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“Policing with Eyes in Sky: Analysis of Drone Programs in Law Enforcement”

by

Keith Ericksen

A Capstone Project Submitted in Partial Fulfillment of the
Requirements for the Degree of Master of Science in Criminal Justice

Department of Criminal Justice

College of Liberal Arts

Rochester Institute of
Technology Rochester, NY

5/2/2019

RIT

Master of Science in Criminal Justice

Graduate Capstone Approval

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Graduate Capstone Title: **Policing with Eyes in Sky:
Analysis of Drone Programs in Law Enforcement**

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I - LITERATURE REVIEW

In the modern era technology is playing a significant role in how our law enforcement modernize to serve the communities. Drones are known as an emerging technology that is changing the way our law enforcement assess the high-risk missions, crimes, and rescue efforts. A drone is an unmanned aerial vehicle (UAV) that is remotely controlled by a person that is used to gather aerial intelligence among other things. In the law enforcement field, the drones usually are equipped with sophisticated cameras that has the capabilities to zoom in, capture stills, and record videos from the sky. More expensive drones are outfitted with thermal camera that can be used to detect a heat signature through smoke or in the night (Feeney, 2016). In some cases, there are custom-made modules such as searchlights, loudspeakers, and flashers that expands how the drone can be utilized in several different methods. The drones are becoming more and more popular because of how flexible and adaptable they are, given the wide array of modules that can be used for different scenarios in contrast to traditional policing like body-worn cameras and traffic cameras. In this literature review, I will provide three working papers that I plan to develop which consists of: different uses of drones in law enforcement, establishing policies to provide oversight on operating the drones and pilot licensing, and finally, data that I plan to obtain for analysis.

In the field of law enforcement, the drones are quite new, but they have quickly become popular in almost over 900 different police agencies in the United States (Gettinger, 2018). There are a whole lot more uses than just gathering aerial intelligence for strategic planning and development. The drones can assist the lead investigators

with assessing crime scenes by taking overview stills and creating models out of the pictures (Bucknell & Bassindale, 2017). These stills captured by the drones are much more accurate and reliable compared to the animated representation that can influence the process of gathering evidence (Barnes, Higgins & Higgins, 2018).

Secondly, the drones can assist with crowd control (Al-Sheary, & Almagbile, 2017). Large gatherings like protests, concerts, street parties where police officers' presence is required to prevent crimes and aid people can be enhanced by drones. Monitoring on the ground level can be exceptionally challenging but the drones can easily see everything from the sky. Furthermore, intelligence gathered by the drones can help police officers know if there is a person who needs help but is unable to request for assistance or to locate the target without endangering bystanders.

Third, the drones equipped with night vision cameras can be utilized to provide support for monitoring unauthorized trespassers, vehicle pursuits smugglers, and identifying the suspects (Lega, Ferrara, Persechino, & Bishop, 2014). Several prison complexes already implemented drone pilots to monitor the area and notify the guards to stop the person if they are spotted to be importing contraband inside (Garnier, 2018). Not only do some prison complexes use the drones for these purposes, the border patrols also use them for the same purpose to prevent contraband from entering the country (Bier, & Feeney, 2018). While these are what the law enforcement officers use for high-risk missions, they can also be utilized to find the missing persons in the dark. To a certain extent a drone mounted with a night vision camera can have a large advantage in resolving the missing cases more quickly and effectively compared to conducting the effort on ground.

In the second working paper I will focus on establishing the policies to provide oversight regarding regulations, data management, and privacy issues as well pilot licensing for police officers. Currently, to establish a drone program and operate drones for a public agency doesn't require Part 107 FAA-Certificate. They can apply to FAA for Certificate of Authorization (COA) and wait to get an authorization on the proposed drone operations (Public Entities). The difference between getting a Part 107 FAA certificate and COA are major. To obtain Part 107 FAA certificate, the person who works with the drones must undergo an exam to display their aeronautical knowledge, such as weather observation, flight inspection, loading & capacity, and regulations. They also are required to pay a \$150 fee and renew their remote pilot license every two years. Getting the license is generally much faster compared to obtaining the COA for the proposed drone operation.

On the other hand, COA license takes a long time to process because the FAA must ensure that the police department's proposed drone operations meets the criteria. But having the COA license provides flexibility for all the drone operation. To be explicit with what having a COA license can do: permission to fly the drone during night time, operate beyond visual line of sight, fly over people, fly above 400 feet, and more importantly, fly in controlled airspace. While the COA authorization expands on the permissions of what an FAA-certified drone pilot can do, it doesn't teach the drone pilot basic aeronautical knowledge which is a crucial factor in operating the drones. If the police officers who works with the drones are FAA-Certified and the department has COA license, that would be a step toward safe flight shown that they have the

aeronautical knowledge to operate the drones safely (Dukowitz, 2018). Obtaining both FAA and COA licenses is the highest standard for an effective drone program.

The COA license gives the law enforcement agencies broad power that supersedes the airspace regulations and creates new issues for those people who value privacy. I plan to further explain in detail and develop a policy that is fully responsive to the privacy concerns, safe flying, and data collection. The FAA Modernization and Reform Act of 2012 required the Federal Aviation Administration to integrate drones into the national airspace by 2015. It protects public concerns that fall under the First Amendment and the Fourth Amendment that imperils the constitutional protects vested by the individuals (Blitz, Grimsley, Henderson, & Thai, 2019). Affording privacy and regulating the collection of data is more important than ever to ensure a healthy relationship between the law enforcement agencies and communities. Protecting the privacy has its limitations in the legal systems due to rapid development of technology that causes privacy issues (Anderson, 2014). The FAA recognizes that there are privacy concerns related to the use of drones. Although, the concerns of privacy risks that was raised by the agencies didn't end with a response to the congressional members who are asking about drones and privacy issues. The core documents which are required by the FAA Modernization Act guide to integrate drones into the National Airspace was explicit about privacy being a critical issue in addressing the use of civilian drones (Scott, 2017).

The public in general mistrust the government and are more supportive of drone regulations on the state and local level regarding the use of police quadcopters by law enforcement agencies (West, Klofstad, Uscinski, & Connolly, 2018). The benefits of

using the drones for surveillance purposes are immense. According to a scholarly article, the cost to operate a small device is less than \$50,000 and only charges between \$25 to \$75 an hour. In contrast to operating helicopter that potentially cost millions of dollars to acquire and charges \$200 to \$400 just to operate it (West, Klofstad, Uscinski, & Connolly, 2018). Monitoring and solving the crimes with drones could well be the future of crime-fighting tools for the law enforcement agencies. It is critical that the agencies establish sound policies and objectives that fosters procedural and distributive justice (West, & Bowman, 2016). If these drone policies can maintain checks and balances, social cohesion and equity, the ability to govern effective as the mean to secure collective obligations, fairness and a sense of community would be possible (West, & Bowman, 2016).

Managing the data captured by the drones can be quite a burden, especially when it comes to the agencies' responsibility to manage the images and videos that can be both memory-intensive and detailed to ensure there are no misuse in the process. An example of data management includes recording the flight plan and navigation data that needs to be collected for analyzing and mining the imagery (Hogan, 2016). The challenge is requiring all the necessary hardware such as drones, operating stations, communications network and a data center that a law enforcement agency might not have to adequately deploy (Hogan, 2016). This implies a legal uncertainty when it comes to operating the drones. Several law enforcement agencies have created their own data management and general operating principles which involves avoiding collection of unnecessary personally identifiable information and adhering the Fourth Amendment prohibiting unreasonable searches and seizures (Hogan, 2016).

The third working paper will discuss non-lethal weapon uses mounted on the drones. This is currently a trending issue and has gained interests in alternative use of force recently. A case study was conducted on three scenarios to test the purpose if the officers feels less inclined to discharge their firearms if they were to operate non-lethal weaponized drones (Spallanzani, 2017). Non-lethal weaponized drones usually are outfitted with tasers and rubber bullets designed to contain and control the crowd -- a traditional method that the law enforcement agencies have been using to settle civil unrest. Even though so, the current law on allowing use of non-lethal weaponized drones only affects small portion of Americans. The North Dakota drone law sets a precedent that the law enforcement agencies may not operate lethal weaponized drones.

While it did specifically state that the lethal weapons are not allowed, there are no specific limitations on the use of non-lethal weapons including tasers, rubber bullets, bean bags, and tear gas (Spallanzani, 2017). There are benefits of outfitting the drones with non-lethal weapons and they are very clear. First, they can help reduce casualties. The operator can sit at a safe distance without having to put their life on the lines and operating the drones doesn't cost that much money. Secondly, flying the drones doesn't makes the operator tired or drowsy compared to apprehending suspects on ground (Spallanzani, 2017). A simulator known as the Violence Confrontation Lab ran a test where a suspect fired twice, and the officer fired four times. However, the object the that suspect drew out was a beer bottle which can be difficult to identify from a distance. If officers spent times trying to figure out what the suspect has in its hands, they could be well dead before making life-changing decisions. This appeals to the use of non-lethality

drones that minimizes the police officers' exposures to risks at the same time deescalating the situations (Spallanzani, 2017).

Finally, the fourth working paper, I plan to develop a survey in Qualtrics to analyze the organization of police departments after the implementation of the drone programs. Whether the drone programs contribute to the success at reducing the crimes, specifically high-risk missions and rescue efforts. Secondly would be strategic planning of how effective the drones are when being utilized in real cases. With the drones' ability to gather aerial intelligence, are the law enforcement agencies better at developing plans and execute tactical operations? Currently the public opinion views the use of police drones unfavorably because of the fear that it has to do with misuse for spying purpose. However, the Fourth Amendment gives people the right to expect privacy in their persons, houses, papers and effects against unreasonable searches and seizures. It doesn't ensure privacy once the person enters the public area. Suppose that the established drone policy that is responsive to privacy concerns and safe flight will improve the public opinion on the use of police drones to lead the trend into general favorable? If the police officers were licensed, had aeronautical knowledge, and can execute operations properly, the community would be more comfortable with the police department using drones?

