hamilton County Fire Chief's Association, September 18, 2013.

134 Ibid.

135 *Hamilton County USAR Policy Manual* (Hamilton County, OH: Hamilton County Urban Search and Rescue, 2015).

2. Ownership and Funding

The HCFCA governs and collectively owns HCUSAR. HCFCA manages a portion of the HCUSAR budget, but it does not directly contribute funding to HCUSAR. HCFCA manages the account where the OEMA stipend is deposited, and the treasurer of the HCFCA approves and pays all requisitions and purchase orders submitted by the commissioner. The budget oversight is for accounting purposes only.

The initial purchase of equipment was completed through fund raising, personal and corporate donations. Once established, the team has continued to receive small personal donations, and additional equipment purchases have been through the Urban Area Security Initiative Grant program and state of Ohio Homeland Security Grants. New equipment purchases do not directly affect HCUSAR's budget. Ownership and funding scoring for the initial purchase category are presented in Table 27.

Table 27. HCUSAR Ownership and Funding—Initial Purchase

HCUSAR Ownership and funding			
	Low (1)	Medium (5)	High (10)
Initial Purchase			10

Ongoing sustainment funding is provided through a small stipend from the Ohio Emergency Management Agency and a stipend from the Hamilton County Emergency Management Agency. HCUSAR can only utilize grant money for new equipment purchases and relies on the state EMA stipend and a budget line within the Hamilton County EMA for sustainment funding. Relying on grant funding does not ensure the continued availability of the asset, as the grants must be renewed consistently. Table 28 represents the scoring for the HCUSAR model of ownership and funding and sustainment and maintenance category.

Table 28. HCUSAR Ownership and Funding—Sustainment and Maintenance

HCUSAR Ownership and funding			
	Low (1)	Medium (5)	High (10)
Sustainment and Maintenance		5	

HCUSAR does not charge the municipality requesting the asset or levy a tax for services. Table 29 depicts the HCUSAR scoring for the bill for service subcategory.

Table 29. HCUSAR Ownership and Funding—Bill for Service

HCUSAR Ownership and funding			
	Low (1)	Medium (5)	High (10)
Bill for service fees	1		

Table 30 presents the subcategories for the ownership and funding category for the HCUSAR model.

Table 30. HCUSAR Ownership and Funding—Compiled Data

HCUSAR Ownership and funding			
	Low (1)	Medium (5)	High (10)
Initial Purchase			10
Sustainment and Maintenance		5	
Bill for service fees	1		

3. Staffing

The 106 members of HCUSAR are provided by 26 fire departments. The sponsoring fire department (sponsoring agency) signs a memorandum of understanding (MOU) with HCUSAR, agreeing to cover the member for workers' compensation as an extension of their employment during their participation with HCUSAR. Some departments choose to pay their members for participation or are bound by labor management agreements (LMA); however, HCUSAR does not pay any members salaries.

Two-thirds of the team should be available to respond to every emergency. The team roster stands at 106 members, providing 70 members potentially available in a perfect world. (The 2/3 availability factor is derived by the typical firefighter work schedule. Most career firefighters work 24 hours on duty followed by 48 hours off duty on a three-platoon system. One platoon is always working and two platoons are off duty.) The off duty members receive an activation notification through their mobile device, which provides the incident details and directions to the location of the emergency. The member responds to the notification and indicates whether he or she is able to respond. The member then responds to the incident in a personal vehicle. Table 31 shows the scoring for the HCUSAR model subcategory for staffing and availability of personnel.

Table 31. HCUSAR Staffing—Availability of Personnel

HCUSAR Staffing			
	Low (1)	Medium (5)	High (10)
Availability of personnel		5	

HCUSAR is mostly staffed by career firefighters volunteering during their off-duty time. As a result, the community where the member works is never short-staffed by the member responding to a deployment, and there is no operational burden to the sponsoring agency. Table 32 shows the operational burden of the HCUSAR model for staffing.

Table 32. HCUSAR Staffing—Operational Burden

HCUSAR Staffing			
	Low (1)	Medium (5)	High (10)
Operational burden			10

There are no personnel costs for HCUSAR since all members are volunteering their time or are covered under their LMA with their sponsoring agency. The financial burden imposed on HCUSAR for staffing is scored in Table 33.

Table 33. HCUSAR Staffing—Financial Burden

HCUSAR Staffing			
	Low (1)	Medium (5)	High (10)
Financial burden			10

The subcategories for the staffing category for the HCUSAR model are presented in Table 34.

Table 34. HCUSAR Staffing—Compiled Data

HCUSAR Staffing			
	Low (1)	Medium (5)	High (10)
Availability of personnel		5	
Operational burden			10
Financial burden			10

4. Duplication of Resources

No one fire department could provide or afford the services of the collective regional urban search and rescue (USAR) team. Each department would need to have a cache of equipment (current equipment cache is over $1.5 million) not to mention the ability to assemble 30–35 trained rescue technicians. No single fire department in the county has 30 members on duty within one municipality except the city of Cincinnati. All 46 communities within Hamilton County have the potential to utilize the services of HCUSAR.

5. Response

HCUSAR vehicles respond to the scene separately from the majority of the personnel, and as a result, the team has to wait until a sufficient number of personnel arrive from all over the region to deploy. Responding in this manner can be both an advantage and a disadvantage. The team is made up of many different departments, and the members live in geographically diverse areas of the region. As a result of members living throughout the region and depending on the time of call, response time has been an advantage, as both equipment and personnel arrive and are operational in one hour from dispatch. Table 35 depicts the scoring for the HCUSAR response time subcategory.

