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Intention to Complain About Unmanned Aircraft System Noise: A Structural Equation Analysis

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This Dissertation was prepared under the direction of the candidate's Dissertation Committee Chair, Dr. Scott R. Winter, and has been approved by the members of the dissertation committee. It was submitted to the College of Aviation and was accepted in partial fulfillment of the requirements for the Degree of Doctor of Philosophy in Aviation.

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Abstract

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Aircraft noise has a long and documented history as a source of public annoyance and a driver of noise complaints. The impending large-scale use of unmanned aircraft systems (UAS)s could expose a broader cross-section of the public to a new type of aircraft noise. Recent research notes some reactions to UAS noise, but no rigorous analyses of public intention to complain about UAS noise have been found.

Due to the potential proliferation of UASs and their attendant noise, understanding public reaction could advise both government and industry. Governments at all levels could apply the results to inform policies related to providing the public information about UASs, aircraft certification standards (including noise), airspace use, routing, and restrictions to hours of operation. The industry could apply the results to optimize package delivery routes, determine regulation-compliant locations of operational hubs, and influence design of small package delivery aircraft to minimize noise.

The purpose of the study was to examine factors, as included in an extended theory of planned behavior, that influence individuals' intentions to complain about UAS noise. The research questions were: 1) what factors influence individuals' intentions to complain about UAS noise, and 2) how do these factors affect individuals' intentions to complain about UAS noise? Data were collected through a cross-sectional survey of a convenience sample of adults in the general public within the United States. Confirmatory factor analysis and structural equation modeling were used to analyze the data. An investigation of moderating interaction effects among select factors was also completed. The study examined the relationships between the measured factors and the general public's intentions to complain about UAS noise.

The results indicated that five factors influence individuals' intentions to complain about UAS noise. These factors, in order of effect size, are 1) individuals' attitudes toward complaining about UAS noise, 2) perceived social pressure to complain about UAS noise, 3) perceived usefulness of UASs, 4) perceptions of risks to safety, and 5) familiarity with UASs. Other factors investigated which were not statistically significant include perceived behavioral control, application type/use of UAS, and privacy concerns. The results of the structural model indicated that only one interaction was present at a statistically significant level. Attitude toward complaining about UAS noise and familiarity with UASs showed an interaction effect. As familiarity with UAS increases, the positive relationship between attitude toward complaining about UAS noise and intention to complain about UAS noise was strengthened. The subject research created and validated a theoretical framework which can be used to improve our understanding of and possibly predict individuals' intentions to complain about UAS noise and help identify significant contributing factors.

Dedication

I dedicate this dissertation primarily to family. First I would especially like to mention my father, Robert Graham Brents, who was a consistent source of encouragement and inspiration to me. This dissertation is also dedicated to my three amazing daughters, Lindsay, Emily, and Kelly, who inspire me as much as I hopefully inspire them. It would be a mistake to not dedicate this work, at least in part, to my fellow students and faculty at Embry-Riddle Aeronautical University for their wisdom, knowledge, patience, assistance, and persistence in the education of this author.

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Chapter I: Introduction

Unmanned aircraft systems are poised to become much more commonplace in the lives of the general public (Ivošević, Ganić, Petošić, & Radišić, 2021; Schäffer, Pieren, Heutschi, Wunderli, & Becker, 2021; Torija, Li, & Self, 2020; Yoo, Yu, & Jung, 2018). Currently, most people's exposure to UASs is limited to hobbyist UASs or news reporting about UASs. However, as UASs begin to be used for small package delivery (Anbaroğlu, 2017; Torija et al., 2020), they will become more commonplace, and the general public's exposure to UASs will rise.

The proliferation of UASs, specifically those used for commercial purposes, has become evident. The Federal Aviation Administration (FAA) began requiring registration of UAS on April 1, 2016. As of January 24, 2022, there were 861,036 UASs with current FAA registrations. Of those, there were 329,114 commercial UAS registrations (FAA, 2022). As the general public's exposure to UASs increases, so will its exposure to the audible noise created by UASs (Ivošević et al., 2021; Schäffer et al., 2021; Torija et al., 2020).

As UAS use rises concomitantly with the introduction of small package delivery, the general public will experience substantial increases in exposure to these new sources of aircraft noise (Ivošević et al., 2021; Schäffer et al., 2021; Torija et al., 2020). The noise generated by UASs has not been investigated as extensively as noise from manned aircraft (Ivošević et al., 2021; Kloet, Watkins, Wang, Prudden, Clothier, & Palmer, 2017; Schäffer et al., 2021). As a result, the impacts of UAS noise are not as well understood. However, the need for UAS noise research has been identified (FICAN, 2018), and research is currently becoming more available.

Individuals are negatively affected by exposure to noise, which leads to the notion that general community noise is an important issue (Ahmed & Ali, 2017; Levine, 1981). General noise levels affect individuals in multiple ways, including creating levels of annoyance, interfering with common activities, and affecting student academic achievement (Onchang, Hawker, & Hawker, 2018). Indeed, student achievement has been shown to be affected across age groups from primary through the university level (Grelat, Houot, Pujol, Levain, Defrance, Mariet, & Mauny, 2016).

Noise, in general, has also been shown to have negative effects on health. Consistent exposure to community noise has been shown to be associated with both weight issues and cardiovascular disease. Consistent exposure to community noise may increase body mass index and rates of cardiovascular disease (Dzhambov, Gatseva, Tokmakova, Zdravkov, Vladeva, Gencheva, & Donchev, 2017). In addition, environmental noise disturbs sleep, impairs learning, and causes hypertension and heart disease (Di, Lu, & Shi, 2018).

While general levels of community noise can have certain negative effects on the public, noise from transportation sources may be particularly problematic. Noise from transportation sources, typically aircraft, railway, and road traffic, has been studied in some detail (Schreckenberg, Belke, & Spilski, 2018). Levels of annoyance with transportation noise have been measured, and aircraft noise has been shown to be considered the most annoying, with railroad noise being second and road traffic noise ranking least annoying (Brink, Schäffer, Vienneau, Foraster, Pieren, Eze, & Wunderli, 2019). Aircraft noise is such a prominent component of environmental noise that it was regulated in 1971 (EPA, 1971; Wolfe, Yim, Lee, Ashok, Barrett, & Waitz, 2014).

While aircraft may have multiple effects on the environment, the primary cause of annoyance related to aircraft is noise (Alexandre, 1975; Guski, Schuemer, & Felscher-Suhr, 1999), especially for those living in close proximity to airports (Durmaz, 2011). Noise from aircraft causes effects similar to those of general community noise and has also been linked to many health issues. Aircraft noise has been associated with negative effects on learning, sleep, depression, anxiety, and health (Basner, Clark, Hansell, Hileman, Janssen, Shepherd, & Sparrow, 2017; Beutel, Jünger, Klein, Wild, Lackner, Blettner, Binder, Michal, Wiltink, Brähler, & Münzel, 2016; Weihofen, Hegewald, Euler, Schlattmann, Zeeb, & Seidler, 2019). In addition, living in an area with consistent daytime aircraft noise has been shown to have negative effects on an individual's life satisfaction, happiness, sense of worth, and anxiety (Lawton & Fujiwara, 2016).

UAS noise has already been predicted to become a contentious issue with respect to affecting individuals and community acceptance. When compared to road noise, UAS noise has been shown to be more annoying (Christian & Cabell, 2017; Ivošević et al., 2021; Schäffer et al., 2021). In addition, while an individual UAS may be considered noisy, consistent exposure to many UASs on small package delivery tasks may comprise a nuisance (Khan, Tausif, & Malik, 2019). Thus, community acceptance of UASs may hinge on noise issues. A negative community response to UAS noise from package delivery indicates a need to understand the nature of how the community will convey its dissatisfaction.

It should be noted that responses to UAS might not always be negative or undesirable. Some studies have discussed the beneficial use of UAS in wildlife control (Mohamed, Naim, & Abdullah, 2020; Penny, White, Scott, MacTavish, & Pernetta, 2019;

Schiano, Natter, Zambrano, & Floreano, 2021) and wildlife observation (Thirtyacre, Brookshire, Callan, Arvizu, & Sherman, 2021). Another interesting use of UAS which has not been rigorously studied with regard to human behavior is as a cue or a deterrent (Heen, Lieberman, & Miethe, 2017; Manzella & Favre, 2015). The two key aspects of UAS operations which could generate a desired impact are the noise and visual stimuli. Potential applications where human perception of UAS noise might prove beneficial could include search and rescue, certain police activities, site security, and surveillance.

In summary, noise from all sources tends to have negative effects on individuals of all ages. Exposure to noise produces wide-ranging effects, including cognitive-intellectual effects, cardiovascular effects (heart disease and stroke), and generating levels of annoyance in individuals. The effects of transportation noise are most impactful, with aircraft noise being the most significant. Aircraft noise is a subset of environmental noise and has been broadly studied in the literature (Basner, Clark, Hansell, Hileman, Janssen, Shepherd, & Sparrow, 2017). Literature related to new sources of aircraft noise, such as UAS, is beginning to become available. Initial indications are that exposure to UASs may also produce levels of annoyance. A key measure of public attitudes toward air transportation is the propensity to complain about aircraft noise. Since UAS use is poised to increase substantially, it is important to understand aspects of the public's attitude toward UAS noise and specifically their attitude toward complaining about UAS noise.

The remainder of this chapter provides the basis from which to understand the subject research effort. First, the problem statement addressed in this research is discussed followed by a statement of the purpose of the proposed research. Subsequent sections of the chapter define the significance of the study and delineate possible theoretical and practical implications. Next, the research questions and testable hypotheses are described as well as the delimitations, limitations, and assumptions that pertain to the research. Finally, key terms are defined, and a list of acronyms is provided.

Statement of the Problem

Aircraft noise has long been a source of public annoyance, and there is a documented history of aircraft noise complaints. In the past, aircraft noise has been generated by piston-powered and subsequently jet-powered manned aircraft. The impending large-scale use of UAS is likely to expose a broader cross-section of the public to new types of aircraft noise. Thus a need exists for increased understanding of the broad impacts UASs will have on the general public.

Extensive literature exists on the effects of noise, including noise from traditional aircraft. Research into individual's perceptions of and reactions to UAS noise has been lagging, but recently some research has become available. While the literature notes some reactions to UAS noise, no rigorous analyses of the factors which affect an individual's intention to complain about UAS noise have been found. The research gap which this study addressed is the aforementioned lack of rigorous analysis of the factors affecting an individual's intention to complain about UAS noise. Thus the problem can be stated as follows: there are no rigorous analyses of the factors which affect an individual's intention to complain about UAS noise.

Purpose Statement

Experts predict that the age of small package delivery via UAS is imminent. Thus, understanding what affects an individual's motivation to complain about the resulting noise could be helpful. Such knowledge carries significance as it informs decision makers in both government and industry while also expanding the body of knowledge with respect to UAS and environmental noise. Since UASs are predicted to proliferate, the purpose of this research was to examine factors and their effects, as included in an extended theory of planned behavior, which influence individuals' intentions to complain about UAS noise.

Data was collected through a cross-sectional survey of a convenience sample of adults in the general public from at least 700 respondents. Descriptive statistics were developed, followed by confirmatory factor analysis (CFA) and structural equation modeling (SEM). An investigation of moderating interaction effects between select factors was also completed. The subject research examined the relationships between the measured factors and the public's intentions to complain about UAS noise.

Significance of the Study

Academic research, such as this study, intends to address a knowledge or research gap. Addressing the identified gap increases the body of knowledge pertaining to the general topic area. Such knowledge has both theoretical and practical implications.

The subject study expands the body of knowledge related to the impacts expanded use of UASs will have on the general public. The identification of the factors which affect an individual's intention to complain about UAS noise expands the understanding of factors related to UAS acceptance. Because this study appears to be the first time the TPB has been applied in an analysis of an individual's intention to complain about UAS noise, the body of knowledge related to the use of the theory of planned behavior (TPB) was also expanded.

Because of the potential proliferation of UASs and the noise which they will generate, a greater understanding of the public reaction to the noise UASs will generate can serve to inform both government and industry (Eißfeldt, 2020). Understanding the public's attitude toward complaining about UAS noise informs both government and industry and allows the development of appropriate UAS-related regulations and UAS platforms, which foster the growth of the nascent industry. Governments at the federal, state, and local levels can apply the results of the subject study to help develop policies related to providing public information about UASs, aircraft certification standards (including noise), airspace use, aircraft routing, and restrictions to hours of operation. The industry can apply the results to optimize UAS package delivery routes, determine regulation-compliant locations of UAS small package delivery hubs, and design of small package delivery aircraft to minimize noise.

Research Questions and Hypotheses

There were two primary research questions:

RQ_1

What factors influence individuals' intentions to complain about UAS noise?

RQ_2

How do these factors affect individuals' intentions to complain about the UAS noise?

The focus of the subject research was an individual's intention to complain about UAS noise and the degree to which it is affected by factors identified in the literature. The underlying behavior connected with the intention to complain about UAS noise is the actual act of complaining about UAS noise. Since the intention was captured indirectly through the development of latent factors from manifest (observed) variables, it is instructive to describe the latent factors prior to describing the hypotheses.

Factor Descriptions

The latent factors under investigation were related to an individual's intention to perform the behavioral act of complaining about UAS noise. Table 1 provides the latent factors investigated in this study.

Table 1

Latent Factors (Variables)

#	Latent Factors	Factor Descriptions
Exogenous Factors / Independent Variables		
1	Attitudes toward Behavior (AB)	Individuals' attitude toward complaining about UAS noise
2	Subjective Norms (SN)	Individuals' perceived social pressure to complain about UAS noise
3	Perceived Behavioral Control (PB)	Individuals' perceived ease or difficulty of complaining about UAS noise
4	Perceived Usefulness of UASs (PU)	Individuals' perception regarding the usefulness of UASs
5	Application Type/Use of UASs (AT)	Individuals' perception of the type, purpose, and use of UASs
6	Privacy (PR)	Individual's perception of the potential that UASs will invade their privacy
7	Risk/Safety of UASs (RS)	Individuals' perception of the risks to personal safety due to UASs
8	Familiarity with UASs (FW)	Individuals' familiarity with UASs
Endogenous Factor / Dependent Variable		
9	Behavioral Intention (BI) to complain about UAS noise	Individuals' behavioral intention to complain about UAS noise

Hypotheses

The key to understanding the hypotheses is to note that this research investigated individuals' intention to complain about UAS noise. It should be differentiated from the underlying behavior. The underlying behavior in question was the actual act of complaining about UAS noise.

The hypotheses can be subdivided into three groups. The first grouping of hypotheses relates to the traditional theory of planned (TPB) behavior factors. The second grouping of hypotheses relates to additional factors that were discovered in the literature. The third grouping of hypotheses relates to the possible interaction of moderating relationships between factors. It is useful to note that within SEM, hypotheses can be used to predict the impact of latent factors on each other, including "causal direction" (Byrne, 2010, p. 7).

Hypotheses Related to TPB Factors

H_1

Individuals' attitudes toward complaining about UAS noise [Attitudes toward Behavior (AB)] are positively related to individuals' Behavioral Intentions (BI) to complain about UAS noise.

H_2

Individuals' perceived social pressure to complain about UAS noise [Subjective Norms (SN)] are positively related to individuals' Behavioral Intentions (BI) to complain about UAS noise.

H_3

Individuals' perceived ease of complaining about UAS noise [Perceived Behavioral control (PB)] is positively related to individuals' Behavioral Intentions (BI) to complain about UAS noise.

Hypotheses Incorporating Extended Factors

H_4

Perceived Usefulness of UASs (PU) is negatively related to individuals' Behavioral Intentions (BI) to complain about UAS noise.

H_5

Individuals' perceptions of Application Type (use) of UASs (AT) is negatively related to individuals' Behavioral Intentions (BI) to complain about UAS noise.

H_6

Privacy (PR) concerns are positively related to individuals' Behavioral Intentions (BI) to complain about UAS noise.

H_7

Individuals' perceptions of UASs Risks to Safety (RS) is positively related to individuals' Behavioral Intentions (BI) to complain about UAS noise.

H_8

Familiarity with UASs (FW) is negatively related to individuals' Behavioral Intentions (BI) to complain about UAS noise.

Hypotheses Related to Moderating Relationships

H_9

The relationship between Perceived Usefulness of UASs (PU) and Behavioral Intention (BI) to complain about UAS noise is strengthened by Attitude toward Behavior (AB) to complain about UAS noise, where BI is further reduced as AB increases.

H_{10}

The relationship between Application Type (use) of UASs and Behavioral Intention (BI) to complain about UAS noise is strengthened by Attitude toward Behavior (AB) to complain about UAS noise, where BI is further reduced as AB increases.

H_{11}

The relationship between Privacy (PR) and Behavioral Intention (BI) to complain about UAS noise is strengthened by Attitude toward Behavior (AB) to complain about UAS noise, where BI is further reduced as AB increases.

H_{12}

The relationship between Individuals' perceptions of Risk to personal Safety (RS) and Behavioral Intention (BI) to complain about UAS noise is strengthened by the moderating effect of Attitude toward Behavior (AB) to complain about UAS noise, where BI is further reduced as AB increases.

H_{13}

The relationship between Familiarity with UASs (FW) and Behavioral Intention (BI) to complain about UAS noise is strengthened by the moderating effect of Attitude toward Behavior (AB) to complain about UAS noise, where BI is further reduced as AB increases.

Delimitations

There are five primary delimitations in the subject research - one temporal, one language-based, one geographical, one parameter-based, and one access-based. The temporal delimitation derives from the fact that the survey collection instrument was promulgated for a finite period of time and, as such, must be considered *cross-sectional*. It should be noted that the survey was issued prior to the advent of the widespread small package delivery via UASs. Longitudinal studies enable an analysis of changes in the variables over time, but such an effort was beyond the scope of this study.

The language delimitation derives from the fact that the survey was created and implemented in English. Surveys in no other languages were distributed. Such a delimitation may result in a failure to consider differences that might accrue related to speakers of other languages (Choi, 2013; Clothier et al., 2015). Alternatively, restriction to one language may remove possible confounding effects.

Since the survey instrument was limited to adult participants from the United States, there is a geographic delimitation. Specifically, the survey instrument was only available to participants who accessed the survey instrument from accounts registered in the United States. Such a delimitation may affect generalizability but may also remove possible confounding effects.

The survey instrument did not query the respondents regarding prior experience with UAS. Thus, there is a delimitation based on the lack of a parameter reflecting UAS experience in the analysis. Such a delimitation prevents comparative analysis of responses from respondents with UAS experience and those with no UAS experience.

The access-based delimitation acknowledges the fact respondents were required to have a computer, Internet access, and an Amazon Mechanical Turk® (MTurk®) account. No other survey data collection methods were used. This delimitation may have exposed the proposed research to selection bias, which in the final analysis becomes a limitation.

Limitations and Assumptions

There were two primary limitations to the subject research: selection bias and generalizability. The effort was limited by the data collection strategy. Data collection followed a convenience sampling strategy using an internet-based method (Amazon MTurk®). Participants were free to choose to participate and self-select based on multiple factors such as the instrument type and title, compensation, estimated time required, and other factors.

Selection bias is a common concern when collecting survey data (Vogt, Gardner, & Haeffele, 2012). However, available research indicates that biases can be reduced through the use of internet-based data collection versus traditional methods (Gosling, Vazire, Srivastava, & John, 2004). One method of reducing sampling bias is genericizing the task description, so the topic is unknown to potential respondents until after the task is chosen (Goodman & Paolacci, 2017). Data obtained from MTurk® has been found to be equal to or better than data collected from students and clearly better than professional panels (Kees, Berry, Burton, & Sheehan, 2017).

Generalizability or external validity is also a common concern when collecting survey data (Vogt et al., 2012). Recent research indicates the use of internet-based research may improve generalizability (Rice, Winter, Doherty, & Milner, 2017) when compared to traditional methods. Internet-based methods have numerous advantages, including access to new populations, increased sample sizes, lower cost, better gender balance, improved timeliness of data collection, improved data reliability, and ensured respondent anonymity. Apropos of the subject study, when security and privacy questions were investigated via MTurk®, responses were found to be more representative of the population than responses from a census-representative panel (Redmiles, Kross, & Mazurek, 2019).

The survey instrument was self-selected by respondents, which ensured their participation was voluntary. Voluntary participation is often an indicator that respondents will answer survey questions truthfully (Vogt et al., 2012). These considerations support one of the significant assumptions in the subject research: that respondents were truthful in their responses to the data gathering questionnaire. It was also assumed that participants understood the pre-screening requirements and questions included in the instrument.

Several assumptions were associated with the analysis method in this study. For structural equation modeling, satisfaction of three primary assumptions was required. The first and second SEM assumptions were the data contained no outliers, and there was no missing data. Typically, outliers and missing data are handled during data cleaning and preprocessing of the collected data. The third SEM-related assumption was that the data were normally distributed. Assessment of normality was completed as part of the data analysis.

Summary

In summary, this chapter introduced the subject research. The notion that UAS will likely be a source of noise to which individuals may react was introduced. The research problem was formally stated with regard to the lack of research related to public intention to complain about UAS noise. The purpose of the research was defined as an examination of the factors related to an individual’s intention to complain about this new source of noise. The significance of the research was described as providing guidance to policy makers in government and industry. The research questions and hypotheses were also provided as well as the delimitations, limitations, and assumptions relevant to the subject research.

The following chapters cover four topics. An extensive literature review is provided, which illustrates the current understanding of UASs, noise, intention, intention to complain, and acceptance of UASs. A detailed description of the research method is then provided, which details the manner of data acquisition and the statistical methods which were used to address the research questions. The results of the analysis are then provided, followed by a discussion of the results, conclusions (particularly its practical and theoretical implications), and recommendations for future research.

Definitions of Terms

Attitude	“The degree to which a person has a favorable or unfavorable evaluation or appraisal of the behavior in question” (Ajzen, 1991, p. 188).

Behavior	An observable act that can be differentiated from other acts (Fishbein & Ajzen, 1975).
Behavioral Intention	An individual’s intention to perform a given behavior (Ajzen, 1991).
Familiarity	A state of understanding or knowledge of something.
Perceived Behavioral Control	“The perceived ease or difficulty of performing the behavior and it is assumed to reflect past experience as well as anticipated impediments and obstacles” (Ajzen, 1991, p. 188).
Perceived Ease of Use	The degree to which an individual believes that using a particular system would be free of physical and mental effort (Davis, 1985).
Perceived Usefulness	The degree to which an individual believes that using an item would enhance their performance of a task (Davis, 1989).

Privacy	A condition in which one is not observed or disturbed by others (Rao et al., 2016).
Risk	“The future impact of a hazard that is not eliminated or controlled” (FAA, 2009, p. G-4).
Safety	Freedom from harm, the freedom from fear of harm - security (Rao et al., 2016).
Subjective Norm	“The perceived social pressure to perform or not to perform the behavior” (Ajzen, 1991, p. 188).

List of Acronyms

AB	Attitude Toward Behavior
AC	Advisory Circular
AGFI	Adjusted Goodness of fit Index
AGL	Above Ground Level
AMOS	Analysis of Moment Structures
ANOVA	Analysis of Variance
ARC	Aviation Rulemaking Committee
AT	Application Type
AVE	Average Variance Extracted
BI	Behavioral Intention
BMI	Body Mass Index
BVLOS	Beyond Visual Line of Sight
CFA	Confirmatory Factor Analysis
CFI	Comparative Fit Index
CFR	Code of Federal Regulations
COA	Certificate of Authorization
CR	Construct Reliability
df	Degrees of Freedom
DHS	Department of Homeland Security
DoD	Department of Defense
DV	Dependent Variable
ERAU	Embry-Riddle Aeronautical University

FAA	Federal Aviation Administration
FSM	Full Structural Model
FW	Familiarity With
GCS	Ground Control Station
GFI	Goodness of fit Index
GOF	Goodness-of-Fit
HIT	Human Intelligence Task
IRB	Institutional Review Board
IV	Independent Variable
MANOVA	Multivariate Analysis of Variance
MI	Modification Index
mph	Miles Per Hour
MSV	Maximum Shared Variance
MTurk	Amazon® Mechanical Turk®
NAS	National Airspace System
NFI	Normed Fit Index
PBC	Perceived Behavioral Control
PEOU	Perceived Ease of Use
PII	Personally Identifiable Information
PR	Privacy
PU	Perceived Usefulness
RMSEA	Root Mean Square Error of Approximation
RS	Risk/Safety

SEM	Structural Equation Modeling
SME	Subject Matter Expert
SN	Subjective Norms
sUAS	Small Unmanned Aircraft System
SPSS	Statistical Package for the Social Sciences
TAM	Technology Acceptance Model
TPB	Theory of Planned Behavior
TRA	Theory of Reasoned Action
TTC	Theory of Trying to Complain
UAM	Urban Air Mobility
UAS	Unmanned Aircraft System

Chapter II: Review of the Relevant Literature

This chapter provides a discussion of the key topics relevant to the completion of the subject research. First, it provides an overview of UASs. Next, noise from various sources and its impact on individuals is discussed. Then, relevant research supporting the grounded theory used in this study is reviewed. Various applications of the grounded theory and analytical method are then reviewed to establish a precedent for their use in the evaluation of intention in general, intention to complain, and individuals' acceptance of UASs. The final portion of the literature review presents the application of the grounded theory, applicable factors derived from the literature, and the hypotheses.

UAS Overview

Understanding four aspects of UASs aids in the understanding of the research presented in this document. The first aspect of UASs discussed is the definition of a UAS. Second is the predicted proliferation of drones, followed by a review of literature related to how the public will accept drones into their daily lives. Third, noise is then discussed from a general perspective, and then other aspects of noise are introduced, such as the sources of noise and its effects on individuals. Individuals may experience certain deleterious effects on their health due to exposure to noise. In addition, noise often causes people to experience annoyance. Finally, general environmental noise is discussed, followed by noise from transportation sources. Subsequently, noise from aircraft is discussed, followed by noise from UASs.

Definition of a UAS

While UASs have had increasing exposure in the media, it is useful to understand the basic definition of an unmanned aircraft and unmanned aircraft system. Unmanned aircraft and unmanned aircraft systems are succinctly defined in the FAA Modernization and Reform Act of 2012. The term *unmanned aircraft* describes “an aircraft that is operated without the possibility of direct human intervention from within or on the aircraft” (FAA, 2012, p. 62). The term *unmanned aircraft system* describes “an unmanned aircraft and associated elements (including communication links and the components that control the unmanned aircraft) that are required for the pilot in command to operate safely and efficiently in the national airspace system” (FAA, 2012, p. 62).

Unmanned aircraft are typically controlled in two ways. They may be actively controlled from a ground control station (GCS), or they may fly autonomously without control inputs from a GCS. In cases where GCSs are used, control of the UAS can be maintained by a person or a computer. Use of a GCS requires a form of communication between the GCS and the UAS.

Types of UASs

The United States has specified a number of UAS attributes in public law, regulation, Orders, Advisories, and other documentation. Several examples follow. FAA Modernization and Reform Act of 2012 defines small UAS (sUAS) as those weighing 55 pounds or less but also defines a category for use by Government safety agencies as 4.4 pounds or less. In Title 14 of the United States Code of Federal Regulations (CFR), Part 107, sUASs are defined as weighing 55 pounds or less, capable of flight at 100 miles per hour (mph) or less, and limited in altitude to 400 ft or less in daylight within visual line-of-sight of the pilot. FAA Order 8130.34C notes a category of UAS weighing 300 pounds or more. FAA Order 8900.1, Vol. 16, Ch. 1 stipulates that a UAS, which weighs 55 pounds or less, is an sUAS. The Aviation Rulemaking Committee (ARC) Final Report dated April 1, 2016, recognizes a category of UAS which weighs 250 grams (0.55 pounds) or less. FAA Advisory Circular (AC) No: 00-1.1A also notes a difference between civil and public use UASs. Despite the noted inconsistencies in the government and industry literature, generally UASs are divided by weight, airspeed, altitude capability, operation type, and user as follows:

- Small UASs weigh 55 pounds or less, fly at speeds of 100 mph or less, at altitudes of 400 ft or less, in daylight, and within visual line of sight of the operator.
- Standard UASs weigh greater than 55 pounds, are not limited in speed, altitude, time of day, or operator proximity, and may operate under Section 333 or under an FAA certificate of authorization (COA) tailored to a specific mission.
- Users are either civil or public (law enforcement, security services, first responders, or the military).

Uses of UASs

Unmanned aircraft have been used for many different purposes in the past. Historically, larger UASs have been used primarily by the military as targets, for surveillance, delivery of propaganda for psychological operations, and for delivery of offensive weapons, as well as other uses. There has also been a significant group of UAS operators that fly smaller UASs as a hobby for their enjoyment. As of August 18, 2020, 1,194,293 recreational UASs have been registered with the FAA (FAA, 2020).

In the recent past, advances in technology have enabled the development of UASs with capabilities that far surpass those of previous generations. Applying these improved capabilities has enabled an expansion of the uses conceived for UAS. In FAA parlance, these conceived uses are often called *use-cases*. Small UAS use-cases include flying these aircraft to perform infrastructure inspection, capturing aerial imagery, surveying, crop inspection, hydrology assessments, obstacle evaluations, and many other tasks. UASs can be leveraged to do jobs where the safety of a human inspector might be in question. It has been conceived that UASs would be appropriate for jobs that are "dull, dirty, or dangerous" (Weber, 2016, p. 14). A list of the wide variety of current and future uses of UASs was compiled by Aydin (2019, p. 2) and is adapted as Table 2.