Furthermore, I want to examine a small sample of police departments selected from over 900 different public agencies from CSD Public Safety Drones scholarly article (Gettinger, 2018) to assess their drone programs based on four categories: Clearance Rate, Number of FAA-Trained Officers, Budget of Drone Program, and Use of Drones. These alone will help understand how much money is being spent on the drone

programs, and how it impacts the clearance rate as well number of licensed police drone pilots. The type of drones does play a role in determining how effective it performs its job since it is related to the operating distance, flight time, and specifications.

The drones are increasingly becoming an important role in the law enforcement field. It has become smarter, autonomous, and possess flexible capabilities that allows the law enforcement agents perform their duties effectively as possible thanks to several real use applications. Regulations, data management, and pilot licensing is another major area that is crucial to developing a fully-fledged drone program. By addressing the community's concerns and providing an oversight that avoids misusing the drones during the flight missions. Ensuring the lives and safety of individuals are the top priority when it comes to using non-lethal force. Drones that are outfitted with stun guns or rubber bullets minimizes the risk exposure to officers as well reduce the likelihood of having to apply deadly force. By apprehending the suspects with non-lethal weapons mounted on the drones, the law enforcement agents can contain the situations safely without putting more lives in danger. Finally, the survey purpose will be used to collect data from the law enforcement agencies that has established drone programs. The data will be used to understand how the law enforcement agencies are using their drones' program and so to pave successful integration into the modern policing.

II – PRESENTING THE POLICING METHODS

Currently, there are more than 900 different agencies that have established their own drone programs (Gettinger, 2018). It is one of the recent technology trends that

shows the law enforcement agencies' strong interest in acquiring the drones for multiple application purposes such as crowd monitoring, surveillance, vehicle pursuit, hostage situation, gathering evidence, search and rescue, reducing emergency response time, strategic planning, and developing tactical responses. While the drones are relatively new, there are real case studies where they have been successful in reducing the time spent, especially in life and death situations and finding missing people. According to a scholarly article *Drone Efficacy Study: Evaluating the Impact of Drones for Locating Lost Persons in Search and Rescue Events*, 50 trials were conducted with Search and Rescue (SAR) teams in two different groups: one equipped with drones and another one without drones. The research study shows that when a SAR team is equipped with a drone, they find a missing person 3.18 minutes faster than the team without a drone. Which raises the insight on how valuable the drones are when it comes direct impact on job performance and effectiveness (Eyerman, Crispino, Zamarro., and Durscher, 2018).

Suppose that a driver who is suspected of breaking the law decides to engage in high-speed pursuit. This presents a wide range of issues that impact law enforcement agencies' ability to perform their job effectively as well as assessing and addressing the risks. Some cities implemented a strict no-chase policy that restricts the police officers from engaging in a high-speed chase, which means the suspected driver can easily get away. Without any form of overview intelligence to apprehend the suspected driver, it is tough to contain the risks. A real-life example of a vehicle pursuit that prompted the police officers to use a drone with thermal imaging camera in Indiana to help find the suspect who fled the scene after crashing his car in a police chase (Glaser., 2017). The drones offer low-cost, easy to operate, and analytically sophisticated remote sensing

solutions that appear to align with the technical objectives of the public safety mission (Eyerman, Crispino, Zamarro, and Durscher, 2018).

The drones' imaging features allows the law enforcement agencies gather aerial intelligence and relay the information to ground-based teams who will be responsible for containing the threats. The use of aerial intelligence allows the police officers to safely contain threats without putting other people's lives in danger. With modern consumer drone technology being constantly refined, the drones are also becoming quieter and sleeker. The low-noise propellers minimize the attention that the drones attract mid-flight and makes them harder to spot which is an integral tool to reduced interference.

As the drones are becoming accessible and affordable, gathering aerial intelligence to assist with the emergency response has become much easier. However, the main challenge is how to make the best use of the data collected via drones by getting the relevant piece of information to the right person at the right time (Eyerman, Crispino, Zamarro, and Durscher, 2018). The research study recommends that the set-ups require a minimum of two people using the drones. One who is responsible for commanding the drone unit and another person who is responsible for analyzing the video and making crucial decisions. It also emphasizes on transmitting the data over an encrypted channel to protect the collection of data during the flight missions which will meet the privacy expectations should any communities become concerned pertaining to the Fourth Amendment.

III - POLICING METHOD: SURVEILLANCE

Another method of policing with the drones is the capability to provide the law enforcement agencies the necessary tools to monitor and assess the situations. Drones that are outfitted with a camera can easily relay information to the ground-based unit to formulate a plan to overcome any scenes. In fact, there are drones already in use by law enforcement agencies that carry the various type of equipment such as live-feed video cameras, infrared cameras, heat sensors, and radar (Scott, 2017). This does raise concerns relating to the Fourth Amendment for the individuals who expect the right to privacy and could be legally challenged pertaining to the collection of data. In current circumstances, once you go out into the public, you are essentially giving up your privacy in a way that you never will imagine with little to no control over the matters. To protect any form of privacy in the public will require extraordinary efforts which will limit your ability to participate in modern society (Scott, 2017).

Compared to the traditional method of body-worn cameras and fixed cameras, the drones provide law enforcement agencies the versatility they need to accomplish a wide range of activities. This allows the police officers to monitor while minimizing the risks and enhancing the aerial intelligence gathering. The drones can be flown in any direction if its battery capacity can support and within its maximum remote-control distance. Because the drone's technology is constantly being improved, the quality of aerial intelligence gathering, and its flight capabilities are only getting better. This intends to improve law enforcement agencies' ability to monitor through sharper image resolution and finer details that play a crucial role in identifying the suspect through face recognition and precise tracking.

In addition to the drones' versatility, law enforcement can mount these quadcopters with any kind of modules such as infrared cameras and night vision cameras. Being able to monitor and assess the scenes from an elevated point of view ensures that the law enforcement agencies a wide view that they need to cover and detect in advance. Not just only that these modules are incredibly useful for surveillance purpose, future technology that doesn't exist yet can be incorporated onto the drones to enhance the law enforcement agencies' ability to monitor. One company called "Persistent Surveillance Systems of Dayton, Ohio works with local law enforcement to fly manned aircrafts over cities for up to 200 hours a month. In Ciudad Juarez, Mexico, the aerial images that they collected in 2009 captured 34 murders as they happened including a cartel killing. This led the police to the hitman, his getaway vehicle and several accomplices. This is an example that will become applicable to drones to monitor a city, providing the law enforcements eyes in the dark areas (Alderton, 2018).

IV - POLICING METHOD: CROWD MANAGEMENT

Crowd management requires the police officers to identify the parameters for estimating safety risks such as the density of individuals per square meter, the direction of movement of groups of people and their movement patterns (Al-Sheary & Almagbile, 2017). To effectively respond to potentially risky situations, it is necessary to build a system that provides surveillance and crowd control. To achieve this, designing a crowd monitoring system to extract real-time information that can communicate instructions to the crowd is crucial for safe crowd management process (Al-Sheary, & Almagbile, 2017). These drones allow law enforcement to see deep in the crowd and identify if

someone commits a crime. The aerial perspective lets the law enforcement agents track the suspect without endangering anybody. In the same light, it allows the law enforcement agents to see if there is anybody who needs assistance but is unable to ask (Margaritoff, 2017). This makes it easier for the law enforcement agencies to solve the crimes and provide better public services. It also reduces the risk and dangers to both the law enforcement agents and civilians.

The drones also can be mounted with non-lethal weapons to effectively disperse riots and protests when needed to. According to a scholarly article, the use of non-lethal drones has benefits for the drone operator including reducing the casualties, operating without putting their lives in danger and it doesn't make them tired or drowsy compared to apprehending suspects on the ground (Spallanzani, 2017). The authors wanted to examine whether utilizing non-lethal weaponized drones will decrease or increase the likelihood of American police officers' use of force. However, they have concluded that implementing armed unmanned aerial vehicles is not a great idea. Furthermore, the benefits of using non-lethal weaponized drones to decrease crimes remains unknown. While there are no lethally weaponized drones have been approved to operate on American soil, North Dakota passed law in April 2015 that allows their law enforcement agencies to deploy non-lethal weaponized drones against their residents (Spallanzani, 2017). The introduction of non-lethal weaponized drones brings out amazing number of features such as minimizing risks and improving the law enforcement agencies overall job performance. However, the idea of deploying armed drones across the United States have been hotly debated. It has many appealing features including protection

and safety of police officers, but it eliminates the human interaction between the law enforcement agencies and police officers.

Today, some law enforcement agencies use non-lethally armed drones outfitted with weapons like rubber bullets, pepper spray, nets, and taser. This gives the law enforcement agents a whole new set of tools to disperse the crowds from an aerial perspective without confronting them. Furthermore, it meets the objective of minimizing the risks and ensuring that the police officers effectively respond to potentially dangerous situations without putting other people's lives in danger. The use of weaponized drones in general isn't that common as they are mainly being used to contain unruly crowds. However, there are a number of companies that specialize in modifying the drones with various weapons (Porter, 2017). For instance, Desert Wolf, a South African company that allows the drone to administer pepper spray and non-lethal paintballs on the crowd. Another type of drone called the "Skunk Copter" is equipped with four high-capacity gun barrels that fires up to 80 balls per second or 4,000 balls per minute (Porter, 2017). There has been a rise of legislation regarding the use of weaponized drones within the United States aiming to prohibit privately owned UAVs with any form of weapons. But these bills don't apply to the government agencies which provides a loophole for the police to use both lethal and non-lethal weaponized drones (Porter, 2017).