Table 35. HCUSAR Response—Response Time

HCUSAR Response			
	Low (1)	Medium (5)	High (10)
Response time		5	

The number of members necessary for each deployment varies by response, but on average, the team deploys with 30–35 members for each activation. All members of the USAR team are trained identically to include all of the technical rescue disciplines. HCUSAR is a large organization and the staffing model is fairly resilient, depending upon the time of day the team is requested to respond. Table 36 depicts the scoring for resiliency of the HCUSAR model for response.

Table 36. HCUSAR Response—Resiliency

HCUSAR Response			
	Low (1)	Medium (5)	High (10)
Resiliency		5	

There is only one HCUSAR team, however, there are two tractor-trailer vehicles that could respond to separate locations. The team members are located throughout the county and the vehicles are located remotely. On average, it takes one hour to be operational on the emergency scene. HCUSAR operates under the HCFCA mutual aid contract for Hamilton County. All fire departments and municipalities have signed the mutual aid agreement.[136] The mutual aid agreement states that the parties will provide requested assistance—if available—without cost.[137] If additional personnel are necessary to supplement multiple requests, the city of Cincinnati has limited technical rescue

[136] "HCFCA Mutual Aid Agreement," Hamilton County Fire Chief's Association, Hamilton County, OH, 2015, personal communication to author.

[137] Ibid.

capability available 24/7/365 by mutual aid request. Table 37 represents the scoring for the tactical reserve of the HCUSAR response model.

Table 37. HCUSAR Response—Tactical Reserve

HCUSAR Response			
	Low (1)	Medium (5)	High (10)
Tactical Reserve		5	

The volunteer staffing model leaves the asset vulnerable to not having enough personnel to deploy. This has almost been a problem in the last two callouts between midnight and 0700 when members were either preparing to go to work or still at work preparing to go off duty. Most employers will not release their firefighters from duty to respond to a HCUSAR call out, nor will they tolerate their members being late as the result of a call out. This creates a predicament several hours before the typical shift change. Fortunately, the situations were resolved by locating the critical missing person prior to deployment of the team.

To ensure a management member is always available, the command staff of HCUSAR, commissioner and four deputy commissioners, rotate duty officer responsibilities on a weekly basis. One of the command staff is always on call one out of five weeks to ensure the team can be activated and a member of the command staff is available to respond. Historically, HCUSAR has never failed to respond to a request. The consistency of the response is scored and depicted in Table 38.

Table 38. HCUSAR Response—Consistency

HCUSAR Response			
	Low (1)	Medium (5)	High (10)
Consistency	1		

Table 39 shows the response subcategories for the HCUSAR model.

Table 39. HCUSAR Response—Compiled Data

HCUSAR Response			
	Low (1)	Medium (5)	High (10)
Response time		5	
Resiliency		5	
Tactical Reserve		5	
Consistency	1		

6. Risk and Liability

HCUSAR is an operating committee of a 501C3 not for profit. Operating as a not-for-profit corporation that is not under the direct auspices of a municipal entity creates a question as to whether HCUSAR could claim sovereign immunity. As a result, HCUSAR carries additional liability coverage for operations and management. This insurance consumes the majority of the annual budget and provides coverage for auto liability ($1M), general liability ($1M per occurrence and $2M aggregate) and management liability protection ($1M per occurrence and $2M aggregate). Additional coverage would be required for a UAV asset and would not be included in the current rates.

There are federal law provisions to protect volunteers. The Volunteer Protection Act of 1997 states that "no volunteer of a nonprofit organization or governmental entity shall be liable for harm caused by an act or omission of the volunteer on behalf of the organization or entity" as long as the act was "within the scope of the volunteer's responsibilities" and the act was not criminal misconduct, gross negligence or willful misconduct.[138] Another exception to immunity is if a volunteer operating a motor vehicle or aircraft that requires a license, which also contains a provision to maintain insurance, causes the harm.[139] This law would only provide immunity to on=scene activities of HCUSAR and would not apply during response to the scene. The law also only applies to the individual and not to the nonprofit organization.[140] The Volunteer Organization

[138] "Volunteer Protection Act of 1997," Congress.gov, accessed June 14, 2016, https://www.congress.gov/105/plaws/publ19/PLAW-105publ19.pdf.

[139] Ibid.

[140] Ibid.

Protection Act of 2015 proposes to amend the 1997 law to extend the liability protections to the nonprofit organization.[141] Table 40 shows the scoring for HCUSAR risk and liability.

Table 40. HCUSAR Risk and Liability

HCUSAR Risk and Liability			
	Low (1)	Medium (5)	High (10)
Sovereign Immunity	1		

The HCUSAR evaluation for risk and liability would dramatically change upon the passage of the Volunteer Organization Protection Act of 2015.[142] The compiled scores for all evaluation categories for HCUSAR are depicted in Table 41.

Table 41. HCUSAR Compiled Evaluation Matrix for All Categories

HCUSAR		
Category	Total Score	AVG
Organizational Structure	10	10.0
Ownership & Funding	16	5.3
Staffing	25	8.3
Response	16	4.0
Risk & Liability	1	1.0

C. SOUTHWESTERN OHIO SOUTHEASTERN INDIANA NORTHERN KENTUCKY REGIONAL ASSETS – DECONTAMINATION TRAILERS AND MASS CASUALTY TRAILERS

SOSINK is a multi-disciplinary steering committee that utilizes regionalization to leverage procurement and allocation of resources. SOSINK has utilized this model to provide a regional approach to maximize UASI grant funding.[143] SOSINK has provided

[141] "Volunteer Organization Protection Act of 2015, Congress.gov, accessed June 14, 2016, https://www.congress.gov/bill/114th-congress/senate-bill/1684.

[142] This act was referred to the Subcommittee on the Constitution and Civil Justice on June 1, 2015.

