11-8-2011

Public Perception of Unmanned Aerial Vehicles

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This proposal is submitted to the faculty of Purdue University, in partial fulfillment of the requirements for the Master of Science in Aviation & Aerospace Management degree

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November 8, 2011

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Abstract

This study explored public risk perception of unmanned aerial vehicles (UAV) for civilian commercial operations, including cargo and passenger transportation. Civilian operators are considering the use of UAVs to increase safety while reducing labor costs, but negative perceptions may delay the advancement of these aircraft. To document perception of UAV or UAS aircraft for commercial operations, a questionnaire was distributed to adults (ages 18+) who use commercial air travel. The survey classified age group, gender, and UAV familiarity as demographic variables. This study assessed risk perception of UAVs and its correlation to the variables through statistical analysis to identify whether there was an association between the demographic variables and risk perception. Upon analysis, it was determined that the data from the sample showed no strong evidence that demographic variables influenced risk perception. Many respondents' risks perceptions involved technology reliability and higher perceived safety with a human pilot onboard.

Keywords: Unmanned Aerial Vehicles, UAV, Risk Perception

Introduction

The aviation industry has been studying the potential use of Unmanned Aerial Vehicle (UAV) commercial airliners in the National Airspace System (NAS) for cargo and passenger transport operations. Commercial carriers may consider the use of unmanned aircraft due to the possible added safety and the cost-reduction benefits, which UAVs may yield. Although the implementation of UAVs can be beneficial, public perception is an influential factor in their use, particularly for passenger transportation. The purpose of this study was to identify the general travelling public's current concerns, issues, and perceptions toward UAVs. This study answered the question: What are the general travelling public's issues, concerns, and perceptions toward the use of Unmanned Aerial Vehicles for Commercial Aviation?

Literature Review

A rapidly expanding technological environment has prompted the consideration of Unmanned Aerial Vehicles for commercial aviation. Currently, UAV access into the NAS is still heavily restricted due to the lack of procedures, standards, and policies. However, the NAS is being restructured to make air travel more convenient, efficient, and dependable. This continuous overhaul process will lead to the Next Generation Air Transportation System (NextGen). That system should be able to accommodate increased air traffic more efficiently with a reduction in accidents. Congress intentionally instituted the Joint Planning and Development Office (JPDO) in 2003 to aid in the design and development of NextGen. The current JPDO (2011) planning document has stated that an essential part of the design and execution of the NextGen is the incorporation of UAVs into the NAS. It is also predicted that in 2018, more than 15,000 UAV will be in use within the United States, while there will be roughly 28,000 active worldwide (TealGroup, 2011).

Although ideas for UAV usage have existed for almost 100 years in military aviation, they have only recently received recognition for use in commercial aviation (Dalamagkidis, Valavanis, & Piegl, 2009). Military employment of UAVs dates back to the early 1900s, with the first examples being balloons and kites. The military generally uses UAVs for reconnaissance, surveillance, and intelligence while civil aviation utilizes them for border patrol and security. UAVs are also used for environmental purposes and relief efforts (Hood, 2009; Hornyak, 2011).

For example, Hood (2009) discussed the National Oceanic and Atmospheric Administration (NOAA) use of UASs to collect data that might have otherwise not been available through use of human-operated aircraft. UAVs can safely penetrate volcanic plumes, as well as aid in the prediction and forecasting of tropical storms, droughts, and floods. Hood postulated that UAVs might help forecast landfall times of tropical storms, which could be a major advantage for evacuation and safety effects. In addition, Hood also anticipated that UAV-gathered data would improve knowledge about climate changes and the possible effects of those changes on coastlines and ecologies. In a recent case, Northrop Grumman's Global Hawk UAV went to Japan to aid in relief efforts from the damage of the March 2011 earthquake and tsunami catastrophe (Globe Newswire, 2011). In addition to the crises in Japan, Global Hawk participated in relief efforts after Haiti's earthquake in January 2010 (Hornyak, 2011). In a PACAF (2011) article, PACAF commander Gary North considered the Global Hawk as an "ideal asset to aid in disaster relief" and that it "directly complemented continued efforts in the area and represented how advanced technology can provide crucial and timely support to senior leadership officials and search, recovery and disaster relief efforts".