V - POLICING METHOD: CRIME INVESTIGATION

Seeing and understanding how the drones help solve the crimes is one of the biggest assets that any law enforcement agencies can greatly benefit from. When it

comes to the application use of drones, the first thing people think that it is used mainly for surveillance purpose. At the SPAR 3D Expo, the drones' capabilities to investigate the crime scenes was demonstrated which show how it can be utilized to accurately capture the information and recreating them into a 3D model (Karpowicz, 2016). A piece of information captured from laser-scanning can be crucial in serving as evidence if the case needs to be present in front of the jury. Although the 3D scanning technology isn't a new thing, it has evolved how the application use of drones has in the law enforcement field by impacting how the information is gathered (Karpowicz, 2016). A recent case where Damon Hall, a Lieutenant in the Montgomery County Sheriff's department discussed that a body was found in the river and they sent a drone to catalog the scene in detail. It is important to gather genuine information as much as possible before anything can happen to the body by natural or unnatural means (Karpowicz, 2016).

Increasingly, police are using drones more for collecting evidence from crime scenes as they do not cause disturbance compared to physical presence of investigators (Bucknell & Bassindale, 2017). Using the drones can be a great alternative to gather evidence from inside large structures such as the warehouses. However, because the quadcopter's downwash is too powerful, it might be concerning when it comes to retaining the evidence. The amount of downwash is dependent on the drone with its weight being the main factor (Bucknell, & Bassindale, 2017). To counter that, a small drone packed a with professional camera would be a viable option compared to high-end models such as the Phantom 4 or Inspire 2. As smaller drones won't create too much downwash that will do a better job at retaining the evidences during the crime

scene investigations. For outdoor crime investigations, the bigger drones are suitable for these kind of situations as they offer the law enforcement agencies more tools and options to maximize the collection of evidence. Currently, there are no recorded instances of drones for indoor crime investigations, but it can become a viable option should the area, like a warehouse or similar large structures, is considered unsafe for the police officers to enter (Bucknell & Bassindale, 2017).

VI - POLICING METHOD: HIGH RISK MISSIONS

The drones offer law enforcement agencies a new tool that is otherwise not possible with traditional body-worn cameras: the ability to see in advance. Tactical teams that are engaged in high-risk missions involving suspects that are potentially armed need to have accurate intelligence to handle the situation as effectively as possible. Being able to investigate the active suspects or shooters with an aerial perspective from the drones enables the law enforcement agents to maintain the safe distance while providing them with actionable real-time intelligence to assess the situation and formulate a strategy to defuse the threat. Aerial intelligence gathered by the drone is relayed back to the ground-based teams which they can use to address the situation. The unique aerial perspective offers the law enforcement agencies the tool they need to be able to maximize intelligence gathering that is not possible with ground-based cameras or large manned helicopters.

This leads to another beneficial use of drones for high profile missions such as hostage crisis. Rather than sending a live man to check if there is a bomb or suspect is armed, the police officer can send in a drone to surveil the area and assess to see if it is

safe for the team to enter. Because the modern-era drones are very advanced and are equipped with obstacle avoidance sensors designed to avoid objects and map out objects in real-time, they can effectively assess in close-quarters. Furthermore, they can provide the team with real-time actionable intelligence and minimizing the casualties. A real-life case which the law enforcement agency used the drone manufactured by Impossible Aerospace that is rated to stay in the air for up to 90 minutes but only took 45 minutes to do its job (Gomez & Green, 2019). The police deployed the tear gas to motivate the suspect to give up himself, but the drone revealed that the gas wasn't doing that good because it was venting outside. Using that information, the officers flooded the restaurant with even more gas that led the suspect to give himself off and allows the police to nab hostage (Gomez & Green, 2019). The aerial unmanned vehicle enables an overview live-feed video to the team, there are additional modules that the law enforcement agencies can utilize such as loudspeaker or searchlights to provide additional support to the team. Small changes and the drones' flexibility can be a major game changer in how the law enforcement officials' approach to the high-risk missions now these days.

Even though the drones are being utilized by several industries, they have plenty of application uses in the law enforcement field from search & rescue missing people to assessing the hostage situations. Drones are the latest technology addition that is evolving how our law enforcement solve the crimes, reducing the risks, and serving the public better. The time it takes for law enforcement officials to respond to emergency situations can be a game-changer with the application of drones as supported by scholarly article *Drone Efficacy Study*. While the drones are relatively new, they have

become more popular in the recent year citing its usefulness for various application uses that traditional body-worn cameras and fixed-cameras lack the ability to do so. It is especially important to note that while the public might see the word “drones” in a negative light because of its connotation with surveillance purpose, the drones are more than just surveillance. Drones provide the law enforcement agencies the tools they need to perform their job better and effectively. Soon, it is possible to see drones becoming an integral core in law enforcement agencies to reduce response time and enhance actionable real-time intelligence for better resolution.

VII – REGULATING THE DRONES

There are many law enforcement applications for drones from gathering data to crowd monitoring. Several real-life case studies have shown that drones can play a critical role in solving situations, especially finding a missing person and rescuing people from natural disasters. Law enforcement agencies obviously want to use the drones for good intentions: to minimize crime and reduce threats toward their police force, particularly in high-risk missions. However, they must address important concerns pertaining to privacy, data management, regulating and monitoring on daily basis. When the drones were first introduced to the consumer market, they didn't have advanced technology such as thermal imaging cameras or sensors that allows them to avoid autonomously tracking a moving suspect.

As of today, the drones such as Mavic 2 Enterprise and Inspire 2 are smarter and easier to command with plenty of features that allow police officers to perform a wide range of tasks from taking a closer look at the subject to gathering evidence at the

crime scene with its powerful camera. Since high-end consumer-grade drones are incredibly capable of capturing footage from the backyard of a house at any angle, it raises concerns regarding privacy, especially the Fourth Amendment expectation of privacy. We are living in a modern society where every individual can form their own opinion concerning technology and must try to address these issues.

The recent introduction of drones as a trending technology have its own issues that clashes with regulations and privacy. It is also hotly debated in how they should be regulated such as the recent incident at the Gatwick Airport (Spinks, 2018) which the British Government expanded the no-fly zone radius up to 3 miles after a remote pilot flew his drone that grounded multiple flights (Holt, 2019). However, there are several major organizations that advocate for privacy and want the United States lawmakers to enact stricter regulations on the use of drones that affects privately-owned and government-owned remote pilots. In this essay, we will discuss five things that address pertaining to the use of drones: privacy, data management, licensing, government agencies, and legislations. The purpose of this essay is to examine and understand how to integrate a successful policy that is responsive to these social concerns. Furthermore, it will help us examine to see if the current policy scheme can be improved upon that satisfies both government agencies and private citizens.

VIII – ENSURING INDIVIDUALS’ PRIVACY RIGHTS ARE PROTECTED

The introduction of professional-grade consumer drones that are both readily accessible and easy to purchase raises issue pertaining to privacy and the Fourth Amendment. The drones that are outfitted with cameras can easily relay the information

back to the remote pilot that reveals what the scene looks like from an aerial perspective. Furthermore, the drones can be mounted with thermal imaging cameras, infrared cameras, heat sensors, radar, and a variety of add-on modules that enhances their capabilities during flight sessions (Scott, 2017). The prime concern comes from the individuals who expects the right to privacy that could be legally challenged pertaining to the collection of personal data. However, once you enter the public, you are giving up your rights to privacy in a way you will never imagine with little to no control over the matters, according to United States Constitution, Fourth Amendment. If an individual wish to protect his / her identification and to retain any form of privacy in the public, it will require extraordinary efforts that will restrict their ability to participate in the modern society (Scott, 2017).

There are federal regulations already placed in effect that limits and dictates how the remote pilots should operate their drones such as ban flying over national forests and limiting the maximum altitude above the ground level. However, Federal Aviation Administration has done little to address concerns relating to privacy as their regulations in general are toothless. Which means the state governments and public agencies are responsible for developing a full-responsive policy that address their local communities and meet the standard expectations to protect the individuals' rights to expect privacy. Major organizations like American Civil Liberties Union and Electronic Frontier Foundations expressed their deep concerns regarding the collection of aerial footage captured by surveillance drones which could contain unsuspecting persons doing their daily business.

The American Civil Liberties Union is a renowned advocate organization that has earned their own reputation for defending the individual's' constitutional rights and views the consumer-based drones as a threat to the democratic values because the current privacy laws are not strong enough (Stanley & Crump, 2011). To ensure that the individuals' rights to expect privacy is protected, they have established an outline that sets the expectations which the drones should be deployed only if there is a ground to believe that the public agencies will collect evidence of a specific crime. If the drones appear to intrude within a reasonable expectation of privacy, then a warrant should be required and restricts on retaining images of identifiable people (Stanley & Crump, 2011).

Another major player that facilitates for stronger privacy rights is the Electronic Frontier Foundation. According to them, the drones have proven to be capable of performing advanced surveillance purposes which is already being used by the law enforcement agencies. Furthermore, these drones can carry multi-purpose equipment such as infrared cameras and thermal imaging and to some certain extent, non-lethal weapons (Electronic Frontier Foundation). Although, both major organizations are supportive of civilian drones, they mainly want to restrict the use of drones to ensure that privacy is protected by limiting to privately-owned UAV operators. This means the government-owned agencies that have their own drone programs will still run as normal, although there would be expectations to comply within the reasonable privacy standards.

VIV – MANAGING THE DATA

Managing the data collected by drones can be quite a burden on the public agencies that have limited resources. The quality, resolution, and size of footage are much more memory-intensive that requires large capacity to support for analyzing and mining imagery (Hogan, 2016). However, the main challenge in establishing a successful data management center is requiring all the necessary hardware such as drones, operation stations, communications network and acquiring a data center, which a law enforcement agency potentially lacks the budget to ensure an effective deployment of drones (Hogan, 2016).

For some public agencies, it might be cheaper to have their data managed by third-party agencies that stores the footage via clouding. However, that presents a legal issue that arise once the footage gets handed over to a third-party vendor, the public agencies is essentially giving up their ownership to a private company that might use the data for commercial purposes. Several law enforcement agencies already avoid collecting personally identifiable information such as facial, car plates and the like to adhere the Fourth Amendment (Hogan, 2016).