[143] "Memorandum to the National League of Cities and National Association of Counties," SOSINK, 2010, 7, personal communication to author.

the funding mechanism for the region to acquire many shared service assets. The two that will be the focus of this study will be the Mass Casualty Incident (MCI) response trailers and the Mass Decontamination (DECON) trailers.[144]

The decontamination trailers provide the capability to decontaminate a large number of people in a short period of time. The DECON trailers require eight members to operate. They require the responders to be trained on the set up and operation of the trailers to properly decontaminate the victims. When operating at full capacity, the DECON trailers can decontaminate 200 victims per hour.[145] The MCI trailers only require two to four members to operate and are primarily a medical warehouse on wheels requiring little technical knowledge.

1. Organization

SOSINK is comprised of multi-disciplinary representatives from Southwestern Ohio, Southeastern Indiana, and Northern Kentucky. SOSINK represents 12 counties and the city of Cincinnati. The city of Cincinnati is the largest population center within the organization. The Regional Steering Committee (RSC) made up of voting members manages SOSINK. Each county has at least one voting member on the RSC, and one additional voting member is added for every 100,000 of population. The Ohio, Indiana and Kentucky Emergency Management Agencies are also allotted one voting membership within the RSC for each state agency. The RSC is the determining body for what projects are funded, as recommended by the disciplinary based sub-committees.[146] While SOSINK is the deciding agency as to what project is funded, the asset is eventually signed over to a municipality for ownership and maintenance through an asset transfer agreement. SOSINK has become less influential with the loss of the UASI grant to the region; however, the assets provided by SOSINK and UASI are still in use and available for response. SOSINK does not require periodic briefings to the overall organization but

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[144] "Southwestern Ohio Southeastern Indiana Northern Kentucky Region," SOSINK, May 28, 2016, http://www.sosink.org/.

[145] SOSINK, *UASI Decontamination Unit Instructor Manual* (Hamilton County, OH: SOSINK, 2008).

[146] "Memorandum to the National League of Cities," 5.

does require periodic inventory verification that the asset is still in service and available. SOSINK expects the asset host to abide by the asset transfer agreement. Table 42 represents the scoring for the SOSINK organizational structure model.

Table 42. SOSINK Organizational Structure

Organizational Structure			
	Low (1)	Medium (5)	High 10
Oversight	1		

2. Ownership and Funding

The SOSINK decontamination and mass casualty trailers purchase was through the Department of Homeland Security–UASI grant program and then signed over to the accepting municipality through an asset transfer agreement. The municipality agrees to maintain and respond with the asset if available, and there is no direct consequence to the municipality's budget for initial acquisition of the asset. While the municipality agrees to accept the asset, there is a clause in the asset transfer agreement that states the municipality must use the asset for "Homeland Security purposes" and cannot transfer or dispose of the asset without written authorization.[147] The receiver of the asset and the two signatories who manage the grant program sign this agreement. The asset is then municipally owned through the asset transfer agreement. Table 43 depicts the ownership and funding scoring for the initial purchase category for the SOSINK model.

Table 43. SOSINK Ownership and Funding—Initial Purchase

SOSINK Ownership and funding			
	Low (1)	Medium (5)	High (10)
Initial Purchase			10

[147] Hamilton County Emergency Management Agency, Asset Transfer Form, city of Cincinnati/ Hamilton County UASI/SHSGP, personal communication to author.

The ongoing maintenance of the asset is borne by the municipality that agrees to own the asset via asset transfer agreement. Municipalities were able to apply for sustainment funding through the Urban Area Security Initiative (UASI) program; however, that resource is no longer available. The loss of the sustainment grant funding has created a maintenance burden on some of the municipalities, and in some instances, the asset has been returned to SOSINK. Table 44 represents the scoring for the SOSINK model of ownership and funding—sustainment and maintenance category.

Table 44. SOSINK Ownership and Funding—Sustainment and Maintenance

SOSINK Ownership and funding			
	Low (1)	Medium (5)	High (10)
Sustainment and Maintenance	1		

There is no fee for service to the requesting municipality for utilizing the MCI or Mass DECON Trailers. The decontamination trailers have the possibility of recovering some funding through the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, depending on the nature of the emergency and whether liability can be determined.[148] CERCLA allows municipalities to recover incurred costs from liable owners and transporters of hazardous materials.[149] Table 45 shows the bill-for-service subcategory scoring for the SOSINK organizational model.

148 "Comprehensive Environmental Response, Compensation and Liability Act of 1980," United States Senate Committee on Environment and Public Works, December 31, 2002, http://www.epw.senate.gov/cercla.pdf.

149 Ibid.

Table 45. SOSINK Ownership and Funding—Bill for Service

SOSINK Ownership and funding			
	Low (1)	Medium (5)	High (10)
Bill for service fees		5	

The subcategories for the ownership and funding category for the SOSINK model are presented in Table 46.

Table 46. SOSINK Ownership and Funding—Compiled Data

SOSINK Ownership and funding			
	Low (1)	Medium (5)	High (10)
Initial Purchase			10
Sustainment and Maintenance	1		
Bill for service fees		5	

3. Staffing

Staffing of the asset depends on the municipality that has agreed to accept the asset. For example, the city of Cincinnati Fire Department has accepted two MCI and two DECON trailers and has agreed to staff the units with the engine and ladder where they are housed. This arrangement provides a trained response team that can respond immediately when a request is received. Other departments that have accepted the assets only make them available when staffing permits or simply transport the asset without a trained crew. Of the 12 DECON units, only two will respond fully staffed at the time of call. Eight will respond with the unit and minimal staffing—not enough to set up and operate the unit, and the balance of the staffing will respond directly to the emergency location. The availability of personnel scoring is shown in Table 47.