Table 2

Current and Future UAS Use-Cases

Use-case	Time-frame
Archeological surveys	Current
Building firefighting	Current
Construction surveying	Current
Control drug trafficking	Current
Control illegal immigration (border control)	Current
Delivering flotation equipment to the victims to aid lifeguards on beaches	Current
Disaster early detection and disaster relief	Current
Drone racing	Current
Early detection of oil spills and pipeline damages or failures	Current
Herding cattle	Current
Highway and bridge inspection	Current
Insurance claims	Current
Meteorology measurements	Current
Military applications	Current
Monitoring air pollution	Current
Monitoring crop health and growth	Current
Monitoring the impacts of global warming	Current
Monitoring wildfire and forest fires	Current
Pesticide spraying	Current
Photogrammetry	Current
Recording personal/family events	Current
Recording sports events	Current
Search and rescue	Current
Surveying wild animal ecosystems	Current

Use-case	Time-frame
Thermal monitoring for detecting poor insulation and air leakage, and water leaks	Current
Track suspected criminals or terrorists	Current
Tracking wildlife poaching	Current
Traffic patrol	Current
Treatment of agricultural fields	Current
Disease spread control	Future
Emergency response (first aid)	Future
Food delivery	Future
Home security systems	Future
Monitoring nuclear plants for nuclear spills	Future
Passenger transportation	Future
Railway infrastructure monitoring	Future
Reforestation (planting trees)	Future
Supplying connectivity via wireless signals	Future
Transport and deliver cargo	Future
Underwater missions to monitor ocean ecosystems	Future

Note. Adapted from Aydin, B. (2019). Public acceptance of drones: Knowledge, attitudes, and practice. *Technology in Society, 59*, 101180. doi:10.1016/j.techsoc.2019.101180

The FAA's *Integration of Civil Unmanned Aircraft Systems (UAS) in the National Airspace System (NAS) Roadmap* (FAA, 2018) has noted a graduated scale of desired operational capabilities for UASs to be integrated into the NAS. The operational capabilities include:

- Operations over people
- Expanded operations – Beyond visual line of sight (BVLOS)
- Small UAS package delivery operations
- Non-segregated operations
- Routine/scheduled operations
- Large carrier cargo operations
- Passenger transport operations

The FAA has approved limited operations over people, BLVOS operations, and UAS package delivery operations. The FAA has granted limited approval of package delivery operations under Part 135 to UPS-Flight Forward, Google-Wing Aviation (with FedEx), and Amazon Prime Air.

Predictions of UAS Proliferation

Estimates of the growth of unmanned aircraft fleets suggest that UASs will proliferate. The Federal Aviation Administration (FAA, 2021) forecasts that by 2025, the commercial non-hobbyist UAS fleet will grow to 835,000 aircraft, 1.7 times larger than the same category fleet in 2020. The proliferation of UASs could accelerate further when small package delivery is fully realized.

The NAS benefits from advanced navigation technologies through more predictable, direct routes and increased throughput enabled by reduced congestion, flight times, and flight distances. These benefits also manifest certain positive environmental impacts, such as reduced fuel consumption and emissions. In application, such technology concentrates aircraft on more exacting flight paths, which reduces noise exposure for broad areas by reducing flight path dispersion. Unfortunately, for locations near or directly under concentrated flight paths, noise exposure may increase.

Flightpath related environmental considerations relative to UASs can be parsed into those related to large UASs and those related to sUASs. When advanced navigation technologies are considered concerning large UASs, there do not appear to be significant UAS-specific environmental considerations. Large UASs are likely to be analogous to other civil aircraft from an environmental perspective with impacts specific to the aircraft type, flight profile, areas and frequency of operation, and population density. The large

UASs that operate today do so primarily in support of Department of Defense (DoD) and Department of Homeland Security (DHS) missions from lower traffic airports. While large UASs are currently not a significant portion of the NAS, as their use increases, noise is likely to become an issue. The primary environmental considerations relating to sUASs are noise, lack of regulatory noise requirements, visual clutter or distraction, and nuisance issues.

Large UAS operational frequency is expected to increase, and research is underway relating to quantifying noise and other environmental impacts of large UASs. sUAS environmental issues are another area of research related to low altitude sUAS operations. Analysis of ground tracks, capturing the magnitude and nature of environmental impacts, and discerning how communities perceive, engage with, and understand UASs is key to establishing policy and gauging public acceptance.

Noise

The literature on noise reveals that it is a many-faceted topic. The following section provides a review of the literature related to the effects of noise from increasingly specific sources. The impacts of general ambient noise sources are reviewed. Literature related to the effects of transportation noise is then reviewed. Subsequently, literature related to the effects of aviation-based noise is reviewed. Finally, a discussion of literature related to UAS-based noise is provided.

General Noise

The reaction of individuals to general noise levels has long been investigated and is well documented. Levine (1981) established that community noise has been studied for an extended period of time as an important issue. His research revealed that community noise and annoyance are related and resulted in the development of a seven-point Likert scale for annoyance.

General noise levels affect the general public in various ways, such as creating levels of annoyance, interfering with common activities, and causing effects on student academic achievement (Onchang, Hawker, & Hawker, 2018). Using a survey design along with physical measurements of noise, Onchang et al. (2018) determined that various community noise sources affect university students' activities and possibly their educational achievement. Some bias may be present in their study as the female-to-male participant ratio was almost 3:1.

Adverse effects of noise at the community level are confirmed by Ahmed and Ali (2017). They examined exposure to noise along with both auditory and nonauditory-related problems experienced by students of a dentistry college in the United Arab Emirates. The study method was similar to Onchang et al. (2018) in that they used a cross-sectional survey along with physical noise measurements. Their results indicate that approximately 80% of those exposed to the noise profile studied exhibited symptoms of annoyance, and that additional sound abatement was recommended.

While Onchang et al. (2018) and Ahmed and Ali (2017) showed that university student achievement might be affected by community noise sources, another study may indicate that in fact, student achievement is affected across age groups from primary through the university level (Grelat, Houot, Pujol, Levain, Defrance, Mariet, & Mauny, 2016). Chronic ambient noise was shown to be related to annoyance in children. Grelat et al. (2016) also used cross-sectional surveys along with physical sound level measurements to collect data. Unfortunately, their study employed a four-point scale, which did not offer a neutral answer to survey questions.

As noted, general noise levels have been shown to affect student achievement and create levels of annoyance. Noise has also been shown to have certain deleterious effects on public health. One such effect arising from consistent exposure to community noise has been shown to be associated with weight issues and cardiovascular disease. Dzhambov, Gatseva, Tokmakova, Zdravkov, Vladeva, Gencheva, and Donchev (2017) used biometrics and survey data to establish that consistent exposure to community noise may increase body mass index and rates of cardiovascular disease. While their study was limited by a small sample size and geographic area (Bulgaria), the results indicate the impact of noise on health.

Di, Lu, and Shi (2018) note that environmental noise disturbs sleep, impairs learning, and causes hypertension and heart disease. These notions are further confirmed concerning sleep by Muzet (2007) and Halperin (2014); impaired learning by Hygge, Evans, and Bullinger (2002); Lercher, Evans, and Meis (2003); and Chetoni, Ascari, Bianco, Fredianelli, Licitra, and Cori (2016); noise as a contributing factor to hypertension and heart disease by Dratva, Foraster, Gaspoz, Keidel, Künzli, and Schindler (2012), Babisch, Beule, Schust, Kersten, and Ising (2005), and Babisch, Swart, Houthuijs, Selander, Bluhm, Pershagen, and Sourtzi (2012).

Noise from Transportation Sources

Noise from all modes of transportation has been studied in some detail. Schreckenberg, Belke, and Spilski (2018) developed an annoyance scale intended to measure noise annoyance from transportation sources. Their study focused on aircraft, railway, and road traffic noise. Three elements were of primary interest: the behavioral response to noise, the attitudinal response, and the perceived control about the noise situation. Other key items measured were trust, the usefulness of the transportation method, user safety, user comfort, environmental impact, and trust.

Sung, Lee, Jeong, Lee, Lee, Jo, and Sim (2017) studied the influence of transportation noise and sensitivity on annoyance. They used a cross-sectional survey design and ANOVA analysis. Their results indicated that both noise level and participant sensitivity to noise affect participant perception of annoyance, while sensitivity produces a greater effect on noise annoyance. Their study appears to exhibit limited generalizability since the sample was limited to participants from South Korea.

Noise from transportation sources often annoys. Levels of annoyance with transportation noise are ranked high-to-low with aircraft being the most annoying, railroad noise being second, and road traffic noise ranking least annoying of the three (Brink, Schäffer, Vienneau, Foraster, Pieren, Eze, & Wunderli, 2019). Brink et al. (2019) studied transportation noise using a survey design. Their study benefitted from a large sample size, but generalizability may be affected due to the geographically limited area (Switzerland) from which surveys were received.

The results of Brink et al. (2019) might be considered supportive of the conclusions found in Kopsch (2016). In his study, Kopsch (2016) performed a meta-analysis of 53 studies that considered both aircraft noise and road traffic noise. The meta-regression determined that the costs of aircraft noise are greater than road traffic noise.

Noise from Aircraft

The environmental effects of aircraft include noise, effects on air quality, and climate change impacts. In the past, the primary environmental cause of annoyance related to aircraft was noise (Alexandre, 1975). Over the past few decades, concern over the effects of exhaust emissions has joined noise as a primary aviation environmental issue (Baharozu, Soykan, & Ozerdem, 2017; GAO, 2007). However, noise remains the most significant concern for those living in proximity to airports (Durmaz, 2011). Aircraft noise is a prominent component of environmental noise, so much so that it was regulated in 1971 (EPA, 1971; Wolfe, Yim, Lee, Ashok, Barrett, & Waitz, 2014).

Noise from aircraft has been widely studied. Basner, Clark, Hansell, Hileman, Janssen, Shepherd, and Sparrow (2017) performed a thorough literature review to inform a consensus paper, which summarizes the state of the science of noise effects research in the areas of noise measurement and prediction, community annoyance, children's learning, sleep disturbance, and health. It also briefly discusses civilian supersonic aircraft as a future source of aviation noise. The consensus opinion formed from their literature review was that aircraft noise had been broadly studied, and there are potential health effects.

Similar to the effects of general environmental noise and other transportation created noise as noted above, exposure to aircraft noise has been linked to many health issues, some of which are serious. Weihofen, Hegewald, Euler, Schlattmann, Zeeb, and Seidler (2019) completed a meta-analysis of the pertinent literature. Their results show that aircraft noise has been associated with an increased risk of stroke. The generalizability of the study is a concern due to the geographically limited nature of the sample (Germany).

Consistent exposure to aircraft noise has also been shown to be associated with depression and anxiety. Beutel et al. (2016) used a five-point Likert scaled survey to assess the relationship between aircraft noise exposure, depression, and anxiety. Their results indicated that depression and anxiety increased with the degree of overall noise annoyance. The generalizability of the study is a concern due to the small size and geographically limited nature of the sample (Germany).

Negative effects of living with consistent exposure to aircraft noise was confirmed by Lawton and Fujiwara (2016). They performed multivariate analysis of extensive survey data (n =189, 162) collected in England. Consistent exposure to aircraft noise was shown to negatively affect individual's life satisfaction, happiness, sense of worth, and anxiety.

Noise from UASs

The proliferation of UASs will increase the exposure of the general public to aircraft noise of a type different than the manned aircraft historical precedent (Ivošević et al., 2021). Aircraft noise, specifically from UASs, has not been investigated to the extent of noise from manned aircraft. In the United States, the Federal Interagency Committee on Aviation Noise (FICAN), a multi-agency committee addressing aviation noise, appears to agree, suggesting that "development of methodologies to characterize and assess noise from UASs is an emerging field of study" (FICAN, 2018, p. 15). Thus, UAS noise impacts are not as well understood, but research is beginning to be completed.

A recent systematic review of UAS noise literature (Schäffer et al., 2021) indicated that no field studies were found on the effects of long-term exposure to UAS. In addition, they found that existing literature suggests that for a given volume, UAS noise is more annoying than road noise and other aviation sources. As a result, they recommended that noise issues be addressed to foster UAS acceptance.

Kloet, Watkins, Wang, Prudden, Clothier, and Palmer (2017) investigated the acoustic impact of quadrotor UASs specifically by analyzing the effect of the number of propeller-blades on acoustic annoyance. Their initial review indicated there is little available information available on: the characteristics of UAS noise sources, the factors influencing propagation, the people impacted, and the psychoacoustic factors influencing their response. The subsequent experimental observations resulted in the development of possible noise mitigation measures including flight path planning, regulatory restrictions, and introduction of low-noise propeller designs inspired by low noise fans. These actions are hypothesized as methods for reducing the acoustic impact of routine UAS operations over populous areas.

In a follow-on study, Kloet, Watkins, and Wang (2019) experimented with sUAS propeller design and operation with the aim of understanding UAS acoustics. Their stated concern related to increasing community concerns regarding UAS noise. They recommended psycho-acoustic propeller design principles for UASs such that noise reduction and a more acceptable tonal quality are achieved.

Bulusu, Polishchuk, and Sedov (2017) created a noise estimation framework applicable to small package delivery operations. Their simulation-based study provided estimates of possible ambient noise levels generated by UASs in uncontrolled low-altitude airspace. The primary conclusion was that noise levels alone may not be a nuisance considering much of the operations will be above 200ft above ground level (AGL).

As noted earlier, Khan et al. (2019) used a survey design to study consumer acceptance of UASs. Their research also indicated the public is concerned about environmental factors relating to drones. Respondents noted that UASs present noise issues. Individual UASs are considered noisy, but the consistent presence of multiple UASs on delivery tasks would create a noise nuisance and add to noise pollution.

An experimental investigation into the psychoacoustics of sUAS noise was completed by Christian and Cabell (2017). A key result from their tests showed there might be differences in annoyance response when subjects were exposed to road noise versus sUAS noise. sUAS noise was considered more annoying. Such results indicate that sUAS noise from package delivery may create a negative community response. This conclusion is in contrast to those of Bulusu et al. (2017), noted above.

In a more recent study, noise levels and human subject responses to both quadrotor and hexarotor UAS were measured (Ivošević et al., 2021). Participants also provided responses to a survey. The results showed that, for the flight states tested (hover, climbing, descending, and overflight) the hexarotor was found to produce a more negative experience for the participants. The result was consistent with the measured difference in noise level between the two types of UAS. The survey results indicated sixty-nine percent of the respondents were concerned about risks of injury or accidents and that greater than eighty percent of the survey respondents generally found more positives than negatives with respect to introducing UAS more widely.

In summary, the literature illustrates many impacts of noise. Noise from all sources tends to have negative affects on individuals of all ages. Exposure to noise produces wide-ranging effects from cognitive-intellectual effects to cardiovascular effects (heart disease and stroke) to generating levels of annoyance. The effects of transportation noise are most impactful with aircraft noise being most significant. Literature related to new sources of aircraft noise such as UASs is beginning to become available. Initial indications are that some UASs may also produce levels of annoyance.

Theoretical Foundation for the Study

It is important to establish a robust theoretical foundation for any study undertaken. Doing so establishes that the study is well-grounded. Creswell (2014) describes theories in quantitative research as an "interrelated set of constructs (or variables) formed into propositions, or hypotheses, that specify the relationship among variables (typically in terms of magnitude or direction)" (p. 54). Under Creswell's proposition, it was imperative that the grounded theories used in this research be able to consider interrelated constructs to determine whether the hypotheses related to individuals' intention to complain about UAS noise are supported. As part of the literature review, an investigation was completed to determine potential foundational theories applicable to the proposed research.

A review of the relevant literature regarding the selection of the grounded theory used in this research follows. Grounded theories considered for this research are discussed, and the grounded theory designated for use is determined. The grounded theory is then discussed including its origin, the history of its use, and the constructs included in the theory. Application of the grounded theory to previous studies is discussed to establish a precedent for its use for the present application. Alterations to the grounded theory are reviewed, including precedents of researchers adding to, or removing factors from, the grounded theory. Criticisms and defenses of the grounded theory are also presented.

Summary of Foundational Theories Considered

The literature review revealed two possible foundational theories. The theories considered were the technology acceptance model (TAM) and the theory of planned behavior. Each of these theories are discussed in this section.

Technology Acceptance Model. Proposed in a dissertation (Davis, 1985) and later in the literature (Davis, 1989), the TAM was developed to determine the "effect of system characteristics on user acceptance of computer-based information systems" (Davis, 1985, p. 2). Over time, the TAM has been used as a general model to assess the acceptance of various types of new technologies (Legris, Ingham, & Collerette, 2003). Since UAS is perceived by many as new technology, and questions of public acceptance are germane, the application of the TAM appeared reasonable.

Four key constructs comprise the TAM (Chuttur, 2009; Davis, 1985): perceived usefulness (PU), perceived ease of use (PEOU), attitude toward using, and actual system use. PU is the extent to which the use of the item or system would improve performance. PEOU is the extent to which an individual believes the use of the item or system would require minimal effort. Attitude toward using is a function of both PU and PEOU. Attitude toward using then directly impacts actual system use.

Davis (1989) determined that perceived usefulness and user acceptance were strongly related and must be included in research related to technology acceptance. Since its introduction, the TAM has become one of the most prevalent models used in the analysis of technology acceptance factors (Marangunic & Granic, 2015). However, the application of the TAM in the context of this research presented a conceptual problem. The subject study was not intended to investigate the public acceptance of UASs in relation to their behavioral intention to use UASs. Rather the subject study intended to investigate the factors that affect an individual's behavioral intention to complain about UAS noise. Since an individual's perception of the usefulness of UASs may affect their behavioral intention to complain about UAS noise, the factor was considered as possibly a useful predictor of intention to complain about UAS noise. An individual's perception of the ease of use of UAS does not appear to have a direct effect on their behavioral intention to complain about UAS noise, so perceived ease of use was not considered a likely useful predictor of intention to complain about UAS noise.

Theory of Planned Behavior. Originally proposed by Ajzen (1985, 1991), the theory of planned behavior was intended to enhance understanding of the relationship of the precursors of behavior to the behavior itself and the inter-relationships between the precursors. The TPB leverages concepts from the behavioral and social sciences and facilitates their application such that behaviors can be better understood and predicted. Ajzen (1991) notes "the theory of planned behavior provides a useful conceptual framework for dealing with the complexities of human social behavior" (p. 206). Lee and Choi (2009) confirm that the TPB is a widely used and well accepted model in the social psychology literature.

The TPB model includes five primary factors. These factors have been shown in the literature to be accurate predictors of behavioral intentions (Ajzen, 1991). The primary TPB factors include attitude toward the behavior, subjective norms, perceived behavioral control, intention, and the actual behavior.

Since its introduction, the TPB has been widely used and is considered an important grounded theory in studies related to human action (Ajzen, 2002). Additionally, the literature provides substantial support for the use of TPB in social psychological contexts. The TPB has been used in over 600 predictive behavioral studies since it was first introduced (Casper, 2007). The TPB was also deemed to be an appropriate theoretical base for use in this research due to the breadth of subject areas for which it has been used. Successful application over a range of subject areas improves the notion that the TPB provides a superior theoretical basis.

Foundational Theory Selected

The TAM model focuses on acceptance by individuals in the context of an individual using a given technology. As noted by Legris et al. (2003), the TAM is useful but is more so if integrated into a broader model. For purposes of the subject research, the full TAM was not used. However, one of the TAM factors, perceived usefulness, was considered appropriate for incorporation as a factor in another model.

The TPB focuses on the factors which are antecedents of intention to perform a behavior. For purposes of the subject research, the TPB model was considered appropriate for use in determining how factors influence an individual’s intention to complain about UAS noise. Therefore, the primary grounded theory used in this research was the theory of planned behavior, as proposed by Ajzen (1985, 1991) with the perceived usefulness factor from the TAM as a viable addition.

Theory of Planned Behavior

This section more fully describes the TPB. The origin of the TPB is discussed as well as its primary components. Application to previous studies follows as well as discussion of extensions of the TPB to include additional factors. Next is a discussion of criticisms of the TPB. Finally, the application of the TPB to the subject research is discussed including factors relating to acceptance and intention to complain.

Origin of the TPB

The genesis of the TPB was a necessary evolution of the theory of reasoned action (TRA). There was a need to accommodate consideration of behaviors over which individuals did not have full volitional control. The TPB "differs from the theory of reasoned action, in that it takes into account perceived as well as actual control over the behavior under consideration" (Ajzen, 1985, p. 12).

Components of the TPB

The TPB is based on the notion that individuals exhibit three aspects of behavior (Ajzen, 2002). First, individuals hold *behavioral beliefs* regarding the consequences of their behaviors and the likelihood of these consequences actually occurring. Second, individuals hold *normative beliefs* related to the expectation other people have regarding their behavior. Third, individuals hold *control beliefs* related to existence of conditions or situations that may either hinder or enable execution of a behavior.

The TPB incorporates the concepts of behavioral, normative, and control beliefs. Behavioral beliefs become manifest in the TPB as favorable or unfavorable attitudes toward a given behavior (*attitude toward the behavior*). Normative beliefs manifest as *subjective norms* which are individual's perceptions of social pressures related to the potential behavior. Control beliefs are bifurcated into actual and perceived behavioral controls. *Perceived behavioral control* (PBC) addresses an individual's perceptions of how easily the behavior might be performed. *Actual behavioral control* (ABC) is the degree to which an individual has the ability to perform the behavior.

According to the TPB (Ajzen, 2002), attitude toward the behavior, subjective norms, and PBC are all direct antecedents and formative of *intention* to perform a *behavior*. The behavior is expected to be performed if intention to perform the behavior and actual behavioral control are present. Thus, the TPB posits that attitude toward a behavior, subjective norms, and perceived behavioral control determine behavioral intentions, and, subsequently (given adequate actual behavioral control), the behavior itself (Ajzen, 1991).

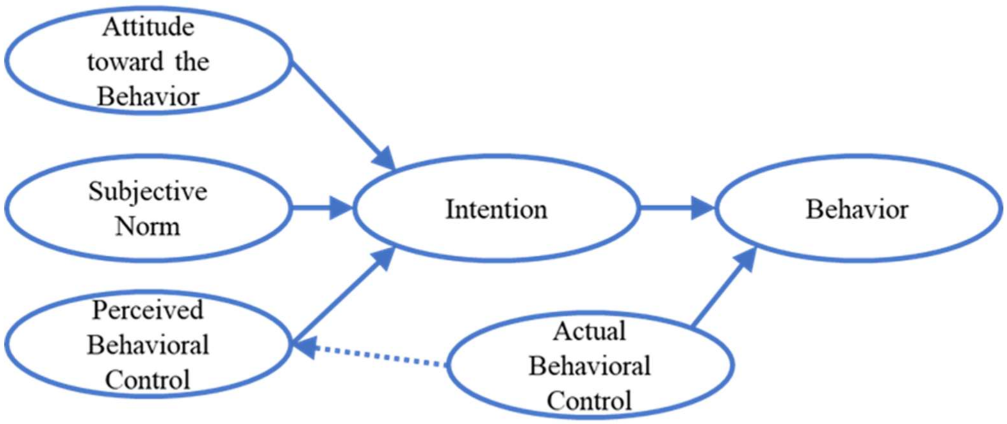
The baseline factors of the TPB are defined as follows (Ajzen, 1991, p. 188):

- *Attitude toward a behavior* is "the degree to which a person has a favorable or unfavorable evaluation or appraisal of the behavior in question."
- *Subjective norm* is "the perceived social pressure to perform or not to perform the behavior."
- *Perceived behavioral control* refers to "the perceived ease or difficulty of performing the behavior, and it is assumed to reflect past experience as well as anticipated impediments and obstacles."
- *Intention* refers to the immediate precursor of a behavior and is the individual's readiness to execute the behavior.
- *Behavior* refers to the actual observable action taken by an individual.

The theoretical framework developed for used in this effort was based on the theory of planned behavior (Ajzen, 1985, 1991). Figure 1 provides an illustration of the TPB framework.

Figure 1

Theory of Planned Behavior



Note. ABC and PBC are related but affect behavior by different paths. The dotted line between PBC and ABC indicates that PBC may be affected by ABC. While PBC is an antecedent of intention, ABC (similar to intention) is an immediate antecedent of behavior. Ajzen (2006) notes that to the "extent that perceived behavioral control is veridical, it can serve as a proxy for actual control and contribute to the prediction of the behavior in question (p. 1)."

An individual's attitude toward a behavior, his or her subjective norms related to the behavior, and his or her perception of his or her ability to control the behavior are directly related and are antecedents of intention. An individual's intention and actual behavioral control are a direct antecedent to the performance of the behavior. An individual’s actual ability to control the behavior also informs their perception of behavioral control.

Use in Previous Studies and Extensions of the TPB

Researchers often desire the inclusion of factors that were not included in the original conception of many analytical models. The TPB is no exception to this notion. The TPB, through the addition of other factors as necessary to accommodate research needs, has been demonstrated to be an effective research model. This section provides examples from the literature of research which utilized the TPB model with extensions which enabled improved understanding of the issues being studied and establishes precedent for extending the TPB in this study.

Pan and Truong (2018) developed and tested a research model based on the TPB which added factors influencing an individual’s intention to patronize low-cost carrier airlines (LCCs). The study used a survey design and SEM analysis. The results indicated that attitudes, subjective norms, price, service quality, access, uncertainty avoidance, and technology self-efficacy significantly influence passenger decisions to travel by LCCs. Two factors, frequency and perceived behavioral control, were not considered important. The ticket price was the most important determinant of the individual’s intention to use LCCs, followed by service quality.

In another study, Hsieh (2015) extended the TPB model by adding factors related to institutional trust and perceived risk related to physicians' acceptance of electronic medical records technology. The study used a survey design and SEM analysis. Concerns about the study include small sample size and limited generalizability (mostly male respondents – doctors in Taiwan). The study confirmed a strong relationship between attitude and intention.

Donald, Cooper, and Conchie (2014) extended TPB by adding psychological factors affecting commuters' intention relating to transport mode use. The study used a survey design and SEM analysis. The results indicated that private auto use was primarily determined by intention and habit but not PBC. Alternatively, intention was the primary determinant of public transport use. The study benefited from good sample size, but the possibility of collection bias exists, as some surveys were completed by an interviewer while others were self-completed.

Researchers have also combined TPB with other grounded theories such as the technology acceptance model. Lee (2009) added TAM factors to investigate adoption of internet banking. The study used a survey design and SEM analysis. The study added five dimensions of risk (security, financial, time, social, and performance) to the TAM and TPB factors. The results indicate that the TPB extended with TAM and other factors are "capable of explaining a relatively high proportion of variation of intention to adopt online banking" (p. 138). The data collection method was an internet survey that exposes the study to self-selection bias.

Another example of combining TPB and TAM was completed by Teo (2012), who examined the intention to use technology among pre-service teachers. The study used a survey design and SEM analysis. The study results indicated that attitude toward computer use had the largest effect on the intention to use technology.

Chan, Prendergast, and Ng (2016) expanded the TPB to better predict intention to engage in healthy eating by adolescents. Their study added self-efficacy and perceived barriers to the foundational TPB factors. The study used a survey design and SEM analysis. The results indicated that perceived behavioral control and self-efficacy exerted greater influence than attitude and subjective norm in adolescent's intention to eat healthy.

In another study on intention, Chen and Tung (2014) extended the TPB to develop a research model that added factors related to environmental concern and perceived moral obligation to study consumer intent to patronize eco-friendly hotels. The study used a survey design and SEM analysis. The results indicated visitor's environmental concern had a positive influence on subjective norms, perceived behavioral control, and attitude toward green hotels. In addition, perceived moral obligation was shown to influence intention to visit green hotels. They conclude that the results of the study illustrate that an extended TPB model can exhibit good explanatory power.

Chen (2016) completed a study utilizing a model comprised of factors from the TPB and TAM along with additional elements to investigate how perceived green value affects loyalty to a system of public bike paths. The study used an interview design and SEM analysis. The study found that the factors perceived pleasure to use and subjective norms had the greatest influence on loyalty to the system of public bike paths.

Using a modified application of the TPB, Czerniak and Lumpe (1996) studied predictors of student participation in science fairs. The study used a survey design and multiple regression analysis. Their theoretical model dropped perceived behavioral control from the TPB but added variables for participation in a gifted class, whether participation counts as a grade in science class, parent's level of education, and whether the project was a science class requirement.

In an interesting extension to the TPB; Lao, Tao, and Wu (2016) studied the sleep habits of college students. Their innovation was adding two additional factors (perceived invulnerability and parental nurturance) and parsing the subjective norm factor into two separate factors: injunctive norms and descriptive norms. The study used a survey design and SEM analysis (although the term *path analysis* was used in this study).

Jung, Cerreto, and Lee (2010) extended the TPB to study teacher intention in relation to their use of educational technologies. The study's extensions of TPB included factors relating to behavioral beliefs, normative beliefs, and control beliefs. The study used a survey design and SEM analysis (although the term path analysis was also used in this study). One of their key findings was that attitude toward behavior had double the influence of subjective norms and triple that of perceived behavioral control.

The TPB has been used to investigate eating disorders and body satisfaction (Pickett, Ginsburg, Mendez, Lim, Blankenship, Foster, & Sheffield, 2012). The study added factors relating to body mass index (BMI) and body satisfaction. The study used a survey design and linear regression analysis. For purposes of the proposed study, the key result was that the TPB is a "superior predictor of behavior" (p. 339).

Wang and Hsu (2016) completed a study relating to the factors contributing to consumer's behavioral intentions with regard to acquiring and using airline co-branded credit cards. They added benefits of airline co-branded credit cards as a second order factor relating to attitude and perceived behavioral control. Subsequently, they added four antecedent benefits to the new benefit factor which include: generic, core, expected, and augmented.