Regarding civil aviation, cargo operators are considering use of UAVs to reduce labor costs and improve safety (Han, et al., 2004). As much as 85% of aircraft accidents are the result of human error (MacSween-George, 2003). Will it really be that much safer to fly if there is a machine making decisions rather than a human? The technology is still undergoing research and development tests, but some believe human error will no longer be such a large contributing factor in safety issues after the removal of the human pilot(s) from the flight deck and with the full automation of UAVs. Four long-term priorities for UAV developments were identified as self-situational awareness, design and certification, integrity and fault tolerance, and crosscutting priorities (JPDO, 2011). These priorities should meet a cargo operator's goal for increased safety, while also meeting economic efficiencies through the reduction of pilot labor. JPDO (2011) gave a brief explanation of each of the priorities. Self-situational awareness of the unmanned system was explained as the system's capability to independently identify and determine external risks, environmental effects, navigation, and control. Design and Certification was defined as the capability to design and certify system platforms and the system in its entirety. Integrity and Fault Tolerance was referred to as the capability to uphold safety and exercise tolerance to component failures without human intervention. Crosscutting Priorities was explained to be trust in unmanned systems and trust in systems-of-systems. This would entail establishing trust that includes facets of reliability of the system and confidence of the system as perceived by humans.

Airline operators, in addition to cargo operators, are contemplating the incorporation of UAVs for passenger transportation. Clothier and Walker (2006) directly addressed some of the risk perception issues related to UAV transportation. For instance, while civilian operators may eventually aspire to use UAVs in flight operations, public perception may hinder the growth of this unmanned resource. A passenger airline's premature acquisition of UAVs might be especially costly if the public were unwilling to accept them. Therefore, it is evident that minimizing risk perception of UAVs will be a vital step toward the advancement of civilian use of UAVs.

MacSween-George (2003) conducted research to determine whether the public would accept UAVs for cargo operations and passenger transportation. MacSween-George developed two standardized surveys containing the same four questions on each form. A random sample of one-hundred twenty people participated. While Survey A contained questions only, Survey B contained the same questions accompanying a paragraph of UAV information to educate the individual completing the survey. MacSween-George split the sample group into two separate groups of sixty participants and provided each group with either form A or B. Survey participants had no knowledge of the other survey form and were only aware of the one they answered. Survey questions included:

1. Would you support the FAA in allowing automated (unmanned) aircraft to transport Cargo?
2. Would you fly in automated aircraft for business?
3. Would you fly in automated aircraft for pleasure trips?
4. Would you fly in automated aircraft if it were 50% cheaper than regular fares?

The possible answers within the questionnaire were yes, no, and not sure. Survey results were tabulated and the data was analyzed with SPSS statistical software. The resulting output was presented in tables and bar charts. MacSween-George used contingency tables and one-dimensional chi-square significance tests to evaluate and decide whether the hypothesis was rejected or supported. The findings generally indicated that education (or other variables) might have influenced public opinion regarding UAV operations in commercial service.

MacSween -George noted Form B's 15% increase in question 1's yes responses may have been influenced by the educational paragraph provided at the top of the survey or other unknown variables. Regarding responses to questions 2-4, there was an increase in the "not sure" response for all three questions. MacSween-George said this might have indicated that the educational paragraph and other unknown factors may have influenced public perception. Concerning questions addressing both cargo and passenger flights, it appeared even a little knowledge provided on the survey form increased the likelihood for UAV approval from the public. Informing and educating the public about UAVs will most likely be an essential and vital part of introducing this new technology for public acceptance to reduce the risk perception in the use of these unmanned systems.

