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DEVELOPMENT OF AN UNMANNED AIRCRAFT SYSTEMS TRAINING PROGRAM FOR THE UTAH DEPARTMENT OF TRANSPORTATION

Prepared For:

Utah Department of Transportation
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RESEARCH
UDOT Keeping Utah Moving
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DISCLAIMER

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16. Abstract

This research was completed to provide recommendations to create a standardized operational framework or pilot training program for Utah Department of Transportation (UDOT) Unmanned Aircraft Systems (UAS) which are used for infrastructure inspections, traffic monitoring, emergency response, and data collection. This will improve safety practices, regulatory compliance, and mission execution. This research addresses the need for a unified UAS operations manual and remote pilot training that ensures safe, efficient, and FAA-compliant drone use across all UDOT divisions.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF ACRONYMS

BVLOS: Beyond Visual Line of Sight

DC: District Coordinator

DOT: Department of Transportation

FAA: Federal Aviation Administration

GIS: Geographic Information System

LAANC: Low Altitude Authorization and Notification Capability

NJDOT: New Jersey Department of Transportation

NOAA: National Oceanic and Atmospheric Administration

ODOT: Ohio Department of Transportation

PennDOT: Pennsylvania Department of Transportation

RPIC: Remote Pilot in Command

SOPs: Standard Operating Procedures

UAS: Unmanned Aircraft System

UAV: Unmanned Aircraft Vehicle

UDOT: Utah Department of Transportation

VO: Visual Observer

EXECUTIVE SUMMARY

The Utah Department of Transportation (UDOT) is increasingly utilizing Unmanned Aircraft Systems (UAS) for infrastructure inspections, mapping, traffic monitoring, emergency response, and data collection. However, the absence of a standardized operational framework or remote pilot training program has led to inconsistencies in safety practices, regulatory compliance, and mission execution. This research addresses the need for a unified UAS operations manual that ensures safe, efficient, and FAA-compliant drone use across all UDOT divisions.

The study draws on best practices from peer agencies including NJDOT, PennDOT, and ODOT as well as industry partner Michael Baker International. These sources provide insight into training protocols, mission planning, safety standards, and data management strategies. A comprehensive survey of UDOT UAS operators further informed the development of a tailored framework, revealing a sturdy foundation of remote pilot experience, but highlighting gaps in flight logging, advanced mission training, and weather forecasting.

Key findings emphasize the importance of centralized oversight, standardized training, and consistent data workflow. The report recommends establishing a centralized UAS program within UDOT's Aeronautics Division, advancing public engagement with a UAS portal and website, and implementing standard operating procedures (SOPs). Additional recommendations include formalizing visual observer (VO) policies and integrating GIS-based data management.

Overall, this report outlines a clear path forward for developing a safe, efficient, and standardized UAS program that aligns with best practices and real-world applications across the transportation industry. This foundation for UAS operations creates a scalable framework that can be applied to various state agencies.

1.0 INTRODUCTION

1.1 Problem Statement

The Utah Department of Transportation's (UDOT) growing use of Unmanned Aircraft Systems (UAS) for inspections, monitoring, and emergency response displays the need for a standardized approach to remote pilot training and operational procedures. Without standard flight operation guidance, there is an increased risk of safety issues, regulatory non-compliance, and inconsistent practices amongst operators. Initiating a remote pilot training program with recurrent education and standard operating procedures will guide safe and effective UAS operations across the department.

UAS remote pilots operating commercially are required by the Federal Aviation Administration (FAA) to obtain a Remote Pilot Certificate. The certificate is currently the only requirement for UDOT employees to pilot UAS. This teaches a basic level of remote piloting knowledge. It does not address numerous important aspects such as actual remote pilot maneuvering skills, aircraft maintenance, or the special uses of UAS that are often applied by Departments of Transportation (DOT).

1.2 Objectives

This study aims to define the essential components of a standardized UAS remote pilot training program for UDOT. The following objectives support safe, compliant, and consistent drone operations across the department.

- Establish standardized procedures for all UAS operations conducted by or on behalf of UDOT.
- Ensure compliance with all FAA regulations, including Part 107, and align with best practices from peer DOTs.
- Promote safe, efficient, and consistent UAS flight practices across all UDOT divisions.
- Develop a centralized UAS program framework that supports mission planning, remote pilot training, data management, and operational oversight.

- Identify gaps in current UAS practices and recommend improvements based on peer agency comparisons and survey data.
- Support UDOT's broader transportation goals by integrating UAS into highway operations, emergency response, and infrastructure monitoring.

1.3 Scope

This research supports the development of a comprehensive UAS framework for UDOT by evaluating best practices from state programs and industry experts. It includes a comparative analysis of UAS manuals from the New Jersey Department of Transportation (NJDOT), Pennsylvania Department of Transportation (PennDOT), and Ohio Department of Transportation (ODOT), as well as insights from Michael Baker International. The study examines mission planning, flight operations, training standards, safety protocols, and FAA compliance to inform a standardized approach for UDOT. Survey data from UDOT UAS operators further informs the current state of operations and highlights areas for improvement. The resulting framework is designed to be flexible and scalable, accommodating a wide range of UAS applications while prohibiting any non-UDOT-related or recreational drone use.