Table 47. SOSINK Staffing—Availability of Personnel

SOSINK Staffing			
	Low (1)	Medium (5)	High (10)
Availability of personnel		5	

The units are staffed by a cross section of staffing mechanisms. Most of the units are assigned to a fire department that has part-time or full-time staffing on station, 24 hours a day, 365 days a year. Most departments cross staff the units so they are not paying to specifically staff the unit. The firefighters would be on duty anyway. However, the municipalities contacted are required to recall firefighters to staff the fire stations to provide service to their community while the asset is being utilized.

Two units have personnel on call that will respond with the asset; however, they must meet at the assembly point and then deploy to the emergency scene. Many of these departments do not have eight personnel available to respond outside of their municipality for an emergency without stripping their community and leaving it unprotected. The MCI trailers are staffed similarly; however, the MCI units only require two to four personnel to operate. The operational burden imposed on host departments by the SOSINK model is summarized in Table 48.

Table 48. SOSINK Staffing—Operational Burden

SOSINK Staffing			
	Low (1)	Medium (5)	High (10)
Operational burden		5	

Many of the host agencies of the SOSINK assets cannot adequately absorb a deployment of the asset and still provide coverage to their communities, resulting in either a protection liability for the agency or a delayed deployment of the asset, as it fails to respond until backfill staffing arrives. Ten of the 12 municipalities must recall members for backfill to replace the members that have responded with the asset thus incurring overtime costs that are not reimbursed. Most of the departments will send the unit immediately upon request and then backfill the positions with recalled firefighters on overtime. The entity that owns the unit incurs the personnel costs. Most of the municipalities must call in back fill overtime for the members transporting the asset. Table 49 represents the scoring for the financial burden subcategory of the SOSINK model.

Table 49. SOSINK Staffing—Financial Burden

SOSINK Staffing			
	Low (1)	Medium (5)	High (10)
Financial burden	1		

Table 50 presents the staffing subcategories for the SOSINK model.

Table 50. SOSINK Staffing—Compiled Data

SOSINK Staffing			
	Low (1)	Medium (5)	High (10)
Availability of personnel		5	
Operational burden		5	
Financial burden	1		

4. Duplication of Resources

Any organization may have the need to utilize a DECON trailer or MCI trailer. The need for these types of assets however, is for low frequency, high impact events. While there is the potential for these events throughout the region, municipalities would not be capable of providing the asset individually due to costs incurred compared to the frequency of use. The SOSINK shared service model reduces the duplication of resources throughout the region by making the resource available for all municipalities within the region.

5. Response

The response time depends on the staffing model of the host agency. Most of the assets respond with a small crew to get the unit to the scene and then must await the trained crew to set up the unit. A trained eight-person crew can have the DECON trailer operational within 20 minutes of arrival on the scene. The geographic locations make it possible to have a unit on scene within 45 minutes to one hour of request and often much sooner. Table 51 shows the response time subcategory scoring for the SOSINK response model.

Table 51. SOSINK Response—Response Time

SOSINK Response			
	Low (1)	Medium (5)	High (10)
Response time		5	

The resiliency of each individual DECON or MCI trailer is dependent on the host agency of the individual unit. Many of the departments do not have eight trained members on duty to respond with the unit and must be recalled from home. Scoring for the SOSINK model for resiliency is contained in Table 52.

Table 52. SOSINK Response—Resiliency

SOSINK Response			
	Low (1)	Medium (5)	High (10)
Resiliency		5	

Tactical reserve is built into the SOSINK system. There are 12 DECON trailers and 12 MCI trailers within the region. Having multiple units within the region increases the tactical reserve and availability of the units. The units are in locations that are geographically remote from one another to avoid the negative impact of a large incident in one specific area. The tactical reserve of the SOSINK response model is depicted in Table 53.

Table 53. SOSINK Response—Tactical Reserve

SOSINK Response			
	Low (1)	Medium (5)	High (10)
Tactical Reserve			10

The staffing of the asset is dependent on the staffing levels of the host department. The units housed within the Cincinnati Fire Department are consistently available for response; however, other units may not always be available. The units are located remotely throughout the SOSINK region. The location of multiple units throughout the region also opens up availability. When the municipality hosting an asset is overwhelmed by an emergency, a remote asset can respond from across the SOSINK region from the initial emergency. Table 54 represents the SOSINK scoring for the consistency subcategory.

Table 54. SOSINK Response—Consistency

SOSINK Response			
	Low (1)	Medium (5)	High (10)
Consistency		5	

The subcategories for the staffing category for the SOSINK model are depicted in Table 55.

Table 55. SOSINK Response—Compiled Data

SOSINK Response			
	Low (1)	Medium (5)	High (10)
Response time			10
Resiliency		5	
Tactical Reserve			10
Consistency		5	

6. Risk and Liability

Additional insurance is not purchased for the SOSINK asset specifically. The asset is covered under the municipality's blanket insurance policy, or some municipalities are self-insured. Assets that are municipally owned in Ohio do enjoy some protection through sovereign immunity. A municipality or its employee that causes injury, death or damage to another may be immune from civil liability, depending on if the action that resulted in the injury is considered a governmental function.[150] An action is considered a governmental function if it "is imposed upon the state as an obligation of sovereignty and

[150] "The History and Future of Government Immunity for Tort Liability," Weltman, Weinberg & Reis Co., December 31, 2012, accessed June 11, 2016, http://www.weltman.com/?t=40&an=40047&format=xml&p=8082.

that is performed by a subdivision voluntarily or pursuant to legislative requirement."[151] Fire services, emergency medical services and rescue services are considered governmental functions.[152] Once the function is determined to be "governmental," there are several exceptions to immunity, which also must be considered. One of the exceptions is the "negligent operation of a motor vehicle," which would waive the immunity.[153] An exception to the exception is provided to reinstate immunity if the operator is a member of a fire department or emergency medical service and is responding to a fire or call for emergency care and is not operating the vehicle in a manner that would constitute willful and wanton misconduct.[154] The DECON trailers and the MCI trailers would have sovereign immunity when responding to and operating on an emergency scene. The SOSINK risk and liability category is scored in Table 56, and Table 57 presents the SOSINK evaluation matrix.

