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Meta-Analysis of Public Acceptance of Unmanned Aircraft Systems in the United States

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Abstract

Automated and unmanned systems are rapidly revolutionizing every aspect of military, commercial, and public use operations in the United States. While this technology serves effectively in dull, dirty, and dangerous tasks, the rapid introduction of unmanned technologies into society has generated intense debate about their ethical, moral, and legal use. Specifically, the rise in the development and application of unmanned aircraft systems (UAS) has created significant public discord. As public acceptance of UAS plays a major role in the regulatory decisions that allow for expanded use in commercial and public use applications, it is critically important to understand the complexities involved in the public acceptance of UAS. A meta-analysis of archival data was conducted to identify a possible relationship between UAS intended missions and their acceptability within the public. Compiled survey research indicated that search and rescue (SAR) applications are the most publicly accepted intended missions. Additionally, a chi-square test of independence found evidence of a relationship between intended mission and public acceptance, with commercial and non-law enforcement public use having the highest levels of public acceptance. Recommendations include increasing the public's knowledge and awareness of UAS through an iPhone Operating System (IOS) device application, and removing "drone" from future survey terminology.

Keywords: unmanned aircraft systems, public acceptance, intended mission

Meta-Analysis of Public Acceptance of Unmanned Aircraft Systems in the United States

Public acceptance of a developing technology has a significant effect on the regulatory decisions that will either hasten or progress the benefit of the technological advancement. In the case of unmanned aircraft systems (UAS), the use of UAS as a means of conducting warfare has had a significant impact on the public's acceptance of commercial applications (e.g. precision agriculture and cargo delivery), as well as public use[1] entities' ability to utilize UAS to their full potential in the United States. While unmanned systems have found extensive use in military applications since World War I, more recently nonmilitary organizations have increased their interest (Krey & Seiler, 2019). However, in the age of instantaneous information and social media, public awareness of domestic UAS use in public use and commercial applications have become a polarizing issue. Public acceptance, defined as "how potential users will react and act if a certain measure or device is implemented," is an important measure of success for new and developing technologies (Vlassenroot, Brookhuis, Marchau, & Witlox, 2010, p. 165). Understanding the complexities in the acceptance of technologies, such as UAS, is critical to addressing public concern, which is a factor in creating regulations, as well as educational campaigns, that will allow UAS use in appropriate applications. Therefore, this study will identify relationships between the intended mission of the UAS[2] and public acceptance. Analyzing qualitative and quantitative data from previous research in a meta-analysis will help identify key variables in the relationship between the intended mission of UAS and public acceptance in the United States.

Monmouth University (2012, 2013) studies indicate growing awareness and subsequent public acceptance in the United States, as well as varying levels of support for UAS use based on the intended mission. For example, 83% of respondents indicated support for using UAS in search and rescue (SAR) missions, while only 21% of respondents support using UAS for issuing traffic citations (Monmouth University, 2013). This stark difference indicates the truly polarizing nature of this issue, demonstrating the need for further research into how intended mission affects public acceptance. Better understanding the relationship between intended mission and public acceptance will enable UAS to reach their full potential in commercial and public use applications within the United States. It is important to note that this study will encompass both UAS and small unmanned aircraft systems (sUAS), as defined by 14CFR Part 107 and Public Law 112-95, but will not include model aircraft.

Research Questions

R_1: What is the relationship between the intended mission of a UAS and public acceptance?

R_2: Is there more acceptability for UAS in commercial applications than public use applications?

Hypotheses

Based on the research questions, the following hypotheses have been generated:

H_o: There is no relationship between intended mission and public acceptance of UAS.

H_a: There is a relationship between intended mission and public acceptance of UAS.

Literature Review

Through merging and analyzing archival data and surveys, insight into the public’s acceptance of specific UAS intended missions is possible, allowing for a refined look into the complexities of public acceptance in commercial and public use UAS intended missions.

Definition of Public Acceptance and Acceptability

Vlassenroot et al. (2010) provides a definition of public acceptance in a theoretical framework for use in acceptability research. Public acceptance is "how potential users will react and act if a certain measure or device is implemented" (Vlassenroot et al., 2010, p. 165). Additionally, Schade and Schlag (2003) describe acceptance and acceptability as:

> Respondents' attitudes, including their behavioral responses, after the introduction of a measure, and acceptability as the prospective judgement before such future introduction. In this case, the respondents will not have experienced any of the measures or devices in practice, which makes acceptability a construction of attitude. (p. 47)

This paper will use a synthesis of these definitions in order to measure public acceptance as it relates to the prospective and already introduced public use and commercial intended missions of UAS.