MacSween-George (2003) implied cargo operations increase each year and believed these operations may be more efficient if UAVs transported cargo. Han, et al. (2004) stated current cargo systems guarantee delivery within 24 hours; however, it is suggested UAV aircraft may decrease the time to as little as 8 hours with short-range operations. Civilian UAV cargo implementation could be economically beneficial for a business, in terms of return on investment. Han, et al. listed different design alternatives for UAVs (e.g., fully autonomous system, use of a co-pilot, and use of a ground operator). A fully autonomous system is completely pilot-less and has an onboard control system that is able to control and make decisions, thus requiring no human interaction. If the system has a co-pilot, he/she would act as an added factor of safety and only assume control if the UAV were to malfunction. Aside from the benefit of safety, the reduction to one pilot in the flight deck also permits cost reduction through mitigation of required labor. Han, et al. (2004) also noted that if the UAV has a ground controller, he/she would monitor operations remotely and be responsible for ensuring safety and security of up to thirty UAV aircraft. In this design alternative with a ground operator monitoring multiple aircraft, it is assumed the operator will only intervene if the system malfunctions. The aircraft would provide information of their flight plan, equipment status, and flight status through an internal information relay system. Through this given information, the operator would know when to intervene and would subsequently contact Air Traffic Control for an alternative course of action (Han, et al., 2004). This alternative may be both a benefit and a liability, depending on the perspective from which one views it. For example, one ground operator monitoring multiple unmanned operations may reduce labor costs for a company under which the UAV is operating. However, this may be a major liability if more than one system malfunctioned at one time. Multiple malfunctions may overload the ground operator, especially if he/she is monitoring up to thirty UAV aircraft. An overloaded and overstressed ground operator would potentially affect the safety and security of all unmanned systems that are experiencing malfunctions.

Prior studies proposed the public's risk perception relied not on actual risk, but rather on perceived benefits of the technology (Weibel & Hansman, 2005). A large influence on risk perception was the fear of what is unknown or unfamiliar. This was a result of the uncertainty in technology and the inadequate understanding of its capability. Because UAV technology is somewhat new to civil aviation and the public, Clothier & Walker (2006) believed underexposure fuels negative perception. To further gain public acceptance and reduce the perceived risk involved, it seems education and greater exposure to UAV will be required.

Methodology

A questionnaire based on earlier work by MacSween-George was developed to collect data pertinent to identifying the public's issues and perceptions toward the use of Unmanned Aerial Vehicles for commercial operations. Copies of this questionnaire were distributed electronically to faculty members at a large Midwestern university as well as members of the International Society of Aircraft Traders (ISTAT), a professional group familiar with aviation industry issues. Adults (ages 18+) within these two groups were asked to participate in this study because they were considered knowledgeable about air travel, and could accurately reflect the views of the general travelling public. The survey took approximately 5 minutes to complete online and all participants remained anonymous.

The questionnaire contained demographic profile questions, which helped determine whether certain demographic variables of the sample population were correlated with risk perception of UAVs. Upon survey completion, data was collected and analyzed with SPSS statistical analysis software. Histograms and bar charts were created to represent data output.

Results and Discussion

Of the 170 respondents, 158 completed the survey and their completed data sets were taken into consideration for data analysis. The 12 remaining incomplete data sets were omitted from data analysis for validity purposes. Out of 158 respondents, 60% of respondents were male and 40% were female. About 53% of the respondents were between ages 50 – 64, 29% between ages 35 – 49, 12% between ages 25 – 34, 4% over age 65, and 2% between ages 18 – 24. Responses indicated that 98% of respondents usually fly at least once a year, 82% generally fly in economy/coach, and 77% fly domestically more often than internationally.