Table 56. SOSINK Risk and Liability

SOSINK Risk and Liability			
	Low (1)	Medium (5)	High (10)
Sovereign Immunity			10

Table 57. SOSINK Compiled Evaluation Matrix for All Categories

SOSINK		
Category	Total Score	AVG
Organizational Structure	1	1.0
Ownership & Funding	16	5.3
Staffing	11	3.7
Response	30	7.5
Risk & Liability	10	10.0

[151] Chapter 2744: Political Subdivision Tort Liability, Ohio Revised Code, October 12, 2006, accessed June 11, 2016, http://codes.ohio.gov/orc/2744.

[152] Ibid.

[153] Steven D. Strang, "Municipality Liability – An Overview," Gallagher Sharp, April 2012, http://www.gallaghersharp.com/sites/default/files/2012%20April%20-%20Municipal%20Liability%20-%20An%20Overview.pdf.

[154] Ibid.

V. EVALUATION AND SYNTHESIS

In this chapter, the data assembled earlier is compiled to permit a side-by-side comparison over all of the evaluation criteria.

A. COMPILING AND EVALUATING THE DATA

SETRAC scored the best overall with 37.1 points out of a total possible of 50 points. HCUSAR finished with a total of 28.6 points, and SOSINK ended with 27.5 points. While the compiled scoring matrix provides data to look at overall performance of each asset, examining each individual component of the asset provides the opportunity to select the most beneficial individual characteristic from each shared service model. The compiled data from the three shared service models is presented in Table 58.

Table 58. Compiled Data from Shared Service Models

	SETRAC	HCUSAR	SOSINK
Organizational Structure	5	10	1
Ownership & Funding	10	5.3	5.3
Staffing	8.3	8.3	3.7
Response	8.8	4	7.5
Risk & Liability	5	1	10
Total	37.1	28.6	27.5

Figure 1 shows that none of the models performed optimally across all evaluation criteria. Applying those characteristics to the development of a regional unmanned aerial vehicle asset provides the opportunity to construct a hybrid organizational model to maximize the benefits from each shared service examined. The highest scoring category from each model examined will be selected to develop the hybrid shared service model for a UAV asset.

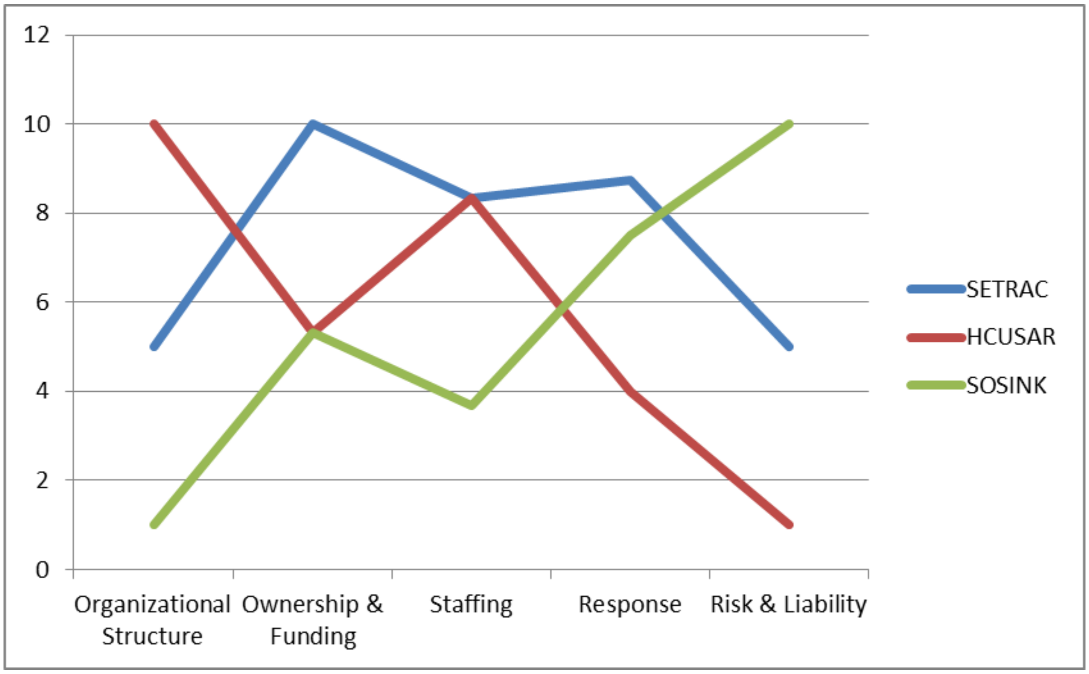

Figure 1. Shared Service Models Evaluation Results

1. Organization

A local level organization that requires regular frequent reporting, such as required by HCUSAR, provided the best oversight when compared to the state organization of SETRAC and the multi-county, multi-state organization of SOSINK. The HCUSAR and the SETRAC model also take advantage of nonprofit status, facilitating the benefit of private funding.