Social, Political, and Environmental Factors of UAS Public Acceptance

Public acceptance of UAS operations in the United States is predicated on growing awareness of UAS operations and capabilities. However, public awareness of UAS operations in the United States is relatively low, with 44% of respondents indicating little to no awareness of global military UAS operations (Monmouth University, 2012). A similar survey conducted by Monmouth University (2013), a year later, found an increase in the public's awareness of military UAS operations, with 60% of respondents reporting significant or at least some knowledge about military UAS operations. However, 52% of respondents indicated knowing little to nothing about domestic UAS operations, indicating a gap in the public's awareness (Monmouth University, 2013). As public awareness of UAS operations is relatively low, there is a significant difference in opinion as to what constitutes a UAS, commonly referred to as a "drone." UAS are referred to in many different ways, including unmanned aerial vehicle (UAV), remotely piloted aircraft (RPA), drone, and autonomous aircraft (Clothier, Greer, Greer, & Mehta, 2015). When participants were asked if a military MQ-1 Predator UAS firing a missile matched their definition of a “drone,” 95% of respondents indicated yes (Vincenzi, Ison, & Liu, 2013). In comparison, only 66% of respondents identified a commercially available quad-copter style UAS as a “drone” (Vincenzi et al., 2013). The use of the term “drone” could significantly influence the way a survey participant responds, especially since most members of the public have no firsthand interaction with UAS technology and rely on third parties and media outlets for information (Clothier et al., 2015). In the same way terminology has an effect on public acceptance, social, environmental, and political factors also have an effect on the public’s awareness and therefore acceptance.

Reddy and DeLaurentis (2016) found education levels, demographics, political preference, and career fields can influence a respondent’s acceptance of UAS technology. For example, respondents who work in the airline industry were less likely to accept UAS than other stakeholders in aviation technology, while men under the age of 36 were more likely to support UAS use than women and respondents over the age of 36 (Reddy & DeLaurentis, 2016). Additionally, respondents who have conservative political preferences are more likely to accept UAS technology than those with liberal political preferences (Reddy & DeLaurentis, 2016). This highlights the importance of social, environmental, and political factors in UAS public acceptance in the United States.

Regulatory and Legal Challenges

Public acceptance of UAS affects the creation of legal and regulatory frameworks that allow for expanded UAS use in the United States. For example, the Federal Aviation Administration (FAA) delayed the implementation of regulations that would have allowed for larger scale testing of UAS, due to the mounting public pressure from political groups (Vincenzi et al., 2013). While the FAA has created a regulatory framework for the safe operation of sUAS, legal challenges still exist for commercial and public use sUAS operations. Recreational flyers must remain outside of controlled airspace by remaining below 400ft, staying within visual line of sight (VLOS) range, as well as avoiding events, groups of people, and emergencies (FAA, 2019b). Additionally, a system called the Low Altitude Authorization and Notification Capability (LAANC) allows recreational flyers to gain airspace authorizations for controlled airspace, pending the operator has passed an aeronautical knowledge and safety test (FAA, 2019b). Additional requirements must be met for commercial UAS operations in accordance with 14 CFR Part 107, such as gaining FAA remote pilot certification and registering the UAS (FAA, 2019b). Public safety or government operators of a UAS, such as law enforcement agencies, must also adhere to 14 CFR Part 107, in addition to meeting the statutory requirements for public aircraft in accordance with 49 U.S.C. §40102(a) and § 40125 (FAA, 2019b). The FAA has also created a process for government agencies to use UAS in the National Airspace System (NAS) through a Certificate of Waiver of Authorization (COA) process (FAA, 2019b). The COA addresses all aspects of UAS operations, including capabilities, training, contingencies, and coordination procedures, and are typically valid for two years (Sakiyama, 2017). sUAS operators must also follow the FAA regulations regarding weight requirements, altitude restrictions, airspace requirements, and certification requirements, as shown in Table 1.

Table 1

Rules for Operating a sUAS in Commercial Applications

Requirement	Expanded Regulation
Remain within VLOS	UAS must remain within view of the operator. If first person view technology is used, another visual observer must clear for the aircraft.
Maximum altitude 400ft AGL	Higher altitudes allowed within 400ft of a structure. Additionally, the maximum speed allowed is 87 knots.
Remain in Class G airspace	Operations in Class G (uncontrolled airspace) do not require ATC approval. Operating in Class B, C, D, and E require ATC approval.
Remote pilot airman certificate	Must be 16 years old and pass aeronautical knowledge test. Part 61 pilots with a flight review completed within previous 24 months can be certified with sUAS online training.
Preflight and operational checks	No requirement for airworthiness standard, but a preflight visual and operational check is required. This includes checking all safety critical systems and communications links on both the UAS and ground equipment.
UAS registered with FAA	UAS must be registered with FAA and available for inspection upon request.
Waivers	Operating requirements can be waived by the FAA if proposed use can be accomplished safely.

Note. VLOS = visual line of sight. AGL = above ground level. Adapted from "Fact Sheet – Small Unmanned Aircraft Regulation (Part 107)," by L. Dorr and A. Duquette, 2016, *Federal Aviation Administration*.

These regulations demonstrate the complexity of safely managing UAS flights. New innovative methods of regulating UAS operations for commercial and public use applications will be a critical part of increasing UAS public acceptance, as privacy and security rank among the public's top concerns (Shakhatereh et al., 2018). The FAA is adapting to the rapid changes in the technological capabilities of UAS, as recent amendment proposals recommend loosening restrictions using a risk-based approach. Current FAA amendment proposals, to 14 CFR Part 107, include removing waiver requirements for night operations and flights over people (FAA, 2019c). Additionally, in an effort to help UAS operators comply with Part 107 and airspace limitations, the B4UFly application was created to increase the situation (terrain, traffic, position, navigational, and spatial) awareness of UAS operators, as shown in Figure 1 (FAA, 2019a).