1.4 Outline of Report

This report is organized into the following chapters:

- **Chapter 1: Introduction** – Presents the problem statement, research objectives, scope, and report structure.
- **Chapter 2: Research Methods** – Describes the methodology used, including peer manual comparisons, survey design, and operational analysis.
- **Chapter 3: Data Collection** – Details the sources of data, including contributions from DOTs and industry experts.
- **Chapter 4: Data Evaluation** – Analyzes the collected data using statistical and comparative methods to identify trends and gaps.
- **Chapter 5: Conclusions** – Summarizes key findings, limitations, and the implications of the research.
- **Chapter 6: Recommendations and Implementation** – Provides actionable recommendations and an implementation plan for UDOT's UAS program.
- **References**

2.0 RESEARCH METHODS

2.1 Overview

This research was developed using UAS manuals and guidance from NJDOT, PennDOT, and ODOT. Each DOT program was analyzed. NJDOT provides structured procedures aligned with FAA part 107, including flight protocols, remote pilot responsibility, and maintenance standards. PennDOT provided data on bridge inspections, pavement assessment, and emergency response supported by UAS. ODOT offered statewide guidance for drone use by staff and contractors under FAA regulations. Michael Baker International provided technical expertise on aviation planning and real-world UAS applications. These sources were reviewed and adapted to address UDOT's operational needs. A survey was distributed to current UDOT UAS pilots to understand the current operations underway.

2.2 Comparison of Peer Manuals

NJDOT, PennDOT, and ODOT provide useful examples for UDOT's UAS program. NJDOT uses a centralized system with strict FAA compliance and detailed flight logging, mainly for inspections and traffic operations. Their focus on regulatory alignment and consistent documentation ensures an elevated level of accountability and data integrity. PennDOT allows more flexibility across the department, focusing on safety standards, GIS integration, and broader uses like emergency response. This decentralized model supports innovation while maintaining core operational standards. ODOT's UAS program is structured to support internal staff and contractors, offering guidance on airspace coordination, safety protocols and mission planning. The program is balanced with operational flexibility, making it well-suited for statewide support. ODOT also emphasizes training and certification, ensuring that both internal and external operators meet consistent performance and safety benchmarks. These manuals were all analyzed to give UDOT the ability to implement its own system design.

2.3 UDOT Remote Pilot Survey

The pilot survey was designed in coordination with UDOT and distributed to current UDOT UAS operators. Since there are regular UAS operations underway amongst different disciplines, the intention is to gather information about the operators and the existing UAS program. Questions in the survey cover remote pilot experience, type of operations, resources to support flight planning, and training needs.

2.4 Summary

Studying the manuals from other DOTs will provide insight into how the programs manage operations of UAS. It will help determine the necessary components that UDOT will need to adopt for their training and procedures. The survey results provided valuable awareness into current UAS operations at UDOT. It is important to understand the current atmosphere surrounding UAS in order to tailor a proposed program to fit the needs of UDOT and its remote pilots.

3.0 DATA COLLECTION

3.1 Overview

Data for this report was collected from state government sources and industry sources. Multiple DOTs provided UAS program outlines that guided structure and compliance practices. Michael Baker International offered experience-specific insight to tailor the outline to UDOT's operational needs.

While UDOT has taken initial steps to incorporate UAS technology, its current policy and procedural framework lacks cohesion and operational maturity demonstrated by peer transportation agencies. This gap presents strategic risks to safety, regulatory compliance, and program scalability.

The UDOT pilot survey was sent out to the list of current UAS operators at UDOT. The response rate was just under half of the list at 22 submissions out of the 49 operators contacted.

3.2 New Jersey Department of Transportation (NJDOT)

The New Jersey Department of Transportation (NJDOT) uses UAS to support transportation planning, inspections, and emergency response. NJDOT developed a UAS program focused on safety, regulatory compliance, and mission efficiency. A standard operating manual guides flight procedures, pilot responsibility, data collection methods, and maintenance practices to ensure consistent and effective use of drones across the department. UAS assists highway operations by supporting planning, design, construction, and maintenance. Aerial data like photos and elevation models help with 3D design, progress tracking, and safety by reducing worker exposure to traffic.

NJDOT Training Overview:

- Training includes initial FAA training for Remote Pilots in Command (RPIC).

- Operators must complete recurrent training every two years to maintain active certification.
- RPICs are required to attend both initial and recurrent ground briefings.
- NJDOT offers online training modules for accessible and standardized instructions.
- Specialized training is available for advanced flight missions and night operations.
- Emphasis is placed on crew resource management to support safe and coordinated UAS operations.
- Supports highway planning, inspections, and construction.

NJDOT UAS Program Successes:

NJDOT has built a safe, well recognized UAS program that's become a national leader in drone deployment. The program has delivered measurable benefits in safety, cost savings, and operational efficiency. UAS missions have successfully supported high mast light pole inspections, construction management, and emergency response, reducing the need for lane closures and minimizing worker exposure to traffic. NJDOT's structured approach includes a detailed Flight Operations Manual and standardized procedures. This helps ensure consistent, compliant, and effective drone use across the department.

3.3 Pennsylvania Department of Transportation (PennDOT)

Pennsylvania Department of Transportation utilizes UAS to enhance data collection for various transportation-related activities. These activities include bridge and building inspections, roadway pavement condition assessments, and emergency response evaluations. By using drones, PennDOT aims to expedite the data collection process while minimizing risks to work crews and motorists. PennDOT uses UAS to inspect bridges, monitor pavement, and assess post-storm damage, reducing required ground crews and improving collection for highway operations.

PennDOT Training Overview:

- Employees must receive District Office approval before beginning UAS training or supporting PennDOT UAS missions.
- All remote pilots must have their FAA Part 107 certification on file with the District Coordinator (DC) before training starts.
- The DC is responsible for submitting remote pilot information to the Bureau of Aviation (BOA) for official tracking.
- The DC evaluates new remote pilots to ensure consistent pilot assessment standards.
- If the DC does not fly, they must have full knowledge of FAA Part 107 rules and UAS flight risks.
- Training seminars are required at least annually and are hosted by the District Office and the BOA.
- Attendance at seminars is mandatory for all remote pilots and flight support personnel and is kept in pilot records.
- Supports highway planning, inspections, and construction.