Criticism of the TPB

While the TPB has been and continues to be widely used, it is not beyond criticism. Armitage and Conner (2001) challenged the efficacy of the TPB. They performed a meta-analysis of 161 studies that utilized the TPB. While they concluded that there was validity with respect to the factors of intention and behavioral intent, they indicated that subjective norm is not a good predictor of behavior and was the TPB component most weakly related to intention.

Some have suggested that it is time to retire TPB (Sniehotta, Presseau, & Araújo-Soares, 2014). Their archival design study completed a meta-analysis of studies employing the TPB. Their expressed concerns about the validity and utility of the TPB stem from the conclusion the TPB ignores certain aspects of human behavior which should not be ignored including the roll of subconscious influences and emotions other than anticipation of outcome. They suggest that there exist alternative models which could be investigated.

Others have suggested that there is a fundament flaw in the TPB in that consciousness is not a true causal agent, and intentionality is not an immediate antecedent of behavior (Ajzen, 2011). There is an argument that thoughts about specific actions including priority, consistency, and exclusivity comprise conscious will, which is offered as a better determinant of behavior (Wegner, 2002; Wegner & Wheatley, 1999). Greenwald and Banaii (1995) maintain that implicit attitudes drive human social behavior. Still other researchers posit that human behaviors are driven by other, often unconscious mental processes which connect habits to goal-action links and formation of intention to implement (Aarts & Dijksterhuis, 2000) or exhibit automaticity theory which maintains that much of human social response is effectively automatic, effortless, unintentional, autonomous, involuntary, or uncontrollable (Bargh, 1989; Bargh & Chartrand, 1999; Brandstatter, Lengfelder & Gollwitzer, 2001; Uhlmann & Swanson, 2004).

It is clear that the TPB is not without its critics. However, the preceding presentation of myriad studies employing the TPB suggests there is general acceptance of the TPB for social behavioral investigations. As noted previously, some have concluded the TPB predicts behavior well (Picket et al., 2012). There appears to be evidence that acceptance and wide use of the TPB is more compelling than the criticisms.

Rivis, Sheeran, and Armitage (2009) completed a meta-analysis of studies employing TPB to investigate the predictive validity of anticipated affect and moral norms in the TPB. The study findings showed that variance explained by intentions was increased by anticipated affect and moral norms. The study also found that intention mediated the influence of anticipated affect and moral norms on behavior.

Application of the TPB to this Study

This section provides a review of literature relevant to the determination of factors which influence an individual's intention to complain about UAS. The assembly of relevant factors begins with the determination of factors related to individual intention. Next is a review of literature related to factors relevant to individuals' intention to complain about various issues. Expanding the literature search beyond intention to complain about UAS noise was necessary due to the paucity of literature which directly investigates the individual's intention to complain about UAS noise. Finally, literature is reviewed relevant to factors affecting individuals' acceptance of UASs. Higher levels of UAS acceptance implies lower propensity for individuals to complain about UAS noise.

Factors Related to Intention

Support for the use of the TPB to assess intention is found in the literature. Researchers have extensively investigated intention using survey designs and SEM or other statistical analysis. This section provides examples of the use of TPB to assess intention. These examples provide support for the use of the TPB factors in the subject research to investigate factors related to an individual's intention to complain about UAS noise.

General support for the use of TPB to assess intention is provided by Fang, Xu, Lin, Jin, and Yan (2017); Bertani, Carone, Caricati, Demaria, Fantuzzi, Guarasci, and Pirazzoli (2016); and Heerwegh and Loosveldt (2009). Fang et al. (2017) used a cross-sectional survey (n = 512) to gather data and employed SEM for analysis in a TPB study regarding attitude and intention related to pain management among nursing students. The TPB model was extended by parsing perceived behavioral control into direct and indirect control factors and parsing attitude into three factors (general attitude, direct attitude, and belief-based attitude). Their primary conclusion was the determination that intention is an important factor in the TPB. The study is limited in geographical extensibility since the sampling frame was limited to Chinese students.

Bertani et al. (2016) used the TPB in a cross-sectional survey design to understand intention of nurses to use a specific medical device. The results indicated that all three of the standard TPB factors predicted respondent's intention with some mediating effects noted. Respondent age was determined to be a relevant demographic variable. The investigators concluded that the TPB is a useful tool to investigate intention. The study may be affected by the small sample size (*n* = 199).

Parker, Manstead, Stradling, Reason, and Baxter (1992) studied intention to commit driving violations. The study used an interview design and SEM analysis. Four rounds of analysis using an unmodified TPB model were completed to investigate: speeding, drinking and driving, close following, and overtaking in risky circumstances. The primary conclusion for purposes of the subject study was that the performance of the TPB model with respect to the prediction of intention was sufficiently reasonable.

A study by Heerwegh and Loosveldt (2009) extended the TPB by adding a factor related to moral obligation to investigate intention to participate in web surveys. The study implemented a cross-sectional survey design (*n* = 523) and performed analysis with SEM. The study found that the TPB is a capable tool for assessing context-specific intentions. Generalizability of the study may be limited as all participants were adults living in the Flemish part of Belgium.

Within the TPB, attitude toward a behavior is one of the factors immediately prior to intention to perform the behavior. Numerous studies have found that attitude is one of the significant predictors of intention. One study found that it was the primary predictor of intention. Droomers, Huang, Fu, Yang, Li, and Zheng (2016) used a cross-sectional survey to gather data and employed SEM for analysis in a TPB study on the intention to quit smoking. Their primary conclusion was conformation that attitude toward a behavior affects intention to perform a behavior. The study is limited in geographical extensibility and lacks discussion of reliability or validity.

Other studies suggest that both attitude and PBC are the significant predictors of intention. A study by Hummel, Candel, Nagelhout, Brown, van den Putte, Kotz, and de Vries (2017) used the TPB as the theoretical framework to compare three instruments designed to measure intention to quit smoking. The study used archival survey data from the Netherlands (*n* = 980), and the statistical analysis was performed using SEM. The study found intention was significant and related to attitude and perceived behavioral control. The subjective norm factor was not significant. Generalizability of the study may be limited as the archival data had been collected from participants living in the Netherlands.

Goodson (2002) completed a study to determine the predictors affecting protestant seminarian's intention to promote family planning. The study employed a survey (*n* = 635) design and SEM analysis. The results indicate that attitudes and perceived behavioral control (self-efficacy) with regard to promoting family planning had the greatest influence on intention. Generalizability of the study may be limited as all participants were American.

Another group of studies suggest that both attitude toward a behavior and subjective norms are the significant predictors of intention. Chen, Tang, Lai, Hung, Hsieh, Yang, and Chuang (2017) used a cross-sectional survey and factor analysis to investigate factors which influence the intention of medical staff to perform cardiopulmonary resuscitation in the presence of the patient's family. The study's primary result showed that attitude and subjective norms were significant predictors of intention. Generalizability of the study may be limited as all participants were Taiwanese.

A study by Delanoë, Lépine, Turcotte, Portocarrero, Robitaille, Giguère, and Légaré (2016) added factors related to anticipated regret and health literacy to the TPB to investigate intention of pregnant women to use a Down syndrome screening decision aid. The study implemented a cross-sectional survey design (*n* = 346) and performed analysis with bivariate ordinal logistic regression and multiple linear regression. The study found that attitude, subjective norms, and anticipated regret were the primary predictors of decision aid use. Generalizability of the study may be limited as all participants were Canadian.

Lai, Aritejo, Tang, Chen, and Chuang (2017) studied the intention of doctors and nurses to allow a patient's family to be present during resuscitation attempts. The study implemented a cross-sectional survey with a questionnaire which extended the normal TPB factors by adding a factor related to awareness of family presence during resuscitation. The study found that attitude and subjective norms, along with one demographic variable (clinical tenure), were the primary predictors. Generalizability of the study may be limited as all participants were staff in one Taiwanese medical center.

Another TPB factor immediately prior to intention is perceived behavioral control. Many studies have found that perceived behavioral control is one of the significant predictors of intention. One study found that it was the primary predictor of intention. Using a survey design (*n* = 195) and multivariate analysis, Cortoos, Schreurs, Peetermans, De Witte, and Laekeman (2012) explored factors affecting physician's intention to comply with antibiotic use guidelines. The study concluded that intention was not as strong a predictor as perceived behavioral control and their added factor (habit strength). A demographic variable (respondent position) was shown to have a moderating effect.

The remaining TPB factor immediately prior to intention to perform the behavior is subjective norms. Few studies note that subjective norms are the sole predictor of intention, but some studies have found that subjective norms and perceived behavioral control are significant predictors of intention. One study found they were the primary predictor of intention. In a study of deer hunters, Shrestha, Burns, Pierskalla, and Selin (2012) surveyed hunters in Oregon to predict intention to hunt deer. The study used a survey (n = 360) design and SEM analysis. The results indicated that the TPB theoretical model was useful in predicting intention with perceived behavioral control as the most influential predictor. Subjective norms were also a significant predictor, but attitude was not significant. The study authors suggest that attitudes toward a behavior may not be a significant factor if participants are predisposed to the behavior.

Still other studies using the TPB suggest that all the factors that are immediate antecedents of intention (attitude, subjective norms, and perceived behavioral control) are significant. Ma, Kuo, and Alexander (2016) investigated the motivational factors affecting nurse’s intention to ensure the privacy of electronic medical records. The study implemented a cross-sectional survey design (n = 302) and performed analysis with SEM. The TPB model was extended to add seven sub-scales (perceived usefulness, perceived ease of use, compatibility, peer influence, superior influence, self-efficacy, and facilitating conditions) as inputs to the nominal TPB factors. The results indicated that attitude, subjective norm, and perceived behavioral control were significant predictors of the behavior studied. In addition, perceived usefulness, compatibility, peer influence, superior influence, self-efficacy, and facilitating conditions were significant predictors of the nominal TPB factors. Generalizability of the study may be limited as all participants were staff at a single Taiwanese military hospital, and 98% of respondents were female.

Rantanen, Lehto, Vuorinen, and Coco (2018) studied attitudes of home care personnel in Finland toward personal care robots. The study employed a cross-sectional survey (n = 200) design based on the TPB framework. Analysis types included EFA, ANOVA, and linear regression. The TPB framework was modified to add sub-scales related to intention (robots as: promoters of safety, as helpers in practical home care, as guides and prompters). The results indicate that the nominal TPB factors significantly predict intention. Generalizability of the study may be limited as all participants were from five separate communities in Finland.

In another TPB-based study, Park and Blenkinsopp (2009) investigated whistleblowing as planned behavior. The study implemented a cross-sectional survey design (n = 296) with a correlation analysis to determine that attitude, subjective norm, and perceived behavioral control were all significant in the determination of intention to perform whistleblowing. Generalizability of the study may be limited, as all participants were South Korean police officers.

Lee and Choi (2009) used a survey design (n = 235) and hierarchical regression analysis to apply an extended TPB. The model predicted behavioral intention as a function of attitude toward behavior, subjective norms, and perceived behavioral control to predict actual behavior. Their study findings indicate that user intentions to use technology were strongly influenced by attitudes, subjective norms, PBC, and past experience. Their extended TPB model was determined to be valuable when used to explain and predict intention to use and actual use of technology.

Intention was investigated in another study by Dunn, Hattie, and Bowles (2018) who studied factors which could influence teacher intentions to take training on state-mandated core standards. The primary result showed the adequacy of the TPB in predicting and understanding intention. Specifically, intention was shown to be predicted in a significant manner by all three of the primary TPB factors (attitude, subjective norm, and perceived behavioral control). The study may be affected by the small sample size (n = 152) and limited in geographical extensibility since the sampling frame was limited to a single California urban school district.

In summary, a substantial amount of literature related to using the TPB to assess intention was found. This section has provided many examples of the available literature. A summary of factors found in the TPB studies related to intention is provided in Table 3. Various permutations of the nominal TPB inputs to intention (attitude, subjective norms, and perceived behavioral control) were found significant. In addition, multiple examples exist in the literature where study-specific and demographic factors were also found significant in certain studies. For purposes of the subject study, all three immediate predictors of intention were included in the analytical models.

Table 3

*Relevant TPB Factors When Assessing Intentio*n

Reference	Design / Analysis	Significant Predictor(s) of Intention
Bertani, Carone, Caricati, Demaria, Fantuzzi, Guarasci, & Pirazzoli (2016)	Survey/ SEM	Attitude, subjective norm, perceived behavioral control. One demographic variable
Chen, Tang, Lai, Hung, Hsieh, Yang, & Chuang (2017)	Survey/ SEM	Attitude, subjective norms
Cortoos, Schreurs, Peetermans, De Witte,& Laekeman (2012)	Survey/ SEM	Perceived behavioral control and an added study specific factor.
Delanoë, Lépine, Turcotte, Portocarrero, Robitaille, Giguère, & Légaré (2016)	Survey/ bivariate ordinal logistic regression and multiple linear regression	Attitude, subjective norms, and an added study specific factor
Droomers, Huang, Fu, Yang, Li, & Zheng (2016)	Survey/ SEM	Attitude
Dunn, Hattie, & Bowles (2018)	Survey/ SEM	Attitude, subjective norm, perceived behavioral control.
Fang, Xu, Lin, Jin, & Yan (2017)	Survey/ SEM	Attitude (general attitude, direct attitude, and belief-based attitude), subjective norm, and perceived behavioral control (direct control, indirect control)
Goodson (2002)	Survey/ SEM	Attitudes, perceived behavioral control
Heerwegh & Loosveldt (2009)	Survey/ SEM	Attitude, subjective norm, and perceived behavioral control, and an added study specific factor
Hummel, Candel, Nagelhout, Brown, van den Putte, Kotz, & de Vries (2017)	Survey/ SEM	Attitude, perceived behavioral control
Lai, Aritejo, Tang, Chen, & Chuang (2017)	Survey/ SEM	Attitude, subjective norms and a demographic variable
Lee & Choi (2009)	Survey / Hierarchical regression analysis	Attitude, subjective norms, and perceived behavioral control, past experience.
Ma, Kuo, & Alexander (2016)	Survey/ SEM	Attitude, subjective norm, and perceived behavioral control, perceived usefulness, compatibility, peer influence, superior influence, self-efficacy, and facilitating conditions
Park & Blenkinsopp (2009)	Survey / Correlation analysis	Attitude, subjective norm and perceived behavioral control
Rantanen, Lehto, Vuorinen & Coco (2018)	Survey/ EFA, ANOVA and linear regression	Attitude, subjective norm, and perceived behavioral control

Reference	Design / Analysis	Significant Predictor(s) of Intention
Sedaghati Shokri, Davoodi, Azimmohseni,& Khoshfar (2017)	Survey / MANOVA & ANOVA	Attitude, subjective norm, perceived behavioral control, perceived benefits, perceived risk
Shrestha, Burns, Pierskalla, & Selin (2012)	Survey/ SEM	Perceived behavioral control

Factors Related to Intention to Complain

The subject study intended to determine factors that influence intention to complain about UAS noise. Apropos to that end, Lervik-Olsen, Andreassen, and Streukens (2016) completed a study that proposed drivers related to the intention to complain. They developed a structural model termed the theory of trying to complain (TTC), which was an extension of the TPB. Their model added a factor for justice and multiple factors related to intention. The additional intention factors were intended to add granularity for the TPB's intention factor by applying a concept of mental accounting. The revised factors are: attitude toward complaining, subjective norm, perceived behavioral control, attitude toward success, attitude toward failure, attitude toward process, attitude toward trying to complain, justice, subjective norm, and intention to complain. Lervic-Olsen et al. (2016) state that the TTC seems to be a better predictor than TPB in explaining intention to complain. Other results indicate that anticipation of justice resulting from complaining and subjective norms are highly related to intention to complain. A potential limitation to the application of the TTC arises since the addition of numerous exogenous variables substantially increases the required sample size.

Wang, Jiang, Zhou, Li, Zhao, and Lin (2019) investigated individuals' complaint behavior considering climate-change information and health-risk perceptions. Their study employed a survey design and SEM analysis. The study results indicate that participant information level and perception of risk exhibit strong relationships to attitudes toward complaining and the intention to complain. Also, attitudes toward complaining, perceived behavioral control, and subjective norm are positively related to the intention to complain. The study may have some geographical limitations to generalizability since all respondents were Chinese.

Little literature related to the intention to complain was found. This section provides examples found in the literature review. A summary of factors related to intention to complain found in the literature is provided in Table 4. The nominal TPB inputs to intention (attitude, subjective norms, and perceived behavioral control) are consistent. Interesting additions by Wang et al. (2019) relate to information level and perception of risk. These potential factors are consistent factors identified in the prior section on factors relating to UAS acceptance where risk and familiarity with UASs were also noted.

Table 4

Summary of Factors Related to Intention to Complain

Reference	Design/Analysis	Factor(s)
Lervik-Olsen, Andreassen, & Streukens (2016)	Survey/ SEM	attitude, subjective norm, perceived behavioral control, attitude toward (success, failure, process, trying to complain), justice, and intention to complain
Wang, Jiang, Zhou, Li, Zhao, & Lin, (2019)	Survey/ SEM	Attitude, subjective norms, perceived behavioral control, participant information level and perception of risk

Consistent with the aforementioned literature related to intention to complain, the subject study used the three TPB factors that are immediate antecedents of intention (attitude, subjective norm, and perceived behavioral control). This study also incorporated participant information level (as familiarity with UASs) per Wang et al. (2019). The primary differences between the subject study and prior studies related to intention to complain are the application to UAS noise and the inclusion of moderating factors in the analysis.

Factors Related to UAS Acceptance

Since UASs are poised to proliferate, the question of public acceptance becomes more important. UASs have been used by hobbyists and the military for decades and heretofore there has been little negative reaction by the general public. However, when the question is posed relative to consistent UAS operations in residential areas, some additional considerations come to light.

Noise is not the only aspect of UASs which may affect individual's intent to complain about UASs. Research has been completed which identifies other considerations which may affect complaint behavior. This section includes discussion of literature comprising multiple studies which suggest applicable factors associated with individual's acceptance of UASs which, in turn, could be hypothesized to be predictive of intention to complain about UAS noise. The final portion of this section summarizes the key factors consistently identified in the literature as significant in UAS acceptance which include privacy, safety, risk, application (use), and familiarity with UASs.

In a vision paper, Anbaroğlu (2017) used archival literature to establish the notion that UASs will be used primarily by the logistics industry specifically for delivering parcels in urban environments. He posits that it is likely there will be hundreds (perhaps thousands) of UASs delivering parcels in the coming decades (Anbaroğlu, 2017). Of the various uses conceived for UASs, delivery of parcels will have the largest societal impact.

The potential consistent presence of UASs leads to questions related to how the public perceives them. Clothier, Greer, Greer, and Mehta (2015) performed a mixed-method study using two surveys to: a) investigate whether public perception of drones shows them to be riskier than manned aviation; b) investigate whether the specific terminology used to describe UAS technology has an influence on public perception, and; c) identify the broader concerns that could affect public acceptance of UASs. Their notion being that, as public knowledge of UASs increases, public perception and concerns are likely to change. The importance of providing the public relevant UAS-related information from industry, the media, and government was noted.

Clothier et al. (2015) note that the public (study population limited to Australia) was neutral toward UASs, as of the study date. They identified initial key considerations concerning an individual's attitudes toward UASs. Their survey featured measurement of public perceptions of safety, privacy, risk, benefits, and threats. The results of their study indicated that: a) UASs are viewed as similar to existing manned aviation; b) the terminology used to describe UASs had little effect on risk perception or public acceptance. Their results suggest the Australian public had yet to form a pervasive, consistent opinion of drones, which may be due to a lack of knowledge.

In a similar study, Lidynia, Philipsen, and Ziefle (2017) investigated acceptance of UASs for civil use by laypersons and active UAS users. Their cross-sectional (n =

200) study confirmed that for laypersons, privacy is a primary concern with respect to public acceptance of UASs. Active users of UASs considered the risk of accidents a greater factor with respect to public acceptance of UASs.

The notion of the importance of public acceptance of UASs is also supported by Boucher (2015). There are three key points related to the public acceptance of UASs. First is the transparency with respect to the UASs' development, its purposes, and uses. The next key consideration is the level of public knowledge of UASs. The third aspect is the importance of early public dialogue about the technologies leveraged by UASs.

In another study, public acceptance of drones was investigated by Chamata and Winterton (2018). Due to the lack of directly applicable research on UASs, their literature-based research included a systematic review of similar technology acceptance scenarios, including genetically modified foods and nuclear energy. They propose a model to predict acceptance of UASs based on a combination of two behavioral models: theory of reasoned action (TRA) and the technology acceptance model. Chamata and Winterton (2018) propose that TRA and TAM, along with additional risk concepts, provide an acceptable model. Key constructs in their model include "intention to purchase/use, attitudes towards using, perceived benefit, perceived risk, and perceived control" (Chamata & Winterton, 2018, p. 34).

To better understand consumer acceptance of UASs; Khan, Tausif, and Malik (2019) used survey data (*n* = 307) from consumers in Pakistan. Their study provided multiple factors that could be considered in the subject study. Factors considered by Khan et al. (2019) include risks (including those related to privacy and safety), functional benefit (including service quality and performance), relational attributes (drone personification), perceived usefulness, and perceived ease of use. Their study combined factors from TPB and TAM to conduct a survey and conducted an analysis using multiple regression with clustering. The results indicated that consumers perceive privacy issues as a primary concern, highlighted noise as a factor, and indicated which consumer segments may be willing to use UAS delivery technology.

A recent German study (Eißfeldt, Vogelpohl, Stolz, Papenfuß, Biella, Belz, & Kügler, 2020) used a survey and ANOVA analysis to investigate aspects of drone acceptance. The results indicated acceptance correlates with many factors. These factors include use (military vs. civil) of the UAS, willingness to use, attitude toward UASs, knowledge about UASs, perceived usefulness, perceived ease of use, own experience with UASs (familiarity), subjective concerns, certain demographic variables (gender, age, housing situation). The provision of information about UAS positively affected attitude toward UAS.

The public perception of the introduction of UASs into the NAS was investigated in a recent study by Keller, Adjekum, Alabi, and Kozak (2018). Their study utilized survey data (*n* = 1040) to enable a four-factor measurement model. Structural equation modeling was used to determine levels of influence that functional knowledge, utilization trust, operational integration support, and safety-risk benefits had on public utilization perception potential. The factors which showed the most impact were related to trust and safety. The demographic variables of note were gender and educational levels. Consistent with other researchers already discussed, Keller et al. (2018) suggest the dissemination of UAS information and training to improve public acceptance.

The notion that acceptance of UASs is related to public concerns regarding privacy, safety, and routing is supported in a concept paper relating to low altitude UASs by Motlagh, Taleb, and Arouk (2016). Privacy and safety are also offered as considerations in the introduction of UASs in a discourse analysis completed by Rao, Gopi, and Maione (2016). In a survey (*n* = 636) based study using univariate, bivariate, and multivariate analyses, Sakiyama, Miethe, Lieberman, Heen, and Tuttle (2017) also confirmed that privacy is a concern for the public about the use of UASs, especially by public safety or policing operations. In another concept paper related to UAS proliferation, Susini (2015) confirms the notion that risk (safety) and privacy are concerns and also confirms that noise is a key issue.

Apropos to the subject study, Ramadan, Farah, and Mrad (2017) proposed adding three UAS-specific factors including risks (privacy and safety), functional benefit (drone's service quality/performance), and relational attribute (drone personification) to the TPB model. The purpose of the adapted TPB was to investigate consumers' acceptance of service-delivery drones. The paper was conceptual in nature and did not include data collection or analysis.

Reddy and DeLaurentis (2016) studied perceptions of UASs. Surveys were administered to determine knowledge, attitude, and practices regarding UASs. Respondents included two groups: the general public (*n* = 400) and UAS stakeholders (*n* = 135). Key factors identified which affect UAS acceptance included risks, application (use), environment, and benefits. The study employed a multinomial logit regression model to analyze relationships with demographic variables. Results indicated that for the general public, men were generally more supportive of UASs than women, and older respondents (> 55 years) were less supportive than younger respondents. A key stakeholder result noted that pilots and airline employees were less supportive of UASs.

In another study of UAS perceptions, Nelson, Nelson, Grubesic, Wallace, and Chamberlain (2019) investigated the public's perception of unmanned aerial vehicles and privacy. The study employed a survey (n = 2108) design with descriptive statistics and t-tests for analysis. Key factors identified which affect UAS perceptions include: UAS use, familiarity with UASs, and knowledge of UAS rules and regulations. The results of the study indicate that respondents who use UASs, are familiar with UASs, and have some knowledge of UAS rules and regulations are more accepting of UASs.

Vincenzi, Ison, and Liu (2013) reviewed UAS public opinion literature and executed a survey (n = 223) to study public perception of domestic UAS operations. Key factors investigated in the study included familiarity with UASs, comfort level (acceptance) with respect to the platform type, comfort level (acceptance) with respect to mission type (use), privacy, and safety concerns. The results indicate that most respondents were familiar with UASs. The most acceptable mission types (use) were firefighting and weather monitoring. Privacy (46%) and safety (38%) were noted as the primary areas of concern.

A study competed by Aydin (2019) also investigated factors relating to UAS acceptance by the general public and stakeholders. The study employed a survey design n = 153, with descriptive statistics and a repeated measures ANOVA analysis. Key factors identified which affect UAS acceptance included: mission type (use), risk, privacy, and familiarity with UAS. The study results indicate acceptance of UAS use for public safety and scientific research missions but not for commercial and hobbyist uses. The public considers UASs as risky and a threat to privacy. The public also lacks familiarity with many current and most planned UAS uses. The study may suffer from reliability issues due to the small sample size.

The importance of privacy and public safety (risk) were confirmed by Vattapparamban, Guvenc, Yurekli, Akkaya, and Uluagac (2016). Their paper provided a review of UAS issues which may arise in smart cities including cybersecurity, privacy, and public safety. While cyber security is a serious concern for UASs, there does not appear to be support for its inclusion as a factor relating to individual's intention to complain about UASs.

In a concept paper, Thipphavong, Apaza, Barmore, Battiste, Burian, Dao, and Idris (2018) suggest that community acceptance is a major barrier to urban air mobility (UAM). They suggested that the design of UAM aircraft must consider public acceptance. UAM operations must also be considered acceptable by the general public. Key concerns affecting public acceptance that must be addressed are design, application (use), privacy, noise, visual disturbances, safety risks, and affordability. Many of these UAM-related concerns are consistent with those noted for UAS operations.

Although literature related to the acceptance of UASs is limited, research is beginning to become available. A summary of factors related to the acceptance found in the literature is provided in Table 5. Concerns about privacy, safety, risk, application (use), and familiarity with UASs appear to be the factors most consistently noted in the literature. Because these factors are most often found significant, they were considered to be good candidates for inclusion in the subject study.

Table 5

Summary of Factors Related to UAS Acceptance

Reference	Design/Analysis	Factor(s)
Anbaroğlu (2017)	Archival / literature review	Application (use)
Aydin (2019)	Survey / repeated measures ANOVA	Privacy, risk, application (use), familiarity with UAS
Boucher (2015)	Interview / literature review	Application (use), familiarity with UAS, public information about UAS technologies
Chamata & Winterton (2018)	Archival	Intention to purchase/use, attitudes towards using, perceived benefit, risk, and PB
Clothier, Greer, Greer, & Mehta (2015)	Mixed methods / surveys	Privacy, risk, safety, perceived benefits, and threats
Eißfeldt, Vogelpohl, Stolz, Papenfuß, Biella, Belz, & Kügler (2020)	Survey / ANOVA	Application (use), willingness to use, attitude towards UAS, perceived usefulness, perceived ease of use, familiarity with UAS, subjective concerns, demographic variables
Keller, Adjekum, Alabi, & Kozak (2018)	Survey / SEM	Familiarity with UAS, functional knowledge, utilization trust, operational integration support, and safety-risk benefits, application (use)
Khan, Tausif, and Malik (2019)	Survey / Regression	Privacy, risk, safety, perceived benefit, perceived usefulness, and perceived ease of use
Lidynia, Philipsen, & Ziefle (2017)	Survey / statistical analysis	Privacy, risk
Motlagh, Taleb, & Arouk (2016)	Conceptual	Privacy, safety, and routing
Nelson, Nelson, Grubesic, Wallace, & Chamberlain (2019)	Survey / t-tests	Application (use), privacy, familiarity with UAS, and knowledge of UAS rules and regulations
Ramadan, Farah, & Mrad (2017).	Conceptual	Privacy, risk, safety, perceived benefit, and relational attribute (drone personification)
Rao, Gopi, and Maione (2016).	Discourse analysis	Privacy, safety
Reddy & DeLaurentis (2016)	Survey/ multinomial logit regression	Risks, application (use), environment, and benefits
Sakiyama, Miethe, Lieberman, Heen, & Tuttle (2017)	Survey / statistical analysis	Privacy, application(use)
Susini (2015)	Conceptual	Risk, safety, and privacy
Thipphavong, Apaza, Barmore, Battiste, Burian, Dao, & Idris (2018)	Conceptual	Privacy, risk, safety, application (use), design, visual disturbances, and affordability
Vattapparamban, Guvenc, Yurekli, Akkaya, & Uluagac (2016)	Review	Privacy, safety, and cybersecurity
Vincenzi, Ison, & Liu (2013)	Survey / statistical analyses	Privacy, safety, familiarity with UAS, application (use), platform type

Privacy. One of the primary concerns related to public acceptance of UASs is the public's perception of potential violations of privacy which may be associated with UASs (Nelson et al., 2019). These concerns are primarily associated with UASs which carry cameras (Aydin, 2019). Many studies note privacy concerns are significant with respect to acceptance of UASs (Aydin, 2019; Clothier, Greer, Greer, & Mehta, 2015; Khan, Tausif, & Malik, 2019; Lidynia, Philipsen, & Ziefle, 2017; Motlagh, Taleb, & Arouk, 2016; Nelson et al., 2019; Ramadan, Farah, & Mrad, 2017; Rao, Gopi, & Maione, 2016; Sakiyama, Miethe, Lieberman, Heen, & Tuttle, 2017; Susini, 2015; Thipphavong, Apaza, Barmore, Battiste, Burian, Dao, & Idris, 2018; Vattapparamban, Guvenc, Yurekli, Akkaya, & Uluagac, 2016; Vincenzi, Ison, & Liu, 2013). Due to its prevalence in the UAS related literature, privacy was considered a relevant factor for use in the subject research.