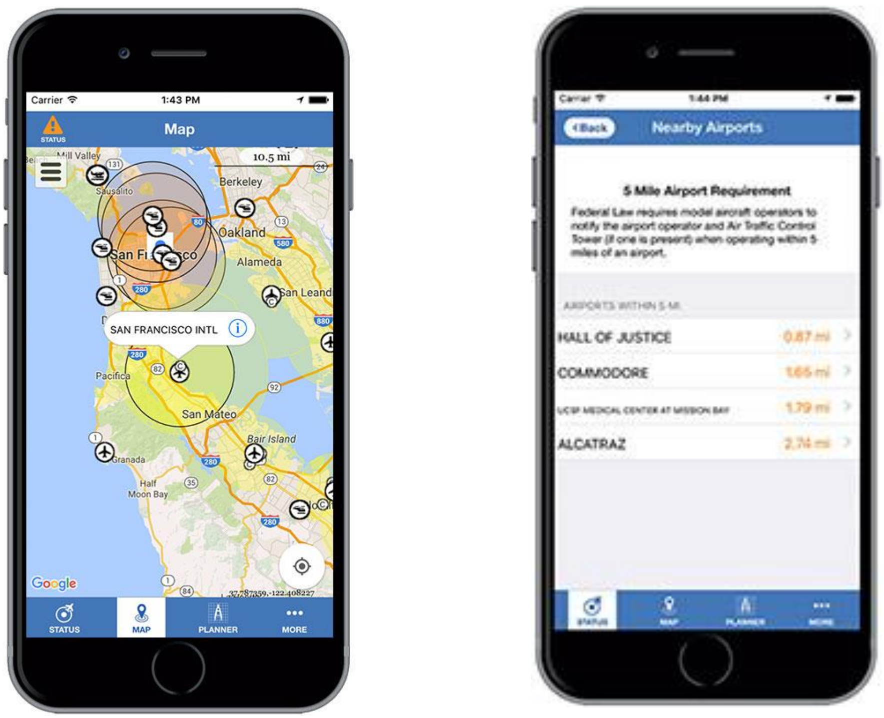

Figure 1. B4UFly for IOS Devices Application interface. Reprinted from "B4UFly Mobile App Update," by Federal Aviation Administration, 2019, *Federal Aviation Administration.*

As the B4UFly for iPhone Operating System (IOS) device application provides remote pilots with higher levels of situation awareness in an easy to use, readily available medium, an IOS device application could also serve as a vehicle to provide UAS education and awareness for the public.

UAS Integration

Advancements in UAS technology have made their use in commercial and public use applications economical and highly efficient, creating a high demand for UAS assets in many organizations. According to Anania et al. (2019), "as of October 2017, more than 300 U.S. agencies were using UAS in law enforcement efforts; and this number will likely continue increasing" (p. 95). However, despite the high demand for UAS technology from government agencies, these agencies only employ 3% of the sUAS that are in use in the United States (FAA, 2019d). Despite their flexibility, low costs, and ability to remain on station for long periods of time, UAS integration into commercial and public use applications faces many challenges. These challenges' mitigation strategies will affect how UAS are accepted and integrated into commercial and public use applications (Martin, Homola, Omar, Ramirez & Jobe, 2018). One challenge to UAS integration is the need for advanced airspace control measures that can handle the projected 3 million commercial and hobbyist UAS flights by 2021 (Martin et al., 2018). This projected number of flights, occurring below 400ft above ground level, creates significant risk for manned aircraft operating in close airspace proximity and poses a threat to bystanders on the ground. Additionally, the diversity of UAS, in terms of their systems, capabilities, size, and endurance, makes the prospect of integrating UAS into the same airspace as manned aircraft extremely challenging (Martin et al., 2018). According to Martin et al. (2018), "individual privacy and security as well as safety and reliability of the unmanned vehicle themselves, and accountability of operators" create a perceived risk to the public (pp. 1-2). The safety and privacy concerns of the public combined with the complexities of integrating a wide variety of UAS at low altitudes, and in the same proximity of bystanders and manned aircraft, highlights the difficulties of UAS integration in the United States. Researching and identifying the variables influencing public acceptance will help enable successful future UAS integration policy.

One innovative method of achieving widespread UAS integration is through the Urban Air Mobility (UAM) project led by the National Aeronautics and Space Administration (NASA) (FAA, 2019d). The UAM represents a UAS inclusive airspace model that effectively integrates manned and unmanned aircraft of varying sizes, allowing UAS to perform a wide variety of intended missions (FAA, 2019d). The high demand for UAS technology in commercial and public use intended missions will drive innovative airspace control measures, such as the UAM concept. However, public acceptance will either progress or hasten the advancement of UAS technology.

Risk Perception

The perceived risk levels for the integration of a new technology can have a significant impact on the likelihood and speed of implementation. Risk assessment is one of several factors that can influence the public's acceptance of developing technologies and is made up of factors, such as benefit, knowledge, control, voluntariness, fear, newness, and consequence (Clothier et al., 2015). Each of these factors can contribute positively or negatively to public acceptance. If the public is knowledgeable, in control (in the context of exposure to the technology), and perceives a public benefit, then the perceived risk of the technology will be lower, and could therefore lead to greater public acceptance (Clothier et al., 2015). However, factors, such as the newness of the technology and potential consequences of its use, can create higher levels of perceived risk, and therefore decrease UAS public acceptance (Clothier et al., 2015). A lack of awareness and knowledge of UAS technology may impact the public's ability to accurately assess and measure perceived risk which could lead to low public acceptance and the rejection of a new technology.