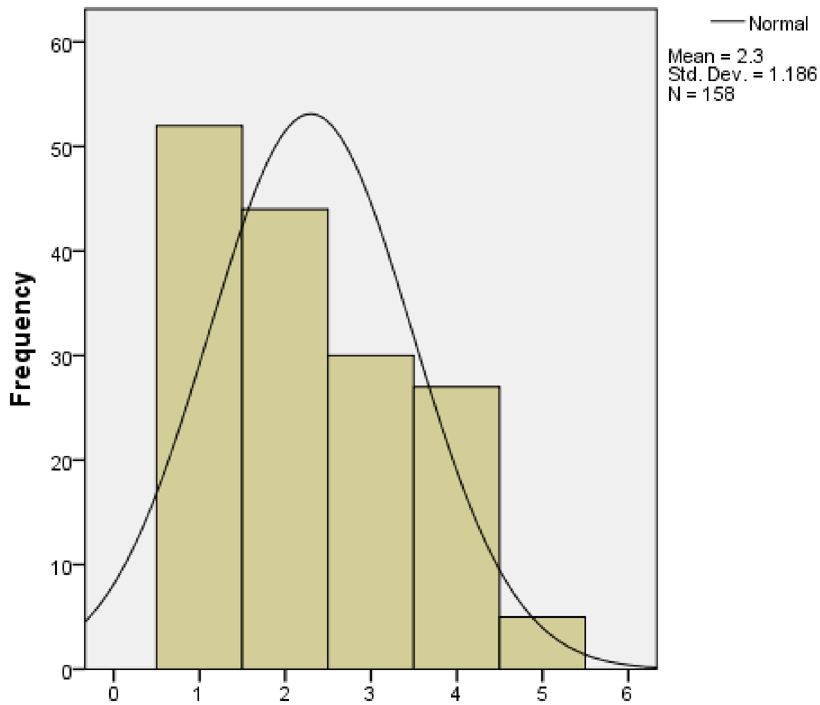

Figure 1. Respondents rated their familiarity with Unmanned Aerial Vehicles on a scale of 1 to 5, 1 being no knowledge and 5 being expert knowledge. The normal distribution curve shows the mean response for familiarity to be 2.3.

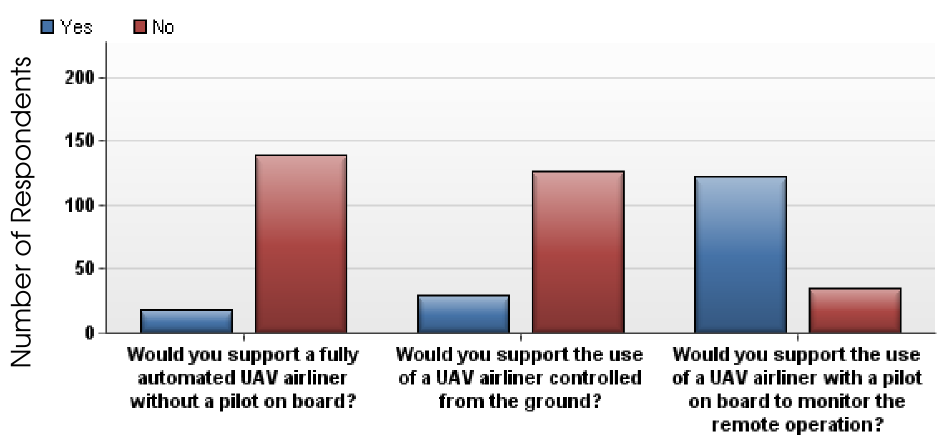

Figure 2. Regarding the use of UAV airliners for passenger transportation, respondents stated whether they supported each respective operation by responding with “Yes” or “No”.

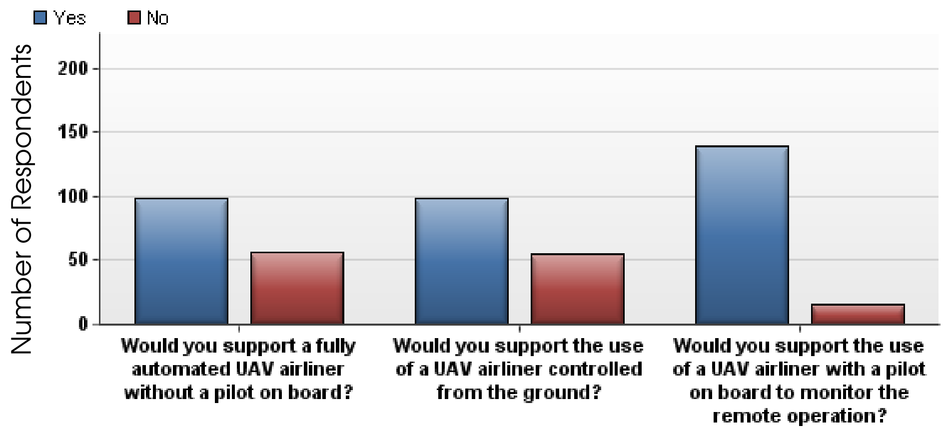

Figure 3. Regarding the use of UAV airliners for cargo transportation, respondents stated whether they supported each respective operation by responding with "Yes" or "No".