Risk and Safety. Another of the primary concerns related to public acceptance of UASs is the perception of the risks associated with UAS use, especially those uses which may result in risks to the safety of persons or property (Keller, Adjekum, Alabi, & Kozak, 2018). The literature search revealed many studies which determined that concerns regarding the risks to safety are significant with respect to acceptance of UASs (Aydin, 2019; Clothier et al., 2015; Keller et al., 2018; Khan et al., 2019; Lidynia et al., 2017; Ramadan et al., 2017; Rao et al., 2016; Reddy & DeLaurentis, 2016; Susini, 2015; Thipphavong et al., 2018; Vattapparamban et al., 2016; Vincenzi et al., 2013). Due to its prevalence in the UAS related literature, a combined factor comprising perception of risk and safety concerns was considered a relevant factor for use in the subject research.

Application (Use). UASs may be used to perform multiple tasks or missions (Aydin, 2019). Public opinion of UASs is often dependent on the perceived purpose of the UASs' mission (Boucher, 2015; Keller et al., 2018). Many prior studies support the notion that the mission profile or perceived use of the UAS affect acceptance (Anbaroğlu, 2017; Aydin, 2019; Boucher, 2015; Clothier et al., 2015; Eißfeldt et al., 2020; Keller et al., 2018; Nelson et al., 2019; Reddy & DeLaurentis, 2016; Sakiyama et al., 2017, Thipphavong et al., 2018., Vincenzi et al., 2013). For purposes of the subject research, a factor reflecting the application, mission, or specific use of UASs was considered relevant.

Familiarity with UAS. As individuals become more familiar with a technology, there is a tendency toward improved acceptance. To that end, as the public gains greater familiarity with UASs, their acceptance of UASs is expected to improve, and their propensity to complain about UAS noise would be diminished. Thus, familiarity with UASs is an important factor with respect to acceptance. The literature review yielded multiple studies supporting the development of a factor related to familiarity with UASs (Aydin, 2019; Boucher, 2015; Eißfeldt et al., 2020; Keller et al., 2018; Nelson et al., 2019; Vincenzi et al., 2013). Since familiarity with UASs has been determined to be a significant factor related to UAS acceptance, it was considered a relevant factor for use in the subject research.

Gaps in the Literature

It is apparent from the literature that information is readily available regarding the deleterious effects of noise and specifically noise from aircraft. The literature also indicates the potential for substantial increases in UAS fleet size and activity. These increases in UAS activity will result in greater exposure of the general public to UASs and their attendant noise.

The literature provides support for the use of TPB to measure intention. Support also exists in the literature for the modification or extension of the TPB framework by the inclusion of additional factors. The collection of data for extended TPB frameworks through the deployment of cross-sectional surveys is also well established, as is the use of SEM to analyze the relationships between the extended TPB constructs.

There appear to be gaps in the literature related to UAS noise. There have been few studies on the topic of UAS noise. Also, no rigorous studies were found related to complaints about UAS noise. More specifically, there appears to be a gap in the literature related to individuals' intention to complain about UAS noise. Finally, no studies were found investigating factors related to individuals' intention to complain about UAS noise.

Research Theoretical Framework

The nominal TPB-based theoretical framework retained major aspects of the TBP but was modified as follows:

- Since the focus of the investigation was the intention to complain and not the actual behavior of complaining about UAS noise, the behavior node was dropped from the model.
- Similarly, the actual behavioral control node was also dropped from the model.
- Based on the literature, multiple factors were added to the theoretical framework. Specifically, perceived usefulness of UASs, application type or

specific use of the UAS, perception of privacy infringement, perception of risks to personal safety, and familiarity with UASs.

The latent factors investigated in this research relate to an individual's intention to perform the behavioral act of complaining about UAS noise. Table 6 provides the latent factors investigated in this research.

Table 6

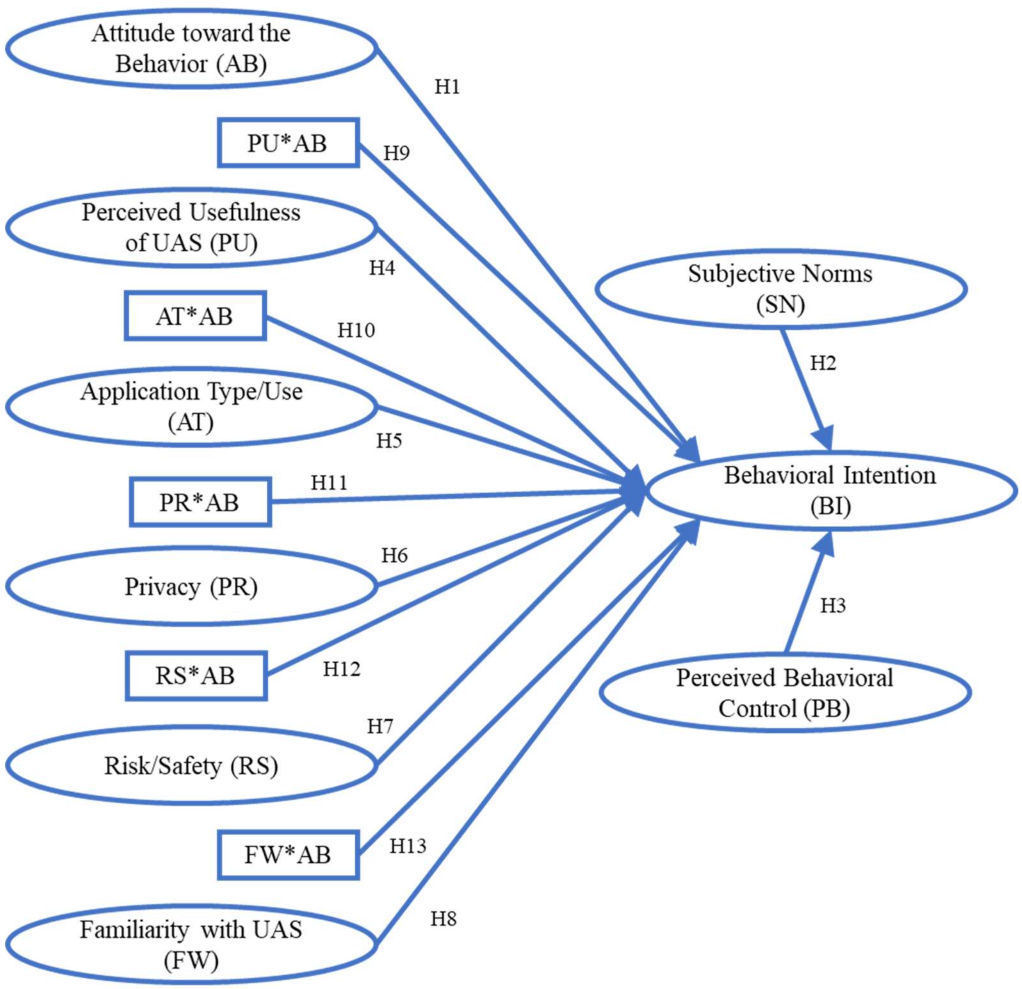
Latent Factors (Variables)

#	Latent Factors	Factor Descriptions
Exogenous Factors / Independent Variables		
1	Attitudes toward Behavior (AB)	Individuals' attitude toward complaining about UAS noise
2	Subjective Norms (SN)	Individuals' perceived social pressure to complain about UAS noise
3	Perceived Behavioral control (PB)	Individuals' perceived ease or difficulty of complaining about UAS noise.
4	Perceived Usefulness of UASs (PU)	Individuals' perception regarding the usefulness of UASs
5	Application Type/Use of UASs (AT)	Individuals' perception of the type, purpose, and use of UASs
6	Privacy (PR)	Individual's perception of the potential that UASs will invade their privacy
7	Risk/Safety of UASs (RS)	Individuals' perception of the risks to personal safety due to UASs
8	Familiarity with UASs (FW)	Individuals' familiarity with UASs
Endogenous Factor / Dependent Variable		
9	Behavioral Intention (BI) to complain about UAS noise	Individuals' behavioral intention to complain about UAS noise

The TPB model provided as Figure 2 was modified to accommodate the results of the literature search noted previously. When the relevant factors noted in the literature review were applied to the TPB model and the other modification noted above were made, the result was the theoretical framework provided as Figure 2.

Figure 2

Theoretical Framework



As per the TPB, attitude toward a behavior, subjective norms, and perceived behavioral control are direct antecedents of behavioral intention. In this theoretical framework, other direct antecedents to behavioral intention were hypothesized to be perceived usefulness of UASs, an individual's perceptions of the application type or use of the UAS, the perceived impacts to privacy, the perceived risk to safety, and the individual's familiarity with UASs. The added factors were hypothesized to have a moderating effect between attitude and intention. Moderating factors are represented as rectangular boxes.

Hypotheses and Literature Support

As noted previously, the underlying behavior subject to this investigation is the act of complaining about UAS noise, and the hypotheses in the subject research relate to individuals' intention to complain about UAS noise. The hypotheses were divided into three groups relating to factors included in the traditional theory of planned behavior, those related additional factors identified in the literature, and hypotheses related to possible moderating relationships.

Hypotheses Related to TPB Factors

The first three hypotheses derive from the traditional TPB factors. As attitude toward a behavior becomes more favorable, the individual's intention to perform the behavior increases (Ajzen 1985, 1991). In the subject study, as an individual's attitude toward complaining about UAS noise becomes more favorable, the individual's intention to complain about UAS noise becomes stronger. Wang et al. (2019) supports the notion that there is a positive relationship between attitude and intention.

H_1. Individuals' attitudes toward complaining about UAS noise [Attitudes toward Behavior (AB)] are positively related to individuals' Behavioral Intentions (BI) to complain about UAS noise.

A positive subjective norm corresponds to a positive social pressure to perform a behavior (Ajzen, 1991). Subjective norms and intention to complain have been found to have a positive relationship (Lervik-Olsen et al., 2016; Wang et al., 2019). Thus, a hypothesis linking a positive subjective norm with regard to complaining about UAS noise and the intention to complain about UAS noise appears appropriate.

H$_2$. Individuals' perceived social pressure to complain about UAS noise [Subjective Norms (SN)] are positively related to individuals' Behavioral Intentions (BI) to complain about UAS noise.

Perceived behavioral control reflects an individual's perceived level of effort required to perform a behavior based on experience or anticipated effort (Ajzen, 1991). As an individual's perception of the ease taking an action increases, there would be a more favorable attitude toward taking that action (Wang et al., 2019). For purposes of the subject research, as an individual's perception of the ease of complaining about UAS noise increases, the individual's intention toward complaining about UAS noise increases.

H$_3$. Individuals' perceived ease of complaining about UAS noise [Perceived Behavioral control (PB)] is positively related to individuals' Behavioral Intentions (BI) to complain about UAS noise.

Hypotheses Incorporating Extended Factors

H$_4$. Perceived Usefulness of UASs (PU) is negatively related to individuals' Behavioral Intentions (BI) to complain about UAS noise.

Multiple aspects of UAS acceptance are thought to be related to intention to complain about UAS noise. As noted by Davis (1989), perceived usefulness and user acceptance are strongly related when investigating technology acceptance. For purposes of the subject research, as the perceived usefulness of UASs increases, the likelihood of an individual intending to complain about UAS noise is thought to decrease.

H_5. Individuals' perceptions of Application Type (use) of UASs (AT) is negatively related to individuals' Behavioral Intentions (BI) to complain about UAS noise.

Boucher (2015) and Keller et al. (2018) note that public opinion of UASs is often dependent on the perceived purpose (application type or use) of the UAS mission. As the perception of the UAS application type (use) becomes more favorable, the desire to complain about the noise it creates is expected to decline. Thus, an individual's positive perception of UAS application type (use) is expected to reduce their intention to complain about the noise it would create.

H_6. Privacy (PR) concerns are positively related to individuals' Behavioral Intentions (BI) to complain about UAS noise.

UAS acceptance has been demonstrated to be related to the public's perception of potential violations of privacy associated with UASs (Nelson et al., 2019), especially for UASs equipped with cameras (Aydin, 2019). As the perception of the privacy risks associated with UASs increases, the desire to complain about the noise it creates is also expected to increase. Thus, an individual's negative perception of UAS privacy risk is expected to increase their intention to complain about the noise it would create.

H_7. Individuals' perceptions of UASs Risks to Safety (RS) is positively related to individuals' Behavioral Intentions (BI) to complain about UAS noise.

UAS acceptance has also been demonstrated to be related to the public's perception of potential risks to the safety of persons and property associated with UASs (Keller et al., 2018). As an individual's perception of the risks UASs pose to persons and property increases, the desire to complain about the noise UASs create is also expected to increase. Thus, an individual's increased perception of UAS safety risk is expected to increase their intention to complain about the noise it would create.

H_8. Familiarity with UASs (FW) is negatively related to individuals' Behavioral Intentions (BI) to complain about UAS noise.

Familiarity with UASs has been shown to be an important factor with respect to acceptance (Aydin, 2019; Boucher, 2015; Eißfeldt et al., 2020; Keller et al., 2018; Nelson et al., 2019; Vincenzi et al., 2013). Levels of UAS acceptance should increase as individuals become more familiar with UAS technology. Thus, as individuals gain greater familiarity with UASs, their acceptance of UASs is expected to improve, and their propensity to complain about UAS noise is expected to diminish.

Hypotheses Related to Moderating Relationships

A moderating relationship occurs when a variable affects the relationship between other variables. The moderating variable may change the intensity, direction, or both of a relationship between other variables. For purposes of the subject research, the factors added to extend the baseline TPB were investigated with respect to the possibility that they may have moderating effects. The hypotheses intended to determine the moderating effects follow.

H_9. The relationship between Perceived Usefulness of UASs (PU) and Behavioral Intention (BI) to complain about UAS noise is strengthened by Attitude toward Behavior (AB) to complain about UAS noise, where BI is further reduced as AB increases.

H_{10}. The relationship between Application Type (use) of UASs and Behavioral Intention (BI) to complain about UAS noise is strengthened by Attitude toward Behavior (AB) to complain about UAS noise, where BI is further reduced as AB increases.

H_{11}. The relationship between Privacy (PR) and Behavioral Intention (BI) to complain about UAS noise is strengthened by Attitude toward Behavior (AB) to complain about UAS noise, where BI is further reduced as AB increases.

H_{12}. The relationship between Individuals' perceptions of Risk to personal Safety (RS) and Behavioral Intention (BI) to complain about UAS noise is strengthened by the moderating effect of Attitude toward Behavior (AB) to complain about UAS noise, where BI is further reduced as AB increases.

H_{13}. The relationship between Familiarity with UASs (FW) and Behavioral Intention (BI) to complain about UAS noise is strengthened by the moderating effect of Attitude toward Behavior (AB) to complain about UAS noise, where BI is further reduced as AB increases.

Summary

The literature review provided in this chapter began by providing an overview of unmanned aircraft systems and established the likelihood that UASs will become much more commonplace in the near term. The chapter also established the notion that noise has multiple deleterious effects on individuals. It further established that noise from aircraft has been demonstrated to be the most harmful of common environmental noise sources, and the advent of UASs creates another aviation noise source.

Two alternative grounded theories were discussed. The TAM and the TPB were considered as grounded theories for the subject research. Because this study was intended to investigate the factors related to an individual's intention to complain about UAS noise and not overtly accept a technology (i.e., UASs) for personal use, the TAM was rejected as the grounded theory. The TPB was selected as the theoretical foundation for the proposed research.

The literature review revealed extensive examples of successful TPB use in multiple domains. Precedent for extension of the TBP through the addition of study-specific factors was demonstrated. In addition, many studies which investigated possible additional factors relevant to the subject research were reviewed. Studies investigating factors related to intention in general, intention to complain, and UAS acceptance provided justification for multiple additional factors. The factors added to the traditional TPB constructs (attitude toward the behavior, subjective norms, and perceived behavioral control) were determined to be perceived behavioral control, perceived usefulness of UASs, application type (use), privacy, risk-safety, and familiarity with UASs.

The next chapter discusses the methodology selected for the subject research. The research method is discussed including the associated research process. Operational definitions of the independent and dependent variables are provided. The population, sample, sample frame, sample size, and selection criteria, measurement instrument, and data collection process (including ethical considerations) are described. Finally, the data analysis approach and process is described.

Chapter III: Methodology

The primary goal of this research was to develop a better understanding of the factors which influence individuals' intentions to complain about UAS noise. To that end, the prior chapter established the basis for the choices of applicable factors and the choice of grounded theory and theoretical model. This chapter describes the research methodology, including the research approach, design and procedures, population and sampling, data collection process, ethical considerations, measurement instrument, and data analysis approach. The chapter is intended to provide adequate detail to allow the study to be replicated by other researchers.

Research Approach

The subject study employed a quantitative non-experimental approach using deductive reasoning to investigate the factors which influence individuals' intentions to complain about UAS noise. The focus was on recursive causative relationships between latent factors (Byrne, 2010). A quantitative approach was chosen for the study as opposed to a qualitative or mixed methods approach. Quantitative research approaches are appropriate for investigating theories through the examination of the interrelationship amongst variables (Creswell, 2014), while qualitative approaches are useful in developing an understanding of emerging topics where meaning or importance placed on issues or problems is a primary goal. A mixed method approach is a hybrid of both qualitative and quantitative methods which is intended to yield a fuller understanding of a research problem (Creswell, 2014). This research benefits from earlier qualitative efforts which identified important factors related to acceptance, intention, and complaint behavior. As illustrated in the prior chapter, these factors have subsequently been used as variables in quantitative research and are used as such in the subject study.

Quantitative research approaches are often differentiated as either experimental or non-experimental (Creswell, 2014). Experimental approaches focus on the manipulation of independent variables and assess the impacts on dependent variables. Non-experimental approaches do not actively manipulate independent variables. This study was non-experimental since the independent variables were not manipulated by the researcher.

Another characteristic of the subject research was its reliance on a deductive as opposed to an inductive approach. Inductive approaches typically flow from the specific to the general by gathering data and subsequently creating generalizations and ultimately theories (Babbie, 2016; Creswell, 2014; Vogt, Vogt, Gardner, & Haeffele, 2014). Deductive approaches typically proceed from theories to hypotheses and then to data collection. Grounded theories help guide the development of hypotheses, and data analysis results are used to test the validity of the proposed hypotheses. The deductive approach in the subject research included an expanded theory of planned behavior as its grounded theory from which hypotheses relating to the relationships between the variables were developed, followed by data analysis using SEM to test the hypotheses.

Research Design

The subject research utilized cross-sectional survey data to identify factors related to individuals' intent to complain about UAS noise. An internet-based platform was used to manage the administration of the electronic questionnaire used as the survey instrument. Participant responses were retrieved from the internet-based platform, and statistical data analysis was accomplished using structural equation modeling (SEM) techniques.

Several research designs are generally accepted including survey, interview, experiment, observational, archival, and combined (Vogt et al., 2012). Survey designs are useful for the collection of quantitative data which indicate "trends, attitudes, and opinions of a population by studying a sample of that population" (Creswell, 2014, p. 13). Attitudes and opinions are of most interest in the subject research. A survey design was considered appropriate since: a) the data comprises short answers to structured questions, b) there is foreknowledge of how the responses will be used, and c) it is considered best to obtain data directly from individuals who will provide reliable responses with an adequate response rate (Vogt et al., 2012).

A temporal choice must be made when conducting surveys. Researchers must determine if the data will be collected during a single timespan (cross-sectional) or over multiple timespans. Surveys taken over multiple timespans may be further differentiated as panel (same specific group surveyed multiple times – commonly called *longitudinal*) and cohort (same population surveyed multiple times) (Vogt et al., 2012). The time horizon for the subject research was cross-sectional since the intent of the study was to better understand individuals' intent to complain about UAS noise at a given point in time and not attempt to assess changes over time.

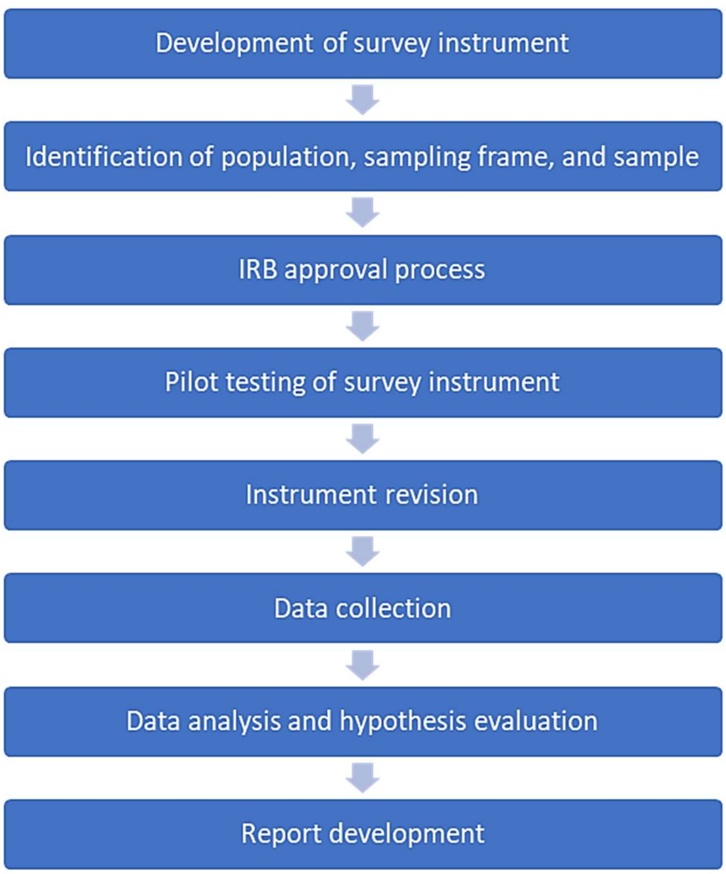
Research Procedures

The research procedure included a sequence of multiple steps. The procedure is illustrated in Figure 3 and began with the development of a survey instrument followed by the identification of the population, sampling frame, and sample. Approval from the

Institutional Review Board (IRB) was next followed by pilot testing of the survey instrument. Revision of the survey instrument was completed prior to full-scale data collection. After the results of the survey instrument were collected, the data were analyzed and the hypotheses were evaluated. The last step was the development of the final documentation.

Figure 3

Research Procedure



Population and Sample

The primary objective of population sampling is the acquisition of data. A determination of the appropriate population is made followed by a plan to access a representative sample of that population. Since the target population for the subject research was the general public, a convenience sample was appropriate.

Population and Sampling Frame

The population for the subject research was the general adult population of the United States capable of submitting a complaint about UAS noise. The population included all adult individuals regardless of their intentions to or not to complain about UAS noise. The sampling frame was those in the identified population which were capable of responding to the survey instrument via Amazon's Mechanical Turk® (MTurk®) or similar capability. The sample was a convenience sample comprising respondents from the accessible population (i.e., those who can be reached via Mechanical Turk® or similar capability).

Collection of the survey data was internet-based. Research has indicated that web-based data collection can yield data of high-quality as valid as traditional laboratory data (Germine, Nakayama, Duchaine, Chabris, Chatterjee, & Wilmer, 2012). Sampling was accomplished using an Amazon MTurk® task. The MTurk® task consisted of a single questionnaire which remained active until the target sample size was collected. No other data collection methods were used.

Mechanical Turk® is a product of Amazon.com, Inc. It is an internet-based crowdsourcing tool which allows researchers access to a tailorable world-wide group of individuals to perform tasks (i.e., take surveys). Researchers may submit *Human*

Intelligence Tasks (HITs) which are self-contained tasks researchers create. Researchers are also allowed to post links on MTurk® to surveys that are hosted on other services such as SurveyMonkey®.

Researchers may also tailor which individuals are allowed to take the survey. These 'worker requirements' help to ensure participants with demonstrated previous quality work are selected for the proposed research, and it helps to ensure the validity of the data (Sheehan, 2018). For the subject research, workers who have completed at least 100 prior tasks and who have an approval rating of 95% (Goodman & Paolacci, 2017; Sheehan, 2018) or greater were selected to participate in the questionnaire.

Multiple methods were implemented to help ensure data quality and sample validity when collecting the data with MTurk®. Periodic attention check questions and speed traps were used, as recommended by multiple sources (Kees et al., 2017; Sheehan, 2018; Silber, Danner, & Rammstedt, 2019). In addition, an upper thresholds for the duration of the survey was established since it has been shown to help eliminate those who are inattentive (Stritch, Pedersen, & Taggart, 2017). The data was also evaluated for response patterns such as all answers being 'strongly agree' (Strich et al., 2017). Successful implementation of these methods has been shown to improve the validity of data gathered using MTurk® (Sheehan, 2018; Silber et al., 2019).

Internet-based data collection resources such as MTurk® have been shown to have benefits. Research indicates that biases can be reduced through the use of internet-based data collection versus traditional methods (Gosling, Vazire, Srivastava, & John, 2004). There is evidence that using MTurk® increases demographic diversity of participants over samples collected via other internet-based methods (Buhrmester, Kwang, & Gosling, 2011). While MTurk® participants are paid, the quality of the data collected is not sensitive to compensation levels - the primary effect relates to the rate of data collection (Buhrmester et al., 2011). Creswell (2012) notes that Internet-based data collection can be uncomplicated and expeditious. Rice et al. (2017) notes other advantages which include: expanded population access, ability to generate larger sample sizes, more representative gender ratios, lower cost, data reliability, and participant anonymity.

Minimizing sampling bias and insuring data quality are key considerations when internet-based data collection such as MTurk® is used. Sampling bias can be reduced by genericizing the task description such that respondents do not know the specifics of the survey until they choose the task (Goodman & Paolacci, 2017). Kees et al. (2017) concluded that quality of data obtained from MTurk® was equal to or better than that collected from student samples and clearly superior to non-student professional panels stating that MTurk® is a “viable alternative to student samples and panel data when testing theory-driven outcomes” (p. 153).

While there are benefits of Internet-based data collection, there are also challenges. Potential issues with Internet-based data collection may include (Rice et al., 2017): samples may not be truly representative, lower response rates may extend study lengths, respondents may be motivated by financial considerations, access, etc. In addition, Sue and Ritter (2012) indicate that study times may be extended since internet-based surveys may encounter higher task abandonment rates.

Sampling Strategy

Sampling was a single stage in that the sampling frame was accessed directly. Due to the broad nature of the identified population and sampling frame, a convenience sample was deemed appropriate (Creswell, 2014), since the respondents could access it at their convenience based on their availability. It was unnecessary to address the effects of a major event (geopolitical, regulatory, economic, etc.) as no relevant events occurred during data collection. If there had been such an event, the data collected would be parsed into two time-frames, nominally 'before' and 'after' the event occurred. If an adequate sample size was gathered in either time frame, then that sample would have been analyzed with appropriate discussion of its relation to the event. If the target sample size had not been attained, post-event data would have continued to be collected until the target sample size had been collected and then that sample would have been analyzed with appropriate discussion of its relation to the event.

Sample Size

In general, larger sample sizes are preferred since, ceteris paribus, confidence in the precision of the results is improved (Vogt et al., 2012). Larger sample sizes reduce errors and increase statistical power (Hair, Black, Babin, & Anderson 2013; Vogt et al., 2014). However, larger sample sizes also imply additional work, cost, and time.

A useful method for determining minimum sample sizes for SEM analyses was developed by Westland (2010). He created an algorithm that includes multiple parameters, including the number of independent and dependent variables, the desired minimum effect, power, and significance levels. During the development of the algorithm, Westland determined that four out of five published research articles used inadequate sample sizes. Westland notes that his formula generally results in a recommendation of larger sample sizes than other methods. Such a notion is confirmed by others who indicate there is no "analytic disadvantage to overestimating the needed sample size" (Vogt et al., 2012, p. 167). Westland's minimum sample size formula for SEM analyses is provided as equation 1 (Soper, 2019):

$$n = \max(n_1, n_2) \quad (1)$$

where:

$$n_1 = \left\lceil 50\left(\frac{j}{k}\right)^2 - 450\left(\frac{j}{k}\right) + 1100 \right\rceil$$

$$n_2 = \frac{1}{2H}\left(A\left(\frac{\pi}{6} - B + D\right) + H + \sqrt{\left[A\left(\frac{\pi}{6} - B + D\right) + H\right]^2 + 4AH\left(\frac{\pi}{6} + \sqrt{A} + 2B - C - 2D\right)}\right) \quad (1)$$

$$A = 1 - \rho^2$$

$$B = \rho \arcsin\left(\frac{\rho}{2}\right)$$

$$C = \rho \arcsin(\rho)$$

$$D = \frac{A}{\sqrt{3 - A}}$$

$$H = \left(\frac{\delta}{z_{1-\alpha/2} - z_{1-\beta}}\right)^2$$

j = number of observed variables

k = number of latent variables

ρ = estimated Gini correlation for a bivariate normal random vector

δ = anticipated effect size

α = Sidak-corrected Type I error rate

β =Type II error rate

z = standard normal score

Westland’s formula is cumbersome. Fortunately, Soper (2019) used it as the basis for a web-based SEM sample size calculator which provides estimated SEM sample sizes based on five inputs. The required inputs are anticipated effect size (f^2), desired statistical power level (1-β), number of latent variables, number of observed variables, and the desired probability (significance) level (α).