UAS Intended Missions

In a wide-ranging study on public perception and attitudes towards UAS in specific applications, Vincenzi et al. (2013) found survey respondents generally favor UAS applications that have a perceived benefit to society, as shown in Figure 2.

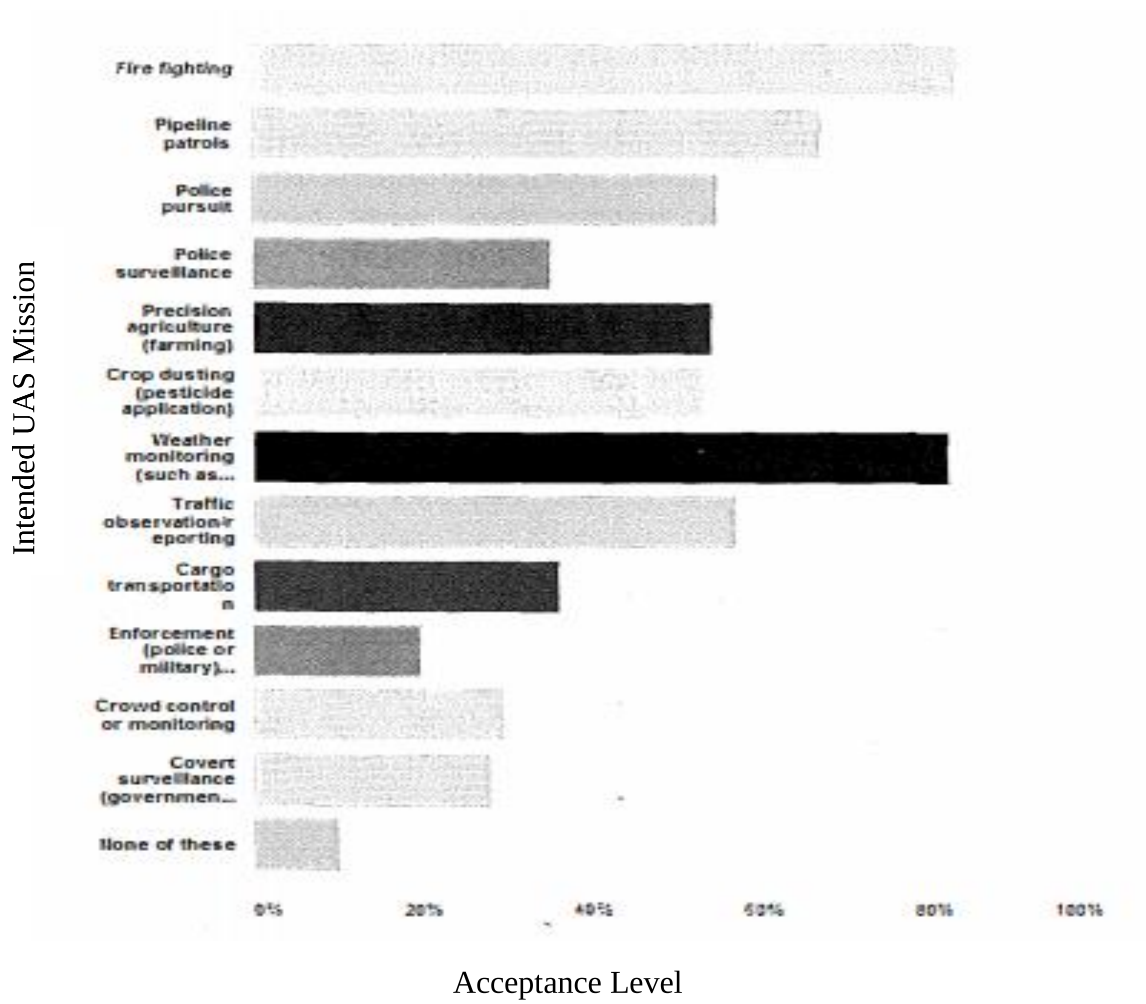

Figure 2. Survey results related to intended mission of a UAS. Reprinted from "Public Perception of Unmanned Aerial Systems (UAS): A Survey of Public Knowledge Regarding Roles, Capabilities, and Safety While Operating Within the National Airspace System (NAS)," by D. Vincenzi., D. Ison., and D. Liu, 2013, *Embry-Riddle Aeronautical University*, p. 108.

In comparison to the generally favorable public opinion towards specific public use UAS intended missions, such as weather monitoring, firefighting, and SAR, public use applications related to specific law enforcement use find little favorability. Vincenzi et al. (2013) asked respondents whether they supported UAS in applications, such as traffic monitoring/issuing citations, immigration law enforcement, and tracking down runaway criminals. The survey also measured public attitudes towards covert surveillance, crowd control, and police pursuit. The other proposed public use applications failed to garner more than 30% public acceptance, as shown in Figure 2 (Vincenzi et al., 2013). Additionally, the Monmouth University (2013) results indicated public opposition to using UAS in law enforcement applications, with the highest levels of public support for border patrol and runaway criminal pursuit at 62% and 67%, respectively. It was also reported that public acceptance for UAS in border patrol activity fell 2% between the 2012 and 2013 studies (Monmouth University, 2013). However, the lack of demographic data regarding the region where respondents live may be a factor. The application that garnered the least support was the proposal to use UAS to issue speeding tickets, which earned only 21% support, down 2% from the previous year's study (Monmouth University, 2013).