One potential solution to this is implementing a government and law enforcement application that can be utilized by the law enforcement. Furthermore, it helps creates a centralized network where the law enforcement agencies all around the United States can share footage and aid other agencies with their cases. Additionally, it will benefit the public agencies who already have their own drone program by reducing the cost to have a localized data management center and make the information readily available for public use.

X - LICENSING REMOTE PILOTS

A step towards meeting the regulations and creating a safer sky is to have the officer undergo training. To become Part 107 FAA-certified, the remote pilots must take and pass an exam with a minimum passing grade of 70% at a testing center that costs \$150 and must be maintained every two years. The exam tests their aeronautical knowledge such as weather observation, loading and capacity, pre-flight inspections, and airspace regulations. In general, the public would feel comfortable if the officers were licensed as to display they have knowledge of how to operate and utilize the drones appropriately within the federal aviation regulations.

The Federal Aviation Administration has already taken steps introducing safe integration of drones into civilian sphere such as piloting training and demonstrating aeronautical knowledge (FAA Reauthorization, 2018). These steps are just an example of filtering out remote pilots that curbs out dangers and increase the growing number of professionals that adhere to the regulations. This is especially important for developing a responsive drone policy that addresses the regulations. Several law enforcement agencies created their own drone policy based on the principles such as limiting the use of drones for natural disaster events and high-risk missions.

While having the officers FAA-certified and trained is a good thing, it limits their ability to do the job effectively. Often because an FAA-Certified remote pilot is required to maintain clear visual line-of-sight and must keep the aircraft under 400 feet above the ground level. Furthermore, an FAA-certified remote pilot can't fly during night time that otherwise could potentially be a life-changing moment if the agency can operate their drones mounted with a thermal imaging camera.

To alleviate this issue, several public agencies can apply for a Part 91 Certificate of Authorization (COA) exemption. This process takes slightly longer time compared to licensing the remote pilots with Part 107 because Federal Aviation Administration have to screen the police department's proposed drone operations to ensure it meets the administration's criteria. However, once COA has been approved, it gives the law enforcement agencies greater flexibility and more permissions to operate their drones during night time, beyond visual line of sight, fly higher than 400 feet, and even fly in controlled airspace if it is necessary.

Ideally, it is beneficial for the law enforcement agency to acquire both Part 107 and Part 91 as that will solidify their drone program. It is a great step to demonstrate the state and local communities that the officers have aeronautical knowledge of how to operate drones and have the piloting experience for safe flights (Dukowitz, 2018). Acquiring both licenses is the highest standard for an effective drone program to maximize the law enforcement agencies' performance while meeting individuals' expectations of privacy. Obtaining both FAA and COA licenses is the highest standard for an effective drone program.

XI – GOVERNMENT AGENCIES & LEGISLATIONS

More than 900 agencies have established their own drone program all over the United States (Gettinger, 2018). Yet, the federal enforcement of drone regulations is rather loose and broad. Enforcement of drone uses and how they are being operated is often delegated to the states and local public agencies that are tasked with developing independent policies to address their community's demographic.

The political affiliation of the local communities influences the support of drones' integration into the law enforcement agencies. Previous research showed that individuals who identify as liberal trust the United States federal government more than they trust the businesses not to misuse their personal information. For those who identify as conservative, the reverse is true (Anania, Rice, Pierce, Winter, Capps, Walters, & Milner, 2018). Although the conservatives displayed a much more favorable attitude toward the law enforcement agencies regarding the use of drones compared to liberals. Therefore, there are some influence of political affiliation on supporting the police use of drones given the opinions towards law enforcement agencies and privacy concerns (Anania, Rice, Pierce, Winter, Capps, Walters, & Milner, 2018).

There are several legislative bills that regulate drones and minimize the threats of drones when it comes to privacy concerns. Last year, the Congress passed FAA Reauthorization Act of 2018 which was signed into law that specifically granted the government more power pertaining to drones (FAA Reauthorization, 2018). On the federal government level, the FAA Reauthorization Act sets the goals to push towards privacy and improving the regulations that remains fair to commercially-owned drone operators. The main purpose of the reauthorization bill is to examine privacy issues and educating the drone pilots community how to self-govern better.

According to FAA Reauthorization Act of 2018, Section 358 regarding to UAS Privacy Review. Drone privacy is a very hot and popular political issue that interferes the lawmaking progress. According to Section 358, it requires the National Telecommunications and Information Administration to carry out review of the privacy issues and concerns associated of unmanned aircraft systems like the national

airspace. It focuses on examining and identifies the existing federal, state, or relevant local laws that address an individual's personal privacy. Furthermore, the Reauthorization Act identify specific issues and concerns that limits the availability of civil or criminal legal remedies regarding inappropriate operation of unmanned aircraft systems in the national airspace. Finally, this act will address any deficiencies on all government levels regarding privacy protections and provide recommendations to resolve limitations.

While Federal Aviation Administration mainly focuses on aviation safety, the Reauthorization Act of 2018 addressed privacy concerns pertaining to the regulations of drones. The drone regulations are largely delegated on the federal, state, and local governments. Major players like the American Civil Liberties Union and the Electronic Frontier Foundation want to have laws that addresses privacy concerns pertaining to the use of drones on the federal level. However, the drone industry trade group suggests that implementation of privacy laws could hinder the unmanned aerial systems sector from growing economically (Koebler, 2013). Many drones are commonly used for agricultural and public safety reasons which benefits the law enforcement agencies greatly. Certain bills championed by the ACLU that limit police use of drones like requiring them to get a warrant before operating it potentially can impact the acquisition of drones and integrating them into everyday tool (Koebler, 2013).

XII – PRIVACY CASE STUDIES

The initial question is whether the privacy concerns have been addressed that majority of the individuals are concerned with. Since the drone regulations on federal

level is broad, it does a little to resolve privacy issues. As mentioned previously in the essay that several law enforcement agencies already create a fully responsive drone policy that aims at protecting the individual's personal information and limiting the use of drones for important missions like finding a missing person or in hostage situations. For instance, in Florida it is illegal to capture an image of a person with the intent to conduct surveillance in violation of a person's reasonable expectation of privacy, without his or her written consent (Pomfret, 2017). Surveillance is defined as the observation of an individual with clarity to identify the individual. Furthermore, the law presumed that the individual has a reasonable expectation of privacy on his / her property if they are not observable by persons located at ground level. Which means if other people can't see them in their property at the ground level, then the same rule applies to use of drones for surveillance purpose (Pomfret, 2017).

Certainly, major players like the ACLU and the Electronic Frontier Foundation would still want to see privacy laws being implemented on the federal level so to ensure a high standard of expectation for everyone. The drone industry doesn't respond lightly to bills regarding privacy laws, citing concerns that it will hurt them economically. If the privacy bills were to become laws such as requiring the police officers to obtain warrant within reasonable ground to operate drones in public setting would limit the drone industry's ability to grow. It also hinders the law enforcement agencies' ability to perform their job, given how many real applications use the drones has for solving the cases.

A real example of a law enforcement agency that utilized MQ-9 Predator B in Nelson County by Sheriff Kelly Janke to investigate the six missing cows that were valued at \$1,000 each. The officers followed up by obtaining a warrant to search the

neighboring Brossart family farm and was threatened off with rifles (Anderson, 2014). The police department followed up by dispatching the Predator drone that located three suspects using sophisticated sensors which led to arrest of these citizens with the help of a drone (Bennett, 2011). The drone which the law enforcement flew featured thermal imaging camera and live video of the follow suspects: Alex, Thomas, and Jacob Brossart – including their mother Susan via the 4-inch screen hand-held device (Anderson, 2014).

Customs Border and Protection (CBP) agents also use the drones for surveillance. However, they are not required by law to obtain warrants and this was upheld by the United States of Supreme Court. The CBP might establish its standards for surveillance and conduct operations without the need of a court order, which allows them to use its surveillance authority to collect information on the law-abiding U.S citizens inside the United States (Bier & Feeney, 2018). This is particularly worrisome because quality of the drones that CBP uses comes with footage and long remote-control distance that goes behind the physical border amplify the concerns pertaining to privacy (Bier & Feeney, 2018). According to Federal Aviation Administration, the CBP can operate their drones up to 60 miles of the southern border and within 100 miles of the northern border. Which leads to change of the U.S residents' behavior in response to the use of drones within the border (Bier & Feeney, 2018).

California v. Ciraolo case is relevant to the use of drones and relies heavily on the reasonable of expectation of privacy test (Feeney, 2016). The case sets a worrisome precedent for the advocate of Fourth Amendment amid the proliferation of drones. The court ruled that the Santa Clara police officers who acted on an anonymous

tip didn't need to obtain a warrant to use an airplane flying at 1,000 feet to look for marijuana plants in Dante Ciraolo's backyard (Feeney, 2016). Because of that, the officers secured a search warrant and arrested Ciraolo. Even though the backyards of homes have been recognized as constitutionally protected areas, the court upheld that the police officers didn't violated any law (Feeney, 2016).

While most drone users fly their quadcopters with good intentions, implementation of privacy laws could lead to unintended consequences that will impose further restrictions which potentially impacts commercially-owned drone operators. The bills, however will not impact the public agencies greatly since they are eligible to apply for Certificate of Authorization. Commercially-owned drone operators who are independent contractors will be impacted significant if the privacy bills were to become laws and additional restrictions such as lower maximum altitude above the ground level. Ultimately, the purpose of the drone regulations is to establish the guidelines that professionals can follow and exercise self-governance that respects privacy of the individuals. The Federal Aviation Administration already provides training for new drone users and certifies those who demonstrates proficient in aeronautical knowledge.

The technology has picked up rapidly and the drones are changing the way our law enforcement agencies uses them for various tools from surveillance to investigating the crime scenes. The direction these consumer-based drones have indicated they are only getting portable, packed and equipped with better camera imaging quality that makes it easier to capture small details than ever before. Throughout the essay, several law enforcement agencies already have drone policy that emphasizes on the principles of privacy and Fourth Amendment. While the FAA Reauthorization Act of 2018

addressed concerns pertaining to privacy, majority of the legislations are delegated to federal, state, and local governments who are tasked with regulating the drones within their jurisdictions.