Figure 1 suggested that the average familiarity of UAVs among 158 respondents was little to moderate knowledge. Although only 5/158 respondents indicated they were experts, it is possible they even they did not really know that much about UAVs. This is because what determined expert knowledge was not clearly defined within the questionnaire. Figure 2 showed an overwhelming majority of respondents would not support a fully automated UAV airliner or a UAV airliner with a remote pilot (ground operator) for passenger transportation. However, responses varied greatly when it was suggested there would be a pilot onboard to monitor the UAV. Could this possibly suggest that a pilot onboard the aircraft, able to intervene and override the automated system, increases perceived safety?

When comparing responses between Figures 2 and 3, respondents were generally dismissive toward UAV airlines for passenger transportation, unless a pilot is onboard. Responses indicated there was not as much resistance to UAVs used for cargo operations when compared to UAVs used for passenger operations. This seemed to be especially true when there would have been a pilot onboard for cargo transportation, as Figure 2 and Figure 3 suggested, many respondents would feel safer with a pilot onboard the aircraft. This might possibly be due to perceived safety risk that a UAV may pose to people during passenger transportation. The perceived risk identified in responses to questions 11 and 12 of the questionnaire (see Appendix A), was caused by the absence of a human onboard. About 38/126 respondents indicated that a human pilot onboard would feel safer because the human can act instinctively and override the unmanned system if anything malfunctions occurred.

Pearson Correlations were calculated and used to analyze data because a key point of the study was to identify whether there was any correlation between UAV familiarity and perceptions toward UAVs. The study hypothesis was that there would be a positive correlation between UAV familiarity and willingness to fly in a UAV airliner commercially (see Appendix B for descriptive statistics of these data). Pearson Correlation analyses were made to find R^2 values to identify correlations between respondents' UAV familiarity against the following:

- Age of respondent vs. UAV familiarity: $R^2 = 0.000012$
- Likeliness to fly on a UAV airliner for business vs. UAV familiarity: $R^2 = 0.021$
- Likeliness to fly on a UAV airliner for leisure vs. UAV familiarity: $R^2 = 0.032$
- Likeliness to fly on a UAV airliner for international travel vs. UAV familiarity: $R^2 = 0.046$
- Likeliness to fly on a UAV airliner for domestic travel vs. UAV familiarity: $R^2 = 0.025$

The Pearson Correlation calculations show no significant correlation between UAV familiarity and the likelihood of flying in a UAV. The resulting R^2 values are interesting, but they are too low to suggest there is a correlation between UAV familiarity and likeliness to fly on a UAV airliner for business, leisure, domestic, or international travel.

An R^2 value was calculated to determine whether a correlation existed between gender and familiarity with UAVs. The resulting R^2 value of 0.21 weakly suggested males had more knowledge and familiarity of UAVs than females. When the R^2 values were calculated for gender vs. likeliness to fly on a UAV for business, leisure, domestic, and international travels, all R^2 values were between 0.019 and 0.031. That indicated no correlation between the respondent's gender and likelihood to fly on a UAV airliner. R^2 values were then calculated for age bracket vs. likeliness to fly on a UAV for business, leisure, domestic, and international travels and all R^2 values fell between 0.002 and 0.007. Those values indicated no correlation between age of the respondent and likelihood to fly on a UAV airliner.