Summary

Understanding UAS public acceptance through surveys is complicated, with many covariates and confounds. Understanding public acceptance in the context of social, political, environmental, regulatory, and economic aspects can help characterize the factors that affect UAS public acceptance. Regulatory and legal frameworks restricting UAS in public use and commercial intended missions in the United States reflect the struggle between high paced technological innovation and slow public acceptance. The capabilities of UAS technology far exceed their limitations, and these regulations significantly degrade their formidable operational capabilities. Media coverage, terminology, and the lack of public awareness of UAS capabilities and operations, are complex and affect UAS public acceptance in the United States. The technological push towards unmanned and autonomous operations has garnered support from both government and commercial agencies, allowing many organizations to anticipate using unmanned assets to conduct future domestic operations. UAS commercial and public use intended missions should maintain a balance between conducting operations with benefits to society and assuaging public concerns in order to gain the public acceptance necessary for regulatory action and increased UAS use.

Method

To address the relationship between the intended mission of a UAS and the subsequent public acceptance, a meta-analysis using archival data was conducted.

Research Design

Due to the availability of previously conducted survey data, a survey will not be conducted for this study. Rather, data was analyzed from archival studies to test the hypotheses and answer the research questions in this paper. Therefore, the appropriate research method for this paper is a meta-analysis. A meta-analysis research method combines quantitative and qualitative data from multiple previously conducted studies in order to increase statistical power and answer specific questions (Tatsioni & Loannidis, 2008). In this case, this paper merged several previously conducted surveys regarding public acceptance and UAS operations in public use and commercial intended missions. Combining quantitative data the studies will help answer key questions about the relationship between intended mission and public acceptance. While these previous studies may not have intended to answer this specific question, drawing upon multiple studies in a meta-analysis will help characterize the relationship between UAS intended mission and public acceptance.

Data collection

A wide-variety of quantitative data was collected from online databases focusing on the public acceptance of UAS in a multitude of commercial and public use intended missions. Data was sourced from the Embry-Riddle Hunt Library, various other scholarly journal sources, and data housed on the internet. Data availability on this topic is abundant. However, this study was delimited to surveys and research conducted in the last 10 years. By using previously conducted research in a meta-analysis format, there will be no original data collected. Therefore, no consideration has been given to generating a sampling plan, utilizing a survey instrument, or developing a proposal for IRB approval.

Data Analysis

Analysis of the archival studies is the critical test of this proposal's hypotheses that UAS intended mission (public use or commercial) has an effect on public acceptance. The survey data was categorized into two categories, public use and commercial, as well as several subcategories further exploring specific applications of UAS and the resulting public acceptance. Data from archival studies was analyzed using the chi-square test of independence, at a 95% significance level, using Stat Crunch software. The chi-square test measures the differences between the recorded values and evaluates the differences based on the sum of squares and the expected values (Riffenburgh, 2012). Using the critical chi-square value, a determination can be made about rejecting or failing to reject the null hypotheses, with a chi-square value larger than the critical value rejecting the null hypothesis, and a chi-square value smaller than the critical value failing to reject the null hypothesis (Riffenburgh, 2012). As each test contained one degree of freedom (DF), the critical chi-square value was 3.84 (Purdue University, 2019). Using intended mission as the independent variable and public acceptance as the dependent variable, a chi-square test of independence indicated if there was a statistically significant relationship between the two variables, as shown in Table 2.

Table 2

Notional Chi-Square Results

Public Acceptability	Intended Mission			
	Commercial	Public Use	*N*	X^2
Yes	13 (68.42%)	17 (39.53%)	62	12.8**
No	6 (31.58%)	26 (60.47%)		

Note. Percentages indicate the row acceptance percentage. Notional chi-square test of independence between intended mission and public acceptance.
** *p = .012*

Assumptions

There are several assumptions of a chi-square analysis that have been accounted for:

- Percentages must be converted into frequencies (McHugh, 2013).
- Categories are mutually exclusive (McHugh, 2013).
- Data must be categorical but *may* be ordinal (McHugh, 2013).
- Sample size must be large enough in relation to the number of categories (McHugh, 2013).