XIII – BENEFITS OF ADD-ON MODULES

The drones provide plenty of benefits in several industries economically and in terms of performance. However, when it comes to law enforcement, the add-on modules play a major factor in how well the drones perform by giving the police officers additional tools. There are plenty of add-on modules to choose from which can be used to customize the drones for certain situations. For instance, the Mavic 2 Enterprise can be mounted with the light cubes module that acts as a searchlight in order to assist with finding the missing persons during night time. Furthermore, they also can be mounted with a speaker that allows the police officers to communicate with the suspect during a hostage crisis. The speaker module can capture all the audio and store in its memory storage that can be retrieved for analysis and as an evidence during the court procedure.

The introduction of add-on modules plays a significant role in how drones can help the law enforcement agencies perform better at gathering aerial intelligence. As the technology is evolving at rapid pace, the modules are becoming useful due to the fact that it gives flexibility to address certain situations. For instance, a police officer that operates a drone mounted with the Active Tracking feature and zoom camera with digital image lossless technology will be able to track a suspect, identify the person and collect necessary information to relay to ground-based units. Not just only that, it gives

more flying distance between the drone and the suspect who potentially could be armed.

Add-on modules can be purchased for several extra hundred dollars, depending on the specifications and its potential use. While the specifications of drones remain the same, modules are adaptive and can be improved over the time as technology improves. For example, the DJI Inspire 2 has a series of cameras featuring different specifications from 4K introduced in 2015 to a 6K resolution introduced in 2017 that captures high levels of detail. They also are outfitted with zoom capabilities that enables the remote pilot to zoom in at close range without losing the quality of digital image. The most expensive camera module with zoom capabilities for DJI Inspire 2 can be bought for \$2,699 (DJI Zenmuse X7 - Cinematic Vision Rising - DJI).

There is limited public knowledge about the benefits of add-on modules in several industries, specifically law enforcement agencies. The main purpose of this essay is to research and examine each module that has been used on the drones prior to Mavic 2 Enterprise, the most recently popular drone released by DJI geared towards law enforcement agencies, fire services, and city officials. In this essay, I will discuss the benefits, potential uses, real case studies of each module starting with: zoom camera, active tracking, thermal imaging, speaker module, light cubes module, and non-lethal weapons.

XIV – ZOOM CAMERA

One of the primary reasons why the zoom camera is incredibly popular and widely utilized on the drones is the fact that they are versatile. They offer law

enforcement officials the ability to zoom the images up close and gather more details in clear visual that isn't otherwise possible with regular cameras. The main difference between using a digital zoom camera and an optical zoom camera is the quality and the level of details that it captures. A digital zoom camera basically enlarges a portion of the footage and trims the edge, which leads to low image resolution and reduction in quality. On the other hand, an optical zoom camera relies on using the right zoom lens that brings distant objects closer without having to reduce the image resolution and quality.

This process is done by interpolating the pixels using oversampling technique so that the size of pixel remains the same. Optical zoom camera is achieved by moving the glasses inside the lens to reach higher focal length. Although, digital zoom can be also achieved without using any mechanical action inside the camera with no impact on the focus. The image lossless technology is a great feature that benefits the law enforcement agencies in observing subjects, gathering evidences or to examine with great detail level.

Drones with zoom capabilities are particularly appealing to the law enforcement agencies which makes perfect sense. The integration of drone and camera technology allows the officials to have a better vantage point during chaotic situations where deploying ground personnel is too risky. The advantage of aerial capabilities allows them to fully evaluate and reconstruct the crime scenes to understand the timeline of events for every incident (Police Drone Infographic). Furthermore, being reliant exclusively on ground assets to respond to emergency events increases the threats to the safety of the community and emergency personnel (Police Drone Infographic). At

the same time, it reduces efficiency and effectiveness of emergency responses. In response to emergency situations such as active shooters, IEDs, and even armed hostage situations, the small unmanned aerial systems (sUAS) can easily observe threats from a safe distance and allows the law enforcement agents to operate on the scenes with greater safety (Police Drone Infographic).

XV – ACTIVE TRACKING

Active Tracking is a feature that is usually built in the sUAS already. This feature uses both the drone's visual sensors and GPS tracking technology to keep the selected subject in the frame. Which means the drone needs to be in P-Mode (Positioning Mode) in order to use ActiveTrack (Flynt, 2019). This works by selecting the subject that the remote pilot wants to track on either a hand-held device or video monitor. Once the drone identifies the subject, it will automatically start tracking the subject and follows anywhere it goes.

While this feature is relatively new, it has received major upgrades with the release of Mavic 2 Enterprise. This drone is outfitted with dual vision sensors that gives them the ability to construct accurate 3D environments which results in a much more precise recognition (Flynt, 2019). Furthermore, it has built-in algorithm that allows the drone to predict the path that the subject will take which minimizes the possibility that the drone will lose the track of its subject (Flynt, 2019). The upgraded ActiveTrack also has a maximum movement speed of 44 miles per hour that makes it harder to leave the drones behind (Flynt, 2019). Finally, the Mavic 2 Enterprise incorporates advanced 3D

environment simulation capabilities that allows them to sense and avoid obstacles more accurately, ensuring most optimal flight path (Flynt, 2019).

XVI – THERMAL IMAGING

The drones can be mounted with a thermal imaging camera which gives the law enforcement officials the capabilities to spot suspects during night time and in hard to spot areas. They have impressive potentials that can change the outcome of the cases. For instance, in the aftermath of the Boston Marathon bombing, there was a major manhunt although they couldn't find the perpetrators, until the authorities were tipped off by a suspicious homeowner who narrowed their search to a large, covered boat (Chandler, 2013). The officials were working in the dark and couldn't see whether the perpetrators were armed (Chandler, 2013). With the introduction of thermal imaging cameras, it will help the officials identify perpetrators easily and improves the officials' situational awareness.

Thermal imaging cameras work by focusing the light using phased array of infrared-detector elements. It creates a detailed temperature pattern called a thermogram and only takes 1/30th of a second to obtain temperature information (Tyson, 2001). Then the detector elements is translated into electric impulses that is sent to a signal-processing unit, which translates the information into data for the display (Tyson, 2001). The data appears in various colors depending on the intensity of the infrared emissions which creates an image for the law enforcement officials to see (Tyson, 2001). By being able to analyze aerial shots with the typology, it gives law enforcement agencies the ability to discover composite of features characteristics of the

same geometric perceptual structure (Lega, Ferrara, Persechino, Bishop, 2014). This is called Thermal Pattern that identifies the relationship of crime and helps out the authorities process the data faster and more accurate (Lega, Ferrara, Persechino, Bishop, 2014).

There are five technical specifications that are important to the law enforcement officials. First, the temperature range that goes between room temperature to a couple of hundred degree is enough (LaPeditas, 2018). Secondly, the field of view versus how much detail do you need to be able to see the image clearly. Some thermal imaging cameras also come with zoom capabilities at slightly higher costs (LaPeditas, 2018). Third, resolution of the images. Higher resolution means it will have an easier time measuring smaller targets at a greater distance and will create sharper thermal images that helps you determine whether the target is concealed (LaPeditas, 2018). Fourth, repeatability is the key feature. If the thermal imaging camera aims at the same type of object in different environments, does it produce the same results? (LaPeditas, 2018). Finally, the thermal imaging cameras need to be able to measure the differences including the spectrum details like numbers, labels, signature and texture on the images (LaPeditas, 2018).

XVII – SPEAKER MODULE

Certain drones such as the Mavic 2 Enterprise can be equipped with speaker module which allows the remote pilot to communicate with the officials. Law enforcement benefits from the security that audio equipment provides for monitoring the suspect, deterring crimes, and using as an evidence in an event of criminal activity. The

speaker module enables the law enforcement officials to communicate with the police force and civilians alike.

The module designed for Mavic 2 Enterprise has a maximum decibel of 100 with a projection of 3.2 feet (Mavic 2 Enterprise - Specifications, FAQs, Videos, Tutorials, Manuals - DJI). It also allows up to 10 custom pre-recorded voices. These voices emitted by the speaker can be heard up to at least several feet away that makes communications accessible and readily available remote location. At the same time, the remote pilot can see through the drone's camera and use the information gathered to convey to the teams for formulating strategic response.

For instance, in a containment situation, the attachable speaker can be used to address the subject and prompt a surrender (Police Operations Made More Effective with Drones). In other situations, the speaker is an invaluable tool for reassuring injured people in search and rescue operations or to monitor large gathering like concerts or demonstrations (Police Operations Made More Effective with Drones)

The integration of a speaker module on the drones is beneficial for a couple of reasons: it is a tool that the law enforcement agencies can use it to alert civilians and officials during a traffic stop or to address hostage crisis. Secondly, this is a great communication tool that benefits ground-based teams by providing the information in advance before making any critical decisions.

XVIII – LIGHTCUBE MODULE

One of the most important modules that is especially popular among law enforcement agencies is the light cube module. It is called the Lume Cube Lighting which plays a crucial role in illuminating anything within 11-miles flight range thanks to

its packed 3,000 lumens of light (Lume Cube adds DJI Mavic 2 Drone Lighting Kit to Current Lineup). The lightcubes module helps eliminate shadow and silhouette from the moon that makes it easier for the law enforcement agencies to operate their drones during night flights.

The integration of lightcubes module is especially important for finding missing persons or to explore area where it is otherwise difficult for the officials to perform the job effectively. Furthermore, the lightcubes module comes with strobing light and continuous lighting options that can be utilized for several other purposes like alerting, or to grab attention (Lume Cube adds DJI Mavic 2 Drone Lighting Kit to Current Lineup). The module itself only weighs 9 ounces which is very lightweight and doesn't impact the drone's overall aerial capabilities, making it a popular choice for providing the law enforcement officials visuals in the dark where thermal imagers and night vision cameras can't do the same.