Questions 11 and 12 of the questionnaire were open-ended and they were categorized to represent the issues and concerns with UAV airliner operations. Respondents were asked to respond to these questions, but they were not obligated to do so. Consequently, not all respondents provided responses to these questions. Question 11 received 126 responses and asked respondents, "What are your issues or concerns with UAV airliner operations? Why?". Question 12 received 127 responses and asked respondents, "What would it take for you to be comfortable with, or support the use of, a UAV airliner for commercial aviation?"

While 72/127 respondents listed stipulations for their support of UAV airliners, 17/127 respondents bluntly stated they would never support UAV airliners, 1/127 stated they were okay with UAV airliners, and 9/127 respondents stated they were not sure what it would take for them to be comfortable with UAVs airliners being used for commercial aviation. Stipulations from 27/127 respondents entailed a pilot onboard to act as a safety or standby pilot, 7/127 respondents expressed the need for fail-safes and redundancies, and 26/127 respondents stated that there needs to be extensive testing, trials, research, and documentation to demonstrate and prove the safety of UAV airliner operations. Although 17/127 respondents stated they would never support UAV airliner operations, 4 those 17 respondents specifically said they would not support its use for passenger transportation. Additional stipulations were override capabilities (whether from a remote pilot on ground or from a pilot onboard the UAV airliner), extensive training in airspace with cargo aircraft, peace (no security or terrorism concerns), interference protection assurance (secure data link), time and experience (to learn about and accept UAVs), more information/education, and a cultural shift.

Regarding concerns toward UAV airliners for commercial aviation, 2/126 respondents had no concerns. One respondent in particular stated the technology is readily available, so it should be used on commercial flights. Of the 124 respondents who disclosed concerns with UAV airliners, 38 of the responses were related to a human pilot onboard to act instinctively and immediately during emergencies and unforeseen situations, such as UAV system malfunction, severe weather, or bird strikes. This may be due to the perceived safety of a human pilot onboard the aircraft, which one of the respondents revealed as their specific concern/issue with UAV airliner operations. Inexperience of current technology was stated as a concern by four respondents, which is related to integrity and reliability of unmanned systems. The integrity and reliability of unmanned systems were stated as concerns by 32 respondents and they are directly related to trials, testing, and experience of the technology. Collision avoidance was stated as a concern by two respondents, bringing up the point that not all aircraft may be participating in conflict avoidance. Unfamiliarity was the concern for two respondents and one of them said they did not know what a UAV was, or anything about their operations.

Conclusion and Recommendations

Based on these findings, if UAV airliners will be used for passenger transportation, results from the sample of this study suggest that there should be a pilot onboard actively monitoring the operation since 77% stated they would support this type of operation. Respondents indicated that an onboard pilot should be able to intervene and override the automated system in critical situations such as an emergency or system malfunction. Fully automated UAV airliners for cargo transportation are only accepted by 63% of the sample, so it is not recommended they be implemented at this time. However, 90% of the sample supported UAV airliners for cargo transportation with a pilot onboard.

Since about 61% respondents indicated they have little to no familiarity with unmanned aerial vehicles, it is suggested that the public should receive education regarding unmanned aerial vehicles. Perhaps some education and insight will reduce the risk perceptions associated with unmanned aerial vehicle operations. It is recommended that the FAA should set high standards for unmanned aerial vehicles so that they are as safe, or safer than, current aircraft that are used for passenger and cargo transportation. Upon certifying unmanned aerial vehicles, the FAA should publish information available to the public so they may learn the benefits and safety standards by which unmanned aerial vehicles operate.

Based on indicated issues and concerns toward UAV airliners, findings from this study suggest that UAV airliners with onboard pilots be considered for cargo transportation before considering them for passenger transportation. Since 63-64% of the sample indicated they would support UAV airliner cargo operations without an onboard pilot and 90% indicated they would support these operations with a pilot onboard, more research should be conducted on a larger sample size. The possible success of UAV airliners for cargo transportation might show the public that these unmanned aerial vehicles are safe for passenger transportation and at that time, UAV airliners could be implemented for passenger transportation.