Limitations and Delimitations

There are several limitations which must be accounted for in this research. First, there is a lack of delineation between what constitutes a sUAS and a UAS in the majority of previously conducted research on UAS public acceptance. In fact, the Vincenzi et al. (2013) study highlighted this limitation when they asked respondents what constituted their personal definition of a “drone.” There was no clear consensus among the respondents as to what constituted a “drone,” therefore limiting this particular study and many others by the general public’s loose definitions of drone, UAS, and sUAS (Vincenzi et al., 2013). This limitation could have a significant effect on how the public perceives UAS, as a sUAS could be more acceptable to the public than a UAS, such as the militarized MQ-1 Predator or MQ-9 Reaper. Second, public awareness of domestic UAS operations is a significant limitation, as only 18% of respondents in the Monmouth University (2013) study indicated knowing a great deal about domestic UAS use. This lack of awareness of domestic UAS use is a significant limitation as public acceptance could be affected by the negative connotations associated with overseas militarized UAS use and biased media coverage. Lastly, this analysis is limited by the use of archival studies. This poses challenges in categorizing and merging surveys with different taxonomy and wording, as well as varying methods of data collection. In cases where “unknown” or “no opinion” was identified as a response, this data was dismissed from the data set.

A delimitation in this analysis is the focus on the U.S. public acceptance of UAS, as opposed to a regional or global analysis. Additionally, this study is delimited to UAS, as defined by 14CFR 1.1 Part 107 and Public Law 112-95, and will not include model aircraft. Lastly, only survey data within the past 10 years was included.

Definitions of Terms

Unmanned aircraft systems (UAS) is defined in accordance with 14CFR 1.1: “Unmanned aircraft and its associated elements (including communication links and the components that control the unmanned aircraft) that are required for the safe and efficient operation of the aircraft in the NAS” (Cornell Law, 2019).

Small unmanned aircraft systems (sUAS) is defined in accordance with 14CFR 1.1: “Unmanned aircraft weighing less than 55 pounds on takeoff, including everything that is on board or otherwise attached to the aircraft” (Cornell Law, 2019).

Public Use is defined in accordance with 49 U.S.C. 140102(a)(41) and 14CFR 1.1: “Public use aircraft are those performing non-commercial governmental functions such as national defense, intelligence missions, firefighting, search-and-rescue, law enforcement, aeronautical research, or biological or geological resource management.”

Results

The relationship between the intended mission of the UAS and public acceptance in the United States was determined using a chi-square test of independence. This research was conducted based on high level applications, public use and commercial, as well as mixture of specific intended missions in order to analyze the relationship between intended mission and public acceptance. This meta-analysis includes survey data compiled from eight research studies, as shown in Table 3.

Table 3

Survey Data Sources

Source	Year	*N*
U.S. Post Office	2016	1207
Scott, A.	2015	2405
Monmouth University	2013	1012
Letterman et al.	2013	119
Ondrovic, L.	2016	1001
Monmouth University	2012	1708
Miethe et al.	2014	636
Cameron, E.	2014	535

Note. Survey data sources from USPS (2016), Scott (2015), Monmouth University (2013), Letterman et al. (2013), Ondrovic (2016), Monmouth University (2012), Miethe, Lieberman, Sakiyama, & Troshynski (2014), and Cameron (2014).

The survey data was then categorized by commercial and public use intended mission, as shown in Tables 4 and 5.

Table 4

Commercial Intended Missions Survey Data

Intended Mission	Acceptance		
	Yes	No	*N*
Delivery Service	1331	1638	2969
Commercial News	1342	1386	2728
Aerial Survey/Farming	238	297	535
Pipeline Patrol	260	275	535
Other Commercial Applications	73	46	119

Note. Data for commercial intended missions from USPS (2016), Miethe et al. (2014), Monmouth University (2012), Monmouth University (2013), Scott (2015), Letterman et al. (2013), Ondrovic (2016), and Cameron (2014).

Table 5

Public Use Intended Missions Survey Data

Intended Mission	Acceptance		
	Yes	No	*N*
Traffic Citations	606	1873	2479
Border Patrol	2153	918	3071
Search and Rescue	3250	546	3796
Criminal Reapprehension	1144	376	1520
Crime Investigation	1635	770	2405
Crime Deterrence	1871	1289	3160
Covert Surveillance	106	429	535
Unarmed Law Enforcement	171	364	535
Armed Law Enforcement	515	962	1477
Weather Monitoring	328	207	535
Geological Research	553	83	636
Traffic Citations/Monitoring	1058	2057	3115
Crowd Control	379	793	1172
Homeland Security	80	39	119

Note. Data for public use intended missions from USPS (2016), Miethe et al. (2014), Monmouth University (2012), Monmouth University (2013), Scott (2015), Letterman et al. (2013), Ondrovic (2016), and Cameron (2014).

A chi-square test of independence was performed to examine the relationship between commercial (see Table 4) and public use (see Table 5) intended missions and public acceptance, as shown in Table 6.

Table 6

Chi-Square Results for Commercial and Public Use Intended Missions

Public Acceptance	Intended Mission			
	Commercial	Public Use	*N*	X^2
Yes	3244 (47.11%)	13849 (56.4%)	31441	187.07**
No	3642 (52.89%)	10706 (43.6%)		

Note. N = number of survey responses. Percentages indicate the row acceptance percentage. Chi-square results for commercial and public use intended missions from USPS (2016), Miethe et al. (2014), Monmouth University (2012), Monmouth University (2013), Scott (2015), Letterman et al. (2013), Ondrovic (2016), and Cameron (2014).
** $p < .0001$.

The relationship between commercial and public use intended missions and public acceptance was significant. Public use intended missions are more acceptable to the public than commercial intended missions.

A chi-square test of independence was performed to examine the relationship between non-law enforcement public use intended missions (e.g. SAR, weather monitoring, and geological research) and commercial intended missions, as shown in Table 7.