Effect size is an indicator of practical significance (Creswell, 2014). It measures the extent to which a measured relationship appears in the sample (Cohen, 1988) and indicates whether a relationship revealed in an analysis is meaningful (Hair et al., 2013). Because effect size is measured in standardized terms, it also provides utility since it allows comparisons between studies (Hair et al., 2013; Vogt et al., 2014) where scales might vary.

Effect size and sample size are inversely related. When researchers attempt to analyze variables with smaller effect sizes, a larger sample is necessary to achieve a desired power (Hair et al., 2013). Cohen (1988) suggests that effect statistics of 0.10, 0.30, and 0.50 are indicative of "small, medium, and large effects” (p. 532), respectively. For the purposes of the subject research, the selection of an effect size of 0.2 was reasonable since it reflects the desire to discover small to medium effects and is consistent with other recent studies (Myers, 2019; Pan & Truong, 2018).

Statistical power indicates the probability that an effect is detected in a sample, provided it exists in the population (Cohen, 1988; Vogt et al., 2014). As statistical power increases, the likelihood of detecting smaller effects increases. A power level of 0.8 was suggested by Cohen (1988) and confirmed by Hair et al. (2013). It is commonly accepted "as a convention that, when the investigator has no other basis for setting the desired power value, the value .80 be used" (Cohen, 1988, p. 56).

Significance levels are indicators which provide the probability of incorrectly rejecting null hypotheses when they are true (Meeker, Hahn, & Escobar, 2017). The literature indicates that convention is to use a significance level of 0.05, where 1 out of 20 times a null hypothesis will be erroneously rejected (Vogt et al., 2014). Therefore, a significance level of 0.05 was used in the subject study.

The key required sample metrics are provided in Table 7. The minimum sample size required for the subject research was estimated (Soper, 2019) to be 460 respondents depending primarily on effect size and the number of latent and observed variables (Westland, 2010). The anticipated effect size was 0.2, as discussed above, the desired statistical power was 0.8 (Cohen, 1988; Hair et al., 2013), and the probability level was 0.05. A lower anticipated effect size of 0.1 was evaluated but was considered less desirable since it resulted in a large minimum sample size.

Table 7

Key Required Sample Metrics

Metric Description	Value
Anticipated effect size:	0.2
Desired statistical power level:	0.8
Number of latent variables:	9
Number of observed variables:	36
Probability level (significance):	0.05
Min. sample size:	460

For purposes of this effort, the respondent count goal was 700 to result in a net of a minimum of 460 usable. The total respondent count goal reflects a strategy to collect enough data to account for deletions required by missing entries or other data quality issues.

Data Collection Process and Survey Procedure

Sources of the Data

There are multiple ways to collect data. When survey designs are used, researchers must choose between several generally accepted survey methods. Survey data can be obtained through telephone, the mail, personal interviews (individual or group settings), and via the Internet (Creswell, 2014). Parsed another way, Vogt et al. (2012) indicate that surveys can be administered using three methods: face-to-face, telephone interview, and self-administration. Face-to-face and telephone interview methods are often preferred options when respondents cannot read, some explanation of the questions is necessary, and time and cost are not primary considerations (Vogt et al., 2012). Self-administered surveys are an option when respondents can read, must receive the same questions, and the resources to gather enough data to accommodate the desired sample size are limited. For the purposes of the subject research, the data collection mode selected was a self-administered survey via the Internet.

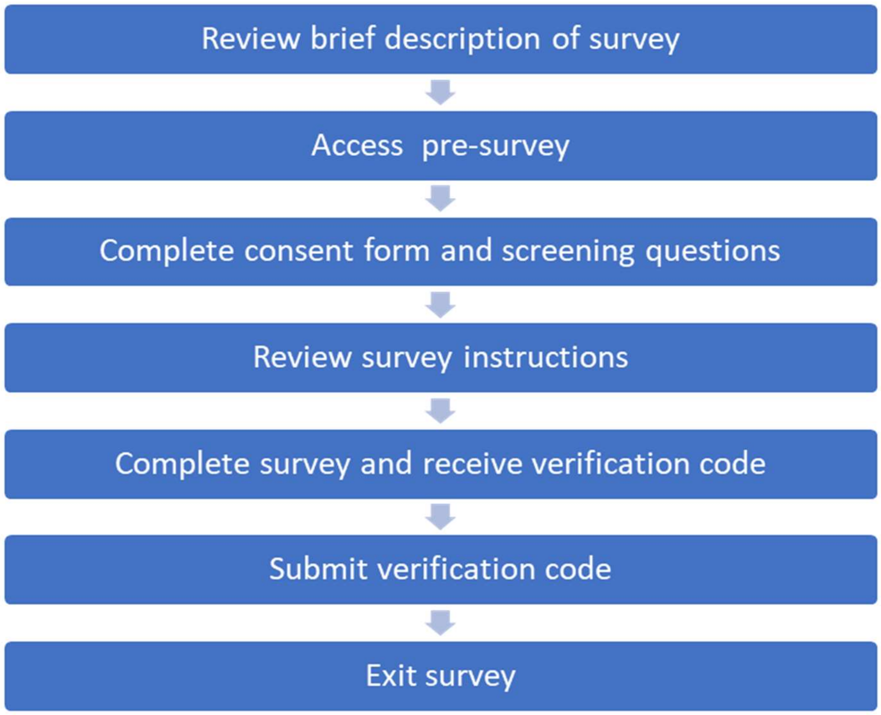
Even when surveys are delivered electronically via the Internet, the researcher must determine if they will be distributed via email, email links to websites, or transactional sites. Transactional Internet sites that facilitate or even specialize in survey data collection have become more commonplace and user-friendly (Rice et al., 2017). Examples of data collection websites include Amazon's Mechanical Turk® and SurveyMonkey®.

Survey Procedure

Respondents were required to follow a standard process to access and answer the survey questions. The process is provided in Figure 4. The first step in the survey process required participants to access a description of the survey through MTurk® or a description which links to SurveyMonkey®, if necessary. If the prospective participant chose to proceed, the participant then entered the formal process by accessing the pre-survey phase, where they first completed the consent form and answered the screening questions. If the participant successfully passed the screen, they were allowed to proceed to the actual survey. The participant was then provided with instructions for completing the survey. The respondent then completed the survey, after which they received a verification code which allowed them to claim their compensation from MTurk®. Participants then submitted their verification codes and subsequently exited the survey.

Figure 4

Respondent Survey Process



The survey instrument included questions pertaining to sets of the four manifest variables which represent each of the exogenous IVs and endogenous DV in the subject research. The questions pertaining to the manifest variables utilized a five-point Likert scale, as noted previously. The intent was for the survey to consume no more than 15 minutes to complete.

Measurement Instrument

Survey instruments are a common tool used to query selected populations (Creswell, 2014; Vogt et al., 2012). Survey instruments are often developed based on a grounded theory as modified or extended to suit the needs of the individual study. For the subject research, the data collection instrument was a survey designed to gather data on observed (manifest) variables (Ajzen, 2006). The observed variables were measurable components of latent factors derived from the grounded theory or other latent factors in the literature.

For purposes of the subject study, the theory of planned behavior was used and was extended to include one TAM factor and UAS-specific factors. The latent factors which reflect the modified TPB and the findings detailed in the literature review as well as the associated observed variables are provided in Table 1. The content of the questionnaire is provided in Appendix B, and the full list of variables and statements used in the questionnaire are provided in Appendices C and D. Demographic variables were also collected. For purposes of SEM, independent variables and exogenous latent factors are synonymous, as are dependent variables and endogenous latent factors (Byrne, 2010).

The measurement instrument was divided into five sections. The first section comprised the consent form where the purpose of the subject research, eligibility requirements, procedures, duration of participation, risks, benefits, compensation, confidentiality and privacy, voluntary participation comments, contact information, and consent declaration were provided. The consent declaration required the participant to actively choose to participate in the survey. If the participant made the choice to not participate and clicked the appropriate button, the survey immediately ended.

The second and third sections respectively included instructions and eligibility questions as well as questions designed to collect demographic information. The instructions and eligibility questions determined whether the participant was eligible to participate in the survey and included only two questions: is the participant's MTurk ® account registered in the United States and is the participant is at least 18 years old. The demographic information collected included age, gender, education level, race, environs (rural, suburban, or urban), and annual income.

The fourth section of the instrument was intended primarily to collect responses to statements aligned with the observed variables associated with the factors under investigation. The section begins by providing general context and simple instructions relating to providing reactions to the statements which were subsequently aggregated to measure the latent factors. The remainder of the section includes nine sets of four statements each which reflect the nine factors under investigation along with a final opportunity to provide textual comments on the use of UASs.

The final section of the instrument is considered the conclusion. In this section, the participant was thanked for completing the survey and notified that they are finished. The participant was also provided an opportunity to create the code through which they may receive compensation through the MTurk® online tool.

Pilot Study

There are two primary uses of pilot studies. The first being the execution of a smaller version of a study prior to distribution to a broader population. The second use is as a pretest or evaluation of the validity of a research instrument (Malmqvist, Hellberg, Möllås, Rose, & Shevlin, 2019). Pilot studies are typically deployed to a small group of participants to assess instrument validity (Creswell, 2012).

The subject research included two pilot studies to evaluate the validity of the data gathering instrument. The pilot studies were performed using the same technology as the full-scale study. Thus, MTurk® was used to distribute the survey to at least 100 respondents. The participant selection criteria was the same as those for participating in the full-scale study meaning participants must be at least 18 years old and their MTurk® account must be registered in the United States.

One feature of both the pilot and full-scale studies was that study participants had the ability to provide feedback on different aspects of the survey. Participants could comment on any aspect of the survey, the wording of the questions, ambiguity of instructions or statements, the amount of time required to complete the survey, and any other issues.

The results of the pilot studies were used to inform changes to the instrument. Feedback from the participants in the pilot studies was used to make changes that improved the questionnaire before its deployment for the main data collection effort. To avoid the introduction of participant learning, participants from either pilot study were excluded from the main data collection effort. In addition, data collected for the pilot studies was not included in the results of the main analysis.

Instrument Reliability

The concept of reliability with respect to research can be succinctly stated as the "consistency or stability of an observation, measurement, or test from one instance to the next" (Vogt et al., 2012, p. 349). For purposes of the subject research, internal consistency was considered a key reliability measure. Internal consistency reliability is the degree to which the responses to the statements within each factor are correlated (Vogt et al., 2012) or measuring the same thing (Drost, 2011; Hair et al., 2013).

The internal reliability of the research instrument was assessed to determine if the responses to the four observed variable statements were correlated above a certain threshold. The test for such correlation is Cronbach's alpha, and the threshold is 0.70

(Hair et al. 2013). Thus, if the Cronbach's alpha for a factor was above 0.70, the observed variable statements remained in the instrument; if not, statements were removed or revised.

Reliability of the constructs represented was assessed to determine if the observed variables adequately represent the constructs independent of the other constructs. Said differently, construct reliability measures how well the observed variables represent the constructs which they were designed to measure (Hair et al., 2013). Generally, construct reliability values of 0.7 or greater indicate good construct reliability (Byrne, 2010; Hair et al., 2013).

Additional efforts were made toward consistency between participants, which could improve reliability. An effort was made to ensure participants shared a common understanding by "making test instructions easily understood" (Drost, 2011, p. 113). The statements for which responses were requested were written as clearly as possible (Babbie, 2013; Drost, 2011). Finally, items were kept as short as possible while avoiding negative and biased terms (Babbie, 2013).

Instrument Validity

In research, validity can be thought of broadly as the "degree to which a measure accurately represents what is it supposed to" (Hair et al., 2013, p. 7). For purposes of the subject research, validity applies to the instrument by virtue of the notion that it accurately measures the factors it is intended to measure. There are two types of validity commonly assessed in survey research: face validity and construct validity.

The notion of face validity concerns the "quality of an indicator that makes it seem a reasonable measure of some variable" (Babbie, 2013, p. 153). Said differently, it is the “extent to which content of the items is consistent with the construct definition, based solely on the researcher’s judgment” (Hair et al., 2013, p. 601). Face validity is subjective and is often established by subject matter experts. As a result, face validity is considered by some to be a weak measure validity (Hair et al., 2013). Nevertheless, for purposes of the subject research, subject matter expert feedback on the proposed instrument was used to ensure face validity.

The second type of validity applicable in the subject research was construct validity. Hair et al. (2013) defines construct validity as the “extent to which a set of measured variables actually represents the theoretical latent construct those variables are designed to measure” (p. 601). For purposes of the subject research, confirmatory factor analysis was completed which helped establish whether the constructs theorized were valid in the context of the theoretical model. Two aspects of construct validity were assessed in the analysis: convergent validity and discriminant validity. These two measures of construct validity are described in the validity assessment below.

Constructs and Manifest Variables

There were eight independent variables (exogenous latent factors) and one dependent variable (endogenous latent factor). Each exogenous latent factor was represented initially by four observed (manifest) variables for each of the TPB factors and the extended factors. The exogenous latent factors, endogenous latent factors, and their associated observed (manifest) variables are provided in Table 8.

Table 8

Latent Factors and Observed (Manifest) Variables

#	Latent Factor	Observed (Manifest) Variables
Exogenous Latent Factors / Independent Variables		
1	Attitudes toward Behavior (AB)	AB1, AB2, AB3, AB4
2	Subjective Norms (SN)	SN1, SN2, SN3, SN4
3	Perceived Behavioral Control (PB)	PB1, PB2, PB3, PB4
4	Perceived Usefulness of UASs (PU)	PU1, PU2, PU3, PU4
5	Application Type/Use of UASs (AT)	AT1, AT2, AT3, AT4
6	Privacy (PR)	PR1, PR2, PR3, PR4
7	Risk/Safety of UASs (RS)	RS1, RS2, RS3, RS4
8	Familiarity with UASs (FW)	FW1, FW2, FW3, FW4
Endogenous Latent Factors / Dependent Variables		
9	Behavioral Intention (BI) to complain about UAS noise	BI1, BI2, BI3, BI4

It is often recommended that at least three observations be used per latent factor (Hair et al., 2013). For purposes of the subject research, responses to four statements per factor were collected initially. Collecting four responses per factor provides for the ability to delete one response per factor if the statement responses are not well correlated (i.e., Cronbach's Alpha below 0.7).

Demographic data (Age, Gender, Environs, Income, Race, and Education Level) was also collected. The demographic variables were collected as categorical and continuous variables, as applicable. The independent variables (IV), or exogenous latent factors were: Attitudes toward Behavior (AB), Subjective Norms (SN), Perceived Behavioral Control (PB), Perceived Usefulness of UASs (PU), Application Type/Use of UASs (AT), Privacy (PR), Risk/Safety of UASs (RS), Familiarity with UASs (FW). The endogenous latent factor or dependent variable (DV) was Behavioral Intention (BI) to complain about UAS noise. The SEM analysis was used to return factor coefficients between the IVs and the DVs. The scale for the factor coefficients was 0.0 to 1.0.

Moderating Relationships

A form of independent variables, moderating variables, or effect modifiers can alter the direction, strength, or both between dependent and independent variables (Creswell, 2014; Vogt et al., 2014). This research hypothesized moderating relationships between certain latent factors.

The moderating variables are shown in the theoretical framework (Figure 2) and the full structural model (FSM) (Figure 7). These relationships were tested following the SEM analysis. In order to analyze moderating relationships, additional *moderator variables* were created. In the subject research, the following moderator variables were developed: PU*AB, AT*AB, PR*AB, RS*AB, and FW*AB.

Variable PU*AB measures if the relationship between Perceived Usefulness of UASs (PU) and Behavioral Intention (BI) to complain about UAS noise was moderated by Attitude toward Behavior (AB) to complain about UAS noise.

Variable AT*AB measures if the relationship between Application Type/Use of UASs (AT) and Behavioral Intention (BI) to complain about UAS noise was moderated by Attitude toward Behavior (AB) to complain about UAS noise.

Variable PR*AB measures if the relationship between Privacy (PR) and Behavioral Intention (BI) to complain about UAS noise was moderated by Attitude toward Behavior (AB) to complain about UAS noise.

Variable RS*AB measures if the relationship between Risk/Safety of UASs (RS) and Behavioral Intention (BI) to complain about UAS noise was moderated by Attitude toward Behavior (AB) to complain about UAS noise.

Variable FW*AB measures if the relationship between Familiarity with UASs (FW) and Behavioral Intention (BI) to complain about UAS noise was moderated by Attitude toward Behavior (AB) to complain about UAS noise.

Scales

Researchers often use Likert-type scales when conducting social research. Likert-type scales are employed as a statement followed by a series of options from which the respondent chooses (Vogt et al., 2012) and are typically useful when measuring the degree of respondent support of or agreement with the beliefs, practices, or policies under investigation. Likert-type scales employ structured questions with forced choice questions measured on a multi-point scale (Vogt et al., 2014). A typical five-point Likert scale allows the following responses: strongly disagree, disagree, neutral, agree, and strongly agree.

The most common Likert-type scales used are five- or seven-point scales (Vogt et al., 2014). When compared, the results from five- and seven-point scales produce comparable means (Dawes, 2008). A key benefit of the use of a Likert-type scale is that it can yield reliable results even if some of the standard assumptions in the statistical analysis are violated (Vogt et al., 2014). Thus, for purposes of the subject research, responses to the statements were measured on a five-point Likert-type scale.

The choice of a five-point scale balances two other considerations. First, scales with too many choices often require additional time to complete and may increase the rate of incomplete surveys (Vogt et al., 2012). Alternatively, Likert scales with fewer than five gradations trend toward lower correlation coefficients (Byrne, 2010), especially when compared to more continuous data.

Ethical Considerations

Anonymity and Confidentiality

When a research effort exhibits anonymity, the researcher has no means by which to identify participants primarily because their identities are unknown (Vogt et al., 2012), and there is no method to link data to participants (Babbie, 2016). Confidentiality is a lesser standard than anonymity since the researcher has access to the participants' identities but shields them from association with the data (Vogt et al., 2012). This study adhered to the more stringent standard of anonymity. Only general demographic information was requested from participants, and no personally identifiable information (PII) was collected. Thus, the researcher had no ability to identify any participant.

Informed Consent Guidelines

Informed consent refers to the requirement that respondents willingly participate in the research with full knowledge of its risks and rewards (Vogt et al., 2012). Informed consent is a multi-faceted concept and is intended to ensure that participants are fully informed of many aspects of the research prior to their participation. These aspects include the identification of the (Creswell, 2012):

- Researcher
- Sponsoring institution
- Purpose of the study
- Benefits of participation

- Level and type of their involvement
- Risks
- Level of anonymity or confidentiality
- Right to withdraw at any time
- Person(s) to contact with questions

One of the primary responsibilities of the IRB process is to make sure the researcher receives informed consent for each participant. It is the responsibility of the researcher to ensure the participant must read, confirm their understanding, and remain willing to participate prior to the start of the effort. Informed consent was acquired by the researcher when the participant confirmed they read and understood the informed consent document and checked "agree" in the survey preamble.

Analysis and Reporting

A key ethical obligation to participants, colleagues, the broader scientific community, and the general public (moral suasion) is a fair and accurate analysis and reporting of the research effort (Vogt et al., 2012). Babbie (2016) notes that investigators have an ethical duty to provide a full representation of the research effort even if it exposes shortcomings or negative findings. During the completion of this research, every effort was made to provide ethically full and complete disclosure of the analysis conducted.

Institutional Review Board

It is vital to protect the rights of and to ensure the safety of human subjects participating in research (Creswell, 2014). The Institutional Review Board for the Protection of Human Subjects in Research, a federally mandated body established under the Department of Health and Human Services, regulates the Protection of Human Subjects by protecting the rights and welfare of participants recruited to volunteer in research activities.

The guiding ethical principles of the IRB are embodied in the Belmont Report: Ethical Principles and Guidelines for the Protection of Human Subjects of Research (National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research, 1979). The principles of respect for persons, beneficence, and justice are accepted as critical considerations for the ethical conduct of research on human subjects. University policy requires that all research involving human participants be reviewed and approved by the IRB prior to initiation of the research. Research involving human subjects includes the recruitment of potential participants in research, collection of data about or from human subjects (including surveys), and the use of existing data. Generally, any subsequent changes to a project must be re-submitted for review, and continuing review is also required at regular intervals for certain protocols.

IRB Review Categories

Research can be broadly defined as a systematic investigation with the purpose of establishing facts or reaching new conclusions. When research includes human participants, researchers have a duty of care to prevent harm to participants. Prior to discussing the IRB review categories, it should be noted that there are research activities that require no IRB consideration at all. These activities include: a) certain relationships between professionals and clients, b) research involving historical documents or archaeological specimens and, c) certain institutional quality improvement and assurance activities.

The three broad categories of IRB review which apply to differing types of research are: exempt, expedited, and full. Exempt research includes human participants but generally involves no more than minimal risk. This limited category includes public benefit or service programs and consumer acceptance studies with certain restrictions. Such research does not require ongoing IRB review unless the research plan is changed and is no longer eligible for the exempt category.

Research activities considered for expedited review must involve activities of no more than minimal risk and includes voice, video, digital or image recordings, surveys, interviews, oral histories, focus groups, evaluations, and quality assurance methodologies. Research requiring full review by the IRB includes all research that is not eligible as exempt or, for expedited review, must undergo full IRB review. Research which always requires a full review includes research involving prisoners, pregnant women, and minor children (unless it is educational research).

The nature of the subject research involved gathering survey data created by human subjects. Because data created by human subjects was queried, the procedures of the Embry-Riddle Aeronautical University IRB were followed. IRB approval was received prior to the initiation of the research. The survey instrument and research process was submitted for IRB approval under the exempt category. The IRB application and approval documentation are provided in Appendix A. As per guidelines, no data gathering occurred without prior IRB approval.

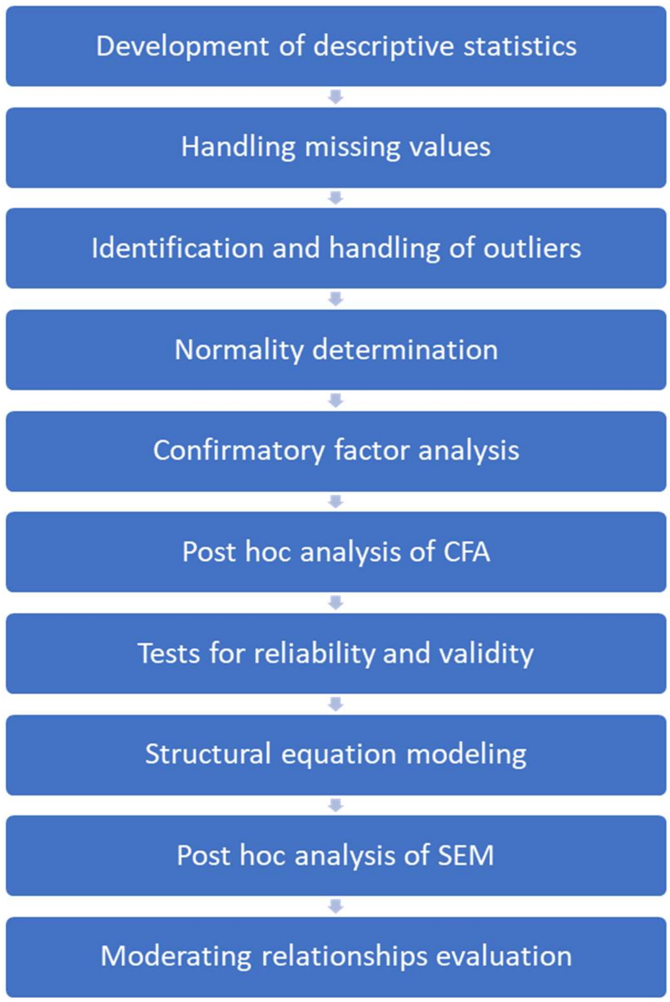
Data collection through a survey instrument presents no known risks greater than normal daily activities. Thus, the only risk associated with the data collection was privacy. The design of the data collection system ensured respondent anonymity since the data created by the collection platform did not record or provide names or other identifying information. Anonymity was assured since the researcher was unable to associate respondents with the data provided.

Data Analysis Approach

Following full scale data collection, the data analysis process was completed. The data analysis process for this research comprised three broad steps which included data exploration and description, confirmatory factory analysis (CFA), and structural equation modeling (SEM). This section discusses the specific analyses which comprise each of these data analysis process steps. The full analysis process is presented in Figure 5.

Figure 5

Data Analysis Process Model



Data Exploration and Description

The data exploration and description step comprises a key first step researchers should take in their analysis (Vogt et al., 2014) as it adds an overall understanding of the data and can help determine if the assumptions necessary for the intended analytical methods are met. In this analysis, descriptive statistics were developed on the demographic data and the observed variables. Measures of central tendency (mean, median, mode), dispersion (standard deviation), and symmetry (skewness, kurtosis) were developed. Other exploratory tasks completed include the identification and handling of missing values (through deletion or imputation), the identifying and handling outliers (identified with the Mahalanobis distance-squared test), and determinations of variable normality.

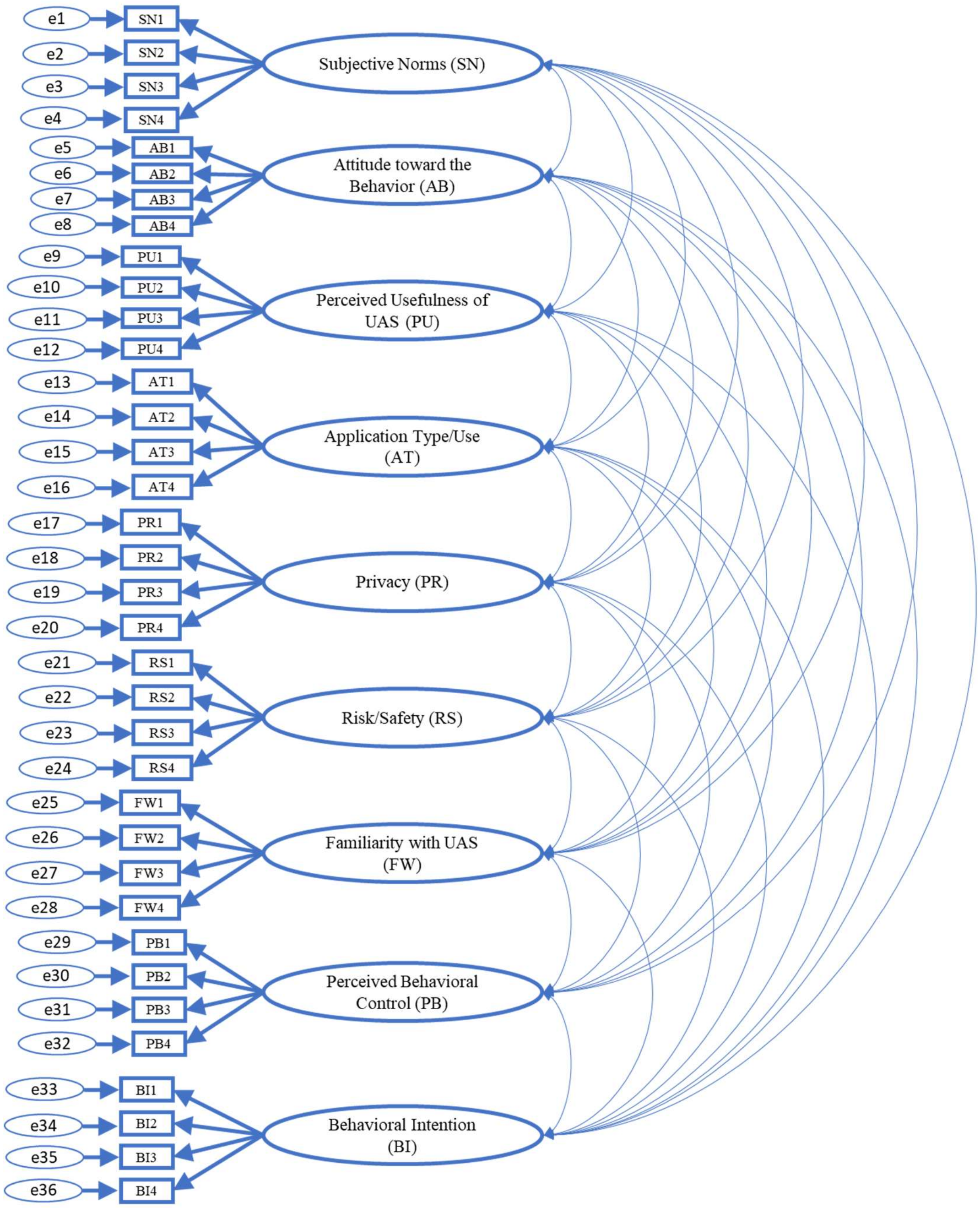
Confirmatory Factor Analysis

The next step in the data analysis process was the CFA. The principal utility of the CFA was that it determined how well the data collected for the measured (observed) variables represented the latent factors or constructs (Vogt et al., 2014). Performance of a CFA is considered appropriate when there is some understanding of the latent structure based on the grounded theory as well as factors gleaned from the literature, and relationships between the factors can be hypothesized (Byrne, 2010). The value of the CFA is in its confirmation of the covariance of the factor specific observed variables which provides evidence that the observed variables are measuring the same latent factor.