2. Ownership and Funding

All three of the assets have predominantly been funded through the grant process. While the HCUSAR team was initially created through the use of private and corporate funding, the majority of the new equipment since 2003 has been grant funded. A federal grant program through the Assistant Secretary of Preparedness and Response funded the initial purchase and continual sustainment of the SETRAC AMBUS. The SOSINK decontamination trailers and the mass casualty trailers were initially purchased through the Urban Area Security Initiative grant program, and the assets were maintained and sustained for several years through this program.

SETRAC's funding mechanism of supporting both the initial asset purchase and then all maintenance and sustainment costs is the best option and has no effect on the host agencies budget. Relying on grant funding for maintenance and sustainment can be a liability. The SOSINK region has since lost UASI funding, and as a result, the sustainment funding has been eliminated. The loss of the UASI grant funding has shifted the burden of sustainment and maintenance to the host entity—a cost many can no longer support in their budgets.

The SETRAC AMBUS enjoys a funding mechanism not available to the other assets. The AMBUS, through Houston Fire, can bill the insurance companies of the patients it transports to the hospital. This money is recovered by Houston Fire and is then funneled back into the AMBUS project through maintenance and upgrades to the unit. The decontamination trailers have the possibility of recovering some funding through the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, depending on the nature of the emergency and whether liability can be determined.[155] CERCLA allows municipalities to recover incurred costs from liable owners and transporters of hazardous materials.[156] A UAV asset utilized for a hazardous materials response would be eligible for the same cost recovery, and this avenue should be explored further.

3. Staffing

The SETRAC staffing model is the most reliable of the three models by utilizing a large, well-staffed department as a host, while the HCUSAR model is the most cost effective, as it does not have a direct personnel cost to the asset and the sponsoring agency decides whether to pay their personnel for participation. SOSINK also capitalizes on housing several units with a large department. Tying the staffing model to a larger host agency provides the most reliable staffing with the least community impact as evidenced by the AMBUS and SOSINK models. While these models are the most

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[155] "Comprehensive Environmental Response, Compensation and Liability Act of 1980," United States Senate Committee on Environment and Public Works, December 31, 2002, accessed June 24, 2016, http://www.epw.senate.gov/cercla.pdf.

[156] Ibid.

reliable they do incur a cost to the host agency—the cost of the personnel to staff the asset that are no longer available to serve the host community—however, the larger agencies can absorb the added workload with other available units. The HCUSAR model is the most cost effective but does not always provide a reliable model for staffing unless an on-call system is implemented.

4. Duplication of Resources

All of the three assets examined are shared service models, and by their very nature reduce the duplication of resources. The three assets are designed for low-frequency, high-consequence events that a single fire department may very rarely, if ever, utilize. The statistics from Chapter II outlining the opportunities for UAV use over the past three years within Hamilton County, Ohio, further delineate the need for a shared service UAV model rather than separate purchases by each department. While all departments want the asset available, very few could actually justify the expense to purchase one, and in the case of the HCUSAR team model, none could staff the asset. Using the statistics from Chapter II would result in the creation of more than 40 UAV programs—one for each fire department in Hamilton County, Ohio. Five of these departments would utilize the asset more than once a month, leaving the UAV unused for much of the time. Since all three assets studied reduce the duplication of resources by using a shared service model, it can be determined that a shared service model would be appropriate for the development of a UAV asset.

5. Response

The SETRAC model scored highest for response in the categories of response time, resiliency and consistency. This is again attributed to the fact that the host agency is a large metropolitan fire department that can absorb the loss of a fire company to provide the asset. The SOSINK model scores well for tactical reserve by having multiple units available throughout the region. HCUSAR scored the lowest in this category; however, if the duty officer on-call model were utilized for the scoring, the consistency ranking would be advanced to high (10).

A hybrid approach to response, as a result of the data, would provide the best model for a UAV shared service asset. Housing one unit in a large metropolitan fire department would provide good response time based on location of the department within the region. Additional on-duty members would need to be trained accordingly to provide resiliency and consistency. The SOSINK model of providing multiple assets to the region improves tactical reserve. A UAV asset that has one UAV based in a large fire department and several other UAVs housed throughout the region would be the best response model.

6. Risk and Liability

The SOSINK model provides the best risk and liability protection of all three models. SOSINK assets within Ohio enjoy sovereign immunity protection as long as the action causing the damage or injury is considered a "governmental function." In order to claim sovereign immunity, the asset must be owned by the municipality emphasizing the importance of the asset transfer agreement executed between SOSINK and the host agency. A stipulation for sovereign immunity within Ohio is the operator must be a member of a fire department, law enforcement, or EMS agency and cannot be operating the UAV with willful or wanton misconduct. The SOSINK model utilizing an asset transfer agreement for ownership of the UAV would afford the best opportunity for sovereign immunity in Ohio.

The passage of the Volunteer Protection Act of 2015, which extends liability protection to the volunteer organizations, may also give credibility to the HCUSAR model. This act is currently sitting in committee and cannot be considered until ratified by Congress.

B. RECOMMENDATIONS

The recommendations are based on the results of the evaluation of each shared service model. The characteristics of the highest scoring model are synthesized into recommendations for the organization and operation of a regional UAV asset.

1. Identify a local, governmental, nonprofit organization for oversight of the asset

While the characteristics of the organization did not have a significant impact on the operation of the asset, it did play a role in the funding, oversight and risk and liability provided to the asset. Utilizing a local asset provides increased responsiveness and oversight and ensures the asset is available equitably within the region. The benefit of nonprofit status provides an avenue for tax-deductible donations from private citizens or corporations. A governmental affiliation is essential in utilizing sovereign immunity to minimize risk and liability.