Table 7

Chi-Square Results for Commercial and Non-Law Enforcement Public Use Intended Missions

Public Acceptance	Intended Mission			
	Commercial	Non-LE Public Use	*N*	X^2
Yes	3244 (47.11%)	4131 (83.17%)	11853	1596.12**
No	3642 (52.89%)	836 (16.83%)		

Note. LE = law enforcement. *N* = number of survey responses. Percentages indicate the row acceptance percentage. Chi-square results for commercial and non-law enforcement public use intended missions from Monmouth University (2012), Monmouth University (2013), Letterman et al. (2013), Miethe et al. (2014), and Cameron (2014).
** $p < .0001$.

The relationship between commercial and non-law enforcement public use intended missions and public acceptance was significant. Non-law enforcement public use intended missions are more acceptable to the public than commercial intended missions.

A chi-square test of independence was performed to examine the relationship between armed law enforcement intended missions (armed law enforcement and weaponized border patrol) and unarmed law enforcement intended missions (e.g. crime investigation, criminal reapprehension, unarmed law enforcement, crime deterrence, covert surveillance, traffic citations/monitoring, crowd control, homeland security, and border patrol), as shown in Table 8.

Table 8

Chi-Square Results for Armed Law Enforcement and Unarmed Law Enforcement

Public Acceptance	Intended Mission			
	Armed LE	Unarmed LE	*N*	X^2
Yes	515 (26.1%)	9203 (50.81%)	20084	435.05**
No	1458 (73.9%)	8908 (49.19%)		

Note. LE = law enforcement. *N* = number of survey responses. Percentages indicate the row acceptance percentage. Chi-square results for armed law enforcement and unarmed law enforcement from Monmouth University (2012), Monmouth University (2013), Ondrovic (2016), Miethe et al. (2014), Cameron (2014), Letterman et al. (2013), and Scott (2015).
** $p < .0001$.

The relationship between armed and unarmed intended missions and public acceptance was significant. Unarmed law enforcement intended missions are more acceptable to the public than armed intended missions.

A chi-square test of independence was performed to examine the relationship between proactive law enforcement intended missions (e.g. traffic citations/monitoring, border patrol, crime deterrence, covert surveillance, and crowd control) and reactive law enforcement intended missions (e.g. criminal reapprehension and crime investigation), as shown in Table 9.

Table 9

Chi-Square Results for Proactive Law Enforcement and Reactive Law Enforcement

Public Acceptance	Intended Mission			
	Proactive LE	Reactive LE	*N*	X^2
Yes	6173 (45.62%)	2779 (70.8%)	17457	772.41**
No	7359 (54.38%)	1146 (29.2%)		

Note. LE = law enforcement. *N* = number of survey responses. Percentages indicate the row acceptance percentage. Chi-square results for proactive and reactive law enforcement from Monmouth University (2012), Monmouth University (2013), Ondrovic (2016), Miethe et al. (2014), Cameron (2014), Letterman et al. (2013), and Scott (2015).
** $p < .0001$.

The relationship between proactive law enforcement and reactive law enforcement intended missions and public acceptance was significant. Reactive law enforcement intended missions are more acceptable to the public than proactive law enforcement intended missions.

Conclusion

Intended mission has an effect on the public's acceptance of UAS in the United States. Qualitative research can help further characterize and identify the nature of the relationship between UAS intended mission and public acceptance.

Perceived Risk and Intrusion

Qualitative data shows how intended mission affects public acceptance, as perceived levels of intrusion, lack of faith in law enforcement agencies operating UAS, involuntary exposure, and lack of control over UAS can contribute to higher levels of perceived risk and lead to lower public acceptance. Clothier et al. (2015) discuss the role that control and voluntariness have on the perceived risk of a technology and subsequent public acceptance, stating that "the more control an individual has over his or her exposure to the risks, the lower the perceived risk" (p. 1170). Additionally, Clothier et al. (2015) state "the members of the general public overflown by UAS operations are largely unable to influence the level of their exposure" (p. 1170). As voluntariness and control are two factors that make up perceived risk, perceived inadequacies in UAS to provide nonintrusive public benefit could explain the importance of intended mission on public acceptance.

Commercial and non-law enforcement public use applications find higher levels of public acceptance than other applications. From this result, there is an understanding as to why law enforcement applications, especially armed UAS platforms find less public acceptance. UAS can be outfitted with a wide variety of sensor packages that can collect and expeditiously disseminate large amounts of data to supporting agencies in near real time. According to Anania et al. (2019), some of these capabilities include "highly sophisticated zoom options, live video streaming, geo-locational tracking, infrared thermal imaging, radar, listening devices, and communication interceptors" (p. 96). UAS could give law enforcement surveillance capabilities that could, in the absence of a warrant, violate the fourth amendment and create public concern about the reasonableness of law enforcement intended missions (Anania et al., 2019). In a study conducted by Lieberman et al. (2014), researchers found that only 39% of respondents believe that UAS would increase public safety, while most respondents were opposed to law enforcement UAS use due to surveillance, hacking, and safety concerns. This concern grows more significant when considering the low levels of trust in law enforcement agencies, as Monmouth University (2013) found the majority of respondents did not trust law enforcement to use UAS technology appropriately. This level of perceived intrusion, created by the involuntary nature of law enforcement surveillance, combined with lack of control or good faith in the controlling agency, is a factor in explaining the relationship between intended mission and public acceptance.