A CFA model was developed which reflects the factors selected from the TPB along with the additional factors gleaned from the literature review. The CFA model includes nine latent factors: AB (attitudes toward the behavior), SN (subjective norms), PB (perceived behavioral control), PU (perceived usefulness of UASs), AT (application type/use of UASs), PR (privacy), RS (risk/safety of UASs), FW (familiarity with UASs), and BI (behavioral intention to complain about UAS noise). The initial CFA model is provided as Figure 6.

Figure 6

Initial CFA Model



Following development and execution of the CFA model using the IBM® SPSS® AMOS® software suite, the results were compared to several goodness of fit (GOF) indices. The GOF indices used in this analysis were primarily gleaned from Byrne (2010) and Hair et al. (2013) but are widely accepted metrics for CFA and SEM models. The GOF indices are provided in Table 9 and include recommended threshold values.

Table 9

Recommended Values for GOF Indices

Indices	Recommended values	References
Comparative fit Index (CFI)	≥ 0.95	Byrne, 2010; Hair et al., 2013
Goodness of fit Index (GFI)	≥ 0.90	Byrne, 2010; Hair et al., 2013
Adjusted Goodness of fit Index (AGFI)	≥ 0.90	Byrne, 2010; Hair et al., 2013
Normed Fit Index (NFI)	≥ 0.90	Byrne, 2010; Hair et al., 2013
Root Mean Square Error of Approximation (RMSEA)	≤ 0.05	Byrne, 2010; Hair et al., 2013
Normed Chi-Square (χ2 /df or CMIN/df)	$1<\chi2/df<3$	Byrne, 2010; Hair et al., 2013

The modus operandi used with respect to the GOF indices required that if any of the GOF indices indicated an unsatisfactory model fit, a post hoc analysis of the CFA would be performed. The primary purpose of the post hoc analysis was to investigate the option to “re-specify and re-estimate the model” (Bryne, 2010, p. 89). When evaluating possible post hoc respecification of the model, modification indices (MI) were considered (Hair et al., 2013). Two sets of MI were calculated, one for error terms between items and another for factor loadings. The former may be useful in identifying potential issues with specific variables, but correlated error terms will not drive a model respecification decision (Hair et al., 2013). Modification indices which identify items exhibiting unfavorable factor loadings inform the researcher which variables are correlated with other constructs (Hair et al., 2013), indicating a cross-loading condition. If indicated by an MI and justified by theory (Hair et al., 2013), the model could be adjusted one variable at a time after which the CFA would be repeated including another post hoc analysis. This process was repeated until a satisfactory model fit was achieved. Subsequent to the CFA, assessments of model reliability and validity was performed.

Reliability Assessment Method

Each construct within the model was evaluated for construct reliability. Construct Reliability (CR) (sometimes Composite Reliability) and Cronbach's alpha were calculated for each construct and compared to required norms. CR measures how well the observed variables represent the latent factor which they were designed to measure (Hair et al., 2013). CR is calculated as the ratio of the square of the sum of standardized factor loadings of the individual construct divided by the square of the sum of factor loadings plus the sum of error variance. CR is calculated with equation (2) below:

$$CR = \frac{(\sum \lambda_\iota)^2}{(\sum \lambda_\iota)^2 + (\sum \epsilon_\iota)} \tag{2}$$

Where:

λ = the standardize factor loading for item i.

Ɛ = the error for item i.

CR was calculated using a Microsoft Excel® file to compute CR values. Standardized regression weights (factor loadings) were captured along with variances (error) from AMOS® and ingested into the Excel® file. CR values of 0.7 and above indicate good construct reliability (Byrne, 2010; Hair et al., 2013).

Cronbach's alpha provides a measure of how well variables measure the same factor or construct (Hair et al., 2013). It is a measure of internal consistency. Cronbach's alpha values of at least 0.7 are considered acceptable while values of 0.9 or above are excellent.

Validity Assessment Method

Convergent and discriminant validity was evaluated. Convergent validity tests determine the extent to which measures of the same factor are correlated. Discriminant validity tests determine the extent to which there is no overlap between factors. Convergent and discriminant validity are determined by the average variance extracted (AVE) and maximum shared variance (MSV) tests, respectively. AVE and MSV results were compared to desired norms.

AVE is the ratio of the sum of the square of individual standardized factor loadings to the number of measured items. Factor loadings and AVE above 0.5 indicate adequate convergent validity, while AVE values above 0.7 are desired. Once calculated, if AVE values are insufficient, Byrne (2010) suggests removing one item at a time to improve convergent reliability.

Discriminant validity measures the extent to which the constructs are distinct and capture phenomenon that others do not. Maximum shared variance was calculated from the square of inter-correlation between pairs of constructs. Discriminant validity is confirmed if the MSV is less than the AVE value (Hair et al., 2013).

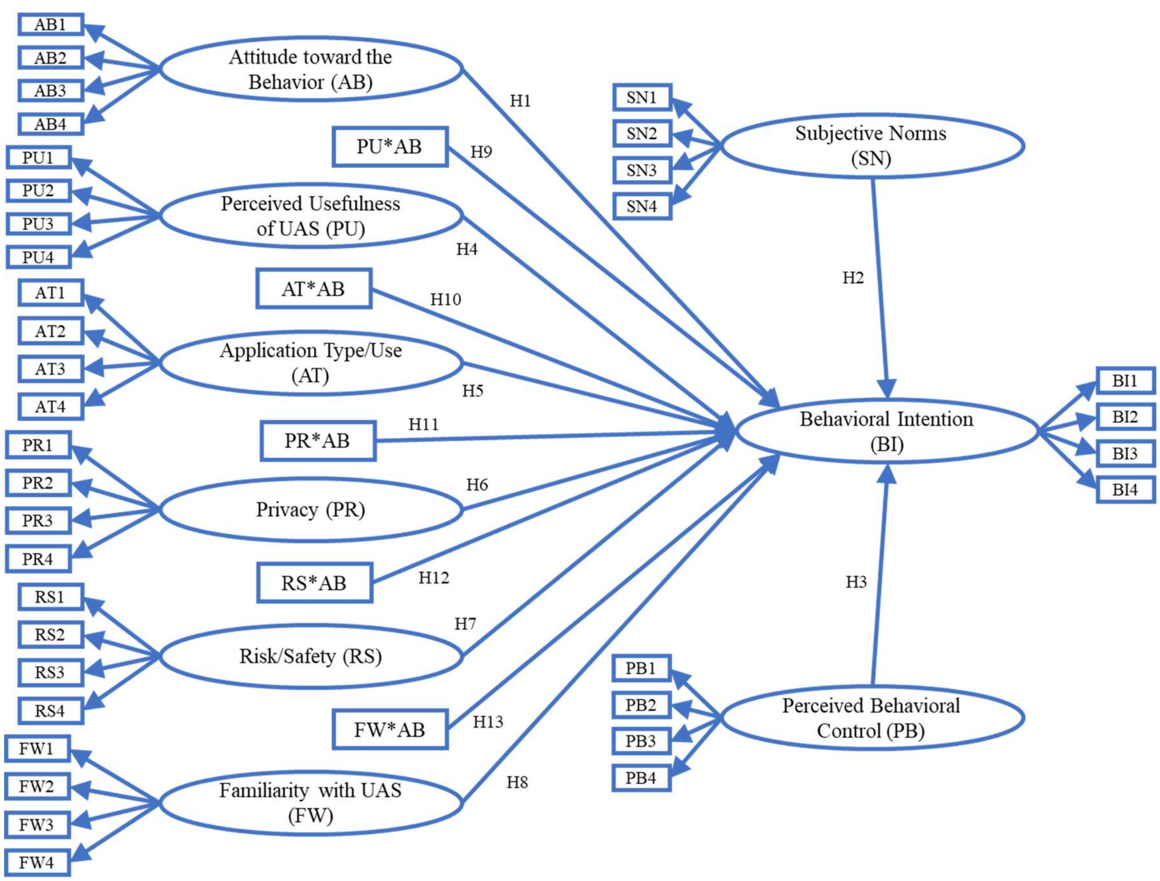
Structural Equation Modeling

The analysis to this point included an examination of the data, development of descriptive statistics, confirmatory factor analysis, and determinations of reliability and validity. The next step in the analysis process was execution of a full structural model. The full structural model facilitated evaluation of the proposed hypotheses.

Structural equation modeling is effectively the combination of a measurement model and a structural model (Byrne, 2010). The measurement model looks at the relationship between the observed variables in the latent variables while the structural model tests relationships between the unobserved latent variables (Hair et al., 2013). The full structural model incorporates the CFA as the measurement model but also specifies relationships between the latent variables. The full structural model for the subject research is provided at Figure 7.

Figure 7

Full Structural Model



The full structural model was executed and was subject to the same evaluation processes as the CFA model. Model results were compared with the thresholds of the goodness of fit indices provided in Table 6.

Additional results from the SEM analysis were used to determine the statistical relationships between the latent factors. A full structural model is considered validated if the relationships between the latent variables are significant and in the hypothesized direction (Hair et al., 2013). Thus, hypothesis testing results were determined from the full structural model.

Moderating Relationships Analysis

The final step in the analysis process for the subject research relates to understanding possible moderating relationships between latent factors. Vogt et al. (2014) suggests performing moderation analysis to consider influences between an IV and DV or two IVs. Additional moderator variables were created in this study, as shown in Figure 7, and include: PU*AB, AT*AB, PR*AB, RS*AB, and FW*AB. These moderator variables were evaluated since multiple moderating relationships are hypothesized. Moderating relationship analysis required the data to be standardized prior to further analysis.

Summary

This chapter described the research methodology followed in the performance of the subject research including the research approach, design, and procedures, population and sampling, data collection process, ethical considerations, measurement instrument, and data analysis approach. The chapter conveyed that the research employed a quantitative approach and a cross-sectional survey design. Data was gathered in conformance with IRB standards via MTurk® and SurveyMonkey® followed by development of demographic statistics. Confirmatory factor analysis was completed to establish validity of the measurement model and SEM analysis was completed for hypothesis testing.

Chapter IV: Results

The subject study intended to examine factors, as included in an extended theory of planned behavior, which influence individuals' intentions to complain about UAS noise. This chapter presents the results of the analysis along with a chapter summary. The primary results topics relate to: the pilot studies, the full scale data collection, demographics results, descriptive statistics, reliability and validity testing results, and quantitative data analysis results (including the confirmatory factor analysis, the structural model assessment, and hypothesis testing).

Pilot Studies

In the execution of this research, pilot studies were completed prior to full-scale data collection. These pilot studies included a subject matter expert review of the survey instrument, an initial pilot study, and a second pilot study. Analysis of the results of the first pilot study revealed issues with the reliability and validity of the survey instrument. Subsequently, changes were made to the instrument, and a second pilot study was done.

Face Validity

The initial SME review of the survey instrument was completed to help establish face validity or how reasonable it is that the observed items measure the variables (Babbie, 2013). The subject matter experts leveraged included industry UAS experts, PhDs, and cohort members. The feedback received indicated that the initial instrument exhibited adequate face validity to proceed with a wider pilot survey.

Pilot Study 1

An initial pilot study was completed (target n = 100) in MTurk® to enable testing of the reliability and validity of the survey instrument. Following the submittal of the

MTurk® HIT, the threshold of 100 respondents was reached in under two hours, resulting in a total of 113 responses. Following an examination of the data, 102 responses were considered acceptable. A small number of cases (11) were removed because, on an initial review of the data, they failed to answer all survey items or answered them all the same. The data was then uploaded into IBM SPSS® for additional analysis.

Demographics of the initial pilot study were calculated and are provided in Table 10. The primary age group of respondents was 20-40 year olds (74.5%). The gender category indicated more male respondents (70.6%) than female respondents (29.4%). The education level most represented was bachelor degree holders (55.9%). The racial group comprising the most respondents was white (80.4%). The majority of respondents reported their environs as suburban (47.1%). The income range represented most was the range from $40,000-$60,000 per year (33.3%). U.S. Census data for 2019 indicate average annual per capita income of $34,103. Additional data from various U.S. government sources were collected for comparison and are provided in the last column.

Table 10

Demographics - Pilot Study 1

Category	Sub-Category	Frequency	Percentage	US Gov't Data
Age	<=20	0	0%	27.0%
	20-40	76	74.5%	26.8%
	40-60	22	21.6%	27.7%
	60-80	4	3.9%	14.9%
	>80	0	0%	3.6%
	Missing	0	0%	N/A
Gender	Female	30	29.4%	50.8%
	Male	72	70.6%	49.2%
	Other	0	0%	N/A
Education	High School	31	30.4%	56.1%
	Bachelor's	57	55.9%	21.3%
	Master's	12	11.8%	9.0%
	Doctorate	2	2.0%	1.8%
Race	American Indian or Alaska Native	1	1.0%	1.3%
	Asian	7	6.9%	5.9%
	Black or African American	7	6.9%	13.4%
	Hispanic, Latino, or Spanish Origin of any Race	4	3.9%	18.5%
	Native Hawaiian or Other Pacific Islander	0	0%	0.2%
	Two or more	1	1.0%	2.8%
	White	82	80.4%	60.1%
Environs	Rural	15	14.7%	21%
	Suburban	48	47.1%	52%
	Urban	39	38.2%	27%
Income	<=25k	31	30.4%	34.0%
	25-50	42	41.2%	23.7%
	50-75	18	17.6%	14.0%
	75-100	7	6.9%	8.9%
	>100	4	3.9%	19.4%
	Missing	0	0%	N/A

Note: Adapted from IRS (2019), Census Bureau (2019), and HUD (2021).

Following the demographics analysis, the data was uploaded into IBM AMOS® Version 27 for analysis with the proposed CFA model. The initial pilot study responses were then evaluated with respect to normality. The skewness and kurtosis values ranged from -1.287 to +0.397 and from -1.069 to +2.229, respectively. Since these values were generally consistent with the range -2.0 to +2.0 as defined by George and Mallery (2010) and well within the range of -5.0 to +5.0 as defined by Byrne (2010), no transformation of the data was deemed necessary.

Following the normality analysis, the data was evaluated for the presence of outliers. The Mahalanobis distance (D^2) was calculated for all observed items to determine the observations farthest from the centroid. No cases were observed with a D^2 value above 100, which indicated no significant outliers. As a result, it was not necessary to consider deleting any cases as outliers.

The CFA model results were then compared to several widely accepted goodness of fit (GOF) indices, as noted in Byrne (2010) and Hair et al. (2013). The GOF indices values are provided in Table 11 and were compared to the recommended threshold values. The first pilot study exhibited unsatisfactory GOF for all indices, with the exception of CMIN/df (1.860), which was in the acceptable range between 1 and 3.

Table 11

Model Fit Indices – Pilot Study 1

Indices	Recommended values	Pilot Study 1	Satisfactory
Comparative fit Index (CFI)	≥0.95	0.813	No
Goodness of fit Index (GFI)	≥0.90	0.670	No
Adjusted Goodness of fit Index (AGFI)	≥0.90	0.606	No
Normed Fit Index (NFI)	≥0.90	0.676	No
Root Mean Square Error of Approximation (RMSEA)	≤0.05	0.092	No
Normed Chi-Square ($\chi2$ /df or CMIN/df)	$1<\chi2/df<3$	1.860	Yes

Because the goodness of fit indices for the first pilot survey CFA indicated an unsatisfactory model fit, a post hoc analysis was performed to investigate the possibility to “re-specify and re-estimate the model” (Bryne, 2010, p. 89). Modification indices were considered in order to identify unfavorable factor loadings in which variables are correlated with other constructs (Hair et al., 2013) indicating a cross-loading condition. Only covariances between two error terms and correlations between an item and a factor were considered.

The highest MI value observed (29.911) was between two error terms (e15 and e16) which are related to items AT3 and AT4. The estimated parameter change of 0.503 implies that covarying the two error terms could improve the model fit. It was therefore decided to add a covariance between e15 and e16. The resulting model fit exhibited a small change in the model fit indices: CFI (0.827), GFI (0.673), AGFI (0.609), NFI (0.687), RMSEA (0.089), and CMIN/df (1.800).

Because of the minor improvements resulting from the respecification and the small sample size used in the pilot study, retaining the covariance in the model and further respecification was foregone. The initial pilot study was then evaluated with respect to reliability and validity criteria. These criteria included factor loadings, Cronbach's Alpha, composite reliability, average value extracted, and maximum shared variance. The reliability and validity results of the initial pilot study are provided in Table 12.

The results of the first pilot survey revealed reliability issues with the instrument. With regards to internal reliability, three questions including AT3, AT4, FW4 were correlated poorly with their respective factors. For factor AT, Cronbach's Alpha (0.604) measured below the threshold of 0.7, indicating the need to examine the factor items for possible modification or deletion. In addition, the composite reliability (0.548) for AT was below the 0.7 threshold.

With regard to validity, the results for the first pilot survey indicated that AVE for both AT and FW were below the 0.5 threshold, indicating an issue with convergent validity. MSV for AT and BI were above their respective AVE values, indicating inadequate discriminant validity. Byrne (2010) suggests that if AVE values are below thresholds, one item at a time should be removed to improve convergent reliability. Thus, for FW, removing item FW4 was considered as a path to improve convergent reliability. In the case of AT, the factor loadings of items AT3 and AT4 were quite distant from AT1 and AT2. As a result, removal of one and rewording of another was therefore considered a better alternative to removing one or more items in sequence.

Table 12

Reliability and Validity Results - Pilot Study 1

Construct / Variable	Survey Item	Factor Loading	CR (≥0.7)	Cronbach's Alpha (≥0.7)	AVE (≥0.5)	MSV (<AVE)
Attitudes toward Behavior (AB)	AB1	0.835	0.913	0.911	0.725	0.717
	AB2	0.914				
	AB3	0.855				
	AB4	0.798				
Subjective Norms (SN)	SN1	0.894	0.920	0.915	0.744	0.594
	SN2	0.94				
	SN3	0.846				
	SN4	0.759				
Perceived Behavioral control (PB)	PB1	0.78	0.891	0.886	0.673	0.082
	PB2	0.832				
	PB3	0.896				
	PB4	0.767				
Perceived Usefulness of UAS (PU)	PU1	0.739	0.862	0.860	0.609	0.355
	PU2	0.835				
	PU3	0.788				
	PU4	0.757				
Application Type/Use of UAS (AT)	AT1	0.629	0.548	0.604	0.283	0.355
	AT2	0.797				
	AT3	0.173				
	AT4	0.266				
Privacy (PR)	PR1	0.824	0.875	0.874	0.637	0.194
	PR2	0.862				
	PR3	0.796				
	PR4	0.701				
Risk/Safety of UAS (RS)	RS1	0.886	0.890	0.891	0.671	0.293
	RS2	0.774				
	RS3	0.88				
	RS4	0.726				
Familiarity with UAS (FW)	FW1	0.832	0.756	0.744	0.445	0.229
	FW2	0.623				
	FW3	0.678				
	FW4	0.489				
Behavioral Intention (BI) to complain about UAS noise	BI1	0.796	0.892	0.890	0.675	0.717
	BI2	0.702				
	BI3	0.883				
	BI4	0.892				

The first pilot study also revealed discriminant validity issues. Discriminant validity was evaluated using the Fornell and Larcker method which compares square root of the AVE estimates to correlation estimates between factor pairs (Fornell & Larcker, 1981; Hair et al., 2013). This method of testing discriminant validity showed the model demonstrated unacceptable discriminant validity for some factors. Table 13 provides the discriminant validity for the first pilot study showing the square root of the AVE estimates in bold and the inter-factor correlation estimates.

Table 13

Discriminant Validity – Pilot Study 1

	FW	SN	AB	PU	AT	PR	RS	PB	BI
FW	**0.667**								
SN	0.082	**0.862**							
AB	0.008	0.721	**0.852**						
PU	0.479	-0.304	-0.387	**0.781**					
AT	0.279	0.207	0.135	0.596	**0.532**				
PR	0.035	0.329	0.441	-0.177	-0.077	**0.798**			
RS	-0.056	0.414	0.375	-0.541	-0.218	0.441	**0.819**		
PB	-0.096	0.003	-0.028	0.214	0.286	0.274	0.115	**0.820**	
BI	0.044	0.771	0.847	-0.446	0.110	0.336	0.470	-0.095	**0.822**

Discriminant validity concerns were evident with factors AT and BI. The square root of the AVE values for AT and BI were less than the absolute value of their correlations with another factor. In addition, the AVE values for AT and BI were less than their respective MSV values. As a result of these issues, the phraseology of the items was reviewed and updated before completing a second pilot study.

Pilot Study 2

A second pilot survey was completed (target $n = 100$) in MTurk®. The second pilot survey enabled testing of the changes made to the instrument due to the reliability and validity concerns noted with the first version of the survey instrument. The second pilot survey used the same questions from the first pilot survey with three changes: items AT4 and FW4 were removed per Babbie (2010), and item AT3 was reworded.

Care was taken to utilize a feature in MTurk® which prevented respondents to the first pilot survey from participating in the second pilot survey. Such prohibitions avoid the possibilities of participant learning. Following the submittal of the MTurk® HIT, the threshold of 100 respondents was reached in under one hour, resulting in a total of 111 responses.

Following an examination of the data, 108 responses were considered acceptable. A small number (3) of cases were removed because they exhibited missing data or all items were answered the same. Demographics of the initial pilot study were calculated and reviewed and are provided in Table 14.

The primary age group of respondents was 20-40 year olds (63.0%). The gender category indicated more male respondents (63.9%) than female respondents (36.1%). The education level most represented was bachelor degree holders (57.4%). The racial group comprising the most respondents was white (67.6%). The majority of respondents reported their environs as suburban (45.4%). The income range represented most was the range from $20,000-$40,000 per year (30.6%).

Table 14

Demographics - Pilot Study 2

Category	Sub-Category	Frequency	Percentage	US Gov't Data
Age	<=20	0	0%	27.0%
	20-40	68	63.0%	26.8%
	40-60	37	34.3%	27.7%
	60-80	3	2.8%	14.9%
	>80	0	0%	3.6%
Gender	Female	39	36.1%	50.8%
	Male	69	63.9%	49.2%
	Other	0	0%	N/A
Education	High School	18	16.7%	56.1%
	Bachelor's	62	57.4%	21.3%
	Master's	26	24.1%	9.0%
	Doctorate	2	1.9%	1.8%
Race	American Indian or Alaska Native	1	0.9%	1.3%
	Asian	4	3.7%	5.9%
	Black or African American	23	21.3%	13.4%
	Hispanic, Latino, or Spanish Origin of any Race	6	5.6%	18.5%
	Native Hawaiian or Other Pacific Islander	0	0%	0.2%
	Two or more	1	0.9%	2.8%
	White	73	67.6%	60.1%
Environs	Rural	18	16.7%	21%
	Suburban	49	45.4%	52%
	Urban	41	38.0%	27%
Income	<=25k	24	22.2%	34.0%
	25-50	44	40.7%	23.7%
	50-75	22	20.4%	14.0%
	75-100	11	10.2%	8.9%
	>100	7	6.5%	19.4%
	Missing	0	0%	N/A

Note. Adapted from IRS (2019), Census Bureau (2019), and HUD (2021).

Following the demographics analysis, the data was then uploaded into IBM AMOS® Version 27 for analysis with the proposed CFA model. The second pilot study responses were then evaluated with respect to normality. The skewness and kurtosis values ranged from -1.128 to -.020 and from -1.160 to +1.530 respectively. Since these values are consistent with the range -2.0 to +2.0 as defined by George and Mallery (2010) and well within the range of -5.0 to +5.0 as defined by Byrne (2010), no transformation of the data was deemed necessary.

Following the normality analysis, the data was evaluated for the presence of outliers. The Mahalanobis distance (D^2) was calculated for all observed items to determine the observations farthest from the centroid. No cases were observed with a D^2 value above 100, which indicated no significant outliers. As a result, it was not necessary to consider deleting any cases.

The CFA model results were then compared to several widely accepted goodness of fit (GOF) indices, as noted in Byrne (2010) and Hair et al. (2013). The GOF indices values are provided in Table 15 and are compared to the recommended threshold values. The second pilot study exhibited unsatisfactory GOF for all indices with the exception of CMIN/df (1.860), which was in the acceptable range between 1 and 3.

Table 15

Model Fit Indices – Pilot Study 2

Indices	Recommended Values	Pilot Study 2	Satisfactory
Comparative Fit Index (CFI)	≥0.95	0.932	No
Goodness of Fit Index (GFI)	≥0.90	0.758	No
Adjusted Goodness of Fit Index (AGFI)	≥0.90	0.707	No
Normed Fit Index (NFI)	≥0.90	0.801	No
Root Mean Square Error of Approximation (RMSEA)	≤0.05	0.061	No
Normed Chi-Square ($\chi 2$ /df or CMIN/df)	$1<\chi 2/df<3$	1.404	Yes

Because the goodness of fit indices for the second pilot survey CFA indicated an unsatisfactory model fit, a post hoc analysis was performed to investigate model respecification. The highest modification index value observed (10.232) was between an item (PB2) and a factor (BI), indicating a cross-loading situation. The estimated parameter change of -0.214 implies that relating the item and the factor could improve the model fit. However, since these results were from a pilot survey and the sample size was small, no modifications were made.

The second pilot study responses were then evaluated with respect to reliability and validity criteria. These criteria included factor loadings, Cronbach's Alpha, composite reliability, average value extracted, and maximum shared variance. The reliability and validity results of the initial pilot study are provided in Table 16.

The results of the second pilot survey revealed that reliability was substantially improved with the second version of the survey instrument. With regards to internal reliability, all items correlated with their respective factors are at or above 0.675. For all factors, Cronbach's Alpha measured above the threshold of 0.7, indicating no need to examine the components for modification or possible deletion. In addition, the composite reliability for all factors was above the 0.7 threshold.

With regard to validity, the results for the second pilot survey indicated that AVE for PU (0.499) was below the 0.5 threshold, indicating an issue with convergent validity. Byrne (2010) suggests that if AVE values are below thresholds, remove one item at a time to improve convergent reliability. Thus, for PU, removing item PU2 was considered as a path to improve convergent reliability. However, discriminate validity issues were discovered which indicated that broader instrument modifications were warranted. Discussion of these discriminant validity issues are presented next.

Table 16

Reliability and Validity Results - Pilot Study 2

Construct / Variable	Survey Item	Factor Loading	CR (≥0.7)	Cronbach's Alpha (≥0.7)	AVE (≥0.5)	MSV (<AVE)
Attitudes toward Behavior (AB)	AB1	0.885	0.930	0.929	0.770	0.876
	AB2	0.854				
	AB3	0.871				
	AB4	0.899				
Subjective Norms (SN)	SN1	0.914	0.928	0.927	0.763	0.704
	SN2	0.809				
	SN3	0.925				
	SN4	0.841				
Perceived Behavioral Control (PB)	PB1	0.789	0.824	0.821	0.539	0.359
	PB2	0.698				
	PB3	0.693				
	PB4	0.753				
Perceived Usefulness of UAS (PU)	PU1	0.716	0.799	0.797	0.499	0.996
	PU2	0.675				
	PU3	0.738				
	PU4	0.695				
Application Type/Use of UAS (AT)	AT1	0.8	0.802	0.800	0.575	0.996
	AT2	0.764				
	AT3	0.707				
Privacy (PR)	PR1	0.891	0.933	0.931	0.776	0.446
	PR2	0.876				
	PR3	0.891				
	PR4	0.865				
Risk/Safety of UAS (RS)	RS1	0.884	0.920	0.920	0.743	0.446
	RS2	0.866				
	RS3	0.859				
	RS4	0.838				
Familiarity with UAS (FW)	FW1	0.774	0.864	0.859	0.679	0.181
	FW2	0.832				
	FW3	0.864				
Behavioral Intention (BI) to Complain about UAS Noise	BI1	0.863	0.922	0.923	0.749	0.876
	BI2	0.795				
	BI3	0.922				
	BI4	0.876				

Similar to the first pilot study, discriminant validity was evaluated using the Fornell and Larcker (1981) method, which compares the square root of the AVE estimates to correlation estimates between factor pairs. Table 17 provides the discriminant validity for the final CFA model showing the square root of the AVE estimates in bold and the inter-factor correlation estimates. This method of testing discriminant validity revealed continuing discriminant validity issues since it showed the model did not demonstrate acceptable discriminant validity for all correlations.

Table 17

Discriminant Validity Results - Pilot Study 2

	FW	SN	AB	PU	AT	PR	RS	PB	BI
FW	**0.824**								
SN	0.351	**0.874**							
AB	0.306	0.758	**0.877**						
PU	0.303	0.039	-0.044	**0.706**					
AT	0.425	0.062	0.091	0.998	**0.758**				
PR	0.166	0.572	0.569	-0.023	0.018	**0.881**			
RS	0.094	0.665	0.593	-0.094	-0.076	0.668	**0.862**		
PB	0.222	0.117	0.170	0.599	0.557	0.201	0.257	**0.734**	
BI	0.293	0.839	0.936	-0.049	0.074	0.519	0.666	0.178	**0.865**

Discriminant validity concerns were evident with four factors: AB, PU, AT, and BI. The square root of the AVE values for AB, PU, AT, and BI were less than the absolute value of their correlations with another factor. In addition, the AVE values for AB, PU, AT, and BI were less than their respective MSV values.