2. Utilize grant funding for initial purchase of the UAV equipment and seek a continual funding stream for sustainment and maintenance

Securing grant funding for the initial purchase alleviates any financial burden on the host agency to initiate the program. Relying on continued grant support for sustainment and maintenance does not guarantee the continuation of the program, as the grants must be periodically renewed. The SOSINK model demonstrated the tenuous nature of relying on grant funding for continued sustainment of the asset. The SETRAC model has been successful utilizing continued grant funding for sustainment and maintenance through a federal grant program.

3. Investigate opportunities for billing for service to supplement maintenance and sustainment budgets

The SETRAC model in billing medical insurance providers for service has been effective due to the nature of the asset. Billing for UAV use will not have as many opportunities but should be considered, especially when utilized for hazardous materials incidents, and the organization can recover costs through the provisions of the CERCLA legislation.

4. House one of the UAV assets in a large metropolitan fire department

There is a distinct advantage to a large fire department housing and staffing the UAV asset. The large department has the ability to absorb the loss of personnel for deployment of the asset with less of an effect than a smaller suburban department. The larger department can deploy the asset and still provide sufficient coverage for the community while not incurring backfill overtime costs. Having a larger department host the asset creates greater resiliency, tactical reserve and consistency, as demonstrated by the SETRAC and SOSINK models; however, this works only if multiple personnel are trained and qualified to operate the asset.

If additional UAV assets are desirable to fully support the region, consider housing the units at suburban departments and staffing the UAV with an “on-call” pilot and observer rotation. The on-call system provides consistency of response similar to the HCUSAR deputy commissioner duty officer rotation but does not incur additional personnel costs and does not impact service delivery to the community.

5. Conduct an evaluation of the responses within the region to determine the need for a shared service UAV asset

The frequency evaluation can assist in determining the number of UAV assets to implement and how often they would be deployed on a daily, weekly, monthly, and annual basis. This information can provide regional fire department administrators with data to make informed decisions on where to house the units and if their department can absorb the cost of personnel for deployment.

This evaluation, similar to the evaluation presented in Chapter II, can illustrate the benefit of a shared service model and the lack of need for every department to purchase, maintain, and train operators for individual UAV programs.

6. Research the applicable state and federal laws that may provide the ability to apply sovereign immunity to the UAV asset

The research revealed sovereign immunity laws are different from state to state. The research also demonstrated that while the municipality may enjoy sovereign immunity for most governmental functions, there are exclusions for some operations, such as operating a motor vehicle or aircraft as in the SETRAC model.

Ownership of the asset is also relevant to the application of sovereign immunity. The SOSINK model can take advantage of sovereign immunity in the state of Ohio, as the result of the execution of an asset transfer agreement. The asset transfer agreement transfers ownership of the asset to the municipality with caveats and expectations. It is recommended that a local municipality is the owner of the UAV asset as a part of the larger UAV regional program.

Know what laws apply to the state where the UAV will be operated. If additional liability insurance is required, investigate the possibility of liability limits within state law in order to purchase the appropriate amount of coverage. The insurance industry is catching up to the UAV technology and proliferation and is beginning to offer UAV liability policies.

7. Develop privacy policies for the UAV program that address data collection and retention, define approved uses, and consider the privacy expectations of the community

These policies must be in place before the creation of the asset. Federal law may dictate the adoption of privacy policies as well as the content of the privacy policies with the ratification of The Drone Aircraft Privacy and Transparency Act (DAPTA) of 2015. Research has shown that conducting public meetings prior to the creation of the asset has been beneficial to public acceptance.[157] Limiting the scope of the responses to emergency services and not including law enforcement surveillance may also be beneficial in garnering public support.

8. Develop organizational policies that delineate the structure of the shared service and define the roles and responsibilities of the organization and the administration, and the expectations of the host agency

Throughout this research, obtaining written copies of well-constructed formative policy documents that delineate the structure and operation of the shared service models was difficult. Reducing these policies into writing, rather than relying on undocumented past practices, provides clear understanding for all entities involved.

C. BARRIERS TO IMPLEMENTATION OF A SHARED SERVICE

Developing a shared service model for a UAV asset has several barriers to implementation that must be overcome. Barriers include developing regional cooperation and participation, securing initial and sustainment funding, addressing community privacy concerns and remaining compliant with federal, state and local aviation regulations.

[157] Karen Vance et al., "Unmanned Aircraft Systems, 10.

1. Cooperation and Participation

The development of a shared service within the region for fire and emergency services presents several competing political challenges. The first is the fact that the county has over 40 separate and distinct fire departments or fire protection districts. The large number of fire departments has already created duplication of fire equipment within the county. A municipality and a fire command staff govern each of these departments and each has its own agenda. Coordinating all 40 departments will be a political challenge, and a key instrument to implementation will be gaining the support and approval of the Hamilton County Fire Chief’s Association (HCFCA). The HCFCA, as described within the shared services chapter, is a non-governmental association of fire chiefs representing each department within the county. Winning the support of the HCFCA, hopefully, will prevent rogue departments from developing their own asset and competing with the shared service model. Individual assets create competition for grant funding, and maintenance and sustainment falls onto a single municipality. This has been evidenced within the region as three NIMS Type 1 hazardous materials teams compete for limited state funding.[158] Individual UAV programs will increase the number of operators but decrease the level of the operators by diluting the number of flight opportunities between multiple UAV programs. Cooperation and partnership with the HCFCA will also be critical to determining the location of the UAVs within the county and developing consensus regarding deployment and response.