PennDOT UAS Program Successes:

PennDOT's UAS program has significantly improved transportation operations across the state. It has enhanced safety by reducing the need for temporary work zones and specialized equipment access during inspections. The program has also increased efficiency by speeding up data collection and enabling remote monitoring of infrastructure. Notable success includes the Kenmawr Bridge Replacement Project, where monthly drone flights and 3D modeling were used to track progress and emergency response efforts like landslide monitoring in western Pennsylvania. These efforts have helped PennDOT manage projects more effectively while keeping personnel and the public safe.

3.4 Ohio Department of Transportation (ODOT)

The Ohio Department of Transportation (ODOT) uses UAS technology to support transportation planning, maintenance, and emergency response. ODOT offers eLearning courses through the Ohio Local Technical Assistance Program (LTAP) that cover remote pilot certification, flight operations, equipment, and UAS applications in transportation projects. ODOT's UAS program supports highway projects by inspecting infrastructure, tracking construction, and collecting traffic data to improve efficiency and safety.

ODOT Training Overview:

- ODOT offers UAS training through its Local Technical Assistance Program (LTAP).
- Training includes UAS Awareness for staff new to drone operations.
- Courses prepare employees for the FAA Part 107 Remote Pilot Certification.
- Modules cover flight team operations, safety, and crew roles.
- Training includes guidance on selecting UAS equipment for different missions.
- Lessons focus on real-world UAS uses in infrastructure inspections, traffic monitoring, and emergency response.
- All training is available through ODOT's online eLearning platform.
- Supports highway planning, inspections, and construction.

ODOT UAS Program Successes:

ODOT's UAS program has become a national leader in drone integration for transportation. Through its UAS Center under the DriveOhio initiative, ODOT has successfully centralized UAS operation and provided shared services to local and state agencies. The program has improved infrastructure inspections, enhanced emergency response, and supported safer and more efficient highway planning. By combining UAS and connected vehicle technologies, ODOT has reduced duplication of efforts and made smarter, data-driven decisions across transportation projects.

3.5 Michael Baker International

Michael Baker International's internal UAS training program and policies provided expertise and experience, specific input to guide the development of the outline. Their experience in aviation transportation engineering and UAS program implementation helped ensure the content was practical, relevant, and aligned with current industry practices. Staff insights supported the customization of procedures, safety protocols, and operational workflows to better fit the needs of UDOT and its mission. Michael Baker's internal flight logging website provides clear checklists and data tracking throughout the country. The national training program provides remote pilot consistency across states. The training program is continuously updated to remain complaint with FAA guidelines.

3.6 Utah Department of Transportation (UDOT)

UDOT's existing UAS Policy and Procedures, published in 2017, are found on the UDOT Aeronautics Division – Advanced Air Mobility web page. They provide a foundational framework for drone operations, procurement, contracting, training, safety, privacy, and flight approvals. However, the documents are broadly written and lack operational depth, leaving critical elements open to interpretation. At over eight years old, the guidance is significantly outdated given the rapid evolution of UAS technology, federal regulations, and industry best practices. A comprehensive update is necessary to ensure the program reflects current standards and supports safe, efficient, and scalable UAS operations across the department. Though UDOT has these policies and procedural documents, there is limited evidence that these guidelines are actively implemented or enforced across the department.

3.7 UDOT Remote Pilot Survey

To gain better insight into current UAS operations at UDOT, an online survey form was distributed to the active remote pilots. Basic contact information was collected along with remote pilot experience. Experience was measured in multiple metrics: how long a remote pilot has been operating UAS at UDOT, how many flights, and how many hours of flying an operator has logged. Given that UDOT UAS operators are embedded across multiple disciplines within the organization, it was valuable to identify the specific categories of UAS operations they perform. Part of an operator's responsibility is choosing the correct location and conditions and obtaining the proper clearance to fly if in controlled airspace. Information was collected to identify the various sources and applications that are utilized by operators to assess these aspects. Operators were also asked how often they utilize a Visual Observer (VO), an assistant to the RPIC for help identifying hazards that could affect the safety of the flight. Finally, open-ended questions were posed to operators to understand what types of training they request to enhance the safety and productivity of their operations.

3.8 Summary

Data for this research was collected from a range of state government and industry sources to support the development of a standardized UAS framework for UDOT. NJDOT, PennDOT, and ODOT provided detailed UAS program documentation, including training protocols, operational procedures, and safety practices. Michael Baker International offered practical insights based on real-world UAS applications in transportation. UDOT's current remote pilots provided responses to the survey to understand experience levels, current operations, and training needs. A comparative review of these sources helped identify common practices and unique approaches, which informed the recommendations for UDOT's future UAS operations.

4.0 DATA EVALUATION

4.1 Overview

This section outlines the methods used to analyze and interpret the collected data. The goal of the evaluation was to assess the accuracy, reliability, and applicability of all the observed parameters. Statistical tools, regression models, and comparative analysis were used to draw meaningful conclusions from the data. The results of the evaluation helped guide decision making and support the development of consistent operational practices.

4.2 Survey Results

Most respondents reported having multiple years of UAS experience, but many had logged fewer than 100 total flight hours (Figure 2). This indicates a need for continued flight practice and mission exposure. The most common UAS operations included mapping, inspections, photo and video documentation, and incident response (Figure 3), which align with UDOT's transportation and safety goals. Remote pilots reported using a variety of weather forecasting tools, with UASidekick being the most frequently used (Figure 4). For airspace authorization, most remote pilots used LAANC- (Low Altitude Authorization and Notification Capability) enabled applications UASidekick and Site Scan (Figure 5), demonstrating awareness of FAA compliance requirements.