Instrument Revisions for Full Scale Data Collection

In order to address the validity issues with the instrument used for the second pilot study, an effort was made to reword the survey statements for the affected factors. Survey statements for AB, AT, BI, and PU were reworded such that they were more closely aligned to their corresponding factors. It was not necessary to reword BI3 and PU1. Since AT4 had been removed from the second pilot, a replacement was developed. Table 18 provides a comparison of the original survey statements and the revised statements.

Table 18

Survey Statement Rewording

Item	Original Statement	Revised Statement
AB1	Complaining about UAS noise is a good idea	I feel it is a good idea to complain about UAS noise
AB2	I think complaining about UAS noise is desirable	To me, it is desirable to complain about UAS noise
AB3	I like the idea of complaining about the noise UAS create	I like the idea of complaining about UAS noise
AB4	I would feel good about submitting a complaint about UAS noise	I would feel good about complaining about UAS noise
BI1	I would complain about UAS noise	I will probably complain about UAS noise
BI2	If motivated by the noise, I intend to complain about UAS noise in the future	I intend to complain about UAS noise
BI3	I plan to complain about UAS noise	No change
BI4	I would recommend complaining about UAS noise to my friends and relatives	I expect to complain about UAS noise
PU1	I think UAS are useful	No change
PU2	UAS have many beneficial uses	Using UAS can improve productivity for some tasks
PU3	UAS can be a more efficient way to get certain things done	Using UAS can be a more efficient way to get certain things done
PU4	Some tasks might be easier to do using UAS	Using UAS can make it easier to do some jobs

AT1	I prefer types of UAS that are used for reasons I like	I only like the types of UAS that are doing something I approve of
AT2	I approve of UAS when they are used to benefit people	I only like the types of UAS that do things which benefit people
AT3	I would find a UAS acceptable if it was doing something positive	I only like the types of UAS that do something positive
AT4	When I see a UAS I would like to know why it is there	I only like the types of UAS that do things I think are worthwhile

In the resulting final version, the configuration of the survey included the questions from the first pilot survey with multiple rewordings of items AT, BI, PU, and AB noted above, with AT4 also reworded and added back. FW4 had been removed because of its poor factor loadings and was not added back or reworded. Hair et al, (2013) indicates that while four items per factor are preferred, deletion of an item, leaving three items in a single factor, is acceptable if all other factors retain four items.

Main Study

Consistent with the pilot studies, data collection for the main study was also completed using MTurk®. The survey instrument was revised based on the results of the pilot studies as described above and subsequently submitted as a MTurk® HIT for primary data collection. The revised survey items are provided as Appendix D.

As noted previously, the minimum sample size required for the full study was determined to be 460 respondents. In order to ensure obtaining adequate amounts of usable data after the culling process, 700 respondents were requested through a MTurk® HIT submittal. As with the pilot studies, care was taken to utilize a feature in MTurk® which prevented respondents to either of the pilot surveys from participating in the main study survey to avoid the possibility of participant learning. A total of 788 responses to the survey request were received in under 24 hours.

Data Exploration and Description

Following collection of the main study data, the data exploration and description step was performed. Such analysis generally helps add an overall understanding of the data and helps determine if the assumptions necessary for the intended analytical methods are met (Vogt et al., 2014). This section includes results of exploratory tasks including the identification and handling of missing values and outliers in addition to determinations of the normality of the observed variable data. Descriptive statistics are presented for the demographic data, and the observed variables and measures of central tendency, dispersion, and symmetry are discussed.

Following collection of the main survey data, it was downloaded into Microsoft Excel® for initial examination. The initial examination of the data revealed that 45 cases contained no responses to the main survey questions and were therefore removed, which left 743 cases remaining. A check of satisfactory responses to the two imbedded attention check questions revealed 20 cases which failed at lease one attention check, leaving 723 cases. A check for responses which were all the same identified an additional six cases which were removed, leaving 717 cases remaining.

The dataset was then uploaded to IBM SPSS® for additional analysis. An analysis to determine missing data was completed, which identified 75 cases which exhibited missing data. The Missing Completely at Random (MCAR) test was run which determined that there were no variables with 5% or more missing values.

Data imputation was subsequently completed on the 75 cases exhibiting missing data. The reflected values method was employed and resulted in the majority of the cases being retained in the data set. Analysis of the data following imputation revealed that 72 of the 75 cases could be retained. Of the three deleted cases, two cases were missing all answers to a single factor which provided no way to reflect values (case 81, factor FW and case 105, factor BI), and one case (306) resulted in all responses being the same. Following data examination and culling, the dataset used for the initial main study analysis included 714 cases which represents a 90.6% (714/788) valid response rate. Table 19 provides a summary of the case deletion rationale and net cases.

Table 19

Case Deletion Rationale – Main Study

Action / Test	Removed	Net Responses
Initial Data Collection	-	788
Delete Cases: No main survey responses	45	743
Delete Cases: Failed attention check #1	7	736
Delete Cases: Failed attention check #2	13	723
Delete Cases: All responses are the same	6	717
Missing Data Count: 75 cases with missing data	-	717
Run Missing Completely at Random (MCAR) Test: There are no variables with 5% or more missing values.	-	717
Data imputation - Reflected Values: • Deleted: 1 case (case 306) with all same responses, 2 cases missing all answers to a single factor thus no way to reflect values (case 81, FW & case 105, BI)	3	714

Test for Non-Response Bias

For purposes of this research, non-response refers to participants who began completing the survey instrument, answered one or more of the demographic questions, but failed to answer the factor item questions. Non-response bias provides a measure of how the survey might have been effected by individuals who answered only some of the demographic questions when compared to those who provided more complete answers to the survey. Chi-square tests were completed to determine any statistically significant differences based on answers to the demographic questions. The results of the Chi-square test are provided in Table 20.

Table 20

Non-Response Bias Chi-Squared Test Results

Attribute	Chi-Square (χ2)	Probability (*p*)	Significant (Yes/No)
Age	4.836	0.305	No
Gender	0.678	0.878	No
Education	4.073	0.396	No
Race	4.043	0.671	No
Environs	0.542	0.910	No
Income	3.461	0.484	No

Note. p is significant at $p < .05$.

All of the probability (p) values exceed the threshold value ($p > 0.05$). Thus, no significant difference was indicated between those that answered the majority of the survey questions and those that did not. The Table 20 results indicate the absence of non-response bias.

Demographics of the main study were reviewed and are provided in Table 21. The primary age group of respondents was 20-40 year olds (50.4%). The gender category indicated more female respondents (51.4%) than male respondents (47.8%) with the remaining reporting as other (0.7%). The education level most represented was bachelor degree holders (47.5%). The racial group comprising the most respondents was white

(74.3%). The majority of respondents reported their environs as suburban (52.2%). The income range represented most was the range from $40,000-$60,000 per year (28.8%).

Table 21

Demographics – Main Study

Category	Sub-Category	Frequency	Percentage	US Gov't Data
Age	<=20	10	1.4%	27.0%
	20-40	353	50.4%	26.8%
	40-60	238	34.0%	27.7%
	60-80	95	13.6%	14.9%
	>80	2	0.3%	3.6%
	Missing	3	0.4%	N/A
Gender	Female	360	51.4%	50.8%
	Male	335	47.8%	49.2%
	Other	5	0.7%	N/A
Education	High School	204	29.1%	56.1%
	Bachelor's	333	47.5%	21.3%
	Master's	142	20.3%	9.0%
	Doctorate	21	3.0%	1.8%
Race	American Indian or Alaska Native	4	0.6%	1.3%
	Asian	77	11.0%	5.9%
	Black or African American	52	7.4%	13.4%
	Hispanic, Latino, or Spanish Origin of any Race	26	3.7%	18.5%
	Native Hawaiian or Other Pacific Islander	2	0.3%	0.2%
	Two or more	19	2.7%	2.8%
	White	521	74.3%	60.1%
Environs	Rural	139	19.8%	21%
	Suburban	366	52.2%	52%
	Urban	195	27.8%	27%
Income	<=25k	191	27.2%	34.0%
	25-50	202	28.8%	23.7%
	50-75	131	18.7%	14.0%
	75-100	103	14.7%	8.9%
	>100	68	9.7%	19.4%
	Missing	6	0.9%	N/A

Note. Adapted from IRS (2019), Census Bureau (2019), and HUD (2021).

Descriptive statistics were also generated for the scale demographic variables (Age, Income). There were 698 valid responses for Age with three missing values. The mean, median, and mode were 42.63, 40.00, and 32.00, respectively. The standard deviation was 13.934 with a variance of 194.165. For Age, the measures of symmetry were skewness = 0.511 and kurtosis = -0.624 over a range of 70, spanning a low of 18 and high of 88.

Descriptive statistics for Income indicated there were 695 valid responses with six missing values. The mean, median, and mode were $54,708.42, $45,000.00, and $50,000.00, respectively. The standard deviation was 43,217 with a variance of 1867770948.3. For Income, the measures of symmetry were skewness = 1.966 and kurtosis = 7.892 over a range of $400,000, spanning a low of $0 and high of $400,000.

Following analysis of the demographics data, the main study data was then uploaded into IBM AMOS® Version 27 for analysis with the proposed CFA model. Descriptive statistics of the main study data were generated and are provided in Table 22. The initial main study responses were then evaluated with respect to normality. The skewness and kurtosis values ranged from -1.039 to 0.420 and from -0.844 to +1.675, respectively. Since these values are consistent with the range -2.0 to +2.0 as defined by George and Mallery (2010) and well within the range of -5.0 to +5.0 as defined by Byrne (2010), no transformation of the data was deemed necessary.

Table 22

Descriptive Statistics

Factor	Item	Mean	Average Mean for Factor	Std. Dev	Average SD for Factor	Skewness	Kurtosis
AB	AB1	2.86	2.685	1.076	1.094	0.046	-0.605
	AB2	2.65		1.122		0.323	-0.638
	AB3	2.57		1.104		0.420	-0.547
	AB4	2.66		1.073		0.307	-0.501
SN	SN1	2.74	2.790	1.052	1.067	0.131	-0.614
	SN2	2.75		1.047		0.132	-0.597
	SN3	2.75		1.050		0.095	-0.657
	SN4	2.92		1.118		0.014	-0.844
PB	PB1	3.87	3.990	0.895	0.851	-0.722	0.356
	PB2	3.96		0.868		-0.831	0.629
	PB3	4.01		0.83		-0.879	1.017
	PB4	4.12		0.811		-1.039	1.467
PU	PU1	3.94	3.978	0.741	0.722	-0.701	1.076
	PU2	3.99		0.699		-0.664	1.254
	PU3	3.97		0.714		-0.732	1.414
	PU4	4.01		0.732		-0.844	1.675
AT	AT1	3.58	3.695	0.940	0.935	-0.546	0.112
	AT2	3.76		0.953		-0.782	0.434
	AT3	3.81		0.882		-0.879	0.976
	AT4	3.63		0.966		-0.663	0.130
PR	PR1	3.54	3.653	1.102	1.076	-0.450	-0.674
	PR2	3.59		1.113		-0.471	-0.66
	PR3	3.64		1.052		-0.536	-0.385
	PR4	3.84		1.037		-0.772	-0.017
RS	RS1	3.21	3.138	0.992	1.023	-0.154	-0.626
	RS2	3.02		1.079		-0.011	-0.833
	RS3	2.87		0.96		0.266	-0.341
	RS4	3.45		1.062		-0.510	-0.506
FW	FW1	3.33	3.217	1.026	1.025	-0.666	-0.401
	FW2	2.93		1.050		0.055	-0.870
	FW3	3.39		1.000		-0.630	-0.318
BI	BI1	2.58	2.480	1.071	1.053	0.357	-0.587
	BI2	2.43		1.036		0.529	-0.215
	BI3	2.4		1.041		0.544	-0.229
	BI4	2.51		1.064		0.414	-0.441

Table 22 also provides measures of central tendency and dispersion for the main study data. Perceived Behavioral Control (PB), followed closely by Perceived Usefulness (PU) had the highest average means for the factors (3.99 and 3.978 respectively). These two factors also had the lowest standard deviations of all factors (0.851 and 0.722, respectively). The numerical surrogate for an answer of *Agree* in the survey was 4 which indicates that PB and PU were predominantly answered *Agree*. Respondents believed they have control over their ability to complain about UAS noise and that their perception of the usefulness of UASs was generally positive.

The average means of responses for Application type/use of UAS (AT) and Privacy concerns (PR) (3.695 and 3.653 respectively) were also closer to *Agree (4)* than *Neutral* (3). Respondents believed that the application type or use of UAS is important to them and that they have some concerns regarding their privacy being violated.

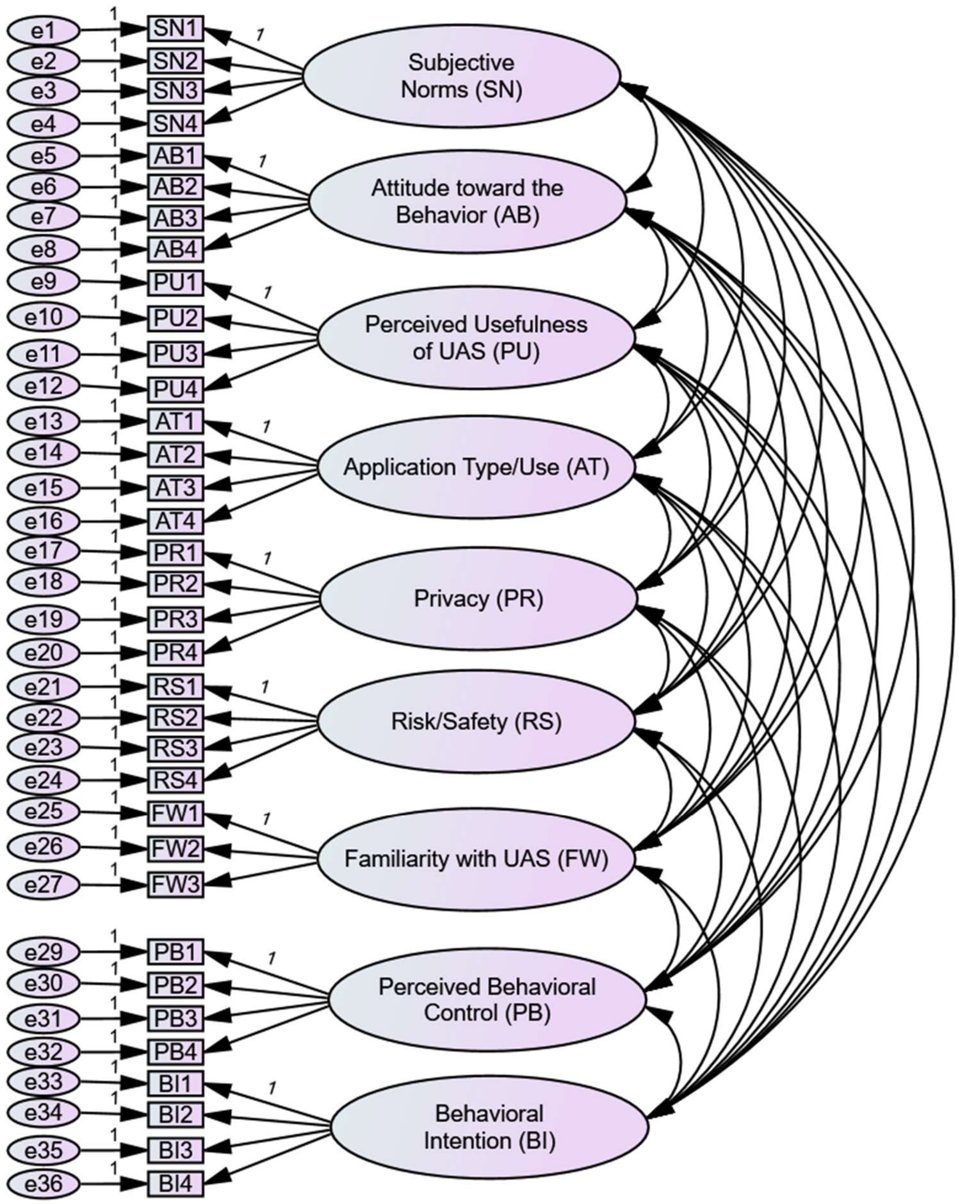
Four factors had average means that were closer to *Neutral* than either *Agree* or *Disagree*. Risks to Safety (RS) and Familiarity with UAS (FW) were slightly above *Neutral* (3.138 and 3.217, respectively) while Attitude toward the Behavior (AB) and Subjective Norms (SN) were slight below *Neutral* (2.685 and 2.79, respectively). Behavioral Intent (BI) had an average mean (2.48) slightly closer to *Disagree* than *Neutral*. The standard deviations of all factors other than PB and PU were between 0.935 and 1.094, indicating consistent variability of the responses.

Confirmatory Factor Analysis

This section provides results of the confirmatory factor analysis. The CFA for the main study was then performed. Figure 8 provides an illustration of the CFA model.

Figure 8

Initial CFA Model-AMOS®.



The initial model fit with the full scale data is provided in Table 23. The results showed that all GOF measures except AGFI indicated acceptable model fit. An investigation for the presence of outliers followed.

Table 23

Model Fit Indices – Main Study, Initial CFA

Indices	Recommended values	Main Study	Satisfactory
Comparative fit Index (CFI)	≥0.95	0.968	Yes
Goodness of fit Index (GFI)	≥0.90	0.910	Yes
Adjusted Goodness of fit Index (AGFI)	≥0.90	0.892	No
Normed Fit Index (NFI)	≥0.90	0.944	Yes
Root Mean Square Error of Approximation (RMSEA)	≤0.05	0.042	Yes
Normed Chi-Square (χ2 /df or CMIN/df)	1<χ2/df<3	2.275	Yes

The main study data was evaluated for the presence of outliers using the Mahalanobis distance (D^2). The Mahalanobis distance was calculated for all observed items to determine the observations farthest from the centroid. The outlier analysis found indications of significant outliers since 13 cases exhibited a Mahanobis-D^2 value above 100. As a result, these cases were deleted, and the CFA run a second time. Table 24 provides the GOF measures for the revised data set with these outliers removed. Removal of the outliers improved all GOF measures. However, AGFI remained below the recommended threshold. Thus, a post hoc analysis was performed since the model fit was not entirely satisfactory.

Table 24

Model Fit Indices – Main Study, CFA with Outliers Removed

Indices	Recommended values	Main Study	Satisfactory
Comparative fit Index (CFI)	≥0.95	0.974	Yes
Goodness of fit Index (GFI)	≥0.90	0.916	Yes
Adjusted Goodness of fit Index (AGFI)	≥0.90	0.899	No
Normed Fit Index (NFI)	≥0.90	0.950	Yes
Root Mean Square Error of Approximation (RMSEA)	≤0.05	0.039	Yes
Normed Chi-Square (χ2 /df or CMIN/df)	1<χ2/df<3	2.077	Yes

Modification indices were considered in order to identify unfavorable factor loadings in which variables are correlated with other constructs (Hair et al., 2013), indicating a cross-loading condition. Only covariances between two error terms and correlations between an item and a factor were considered. The highest MI value observed (31.022) was between two error terms (e34 and e35) which are related to items BI2 and BI3. A covariance was added to the model between e34 and e35, and the CFA was run model again. The resulting model fit is shown in Table 25 and resulted in an improvement of all GOF indices and increased AGFI above the required threshold. As a result, further model modifications were deemed unnecessary. The final CFA model is provided as Figure 9.

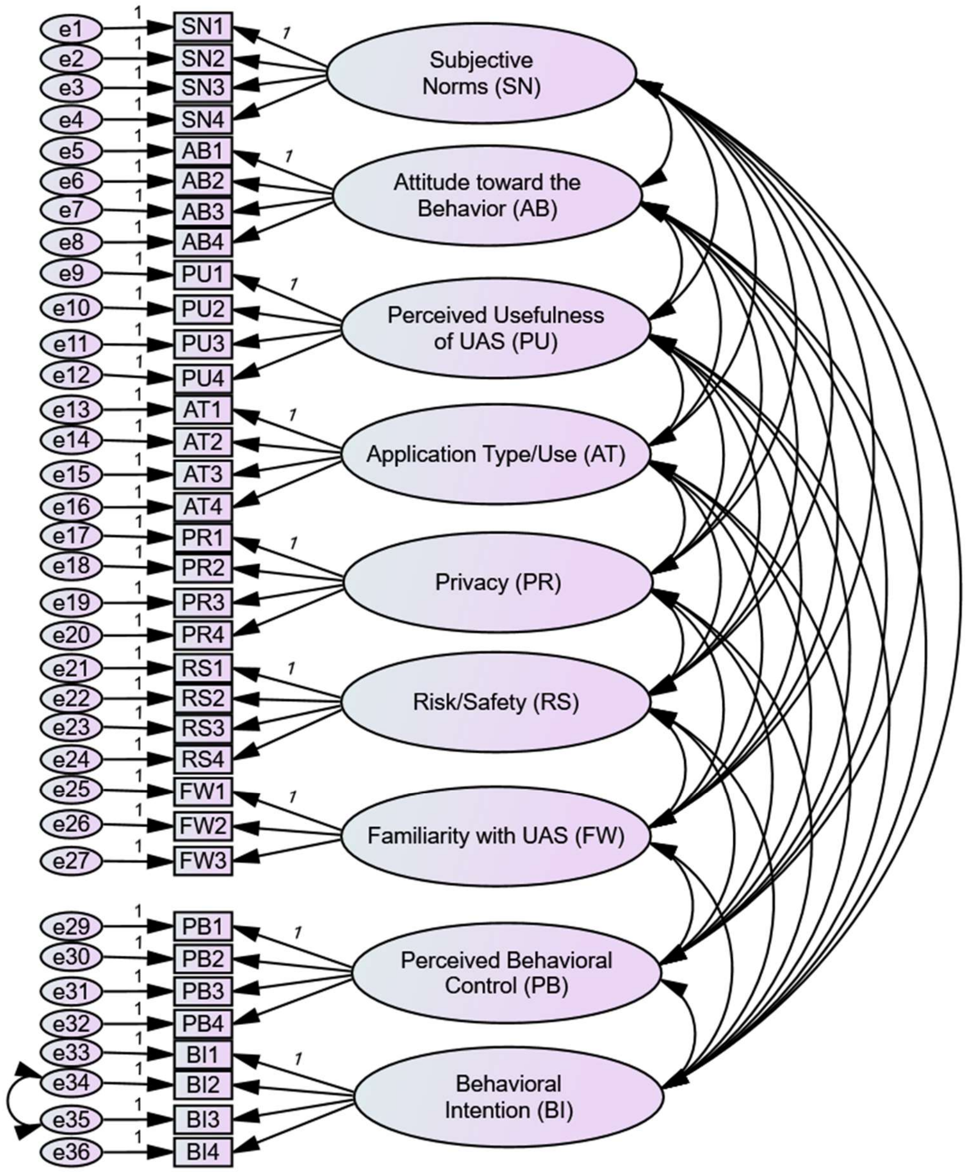
Table 25

Model Fit Indices – Main Study, CFA with Error Terms e34 and e35 Covaried

Indices	Recommended values	Main Study	Satisfactory
Comparative fit Index (CFI)	≥0.95	0.976	Yes
Goodness of fit Index (GFI)	≥0.90	0.921	Yes
Adjusted Goodness of fit Index (AGFI)	≥0.90	0.905	Yes
Normed Fit Index (NFI)	≥0.90	0.953	Yes
Root Mean Square Error of Approximation (RMSEA)	≤0.05	0.037	Yes
Normed Chi-Square (χ2 /df or CMIN/df)	1<χ2/df<3	1.960	Yes

Figure 9

Final CFA Model – AMOS®



Reliability and Validity Testing

The full scale data collection responses were evaluated with respect to reliability and validity criteria. These criteria included factor loadings, Cronbach's Alpha, composite reliability, average value extracted, and maximum shared variance. The reliability and validity results of the main dataset are provided in Table 26.

The results of the full scale data analysis revealed that reliability was substantially improved with the final survey instrument. With regard to internal reliability, all items correlated with their respective factors above 0.762. For all factors, Cronbach's Alpha measured above the threshold of 0.7, indicating no need to examine the components for modification or possible deletion. In addition, the composite reliability for all factors was above the 0.7 threshold.

With regard to validity, the results for the full scale data collection indicated that AVE values for all factors were above the 0.5 threshold, indicating no issues with convergent validity. In addition, the MSV values for all factors were below their respective AVE indicating adequate discriminant validity. The full scale data collection yielded adequate and acceptable measures of reliability and validity which indicated there was no need to further modify the instrument.

Table 26

Reliability and Validity Results – Main Study

Construct / Variable	Survey Item	Factor Loading	CR (≥0.7)	Cronbach's Alpha (≥0.7)	AVE (≥0.5)	MSV (<AVE)
Attitudes toward Behavior (AB)	AB1 AB2 AB3 AB4	0.905 0.917 0.904 0.859	0.932	0.942	0.8038	0.599
Subjective Norms (SN)	SN1 SN2 SN3 SN4	0.932 0.936 0.920 0.785	0.932	0.938	0.8018	0.497
Perceived Behavioral control (PB)	PB1 PB2 PB3 PB4	0.772 0.871 0.806 0.827	0.919	0.890	0.672	0.075
Perceived Usefulness of UAS (PU)	PU1 PU2 PU3 PU4	0.849 0.861 0.875 0.808	0.952	0.911	0.7202	0.088
Application Type/Use of UAS (AT)	AT1 AT2 AT3 AT4	0.866 0.848 0.850 0.789	0.916	0.904	0.7035	0.044
Privacy (PR)	PR1 PR2 PR3 PR4	0.762 0.850 0.922 0.930	0.916	0.920	0.7545	0.311
Risk/Safety of UAS (RS)	RS1 RS2 RS3 RS4	0.767 0.808 0.811 0.861	0.880	0.884	0.6600	0.311
Familiarity with UAS (FW)	FW1 FW2 FW3	0.866 0.861 0.854	0.891	0.895	0.7402	0.067
Behavioral Intention (BI) to complain about UAS noise	BI1 BI2 BI3 BI4	0.943 0.919 0.929 0.928	0.959	0.965	0.8645	0.599

Discriminant validity was evaluated using the Fornell and Larcker (1981) method which compares the square root of the AVE estimates to correlation estimates between factor pairs. This method of testing discriminant validity showed the model demonstrated acceptable discriminant validity for all factors. Table 27 provides the discriminant validity for the final CFA model showing the square root of the AVE estimates in bold and the inter-factor correlation estimates.

Table 27

Discriminant Validity Results - Main Study

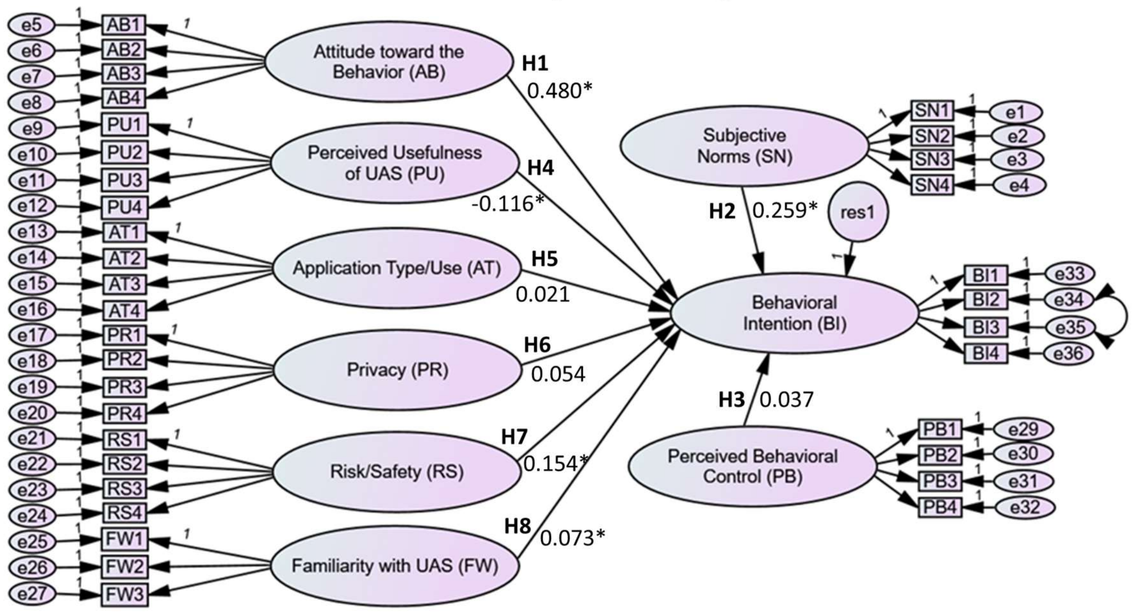
	FW	SN	AB	PU	AT	PR	RS	PB	BI
FW	**0.860**								
SN	0.124	**0.895**							
AB	0.127	0.670	**0.897**						
PU	0.259	-0.176	-0.164	**0.849**					
AT	0.131	0.196	0.209	0.202	**0.839**				
PR	-0.015	0.318	0.338	-0.132	0.157	**0.869**			
RS	-0.087	0.469	0.447	-0.297	0.183	0.558	**0.812**		
PB	0.222	0.051	0.041	0.273	0.152	0.105	0.056	**0.820**	
BI	0.133	0.705	0.774	-0.260	0.200	0.406	0.554	0.072	**0.930**

Structural Equation Model

Following the CFA, the next step in the analysis process was the development and execution of a full structural model in order to facilitate evaluation of the hypotheses. Structural models are often developed by modifying a CFA measurement model. The full structural model was developed by adding an error term to the endogenous factor (BI), adding one-way arrows representing the hypothesized relationships between the appropriate factors, and adding covariances between exogenous factors. The full structural model developed for this analysis is provided as Figure 10. Please note that the factor covariance arrows have been removed for clarity.