Because this was only an exploratory study, it is recommended that further research be conducted regarding the use of UAVs for commercial airliners. Additionally, if respondents are asked to rate their knowledge of UAVs on a scale of 1 to 5, from no knowledge to expert knowledge, it is suggested that there should be a method to evaluate this knowledge. The familiarity, or knowledge level, should be assessed with a test of some sort to set the criteria for the level of familiarity or knowledge.

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Appendix A

UAV Airliner Questionnaire

1. The aviation industry has been studying the potential use of Unmanned Aerial Vehicles (UAV) commercial airliners in the National Airspace System. Military UAVs are currently used for operations such as surveillance and reconnaissance. Researchers are interested in your opinions regarding the potential certification by the Federal Aviation Administration (FAA) of UAV airliners for commercial passenger and/or cargo usage. Please complete the following survey to convey your issues & perceptions of UAVs.

This survey should take about 5 minutes to complete. It is conducted for research purposes only. You will not be identified and will remain anonymous upon completion of this survey. This survey is entirely voluntary and you may stop at any time. You must be at least 18 years of age to participate. Thank you in advance for your participation, your responses are very important.

Are you at least 18 years of age?

- ❍ Yes
- ❍ No

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2. Please Specify Your Age Bracket

- ❍ 18-24
- ❍ 25-34
- ❍ 35-49
- ❍ 50-64
- ❍ 65+

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3. Gender

- ❍ Male
- ❍ Female

4. Which best describes how often do you typically travel by air each year?

- ❍ Never
- ❍ Once a Year or Less
- ❍ Several Times a Year
- ❍ Once a Month
- ❍ Several Times a Month

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5. What class do you typically fly?

- ❑ First
- ❑ Business
- ❑ Economy/Coach

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6. Which type of travel do you utilize more often?

- ❍ Domestic
- ❍ International

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7. On a scale of 1 to 5, 1 being no knowledge and 5 being expert knowledge, please rate your familiarity with Unmanned Aerial Vehicles.

- ❍ 1
- ❍ 2
- ❍ 3
- ❍ 4
- ❍ 5

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8. On a scale of 1 to 5, 1 being least likely and 5 being most likely, please rate the following:

	1	2	3	4	5
How likely would you be to fly in a UAV airliner for business travel?	❍	❍	❍	❍	❍
How likely would you be to fly in a UAV airliner for leisure travel?	❍	❍	❍	❍	❍
How likely would you be to fly in a UAV airliner for International Travel?	❍	❍	❍	❍	❍

How likely would you be to fly in a UAV airliner for Domestic Travel?	❍	❍	❍	❍	❍

9. Assuming Unmanned Aerial Vehicles airliners have been certified by the Federal Aviation Administration to be as safe or safer than current operating commercial aircraft, please answer the following:

	For Passenger Transportation		For Cargo Transportation	
	Yes	No	Yes	No
Would you support a fully automated UAV airliner without a pilot on board?	❍	❍	❍	❍
Would you support the use of a UAV airliner controlled from the ground?	❍	❍	❍	❍
Would you support the use of a UAV airliner with a pilot on board to monitor the remote operation?	❍	❍	❍	❍

10. What are your issues or concerns with UAV airliner operations? Why?

11. What would it take for you to be comfortable with, or support the use of, a UAV airliner for commercial aviation?

Appendix B

Table 1

Descriptive Statistics

	Mean	Std. Deviation	N
On a scale of 1 to 5, 1 being no knowledge and 5 being expert knowledge, please rate your familiarity with Unmanned Aerial Vehicles.	2.30	1.186	158
On a scale of 1 to 5, 1 being least likely and 5 being most likely, please rate the following: How likely would you be to fly in a UAV airliner for business travel?	1.61	.936	158
On a scale of 1 to 5, 1 being least likely and 5 being most likely, please rate the following: How likely would you be to fly in a UAV airliner for leisure travel?	1.56	.892	158
On a scale of 1 to 5, 1 being least likely and 5 being most likely, please rate the following: How likely would you be to fly in a UAV airliner for International Travel?	1.49	.850	158
On a scale of 1 to 5, 1 being least likely and 5 being most likely, please rate the following: How likely would you be to fly in a UAV airliner for Domestic Travel?	1.61	.923	158