Survey responses also identified interest in additional training topics, including standard procedures and LAANC operations (Figure 6). While the FAA does not require a visual observer (VO), many UDOT missions include one, and some use a second VO for complex flights (Figures 7 and 8), reflecting a strong internal focus on safety. Respondents also suggested improvements to training, such as more scenario-based exercises, regular refresher courses, and standardized evaluation criteria (Figure 9). These findings will help guide future updates to UDOT's UAS training and operational procedures. The analysis of UAS operations at UDOT reveals significant opportunities for growth. Although UAS usage has increased nationwide over the past six years, mostly for mapping, inspection, and emergency response, they have inconsistency in standardized training. Flight data shows that most missions are concentrated in specific regions, leaving other areas underutilized. Seasonal trends indicate peak activity during warmer months, with most operations lasting under 30 minutes and conducted below 200 feet in altitude. Infrastructure efforts have largely focused on pavement and bridge inspections, with limited attention to other assets such as traffic systems and stormwater infrastructure.

UDOT's Incident Management Team (IMT) provides an informal training for UAS operators within the department. The IMT provides a 5-day in-person training based on the FAA Remote Pilot Study Guide (FAA-G-8082-22). The goal of the training is to assist their team members in passing the Unmanned Aircraft General Small (UAG) Knowledge Test. The training includes rules and regulations of flying UAS, basics of aviation, airspace, reading sectional charts, weather theory, aircraft performance, and other topics listed in FAA-G-8082-22. As the weather permits, they practice basic flight maneuvers in a controlled environment with a licensed RPIC.