Public Benefit

Non-law enforcement public use applications are perceived to have significant public benefits, indicating another explanation for the significance of intended mission on public acceptance. Law enforcement applications with perceived benefits, such as criminal reapprehension, have also gained higher levels of public acceptance. As law enforcement agencies around the country have gained access to UAS through the COA process, anecdotal evidence of public benefit overriding the public's privacy and security concerns has been recorded. In 2016, a local law enforcement agency in Vermont used a UAS as part of an effort to locate a missing 12-year-old girl (Viglienzoni, 2016, as cited in Sakiyama, 2017). After the girl had been found, a law enforcement officer stated "there is the aspect that Big Brother is watching you and invading your privacy. But in a situation like this…I'm pretty sure that the members of the community would overlook that" (Viglienzoni, 2016, as cited in Sakiyama, 2017 p. 16). This suggests that public acceptance of UAS is a balance between benefit and risk. The general public's risk-reward equation seems largely dependent on what the UAS is being used for. This could indicate why reactive law enforcement activities, such as crime investigation and criminal reapprehension, are more acceptable to the public, whereas proactive law enforcement measures, such as surveillance and traffic monitoring/citation issuing, are not as widely accepted (Sakiyama, 2017). UAS use in reactive law enforcement intended missions provides the public with a tangible and immediate need for UAS employment, while proactive law enforcement intended missions lack the immediacy and clear tangible need, indicating that immediacy also plays a factor in public acceptance. This meta-analysis shows the importance of UAS intended mission on public acceptance.

Recommendations

First, “drone” has been determined to hold negative connotations (Clothier et al., 2015). Nearly all surveys in this research use the term “drone” to describe a wide variety of sUAS and UAS, possibly affecting public acceptance of these systems just based on terminology alone, instead of operational merit. Eliminating the term “drone” for future research would remove biased terminology and provide higher quality results. Next, in order to increase public acceptance of UAS in the United States, educational campaigns should demonstrate specific intended missions. Effectively demonstrating the capability of UAS to perform a specific task that is beneficial to the public, in a manner with respect to human life on the ground and in the air, will display the capabilities of UAS and help the public better evaluate these systems in a balanced risk-reward manner. Further research into the relationship of risk perception and public acceptance should be conducted to better understand how a lack of awareness and knowledge of a technology can affect public acceptance. As the public grows more knowledgeable and aware of UAS technologies and capabilities, it is important to distinguish between military and commercial/public use UAS. Vincenzi et al. (2013) research shows many survey respondents had a difficult time distinguishing between militarized UAS platforms, such as the MQ-1 Predator and MQ-9 Reaper, and UAS variants that would likely be used in domestic commercial and public use intended missions. Additionally, armed law enforcement UAS applications have a negative impact on public acceptance, and should be a payload consideration for UAS seeking public acceptance. Since militarized UAS are a controversial application, it is critical that developers of UAS technology for commercial and public use applications are highly transparent about their designs and the intended mission of their UAS. Educational campaigns should provide the public awareness and knowledge on both commercial and public use intended missions, and should also provide open discussion on all intended missions of UAS, even if controversial (Boucher, 2015).

Theory of Operation

The FAA's application, B4UFly for IOS devices, has been a successful method of helping UAS operators maintain airspace and all other forms of situation awareness. This same concept can be extended to UAS public acceptance. By providing communities exposure to UAS, and the capability to monitor public use and commercial operations, many of the factors that create perceived risk surrounding UAS intended missions could be mitigated. This application should be synched to the LAANC system, allowing members of the public access to information regarding when and where UAS are being flown. Developing an application which has the potential to be the vehicle for education and increased awareness of domestic public use and commercial UAS intended missions, allows for easy dissemination of information about UAS operations. Additionally, an interface that allows members of the public to see the platform's capabilities, planned route of flight, and intended mission could help lower perceived risk, and therefore increase public acceptance. Lastly, an IOS device application could be a method of reporting illegal UAS operations, and provide a vehicle for reporting UAS incidents to the FAA or local law enforcement.

As the chi-square analysis showed, non-law enforcement public use and commercial intended missions found high levels of public acceptance, displaying specific intended missions that could be the first iteration of widespread public use and commercial UAS in the United States. In contrast, armed law enforcement found significantly lower public acceptance, indicating the pathway for UAS integration in the United States should focus on unarmed platforms and applications with higher levels of public acceptance. Intended mission is a critical component of UAS public acceptance in the United States, and must be a focal point for future integration of domestic UAS technology into the everyday lives of Americans. This knowledge will help develop educational campaigns and initiatives, such as an IOS device application, that could facilitate higher levels of public acceptance and realize the considerable benefits of public use and commercial UAS.

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Footnotes

[1] As defined by 14CFR 1.1 to include national defense, intelligence missions, firefighting, search and rescue, law enforcement, aeronautical research, or biological and geological resource management.

[2] Encompassing both sUAS and UAS as defined in 14CFR 1.1, 14CFR Part 107, and Public Law 112-95.