2. Securing Initial and Sustainment Funding

Identifying sources of initial and sustainment funding are critical to the implementation of the UAV program. All of the shared services studied in this thesis utilized grant funding for initial purchase of equipment and continue to be successful in obtaining new equipment grants. Identifying sustainment funding is more difficult. Many grants are limited to the purchase of new equipment to fill an identified gap in homeland security. These grants will not allow for the routine maintenance and repair of existing

[158] The region currently has three NIMS type 1 hazardous materials response teams. All of these teams compete for the same limited state grant funding. The state has not limited the duplication of resources in the region and the funding available for three assets is insufficient for sustainment.

equipment. In some instances, it is literally easier to secure funding for a new generator, than to secure money to service the generator. Identifying a reliable source of maintenance and sustainment funding, outside of the grant funding mechanism, is crucial to the continual availability of the asset.

3. Privacy Concerns

Addressing the community's concern for privacy will be critical to get the UAV program off the ground—literally. As UAVs continue to proliferate, the opportunity for encounters with the public will increase. The concern over privacy and how UAVs impact the expectation of privacy has led to the introduction of The Drone Aircraft Privacy and Transparency Act (DAPTA) of 2015, which has been proposed in the Senate to address UAV privacy issues as they relate to commercial and governmental use of unmanned aerial vehicles.[159] This act will mandate the adoption of community-based privacy policies and regulate the collection and retention of the data collected. Working proactively with the community to address privacy concerns and developing transparency with the community regarding data collection and retention is critical.

4. Federal, State, and Local Regulations

Staying abreast of the changes to federal, state, and local regulations applicable to the public use of UAVs is imperative. In addition to the federal Part 107 regulations, which were recently approved for civilian UAV operations yet do not apply to public operations, state and local governments are beginning to investigate new regulations pertaining to UAV use for both hobbyist and public operations. New legislation that restricts the operation of public UAVs would be detrimental to the regional program.

D. CONCLUSION

The utility of UAVs has been demonstrated to be effective in a variety of emergency incidents. UAVs have been successful in locating missing persons, providing situational awareness to incident commanders at the scene of structure and wildland fires,

[159] "S.635 -Drone Aircraft Privacy and Transparency Act of 2015."

and have the potential to perform reconnaissance missions to allow first responders to remain at a safe distance and capture needed information using sensor technologies. All of these applications are beneficial for the emergency services; however, one must ask: How often would these services be utilized by an individual fire department?

The need for a shared service asset was demonstrated by compiling the response statistics for Hamilton County, Ohio. The statistics were analyzed based on the responses where a UAV asset would be beneficial. The results of that analysis supported the creation of a shared service UAV model, which would avoid the duplication of resources that would occur if each individual fire department creates its own UAV asset. The research has also demonstrated the fiscal responsibility of a shared service asset. By only implementing five UAVs throughout the county rather than over 40, a shared service asset would save more than $1.5 million.

In addition to the cost savings, the shared service model would prevent the loss of the firefighter at the scene of a fire in the cases where departments do not have the discretionary personnel to implement the UAV on scene. The loss of a single firefighter from a fire company to deploy the UAV can greatly affect the firefighting ability of smaller departments. The shared service model would provide an operator from a department not involved in initial firefighting operations.

The research question of identifying shared service models that can be applied to develop a regional unmanned aerial vehicle asset was answered by evaluating three shared service organizations including the SETRAC Multiple Patient Vehicle (AMBUS), the Hamilton County Urban Search and Rescue Team, and the SOSINK decontamination and mass casualty trailers. The shared service models were evaluated on five categories, and each category had several subcategories that were utilized to complete the evaluation. Using the evaluation of the three shared service models, an analysis was conducted to select and apply those characteristics to form recommendations for creating a shared service UAV asset. As a result of the evaluation and the additional research questions related issues were addressed, such as the assumption and management of risk and liability, the concept of sovereign immunity as applied to a UAV asset, the privacy concerns of the public, and the applicable legislation and policies for the implementation of a regional shared service UAV asset.

The future for UAV utilization within the emergency services is full of potential. The continued evolution of new sensors and capabilities may make UAV use on the emergency scene commonplace. A breakthrough in autonomous sense and avoid technology that can be adapted for a UAV could safely open up the skies for UAV flight beyond the line of sight, producing flights covering a much larger area. Innovation into new battery technology could increase UAV flight times and payload capacity. The UAV may evolve into an essential piece of emergency equipment, ready for deployment in a moment's notice. The development of a robust shared service UAV asset will be essential to guarantee the availability of UAV capability for the region without the duplication of resources.

APPENDIX. UAV ASSET EXPENSE

Cost of UAV Asset:[160]

Description	Item	Price	Notes
Drone	Inspire 1 V2.0 Everything You Need Kit	$3,349.00	
Drone	Lightbridge 2	$1,399.00	
Drone Controller	Transmitter	$2,995.00	
Drone Controller	Lightbridge 2 Ground Unit	$799.00	
Drone Controller	Transmitter Battery	$530.00	
Drone Controller	Transmitter Battery Plate	$290.00	
Receive Monitor	Monitor	$999.00	
Receive Monitor	Grip	$299.00	
Receive Monitor	Receiver	$2,995.00	
Receive Monitor	Receiver Battery	$530.00	
Receive Monitor	Receiver Battery Plate	$290.00	
Accessories	Battery Charger	$799.00	
IR Camera[161]	Infrared camera (FLIR)	$14,000.00	
Training	Five Firefighters per Aircraft for on duty coverage @ $3000 each	$15,000.00	Does not include annual currency training
	Total	$44,274.00	
	Cost over 40 Fire Departments	$1,770,960.00	

[160] The cost of the UAV and accessories was derived from information on the DJI website as of July 7, 2016, http://store.dji.com/.

[161] FLIR camera pricing from the FLIR website on August 2, 2016, http://www.flir.com/uploadedFiles/sUAS/Products/Drone-Packages/FLIR-Drone-First-Responder-Datasheet.pdf.

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