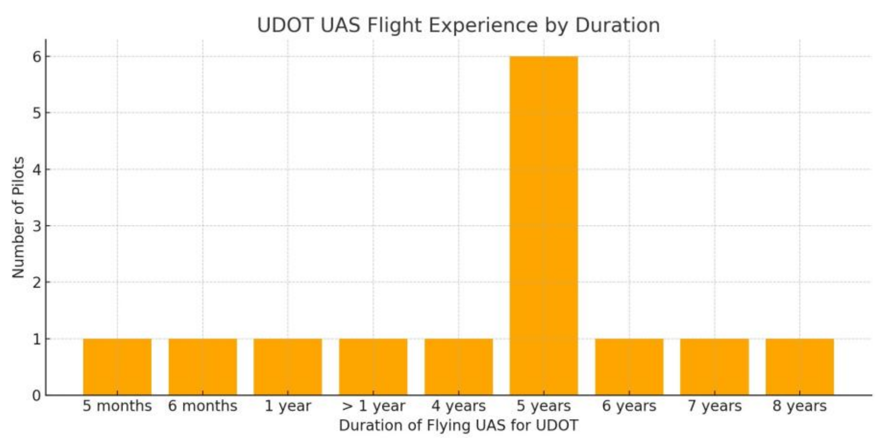

Figure 1 - UDOT UAS Flight Experience

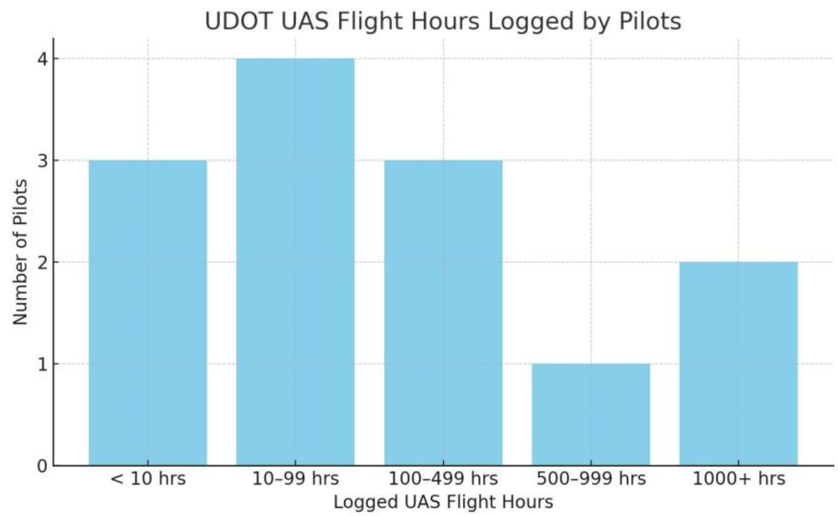

Figure 2- UDOT UAS Flight Hours

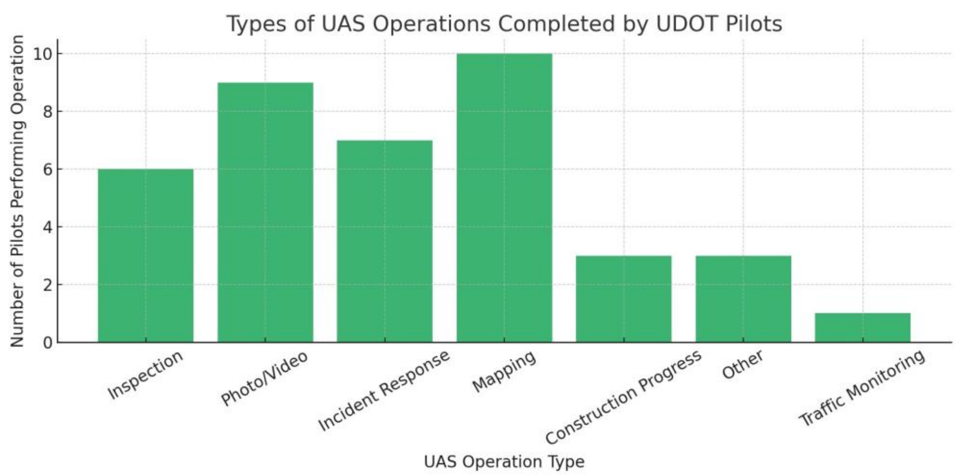

Figure 3 – UDOT UAS Operation Types

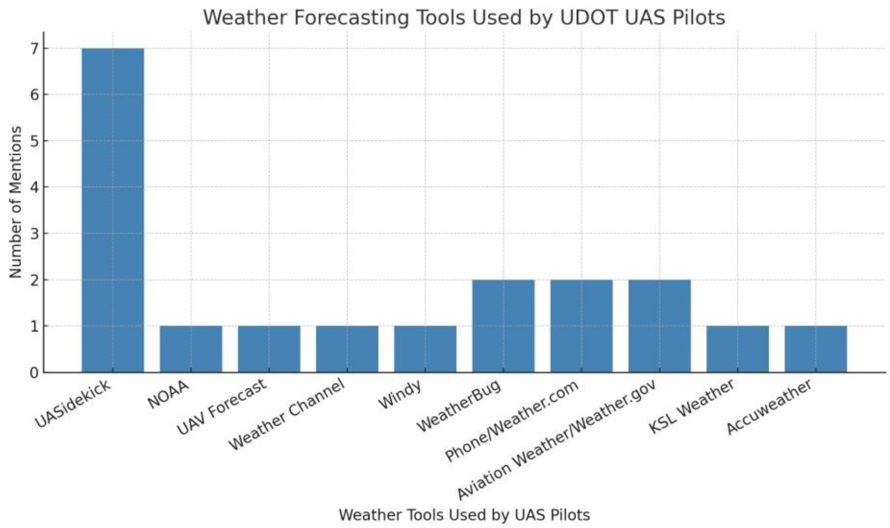

Figure 4 – UDOT Weather Forecasting Tools

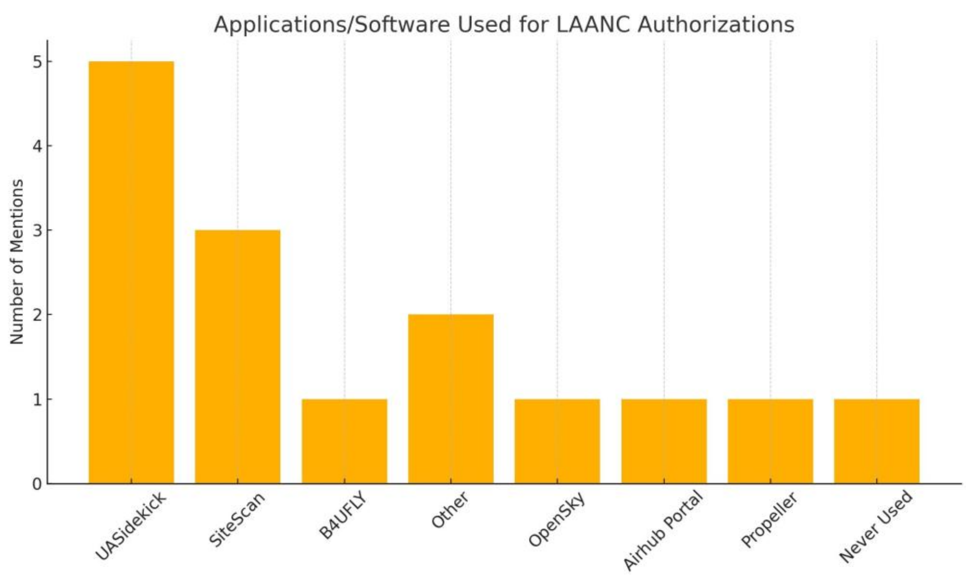

Figure 5 – Software Used for LAANC Authorization

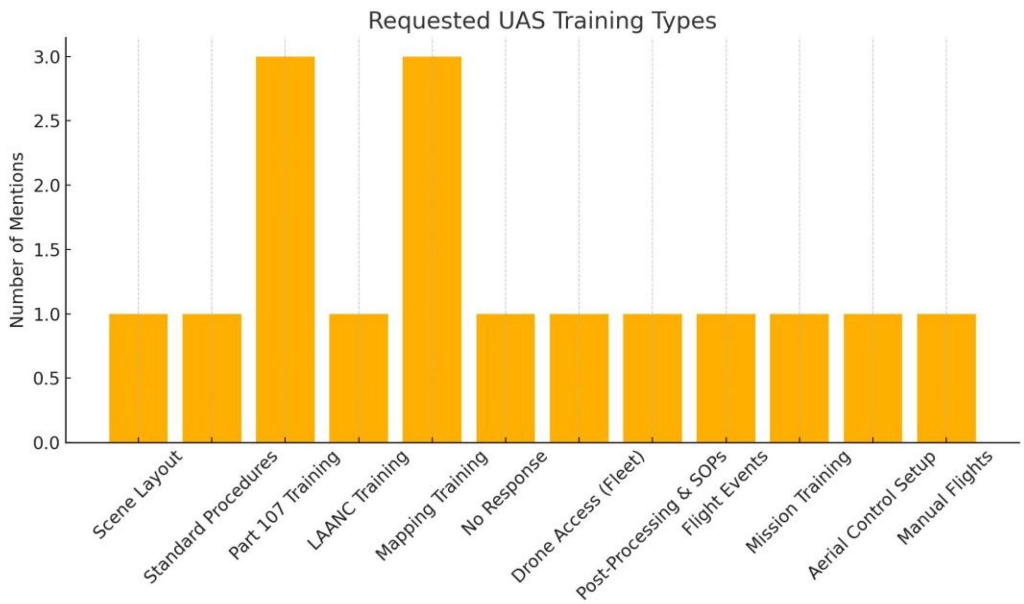

Figure 6 – UAS Requested Training

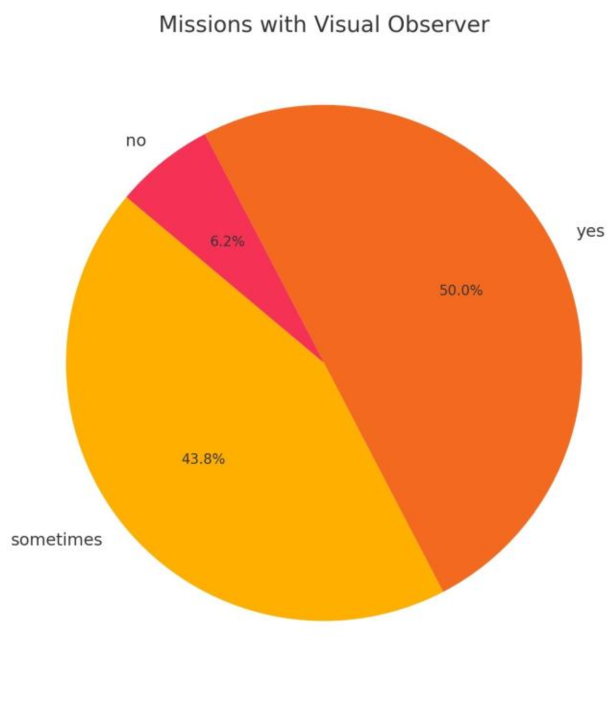

Figure 7 – Missions with VO

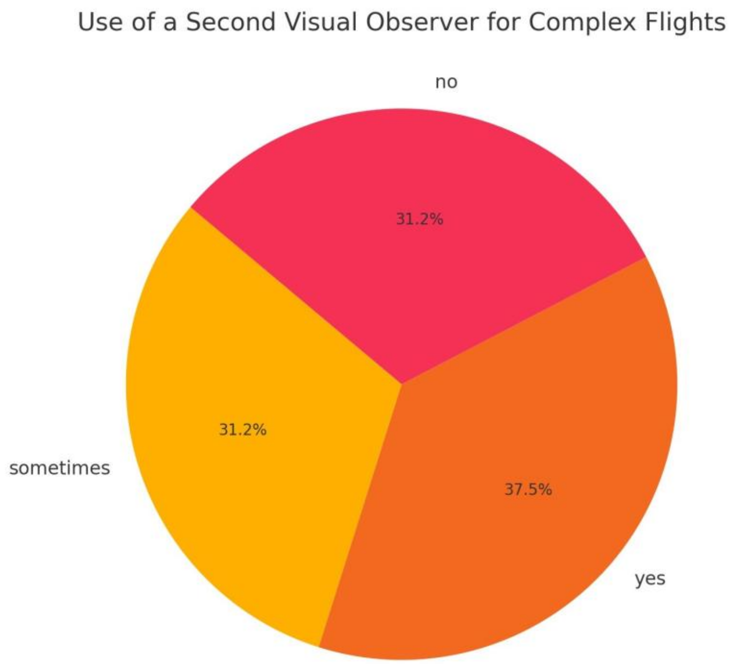

Figure 8 – Use of Second VO for Complex Flights

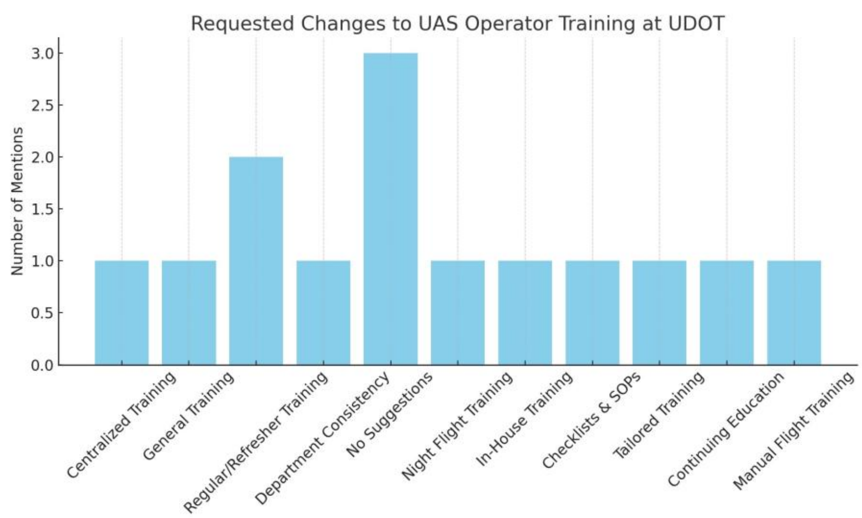

Figure 9 – Requested Changes to UAS Operator Training

4.3 Peer DOT UAS Program Comparison

To inform the development of a standardized UAS framework for UDOT, a comparative analysis was conducted examining key program elements from NJDOT, PennDOT, and ODOT. The table below outlines each agency's approach to centralized program management, operational procedures, training, and data practices. Based on these findings, targeted recommendations are provided to guide UDOT in establishing a comprehensive and scalable UAS program aligned with peer DOT UAS programs, industry best practices, and regulatory standards.

Category	***NJDOT***	***PennDOT***	***ODOT (Ohio)***	***UDOT Recommendation***
Centralized UAS Program	Yes – under Bureau of Aviation	Yes – under Bureau of Aviation	Yes – dedicated UAS team and guidance	Build centralized UAS program to create a standardized approach in Division of Aeronautics
Public Web Portal	Limited; internal only	Public-facing info available	UAS-specific website with policies and use cases	Build a public-facing UAS page to highlight capabilities and safety guidance