XVIV – NON-LETHAL WEAPONS

Currently, not many law enforcement agencies use non-lethal weapons mounted on the drones for several reasons: the use of force exerted is greater than what the drones can handle (Hambling, 2018) and to mount them will require an entire new 800-class which means heavier weight and bigger size that makes flying overhead more dangerous (Hambling, 2018). By the definition non-lethal weapons are tasers, rubber bullets, bean bags and tear gas (Spallanzani, 2017). There are benefits of combining non-lethal weapons on the drones, mainly for the safety of officers, and providing better crowd control. Whereas sending in police officers to dispatch riots could be a rather

risky assessment, a drone equipped with non-lethal weapons can safely dispatch riots without putting both sides' lives in danger.

This is particularly appealing to the law enforcement because it minimizes the officers' exposure in a life-threatening situation (Spallanzani, 2017). Furthermore, it can be used to deescalate the situation with a non-lethal force alternative (Spallanzani, 2017). For instance, the Israeli Defense Force successfully implemented non-lethal skunk water nylon bags mounted on drones and used it on the riots at the Gaza Strip (Ben-Dov, 2018). The drones release the bags upon request and breaks on impact that opens the content which drives the rioters away. Department of Defense announced that the development was checked and assessed that they didn't cause any damage even in cases of a direct hit (Ben-Dov, 2018).

The introduction of add-on modules brings a lot of benefits and additional tools that the law enforcement agencies can use to improve their job efficiency. While the drone has already proven to be an invaluable tool for gathering aerial intelligence, integral modules such as lightcubes and speaker can play crucial role in identifying the persons and simplifying the job. Not only these add-on modules are beneficial for data purposes, they do also serve the role to minimize the officers' exposure and provide information that is essential for strategic and tactical purposes.

One of the main advantages of add-on modules is the flexibility that is key for all law enforcement agencies. New technology can be incorporated into a module which can be mounted on an existing drone to enhance its usability and roles it plays in every situation. As the drones are becoming more affordable and readily accessible, the tools that they provide will help the public agencies with their job more effectively.

XX – INTRODUCTION TO SURVEY

The primary objective of this survey is to gather the information to develop an understanding of how law enforcement agency utilizes the drones. At the same time, the objective of this survey is to help educate the public about the use of drones and how they benefit law enforcement through a series of factors notable for: regulations, policy, decision-making, and licensing. 48 law enforcement agencies, both police departments and sheriff, were identified in the northeast region using the information from Center for the Study of the Drones at Bard College (Gettinger, 2018). These law enforcement agencies are in the following seven states: New York, Pennsylvania, Connecticut, New Jersey, Massachusetts, Vermont and New Hampshire -- with New York State being the largest number of established drone programs.

The recent adoption and integration of drones into everyday law enforcement agencies' toolset is becoming popular. We want to understand what they use the drones for and whether the public communities should be concerned regarding to privacy and Fourth Amendment. In this essay, we will discuss the research questions that examines the relationships between survey items such as are large police agencies more likely to establish written drone policies and use the drones more frequently. Secondly, we will talk about the sampling, survey distribution, survey items and questions pertaining to the survey design. Third, we will analyze the findings that reveals what I learned from the research questions and how they impact our modern law enforcement agencies' integration of the drone programs.

XXI – RESEARCH QUESTIONS

The survey was comprised of multiple questions that examines the relationships between law enforcement agencies and the drone programs. These research questions attempt to explain how these law enforcement agencies uses these drones for, how they manage the data collected with the drones, and how they educate their local communities about the drones.

The first research question asks what type of drone model and how many they own. We included the type of model and number of models that they own so that we can examine the relationship to compare the difference between drone ownership and agency sizes. Such as are the large law enforcement agencies more likely to purchase expensive models compare to small police departments? And does the size of drone fleet influences the law enforcement agencies' acquisition of pilot licenses?

The second research question studies the relationship between the police departments and pilot's licensing. We want to understand whether the size of law enforcement agencies and classification of the police department is relative to acquiring Federal Aviation Administration (FAA) Part 107 and Certificate of Authorization (Part 91). Furthermore, this question will help us analyze how frequently they operate their drones for crime scene analysis, traffic accident analysis, crowd monitoring, missing persons, natural disaster response, investigative surveillance, active suspect tracking and SWAT response since the pilot's license plays a role in demonstrating aeronautical knowledge and adhering to the federal drone regulations.

Third research question focuses on how often these law enforcement agencies utilize their drones. This is based on frequency under eight different categories: crime

scene analysis, traffic accident analysis, crowd monitoring, missing persons, and natural disaster response, investigate surveillance, active suspect tracking and SWAT response. The law enforcement agencies are given the options to indicate how frequently they use their drone programs to assist with fighting the crimes and providing relief. In addition to that, this research question also will help us examine whether the size of law enforcement agencies influences the frequency of flight missions.

Fourth research question asks the law enforcement agencies regarding add-on modules that can be mounted on the drones. The purpose of this research question is to examine how many law enforcement agencies use these add-on modules. We want to see how many of them use them and whether these add-on modules have any importance in the drone programs.

To examine how the law enforcement agencies handles the data to approach the citizens' concerns pertaining to privacy issues and Fourth Amendment. Public who are liberal in general has a slightly negative perspective about the use of drones because they associate them with privacy issues (Anania, Rice, Pierce, Winter, Capps, Walters, & Milner, 2018). Would a law enforcement agency that doesn't have throughout written drone policy associate with pilot licensing? Furthermore, would a police department that actively participates in the community leads to an overall better written drone policy?

XXII – SAMPLING PROCESS

I decided to focus on Northeast region and selected the following seven states: New York, Pennsylvania, Massachusetts, Connecticut, Vermont, New Hampshire and New Jersey that the public agencies have established drone programs. The original list

from CSD contained a combination of police and fire departments (Gettinger). Thus, I sampled mainly law enforcement across seven states which consisted 60 law enforcement agencies. The sampling consisted of 60 public agencies mixed of police departments, sheriffs and state police departments which are presented below in Figure 1. To gather information from them pertaining to use of drones in law enforcement field, I scoured the internet for their e-mail addresses and phone numbers and filled them out on the Excel.

Figure 1: Total Sampled Law Enforcement Agencies in Northeast Region

State	# of Agencies
CT	9
MA	7
NH	1
NJ	5
NY	24
PA	13
VT	1
Total	60

I then eliminated the agencies which didn't have e-mail contact information after following up with them for their addressed. Some police departments and sheriffs don't publicly list their email address, only phone number information. I personally contacted these public agencies and explained to them that I am doing a research project about

drones use in law enforcement agencies and requested their email address for survey purpose. I was able to get their email address before sending the survey. With the sample size, I was left with 48 law enforcement agencies for which I had an identified email contact for receipt of the survey. Below (Figure 2) is the updated table of the corresponding agencies that received the survey.

Figure 2: Corresponding Law Enforcement Agencies that received survey

State	# of Agencies
CT	5
MA	6
NH	1
NJ	2
NY	23
PA	10
VT	1
Total	48

The main reason why I chose to focus on a small sample size especially in Northeast region is for the three following points: a small sample size is easier to analyze and understand how these public agencies operate their drone programs. The smaller sampling size is, the less time consuming the research effort is and information gathered pertaining the use of drone programs can be obtained easily. However,

because the sampling size is small doesn't mean it accurately represents the whole law enforcement agencies in the United States.

Once I compiled all 48 public agencies throughout the northeast region. The survey was sent via e-mailing to the corresponding law enforcement officials who are either responsible for managing or have knowledge of the drone programs. Upon the first 24 hours of emailing the survey, we obtain several responses and the numbers gradually decrease during the following week. The number of responses bounced up with a polite prompt reminding the corresponding law enforcement agencies to complete the surveys. Although out of all 50 agencies that we sent the survey to, we gathered 14 respondents which is a good number for a small sampling size within seven states in the northeast region.

XXIII – SURVEY DESIGN

The design of survey mainly focuses on the law enforcement agencies with drone programs and falls under the following classifications: county sheriffs, municipals and state. It is designed to gather information regarding the law enforcements' drone programs. The initial question asked whether they wish to participate in this study. With a sample size of 60 which was reduced to 48 since twelve agencies didn't have e-mail address to send the survey. Only 14 respondents took the survey with one respondent selecting "no" which immediately brought to the end of survey with no questions answered.

The initial question was followed by another question that asks if they use drones. We assumed that these law enforcement agencies already have drone

programs since we derived the information from CSD research study by Gettinger. The purpose of this question in its place is to confirm that these law enforcement agencies still operate drone programs. The next survey question asks what type of model they use and how many they own. This is essential to know what type of drones they use for their job.

The survey also asks whether the law enforcement agencies are licensed and if so, what type of licenses they have: Part 107 (FAA) or Part 91 (COA) or both? Since those pilots who have Part 107 license are required to follow the drone regulations and it can play a role in how they operate their drones due to restrictions imposed by the federal government. Part 91 COA have far less limitations but that would require more responsibilities for the public agencies including officer training and altitude of aeronautical knowledge. We included the pilot licensing because they might potentially impact the overall drone activities that the law enforcement agencies can do and type of flight missions.

We also added a survey question that asks them what type of activities they used their drones for. Each activity has multiple options to choose from: never, seldom, occasionally, and frequently. Because this question focuses on flight activities, we included a follow-up question that asks what type of add-on module. This is designed to help capture the responses more smoothly and get an idea of how these add-on modules impacts the drone programs.

After that section is concluded, we moved on to regarding the written drone policies. Because privacy concerns are highly valued in the United States and every individual are concerned about it. We designed to include that question which provided

the law enforcement agencies multiple choices that they can choose from: pilot licensing, data management, privacy expectations, and prohibited uses. Furthermore, we included a question that asks them how they educate the public about drones. Because we felt that educating the public is a good way for the individuals to learn about the drones, it also ties in closely with the privacy concerns to show what the law enforcement agencies can do to improve public's confidence in them.