SOPs (Operations)	Yes – flight planning & data standards	Yes – includes safety & data workflows	Yes – with pilot certification policies	Establish statewide SOPs for flight approval and data management
Training/Certification	Internal training + FAA 107	Internal training + FAA 107	State-sponsored training and recurring education	Create in-house training to standardize operations and promote culture focused on safety

Use Cases	Asset inspection, traffic, emergency response	Asset inspection, crash recon, env. review	Roadway mapping, flood response, 3D modeling	Broaden UAS use into 3D modeling, environmental review, and crash investigation
Data Management	Centralized database with GIS links	Metadata tagging and consistent storage	Cloud GIS integration	Develop standard GIS-integrated data management statewide
Flight Logging	Internal tools	3rd-party apps + internal dashboard	Uses DroneSense + ArcGIS	Implement a centralized flight tracking and logging platform
Visual Observer Policy	Encouraged	Mandatory for select missions	Required for BVLOS	Define a formal VO policy for mission safety and regulatory compliance

4.4 Summary

The data evaluation phase focused on analyzing survey responses from UDOT UAS operators and comparing UDOT's practices with those of peer DOTs. Survey data revealed that while most remote pilots have several years of experience, many still have limited flight hours, highlighting the need for more mission exposure. The most common UAS applications include mapping, inspections, and incident response, which align with UDOT's operational goals. Remote pilots reported using a variety of weather tools and LAANC-enabled applications, and many missions include visual observers, even when not required.