XXIV - FINDINGS

Even though the sample size only consisted of 14 respondents, it still provided us with ample of data to work with. The first research question asks what type of model and how many drones they own. We gathered the following data as shown in the Figure 3 series below examining the type of drone model and number of drones owned in comparison to classification and size of law enforcement agency.

Figure 3.1: # of DJI Inspire owned * Classification of Law Enforcement Agency

		Local Municipal	County Sheriff	State Police	Total
Please indicate the number		5	2	0	7
of drone makes/models that	1	4	1	0	5
your agency owns. - Number	18	0	0	1	1
of Drones - DJI Inspire - #					
Total		9	3	1	13

Figure 3.2: # of DJI Inspire owned * Size of Law Enforcement Agency

		16-50	51-100	101-500	501+	Total
Please indicate the		2	1	4	0	7
number of drone	1	2	2	0	1	5
makes/models that your	18	0	0	0	1	1
agency owns. - Number						
of Drones - DJI Inspire -						
#						
Total		4	3	4	2	13

Figure 3.3: # of DJI Phantom owned * Classification of Law Enforcement Agency

		Local Municipal	County Sheriff	State Police	Total
Please indicate the number		5	0	0	5
of drone makes/models that	1	4	2	0	6
your agency owns. - Number	11	0	0	1	1
of Drones - DJI Phantom - #	3	0	1	0	1
Total		9	3	1	13

Figure 3.4: # of DJI Phantom owned * Size of Law Enforcement Agency

		16-50	51-100	101-500	501+	Total
Please indicate the		1	2	1	1	5
number of drone	1	3	1	2	0	6
makes/models that your	11	0	0	0	1	1
agency owns. - Number						
of Drones - DJI Phantom	3	0	0	1	0	1
- #						
Total		4	3	4	2	13

Figure 3.5: # of DJI Mavic owned * Classification of Law Enforcement Agency

		Local Municipal	County Sheriff	State Police	Total
Please indicate the number		7	3	0	10
of drone makes/models that	1	1	0	0	1
your agency owns. - Number	11	1	0	0	1
of Drones - DJI Mavic - #	19	0	0	1	1
Total		9	3	1	13

Figure 3.6: # of DJI Mavic owned * Size of Police Department

		16-50	51-100	101-500	501+	Total
Please indicate the		4	2	4	0	10
number of drone	1	0	1	0	0	1
makes/models that your	11	0	0	0	1	1
agency owns. - Number	19	0	0	0	1	1
of Drones - DJI Mavic -						
#						
Total		4	3	4	2	13

Figure 3.7: # of DJI Matrice owned * Classification of Law Enforcement Agency

		Local Municipal	County Sheriff	State Police	Total
Please indicate the number		8	2	1	11
of drone makes/models that	1	0	1	0	1
your agency owns. - Number	2	1	0	0	1
of Drones - DJI Matrice - #					
Total		9	3	1	13

Figure 3.8: # of DJI Matrice owned * Size of Law Enforcement Agency

		16-50	51-100	101-500	501+	Total
Please indicate the		4	3	3	1	11
number of drone	1	0	0	1	0	1
makes/models that your	2	0	0	0	1	1
agency owns. - Number						
of Drones - DJI Matrice -						
#						
Total		4	3	4	2	13

We found out that the relationship between number of the drones owned and type of models that they have relationship in terms of size and classification. For instance, a state police department has more than 501+ employees and has 18 Inspire, 11 Phantom and 19 Mavic, while a local municipal with more than 501+ employees has 11 Mavic, 1 Inspire and 2 Matrice. Majority of the law enforcement with less than 501

employees usually have between 1 to 2 drones with DJI Phantom being the most popular model, accounting for 57.1% of the respondents, followed by 42.8% who chose Inspire, 21.4% for Mavic, and 14.2% for Matrice. The findings lead that law enforcement agencies who are classified as state suggests that they have high demand for acquisition of drones since they have a much wider jurisdiction and thus can provide support on the state level. Furthermore, the size of the law enforcement agencies also determines how many drones they will be able to own as indicated by Figure 3.9 table below.

Figure 3.9: Number of Drones per Agency & Avg. of Drones

Size of Agency	# of Drones	# Drones / # Agency (Avg)
16-50 (4)	5	1 (1.25)
51-100 (3)	4	1 (1.33)
100-500 (4)	7	2 (1.75)
501+ (2)	62	31

We also found that at least 46.1% of the law enforcement agencies have between three to five employees who are approved to operate the agency drones. Only five (38.4%) of these law enforcement agencies have one to two approved employees while both agencies with more than 10 employees represents 15.3% of the total respondents.

Figure 3.10: Classification * Approved Employees to Operate Agency Drones

		Local Municipal	County Sheriff	State Police	Total
Please indicate the number of employees approved to operate agency drones.	1-2	3	2	0	5
	3-5	5	1	0	6
	10 or More	1	0	1	2
	Total	9	3	1	13

Throughout the research papers, those public agencies who acquired both FAA Part 107 and COA Part 91 are considered the highest standard. It would make sense if the law enforcement agencies have both pilot licensing, not only to demonstrate that they have knowledge of drone regulations, but also permission and the authorization to operate drones safely with public's confidence in the police officers' ability to perform flight activities legally.

Figure 4.1: Regulatory Pilot Licensing * Classification of Law Enforcement Agency

		Local Municipal	County Sheriff	State Police	Total
Please indicate the type of regulatory pilot licensing that your agency has acquired.	FAA (Part 107) Only	5	0	0	5
	Certificate of Authorization (Part 91 COA) Only	1	1	0	2
	Both FAA & COA	3	2	1	6
	Total	9	3	1	13

Figure 4.2: Regulatory Piloting Licensing * Size of Law Enforcement Agency

		16-50	51-100	101-500	501+	Total
Please indicate the type of regulatory pilot licensing that your agency has acquired.	FAA (Part 107) Only	3	0	2	0	5
	Certificate of Authorization (Part 91 COA) Only	1	1	0	0	2
	Both FAA & COA	0	2	2	2	6
	Total	4	3	4	2	13

Since majority of the law enforcement agencies are classified as local municipal, we saw that only five of them acquire FAA Part 107, two obtained COA Part 91 and six have both FAA and COA as shown in Figure 4.1. We also found out that law enforcement agencies that have more than 501+ employees all acquired both FAA and COA as shown in Figure 4.2. While the law enforcement agencies that have employee size between 16 to 50 either obtain FAA Part 107 or COA Part 91.

We also wanted to analyze how the acquisition of pilot licensing impacts the law enforcement agencies' ability to perform these following categories: crime scene analysis, traffic accident analysis, crowd monitoring, missing persons, natural disaster response, investigative surveillance, active suspect tracking and SWAT. In Figure 5.1, it reveals that the law enforcement agencies who have both FAA and COA perform crime scene analysis more often compare to others who has either COA or FAA. With five (41.6%) of the law enforcement agencies using it occasionally, and another five (41.6%) use it seldom. While one (8.3%) of the law enforcement agency state that they never used it for crime scene analysis.

Figure 5.1: Frequency of Crime Scene Analysis * Regulatory Pilot Licensing

		FAA (Part 107) Only	Certificate of Authorization (Part 91 COA) Only	Both FAA & COA	Total
Crime Scene Analysis	Frequently	0	0	1	1
	Occasionally	0	1	4	5
	Seldom	3	1	1	5
	Never	1	0	0	1
Total		4	2	6	12

The Figure 5.2 is interesting because of the FAA Part 107 limitations that prevents the remote pilot from being able to fly their drones overhead the vehicles or persons. If the public agencies want to perform Traffic Accident Analysis, it would make sense to acquire COA since it provides flexibility and allows the law enforcement agencies to perform flight activities that is otherwise not possible with a FAA Part 107 license. The law enforcement agencies that have both FAA and COA perform traffic analysis more common compared to others that only have either FAA or COA licenses as expected.

Figure 5.2: Frequency of Traffic Accident Analysis * Regulatory Pilot Licensing

		FAA (Part 107) Only	Certificate of Authorization (Part 91 COA) Only	Both FAA & COA	Total
Traffic Accident Analysis	Frequently	0	0	1	1
	Occasionally	0	0	1	1
	Seldom	3	0	3	6
	Never	1	2	1	4
Total		4	2	6	12

The Figure 5.3 provides information on how frequency the law enforcement with corresponding pilot licenses perform crowd monitoring. The data reveals that they do it occasionally (23%), seldom (53.8%) and never (23%). Which indicates that the majority of the law enforcement agencies utilizes their drones seldom for monitoring the crowds which is lower than we expected.

Figure 5.3: Frequency of Crowd Monitoring * Regulatory Pilot Licensing

		FAA (Part 107) Only	Certificate of Authorization (Part 91 COA) Only	Both FAA & COA	Total
Crowd/event Monitoring	Occasionally	0	1	2	3
	Seldom	3	0	4	7
	Never	2	1	0	3
Total		5	2	6	13

Figure 5.4 analyzes the frequency of drone uses to find missing persons and compares with law enforcement agencies with pilot licensing. This flight activity seems to be the most popular for using the drones since there are benefits of finding the missing person quickly. We expected that law enforcement agencies would use their drones frequently to find missing persons and the following results are: 25% frequently use it, 16.67% uses it occasionally, and 58.3% uses it seldom.

Figure 5.4: Frequency of Missing Persons * Regulatory Pilot Licensing

		FAA (Part 107) Only	Certificate of Authorization (Part 91 COA) Only	Both FAA & COA	Total
Missing Persons	Frequently	0	1	2	3
	Occasionally	0	1	1	2
	Seldom	5	0	2	7
Total		5	2	5	12

Figure 5.5 examines the frequency of drone uses to response to the natural disaster in comparison to the pilot licensing acquisition. As expected that law enforcement agencies who has both FAA and COA licenses would be able to response the natural disasters more frequently compared to others that only have either FAA or

COA license. Only five (45.4%) of the law enforcement agencies never used their drones for responding to the natural disasters.

Figure 5.5: Frequency of Natural Disaster Response * Regulatory Pilot Licensing

		FAA (Part 107) Only	Certificate of Authorization (Part 91 COA) Only	Both FAA & COA	Total
Natural Disaster Response	Frequently	0	0	1	1
	Occasionally	0	1	1	2
	Seldom	1	1	1	3
	Never	3	0	2	5
Total		4	2	5	11

In the Figure 5.6, we gathered data pertaining the frequency of investigative surveillance and how acquisition of pilot licensing impacts those law enforcement agencies. Privacy is highly valued in the United States and majority of the individuals care about their information not being collected in the public. Which reveals that 61.5% of the law enforcement agencies never used their drones for investigative surveillance purpose.

Figure 5.6: Frequency of Investigative Surveillance * Regulatory Pilot Licensing

		FAA (Part 107) Only	Certificate of Authorization (Part 91 COA) Only	Both FAA & COA	Total
Investigative Surveillance	Seldom	3	0	2	5
	Never	2	2	4	8
Total		5	2	6	13

The Figure 5.7 analyzes how often the law enforcement agencies utilized the active tracking feature to track suspects in corresponding to the pilot licensing. We

found out that five (41.6%) out of 12 used it occasionally, while three (25%) used it seldom and four (33%) never performed that. This finding is interesting because we thought it would be one of the most popular flight activities since active tracking would follow the suspect anywhere they go and provide the tactical police teams aerial intelligence.

Figure 5.7: Active Suspect Tracking * Regulatory Pilot Licensing

		FAA (Part 107) Only	Certificate of Authorization (Part 91 COA) Only	Both FAA & COA	Total
Active Suspect Tracking	Occasionally	1	2	2	5
	Seldom	2	0	1	3
	Never	2	0	2	4
Total		5	5	5	12

The Figure 5.8 focuses on frequency of SWAT response in relation to the acquisition of pilot licensing. We found out that one law enforcement agency who COA Part 91 license has used it frequently. While three law enforcement agencies with both FAA and COA used it occasionally. Furthermore, 6 of these law enforcement agencies used the drones for SWAT response seldom. Although, two law enforcement agencies responded that they never used it for this type of flight activity category.

Figure 5.8: SWAT * Regulatory Pilot Licensing

		FAA (Part 107) Only	Certificate of Authorization (Part 91 COA) Only	Both FAA & COA	Total
SWAT	Frequently	0	1	0	1
	Occasionally	0	0	3	3
	Seldom	3	0	3	6
	Never	1	1	0	2

Total	1	5	6	12
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Followed by add-on modules question, we analyzed what type of add-on modules these law enforcement agencies. The figure 6.1 reveals how many law enforcement agencies use per corresponding add-on module.

Figure 6.1: Type of Modules and Law Enforcement Agencies

Type of Modules	Agencies Reported (%)
Zoom Camera	71.4%
Thermal Imaging Camera	64.2%
Night Vision Camera	21.4%
Auto Object Tracking	14.2%
Loudspeaker	0%
Searchlights	0%
Non-lethal Weapons	0%

We found out that the zoom camera add-on module makes up for 71.4% of the total law enforcement agencies and is the most popular module. Nine out of fourteen use thermal imaging camera which accounts for 64.2% of the total law enforcement agencies. The night vision camera, although, is less popular add-on module which only three law enforcement agencies responded that they use it, accounting for 21.4% of total respondents. While the Auto Object Tracking feature is the least utilized which only two law enforcement agencies (14.2%) used it. Furthermore, none of the law enforcement agencies uses loudspeaker, searchlights or non-lethal weapons.

The next finding examines the relationship between regulatory pilot licensing and written drone policies. We found out that there are five law enforcement agencies that

have acquired FAA Part 107, two law enforcement agencies are COA Part 107 and six of these law enforcement agencies have both FAA and COA licenses. The Figure 7 series analyzes how many law enforcement agencies have written drone policies respectively to their regulatory pilot licensing below.

Figure 7.1: Regulatory Pilot Licensing * Written Drone Policies

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Pilot Licensing *	11	68.8%	5	31.3%	16	100.0%
Data Management *	10	62.5%	6	37.5%	16	100.0%
Privacy Expectations	11	68.8%	5	31.3%	16	100.0%
Prohibited Uses	10	62.5%	6	37.5%	16	100.0%

Figure 7.2: Regulatory Pilot Licensing * Written Drone Policies

Policy Area	FAA Part 107 (5)	COA Part 91 (2)	Both (6)
Pilot Licensing	80% (4)	50% (1)	100% (6)
Data Management	60% (3)	50% (1)	100% (6)
Privacy Expectations	60% (3)	100% (2)	100% (6)
Prohibited Uses	80% (4)	0% (0)	100% (6)

We found out that the law enforcement agencies who has both FAA Part 107 and COA Part 91 license are consistent with the written drone policies, scoring 100% in all category. The law enforcement agencies who has FAA Part 107 license, only 80% of them have pilot licensing and prohibited uses established, while 60% of them have data management and privacy expectations in the place. Although, the percentage might seem higher for the law enforcement agency who have acquired COA Part 91 license only, it is because there are only two of these agencies. Only one (50%) of these law enforcement agencies have written drone policy for pilot licensing and data

management. But, both agencies have privacy expectations. However, when it comes to prohibited uses, none of them have any written policy pertaining to it.

Pertaining the data management, we found out that all law enforcement agencies manages the data internally. One respondent didn't indicate whether they manage the data internally because they wished not to participate in this research study and thus was excluded. This data implicates that the law enforcement values and respects privacy of individuals.

Upon further analysis, we examine to see if there is any relationship between the written drone policies and size of the law enforcement agencies. The Figure 8.1 table reveals that there is little connection between the written drone policies and size of the law enforcement agencies. From the data shown below, it doesn't appear to have any impact on the written drone policies as the regulatory pilot licensing does.

Figure 8.1: Size of Law Enforcement Agency * Written Drone Policies

Policy Area	16-50 (4)	51-100 (3)	101-500 (4)	501+ (2)
Pilot Licensing	75% (3)	100% (3)	75% (3)	100% (2)
Data Management	50% (2)	100% (3)	75% (3)	100% (2)
Privacy	75% (3)	100% (3)	75% (3)	100% (2)
Expectations				
Prohibited Uses	75% (3)	67% (2)	75% (3)	100% (2)

Drawing from the information provided by the Figure 8.1, we can conclude that the law enforcement agencies who has more than 501+ employees are consistent with the following four written drone policies. While law enforcement agencies with size

between 16 to 50 employees are less likely to be consistent with the written drone policies.

The next finding examines how these law enforcements outreach their community to better educate their local communities. According to Figure 9 table, we found out that media outreach / Q&A is the most popular method of educating the public community accounting for 78.5% of the respondents. Followed by public demonstration which 57.1% of the law enforcement agencies indicated they do that. Only 42.8% of the respondents educates their communities via social media platforms. Community Event and Citizen Police Academy are the least utilized methods to educate the public communities, accounting for 21.4% and 14.2% respectively.

Figure 9: How Law Enforcement Agencies Educate Their Communities

Educating Method	Respondents (Out of 14)
Media Outreach / Q&A	78.5%
Public Demonstration	57.1%
Social Media	42.8%
Community Event	21.4%
Citizen Police Academy	14.2%

XXV - CONCLUSION

Before we highlight major findings, I want to briefly discuss the limitations of the research study. One of the limitations that we had is small number of the respondents to the survey, however, that is expected with a sample size of 60 from the following selected seven states. Another limitation is that not all the law enforcement agencies list

their e-mail address publicly. After several attempts to reach out those law enforcement agencies that don't have e-mail address, our sample size reduced to 48 that have working contact e-mail information. It furthers limits the data we were able to gather.

As we conclude the research study on analysis of drone programs in law enforcement agencies, there are several major findings that I want to highlight. We found out that the larger law enforcement agencies, the greater number of drones they own. One law enforcement agency identified as state police department who have more than 501+ employees has one of the biggest drone fleet, consisted of 18 DJI Inspire, 11 Phantom and 19 Mavic models which heavily skews the data. On the other hand, a local municipal with more than 501+ employees have more than 10 drones, although less compared to what the state police department has. We also concluded that these large law enforcement agencies have more than 10 employees who are approved to operate the agency drones.

One of the most important finding that we want to highlight is the data management. With the privacy being a hot and contentious issue regarding to the individuals' expectations to have rights to privacy. All the law enforcement agencies manage the data internally rather than using third-party service providers to store the data. This prevents the data from being used for commercial purpose and improves the public perception of how the data is handled.

We also want to highlight that majority of the law enforcement agencies tend to utilize both zoom camera and thermal imaging modules often. These add-on modules appear to be a very popular combination choices due to the benefits that they bring to

table. Both zoom camera and thermal imaging modules are used by 71.4% and 64.2% of the law enforcement agencies, respectively.

Finally, we want to point out that all four written drone policies are consistent with six law enforcement agencies who have both FAA Part 107 and COA Part 91 license. While this indicates that the law enforcement agencies who have both regulatory pilot licensing have developed solid policy foundation pertaining to operating the drones and meeting community's expectations when it comes to privacy.

In the future research study, the sampling size of law enforcement agencies should be further expanded to include across the United States to get a better insight of how the drone programs operate. Additionally, these law enforcement agencies should be classified within the region so to focus certain states in a specific region i.e. West, Midwest, South, North, Northeast, etc. for comparison. Expanding the number of law enforcement agencies will help complete more information including certain sections like add-on modules and get better understanding of how they operate their programs in each region, allowing to get more concrete data. Finally, an estimated budget that indicates how much they spend to operate the drone programs would play an important factor in understanding each law enforcement agency's demands as per classification and agency size.

XXVI – WORKS CITED

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