In addition to internal data, a comparative review of NJDOT, PennDOT, and ODOT programs was conducted. This analysis identified key areas where UDOT can enhance its UAS operations, including centralized program management, standardized training, public-facing resources, and consistent data management practices. These findings support the development of a more unified and scalable UAS framework for UDOT, grounded in both internal feedback and external best practices.

5.0 CONCLUSIONS

5.1 Summary

The survey data provides a comprehensive view of how UAS remote pilots at UDOT are currently trained, equipped, and deployed. Most remote pilots have over five years of experience, but logged flight hours vary widely, with many still operating under 100 hours, indicating room for continued flight practice and mission exposure. UAS operations at UDOT are diverse, with mapping, inspection, photo/video, and incident response being the most common applications. This aligns well with highway operations, where drones improve safety, reduce field time, and enhance data accuracy for planning and maintenance tasks.

Regarding weather forecasting tools, while there is no mandated application, most pilots rely on UASidekick, UAV Forecast, and NOAA, reflecting the importance of accessible, trusted platforms. Overall, the results highlight UDOT's sturdy foundation in UAS operations, while also pointing to opportunities to standardize flight logging, expand advanced mission types, and reinforce the use of reliable weather forecasting resources. This data supports continued investment in UAS training and infrastructure to enhance transportation safety and efficiency across Utah.

5.2 Findings

The evaluation of survey responses and peer agency comparisons revealed several key findings. While most UDOT UAS remote pilots have multiple years of experience, many have logged fewer than 100 flight hours, indicating a need for more hands-on practice and mission exposure. UAS operations at UDOT are primarily focused on mapping, inspections, photo and video documentation, and incident response, which align well with the department's transportation and safety objectives. Remote pilots reported using a wide variety of weather forecasting and LAANC-enabled airspace authorization applications, with the most popular being UASidekick. However, the lack of a standardized tool set suggests an opportunity to provide clearer guidance. Many missions include a visual observer (VO), and some use a second VO for complex flights, reflecting a strong internal emphasis on safety.

When compared to NJDOT, PennDOT, and ODOT, UDOT's UAS program lacks centralized oversight, standardized training, and consistent data management practices. These peer programs offer structured systems that UDOT can adapt to improve its own operations, including centralized flight logging, public-facing resources, and expanded training opportunities.

The UAS program will be best managed under the Division of Aeronautics, following the organizational structure of the DOT studies. UAS are quickly becoming more relevant in the national airspace system, requiring similar oversight to the manned aircraft it shares the skies with. The Division of Aeronautics has the appropriate scope, knowledge, and authority to develop UAS policy and SOPs. As other state agencies grow their need to adopt usage of UAS, this program will be suitable for adoption across all departments within the State of Utah. In an effort to maintain a high-quality training program with quality oversight and instruction, the Division of Aeronautics should serve as the central hub for statewide agency training.

5.3 Impact on Highway Operations

UAS has become an invaluable tool for DOTs due to their growing role in highway operations. They are used for tasks such as bridge inspections, traffic flow analysis, construction monitoring, and post-incident assessment. These applications reduce field time, enhance safety, and provide high resolution data that traditional methods cannot achieve efficiently. By streamlining data collection and improving the accuracy and timeliness of information, UAS helps agencies make faster, more informed decisions. This leads to reduced project delays, lower operational costs, and improved asset management.

Bridge inspections benefit from UAS greatly due to the equipment and time savings compared to traditional methods. Difficulties in accessing hard-to-reach areas arise when bridges cross hazardous features such as other busy roadways, deep canyons, and rivers. Snooper/bucket trucks are typically needed to look at critical features below the bridge deck such as girders, piers, and bearings. Observing these features takes a fraction of the time when utilizing UAS. Inspection of bridge decks becomes a more efficient task by mapping out the deck without the need to close lanes of traffic. After processing photos into an orthomosaic, a quantity list of potholes and other defects can be compiled with highly accurate measurements from the office.

Construction monitoring gains a new perspective that has never been achievable before UAS. Obtaining quantities and volumes of material saves time and resources throughout the construction process. The ability to show overall progress aids communication between clients, contractors, stakeholders and the public. As UAS technology continues to improve, its scalability and versatility make it an increasingly valuable tool for modern transportation agencies.

5.4 Return on Investment

Implementing UAS technology has proven to be a cost effective and efficient alternative to many traditional methods across several key transportation operations. Traditional ground surveys can take multiple days of field work to complete. Depending on the site, UAS missions with ground control points can survey the same area in hours with centimeter accuracy. In photo and video collection, drones eliminate the need for costly and time-consuming plane flights. For inspections, UAS reduces the need for a ground team and provides more accurate documentation in less time. During incident response, drones offer a safer and faster way to assess damage by creating a digital 3D model to assess in the office, allowing the site to be cleared in less time.

Investing in a strong UAS policy and training helps create a safer environment for remote pilots. Proper training and compliance reduce the risk of costly incidents, legal violations, or even life-threating situations. Having a strong UAS program not only makes the program more efficient, but also responsible and sustainable.

5.5 Limitations and Challenges

One limitation of this research is that under half of the current UDOT UAS remote pilots responded to the survey. While the responses provided helpful insights, they may not fully represent the experiences or needs of all the remote pilots across the department. This limited participation could affect the accuracy of findings related to training, tool usage, and mission types. Another challenge is that the peer agency comparisons were based on publicly available information, which may not capture the full scope of each program. Differences in agency size, structure, and resources may also impact how easily certain practices can be applied at UDOT. These factors should be considered when interpreting the results and implementing recommendations.

6.0 RECOMMENDATIONS AND IMPLEMENTATION

6.1 Recommendations

Based on the findings of this research, it is recommended that UDOT establish a standardized UAS program, under the UDOT Division of Aeronautics, that ensures all remote pilots meet a consistent baseline of training, tools, and procedures. While many DOTs have developed strong individual practices, the most effective programs share a common foundation. UDOT should adopt these shared basics to improve safety, consistency, and compliance across all UAS operations. This foundation for UAS operations creates scalable framework that can be adopted by all departments in the State of Utah.

UAS Training Program:

- Virtual Training - Create a standardized training program that covers FAA Part 107 requirements, airspace awareness, weather tools, emergency procedures, and mission planning. Training inclusive of clear guidelines on approved weather and LAANC-enabled applications to ensure consistent practices amongst operators.

- Hands-On Training - Suggest requiring all remote pilots to complete a minimum level of hands-on flight training and maintain a record of flight hours. Hands-on training will include preflight inspection of air frame, account information setup for flight logs, and UDOT-specific requirements in the classroom followed by flight maneuvers. Flight training is recommended to be grouped by remote pilot flight experience, desired air frame and operational group.

UAS Policy:

- Develop a centralized UAS program within UDOT to oversee training, flight approvals, data management, and compliance.
    - Implement a formal policy for using visual observers, especially for complex or high-risk missions.

- Build a public-facing UAS webpage to share program goals, safety practices, and approved use cases.
- Adopt a centralized system of flight logging and data storage, ideally integrated with GIS platforms.

6.2 Implementation Plan

To implement the recommended UAS Framework, UDOT should begin by establishing a centralized policy within their Division of Aeronautics. This program will oversee training, flight approvals, data management, and compliance with FAA regulations.

Step 1: Assign Roles and Responsibilities

Appoint a UAS Program Manager to lead implementation. This person will coordinate with internal teams, manage training development, and ensure alignment with FAA Part 107 requirements. Regional coordinators or district leads can support local oversight and remote pilot support. Establish UAS purchasing, maintenance, and storage policies for each region and department.

Step 2: Develop Training Program with UDOT UAS Pilots

Create a core training program that includes FAA Part 107 preparation, airspace awareness, weather forecasting tools, mission planning, and safety procedures. Include hands-on flight time and scenario-based exercises. Use existing IMT training as a foundation and expand to cover requested topics like inspection, mapping, LAANC procedures, and post-processing. Incorporate UDOT pilot feedback into the training program.

Step 3: Standardize Tools and Procedures

Select and approve a set of mapping, weather forecasting, and LAANC-enabled applications for department-wide use. Develop SOPs for flight planning, data collection, and emergency procedures. Create a formal policy for visual observer use, especially for complex or BVLOS missions.

Step 4: Launch a Centralized Logging and Data System

Implement a flight logging platform that integrates with GIS. This system should track remote pilot hours, mission types, and data collected. Ensure all remote pilots and teams use the same platform for consistency.

Step 5: Launch Training Program

The final training program should bring together virtual and hands-on training, along with key policies to guide safe and consistent operations. It should also cover flight logging, data management systems and include standardized policies for visual observers and other UDOT-specific procedures.

Step 6: Incorporate UAS into UDOT's Aeronautics Division Webpage

Create a webpage that outlines UDOT's UAS capabilities, safety practices, and approved use cases. This will improve transparency and help communicate the value of the program to the public and stakeholders.

Step 7: Monitor and Adjust

Collect feedback from remote pilots and coordinators regularly. Use this input to update training, tools, and procedures. Conduct annual reviews to ensure the program remains aligned with FAA updates and UDOT's operational needs.

REFERENCES

Fillmer, S. (n.d.). *PennDOT's drone program is taking flight - reshaping transportation across the State.* The Drone Life. https://thedronelifenj.com/penndot-drone-program/

Lawson, J. (2017). *Ohio Department of Transportation Standard Policy and Procedure for Unmanned Aircraft Systems Use.* Ohio Department of Transportation. https://www.transportation.ohio.gov/about-us/policies-and-procedures/procedures/35-001-sp

New Jersey Department of Transportation. (n.d.). *NJDOT Unmanned Aircraft Systems Final Report.* https://www.njdottechtransfer.net/wp-content/uploads/2024/05/NJ-2023-004.pdf

New Jersey Department of Transportation. (2021). *NJDOT UAS/Drone Procedures Manual and Best Practices for Use in New Jersey*. https://www.njdottechtransfer.net/wp-content/uploads/2021/11/NJ-2021-001.pdf

Ohio Department of Transportation. (2019). *Uncrewed Aircraft Systems (UAS) Center.* https://drive.ohio.gov/programs/aam/uas/

Pennsylvania Department of Transportation. (n.d.). *Unmanned Aircraft System (UAS) Policy*. https://www.pa.gov/content/dam/copapwp-pagov/en/penndot/documents/public/pubsforms/publications/pub%20832.pdf

Utah Department of Transportation. (2017). *Unmanned Aircraft Systems (UAS) Policy*. https://www.udot.utah.gov/main_old/uconowner.gf?n=33805627207740213

Utah Department of Transportation. (2017). *Unmanned Aircraft Systems (UAS) Procedures*. https://www.udot.utah.gov/main_old/uconowner.gf?n=33969713855476803