Figure 10

Full Structural Model with Standardized Regression Weights



Note. (Covariance arrows removed for clarity). * Indicates significant relationships at the $p < .05$ level.

The full structural model was executed in IBM AMOS® 27. GOF results for the full structural model were satisfactory as all criteria were met. Table 28 provides model fit results for the full structural model. Since the model fit was satisfactory, a post hoc analysis was not necessary. The squared multiple correlation (R^2) for the endogenous dependent factor (BI) was 0.708, indicating how much of the variance in factor BI is accounted for by the exogenous independent factors.

Table 28

Model Fit Indices – Full Structural Model

Indices	Recommended values	Main Study	Satisfactory
Comparative fit Index (CFI)	≥0.95	0.976	Yes
Goodness of fit Index (GFI)	≥0.90	0.921	Yes
Adjusted Goodness of fit Index (AGFI)	≥0.90	0.905	Yes
Normed Fit Index (NFI)	≥0.90	0.953	Yes
Root Mean Square Error of Approximation (RMSEA)	≤0.05	0.037	Yes
Normed Chi-Square (χ2 /df or CMIN/df)	1<χ2/df<3	1.960	Yes

The values of the covariances between the exogenous varuables are provided in Table 29. The largest statistically significant covariance results for the structural model without moderation factors were between AB and SN (0.607) and PR and RS (0.488). The weakest statistically significant covariance results were between PR and FW (-0.014) and AB and PB (0.028).

Table 29

Covariances Between Exogenous Variables – Full Structural Model

Relationship			Estimate	S.E.	C.R.	P
AB	<-->	AT	0.143	0.029	4.938	***
AB	<-->	FW	0.103	0.034	3.057	0.002
AB	<-->	PB	0.028	0.028	0.998	0.318
AB	<-->	PR	0.32	0.041	7.887	***
AB	<-->	PU	-0.091	0.023	-3.96	***
AB	<-->	RS	0.352	0.037	9.621	***
AT	<-->	FW	0.085	0.028	3.088	0.002
AT	<-->	PB	0.083	0.023	3.555	***
AT	<-->	PR	0.119	0.032	3.776	***
AT	<-->	RS	0.116	0.027	4.255	***
e35	<-->	e34	0.066	0.01	6.862	***

Relationship			Estimate	S.E.	C.R.	P
FW	<-->	PB	0.144	0.028	5.098	***
PR	<-->	FW	-0.014	0.037	-0.366	0.714
PR	<-->	PB	0.08	0.031	2.544	0.011
PR	<-->	RS	0.488	0.042	11.565	***
PU	<-->	AT	0.09	0.019	4.703	***
PU	<-->	FW	0.135	0.023	5.899	***
PU	<-->	PB	0.121	0.02	6.182	***
PU	<-->	PR	-0.081	0.025	-3.196	0.001
PU	<-->	RS	-0.152	0.023	-6.669	***
RS	<-->	FW	-0.065	0.032	-2.047	0.041
RS	<-->	PB	0.035	0.027	1.322	0.186
SN	<-->	AB	0.607	0.045	13.388	***
SN	<-->	AT	0.142	0.03	4.69	***
SN	<-->	FW	0.107	0.035	3.013	0.003
SN	<-->	PB	0.037	0.03	1.253	0.21
SN	<-->	PR	0.319	0.042	7.557	***
SN	<-->	PU	-0.103	0.024	-4.266	***
SN	<-->	RS	0.392	0.039	10.175	***

Moderation Analysis

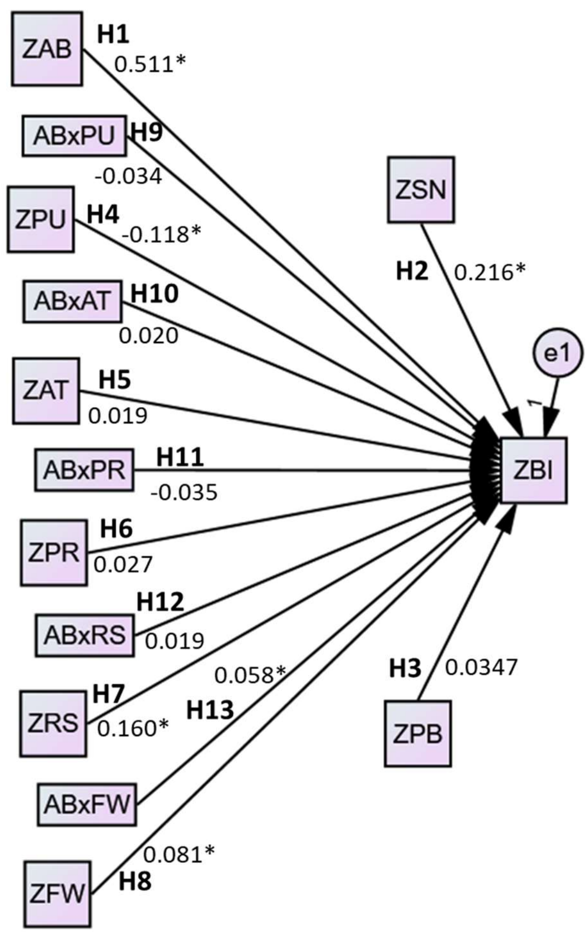
Following the development and execution of the full structural model, an additional structural model was developed for use in determining if there were moderating relationships or interactions effects between certain latent factors. The moderation analysis was intended to determine if there are interactions between certain IVs (PU, AT, PR, RS, FA, and AB) and the DV(BI) (Vogt et al., 2014).

The moderation analysis required a multi-step process using IBM AMOS® 27. The first step required the creation of composite factors from the latent factors through regression imputation. Subsequently, these composite factors were saved as standardized variables denoted with a leading 'Z' appended to the prior two letter designation. Next, additional moderator variables were created as the product of the new standardized variables (Kline, 2011; Williams, Vandenberg, & Edwards, 2009) and include ABxPU, ABxAT, ABxPR, ABxRS, and ABxFW. Note that the leading ‘Z’s were dropped from product terms for clarity.

The standardized composite factors and the product terms were used to create the full structural model with interaction variables. The full structural model with moderating factors developed for this analysis is provided as Figure 11. Please note that the factor covariance arrows have been removed for clarity. For the structural model with moderating factors, the squared multiple correlation (R^2) for the endogenous dependent factor (BI) was 0.729.

Figure 11

Full Structural Model with Moderating Factors and Standardized Regression Weights



Note. * Indicates significant at the $p < .05$ level.

For the full structural model with interaction variables the values of the covariances between the exogenous varuables are provided in Table 30. The largest statistically significant covariance results for the structural model with moderation factors were between ABxPR and ABxRS (0.838), ZAB and ZSN (0.701), and ZPR and ZRS (0.6). The weakest statistically significant covariance results were between ZPU and ABxPU (0.006), ZAT and ABxPR (0.008) and ZPR and ABxAT (0.008).

Table 30

Covariances Between Exogenous Variables – Full Structural Model with Moderating Factors

Relationship			Estimate	S.E.	C.R.	P
ZAB	<-->	ABxAT	0.186	0.047	3.992	***
ZAB	<-->	ABxFW	0.185	0.043	4.26	***
ZAB	<-->	ABxPR	0.121	0.041	2.917	0.004
ZAB	<-->	ABxPU	0.146	0.043	3.407	***
ZAB	<-->	ABxRS	0.169	0.044	3.879	***
ZAB	<-->	ZAT	0.224	0.039	5.785	***
ZAB	<-->	ZFW	0.137	0.038	3.6	***
ZAB	<-->	ZPB	0.045	0.038	1.188	0.235
ZAB	<-->	ZPR	0.357	0.04	8.905	***
ZAB	<-->	ZPU	-0.176	0.038	-4.603	***
ZAB	<-->	ZRS	0.482	0.042	11.511	***
ZAB	<-->	ZSN	0.701	0.046	15.197	***
ZAT	<-->	ABxAT	-0.113	0.046	-2.438	0.015
ZAT	<-->	ABxFW	0.139	0.043	3.223	0.001
ZAT	<-->	ABxPR	0.008	0.041	0.2	0.841
ZAT	<-->	ABxPU	0.168	0.043	3.903	***
ZAT	<-->	ABxRS	-0.03	0.043	-0.688	0.491
ZAT	<-->	ZFW	0.145	0.038	3.79	***
ZAT	<-->	ZPB	0.167	0.038	4.368	***
ZAT	<-->	ZPR	0.169	0.038	4.421	***
ZAT	<-->	ZRS	0.201	0.038	5.218	***
ZAT	<-->	ZSN	0.209	0.039	5.43	***
ZFW	<-->	ABxAT	0.139	0.046	3	0.003
ZFW	<-->	ABxFW	-0.088	0.043	-2.045	0.041
ZFW	<-->	ABxPR	0.07	0.041	1.71	0.087
ZFW	<-->	ABxPU	-0.027	0.043	-0.638	0.523
ZFW	<-->	ABxRS	0.161	0.044	3.706	***
ZPB	<-->	ABxAT	0.1	0.046	2.154	0.031
ZPB	<-->	ABxFW	0.017	0.043	0.399	0.69
ZPB	<-->	ABxPR	0.162	0.042	3.886	***
ZPB	<-->	ABxPU	-0.061	0.043	-1.441	0.15
ZPB	<-->	ABxRS	0.198	0.044	4.514	***
ZPB	<-->	ZFW	0.245	0.039	6.315	***
ZPB	<-->	ZPR	0.114	0.038	2.997	0.003
ZPB	<-->	ZRS	0.061	0.038	1.621	0.105
ZPB	<-->	ZSN	0.055	0.038	1.464	0.143
ZPR	<-->	ABxAT	0.008	0.046	0.179	0.858

Relationship			Estimate	S.E.	C.R.	P
ZPR	<-->	ABxFW	0.07	0.043	1.641	0.101
ZPR	<-->	ABxPR	-0.159	0.042	-3.826	***
ZPR	<-->	ABxPU	0.127	0.043	2.972	0.003
ZPR	<-->	ABxRS	-0.067	0.043	-1.542	0.123
ZPR	<-->	ZFW	-0.016	0.038	-0.427	0.669
ZPR	<-->	ZRS	0.6	0.044	13.628	***
ZPU	<-->	ABxAT	0.168	0.047	3.607	***
ZPU	<-->	ABxFW	-0.027	0.043	-0.633	0.527
ZPU	<-->	ABxPR	0.127	0.041	3.071	0.002
ZPU	<-->	ABxPU	0.006	0.043	0.141	0.888
ZPU	<-->	ABxRS	0.13	0.043	3.005	0.003
ZPU	<-->	ZAT	0.218	0.039	5.653	***
ZPU	<-->	ZFW	0.282	0.039	7.192	***
ZPU	<-->	ZPB	0.298	0.039	7.556	***
ZPU	<-->	ZPR	-0.142	0.038	-3.717	***
ZPU	<-->	ZRS	-0.324	0.04	-8.154	***
ZPU	<-->	ZSN	-0.188	0.038	-4.896	***
ZRS	<-->	ABxAT	-0.03	0.046	-0.644	0.519
ZRS	<-->	ABxFW	0.161	0.043	3.73	***
ZRS	<-->	ABxPR	-0.067	0.041	-1.617	0.106
ZRS	<-->	ABxPU	0.13	0.043	3.048	0.002
ZRS	<-->	ABxRS	-0.035	0.043	-0.818	0.414
ZRS	<-->	ZFW	-0.094	0.038	-2.485	0.013
ZSN	<-->	ABxAT	0.103	0.046	2.228	0.026
ZSN	<-->	ABxFW	0.206	0.044	4.727	***
ZSN	<-->	ABxPR	0.026	0.041	0.63	0.529
ZSN	<-->	ABxPU	0.154	0.043	3.599	***
ZSN	<-->	ABxRS	0.057	0.043	1.326	0.185
ZSN	<-->	ZFW	0.134	0.038	3.508	***
ZSN	<-->	ZPR	0.334	0.04	8.395	***
ZSN	<-->	ZRS	0.503	0.042	11.902	***
ABxAT	<-->	ABxFW	0.394	0.054	7.246	***
ABxAT	<-->	ABxPR	0.229	0.051	4.505	***
ABxAT	<-->	ABxRS	0.306	0.054	5.685	***
ABxPR	<-->	ABxFW	0.091	0.047	1.939	0.053
ABxPR	<-->	ABxRS	0.838	0.057	14.795	***
ABxPU	<-->	ABxAT	0.44	0.054	8.072	***
ABxPU	<-->	ABxFW	0.436	0.051	8.558	***
ABxPU	<-->	ABxPR	-0.218	0.047	-4.629	***
ABxPU	<-->	ABxRS	-0.341	0.05	-6.781	***
ABxRS	<-->	ABxFW	0.014	0.049	0.292	0.77

Hypothesis Testing

Following creation and execution of the full structural model and the full structural model with moderating factors, the original hypotheses were able to be tested. For purposes of this study, there were two thresholds for establishing the existence of a statistically significant relationship between variables. First, the absolute value of the Critical Ratio (C.R.) (also *t*-value) must have been greater than 1.96 (Byrne, 2010). Second, the *p*-value must have been less than 0.05 so that the null hypothesis could be rejected in favor of the alternative hypothesis.

The testing results of the full structural model is discussed first followed by the results of the full structural model with moderating factors. In general, a portion of the hypotheses were supported while a portion were not.

The full structural model which did not include moderating interactions provided results from which only hypotheses 1-8 can be evaluated since the remaining hypotheses pertain to moderation. Results, including both standardized and non standardized estimates for the full structural model are provided in Table 31. The results indicate that hypotheses 1, 2, 4, and 7 were supported while hypotheses 3, 5, 6, and 8 were not supported.

Table 31

Hypothesis Testing Results – Full Structural Model

#	Relationship	Un-Standardized Estimate	*Standardized Estimate*	C.R.	P	Rationale
H1	BI <-- AB	0.516	0.480	13.327	***	Supported
H2	BI <-- SN	0.262	0.259	7.532	***	Supported
H3	BI <-- PB	0.049	0.037	1.410	0.159	Not Supported: Not Significant
H4	BI <-- PU	-0.193	-0.116	-4.083	***	Supported
H5	BI <-- AT	0.028	0.021	0.809	0.419	Not Supported: Not Significant
H6	BI <-- PR	0.053	0.054	1.843	0.065	Not Supported: Not Significant
H7	BI <-- RS	0.179	0.154	4.379	***	Supported
H8	BI <-- FW	0.083	0.073	2.774	0.006	Not Supported: Effect Opposite from hypothesized

Hypothesis 1 (Individuals' attitudes toward complaining about UAS noise [Attitudes toward Behavior (AB)] are positively related to individuals' Behavioral Intentions (BI) to complain about UAS noise) was supported since C.R.=13.327 (C.R.>1.96), and $p < 0.001$ ($p < 0.05$). This result suggests that a one-point increase in attitude toward complaining about UAS noise leads to an increase in an individual's behavioral intention to complain about UAS noise by 0.516.

Hypothesis 2 (Individuals' perceived social pressure to complain about UAS noise [Subjective Norms (SN)] are positively related to individuals' Behavioral Intentions (BI) to complain about UAS noise) was supported since C.R.=7.532 (C.R.>1.96), and $p < 0.001$ ($p < 0.05$). This result suggests that a one-point increase in an individual's perceived social pressure to complain about UAS noise leads to an increase in an individual's behavioral intention to complain about UAS noise by 0.262.

Hypothesis 3 (Individuals' perceived ease of complaining about UAS noise [Perceived Behavioral control (PB)] is positively related to individuals' Behavioral Intentions (BI) to complain about UAS noise) was not supported. The hypothesized effect was not statistically significant ($p = 0.159$) which suggests that an individual's perceived ease of complaining about UAS noise is not a significant factor in actually complaining about UAS noise.

Hypotheses Incorporating Extended Factors. Hypothesis 4 (Perceived Usefulness of UASs (PU) is negatively related to individuals' Behavioral Intentions (BI) to complain about UAS noise) was supported since C.R.=-4.083 (|C.R.|>1.96), and $p < 0.001$ ($p < 0.05$). This result suggests that a one-point increase in an individual's perceived usefulness of UAS leads to a decrease in an individual's behavioral intention to complain about UAS noise by 0.193.

Hypothesis 5 (Individuals' perceptions of Application Type (use) of UASs (AT) is negatively related to individuals' Behavioral Intentions (BI) to complain about UAS noise) was not supported. The hypothesized effect was not statistically significant ($p = 0.419$) which suggests that an individual's perceptions regarding the application type (use) of UASs is not a significant factor in actually complaining about UAS noise.

Hypothesis 6 (Privacy (PR) concerns are positively related to individuals' Behavioral Intentions (BI) to complain about UAS noise) was not supported. The hypothesized effect was not statistically significant ($p = 0.065$) which suggests that an individual’s concerns that UAS may violate their privacy are not a significant factor in actually complaining about UAS noise.

Hypothesis 7 (Individuals’ perceptions of UASs Risks to Safety (RS) is positively related to individuals’ Behavioral Intentions (BI) to complain about UAS noise) was supported since C.R.=4.379 (C.R.>1.96), and $p < 0.001$ ($p < 0.05$). This result suggests that a one-point increase in an individual’s perception of how UAS might pose a risk to their safety leads to an increase in an individual’s behavioral intention to complain about UAS noise by 0.179.

Hypothesis 8 (Familiarity with UASs (FW) is negatively related to individuals’ Behavioral Intentions (BI) to complain about UAS noise) was not supported. While the result was statistically significant since C.R.=2.774 (C.R.>1.96) and $p = 0.006$ ($p < 0.05$), the direction of the relationship was opposite the hypothesis. The result suggests that a one-point increase in an individual’s familiarity with UAS leads to an increase in an individual’s behavioral intention to complain about UAS noise by 0.083.

The full structural model with moderating factors provided results to evaluate hypotheses 9-13 which pertain to moderation effects. The results can also be compared to the results of the full structural model without moderating factors to confirm the results of hypotheses 1-8. Results for the full structural model with moderating factors are provided in Table 32. The results indicate that hypotheses 9-13 were not supported and also confirms the results of the full structural model without moderating interations in that hypotheses 1, 2, 4, and 7 were supported, while hypotheses 3, 5, 6, and 8 were not supported.

Table 32

Hypothesis Testing Results – Full Structural Model with Moderating Factors

H	Relationship			Un-Standardized Estimate	Standardized Estimate	S.E.	C.R.	P	Rationale
1	ZBI	<---	ZAB	0.500	0.511	0.032	15.632	***	Supported
2	ZBI	<---	ZSN	0.211	0.216	0.031	6.876	***	Supported
3	ZBI	<---	ZPB	0.033	0.0347	0.023	1.450	0.147	Not Supported: Not Significant
4	ZBI	<---	ZPU	-0.116	-0.118	0.025	-4.605	***	Supported
5	ZBI	<---	ZAT	0.018	0.019	0.023	0.773	0.440	Not Supported: Not Significant
6	ZBI	<---	ZPR	0.027	0.027	0.027	1.000	0.317	Not Supported: Not Significant
7	ZBI	<---	ZRS	0.157	0.160	0.030	5.157	***	Supported
8	ZBI	<---	ZFW	0.079	0.081	0.023	3.440	***	Not Supported: Effect Opposite from hypothesized
9	ZBI	<---	ABxPU	-0.030	-0.034	0.022	-1.352	0.176	Not Supported: Not Significant
10	ZBI	<---	ABxAT	0.016	0.020	0.020	0.796	0.426	Not Supported: Not Significant
11	ZBI	<---	ABxPR	-0.031	-0.0354	0.026	-1.183	0.237	Not Supported: Not Significant
12	ZBI	<---	ABxRS	0.017	0.019	0.026	0.634	0.526	Not Supported: Not Significant
13	ZBI	<---	ABxFW	0.050	0.058	0.020	2.476	0.013	Not Supported: Effect Opposite from hypothesized

Hypotheses Related to Moderating Relationships. Hypothesis 9 (The relationship between Perceived Usefulness of UASs (PU) and Behavioral Intention (BI) to complain about UAS noise is strengthened by Attitude toward Behavior (AB) to complain about UAS noise, where BI is further reduced as AB increases) was not supported. The hypothesized effect was not statistically significant ($p = 0.176$) which suggests the relationship between an individual's perceived usefulness of UAS and their intention to complain about UAS noise is not strengthened by their attitude toward complaining about UAS noise.

Hypothesis 10 (The relationship between Application Type (use) of UASs and Behavioral Intention (BI) to complain about UAS noise is strengthened by Attitude toward Behavior (AB) to complain about UAS noise, where BI is further reduced as AB increases) was not supported. The hypothesized effect was not statistically significant ($p = 0.426$) which suggests that the relationship between an individual's perceptions regarding the application type (use) of UASs and their intention to complain about UAS noise is not strengthened by their attitude toward complaining about UAS noise.

Hypothesis 11 (The relationship between Privacy (PR) and Behavioral Intention (BI) to complain about UAS noise is strengthened by Attitude toward Behavior (AB) to complain about UAS noise, where BI is further reduced as AB increases) was not supported. The hypothesized effect was not statistically significant ($p = 0.237$) which suggests that the relationship between an individual's concerns that UAS may violate their privacy and their intention to complain about UAS noise is not strengthened by their attitude toward complaining about UAS noise.

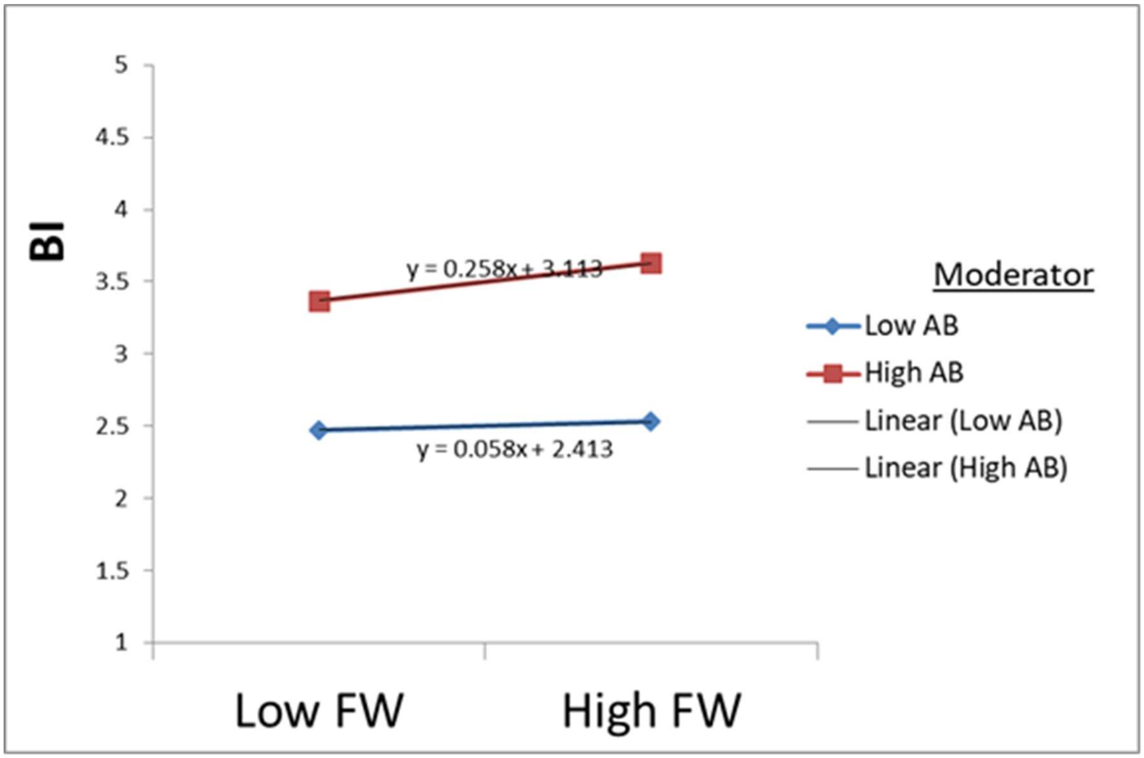
Hypothesis 12 (The relationship between Individuals' perceptions of Risk to personal Safety (RS) and Behavioral Intention (BI) to complain about UAS noise is strengthened by the moderating effect of Attitude toward Behavior (AB) to complain about UAS noise, where BI is further reduced as AB increases) was not supported. The hypothesized effect was not statistically significant (p = 0.526) which suggests that the relationship between an individual's perception of how UAS might pose a risk to their safety and their intention to complain about UAS noise is not strengthened by their attitude toward complaining about UAS noise.

Hypothesis 13 (The relationship between Familiarity with UASs (FW) and Behavioral Intention (BI) to complain about UAS noise is strengthened by the moderating effect of Attitude toward Behavior (AB) to complain about UAS noise, where BI is further reduced as AB increases) was not supported. While the result was statistically significant since C.R.=2.476 (C.R.>1.96) and p = 0.013 ($p < 0.05$), the direction of the relationship was opposite of the hypothesis. The result suggests that the relationship between an individual's familiarity with UAS and their intention to complain about UAS noise is strengthened by their attitude toward complaining about UAS noise. Said differently, an individual's attitude toward complaining about UAS noise strengthens the positive relationship between their familiarity with UAS and the intent to complain about UAS noise.

A graphical representation of the interaction effects between FW, BI, and AB is provided as Figure 12. An increase in AB manifests as an increase in BI. Additionally, an increase in AB leads to an increase in BI, as FW increases.

Figure 12

Interaction Effects: How AB Effects Relationship Between FW and BI



Model Comparison

The model fit parameters for the full structural model with and without interaction effects were compared. Table 33 provides model fit results for both models. GOF results for the full structural model were satisfactory, as all criteria were met. The GOF results for the full structural model with interaction effects showed that most of the criteria were met except that the model exceeded the recommended criteria for the RMSEA (0.054) (≤ 0.05) and Normed Chi-Square (3.031) (1 < CMIN/df > 3) indices.

Table 33

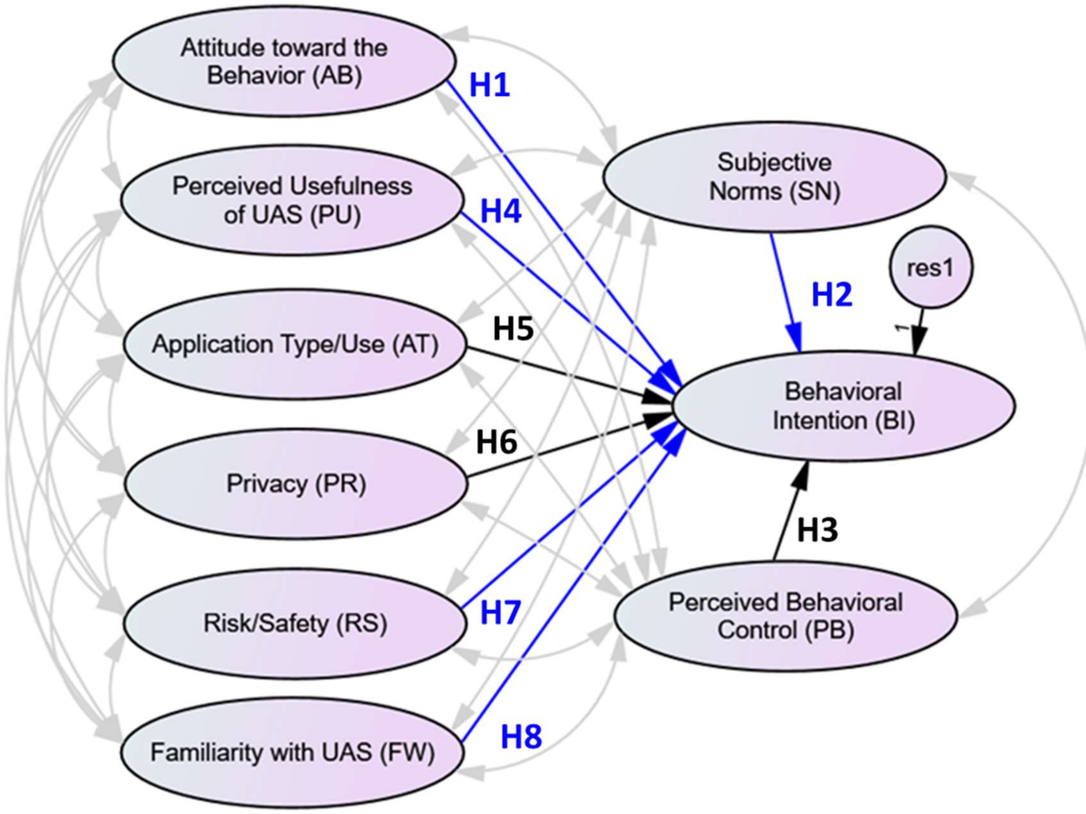
Model Fit Indices – Full Structural Model with and without Interaction Effects

Indices	Recommended values	Main Study	Main Study with Interaction
Comparative fit Index (CFI)	≥0.95	0.976	0.988
Goodness of fit Index (GFI)	≥0.90	0.921	0.978
Adjusted Goodness of fit Index (AGFI)	≥0.90	0.905	0.917
Normed Fit Index (NFI)	≥0.90	0.953	0.982
Root Mean Square Error of Approximation (RMSEA)	≤0.05	0.037	0.054
Normed Chi-Square (χ^2 /df or CMIN/df)	$1<\chi^2/df<3$	1.960	3.031

The full structural model which considered interaction effects confirmed the results of the unaltered FSM. It also identified only one possible interaction (FW, AB) which was a modest effect (0.058), and the interaction model violated both the RMSEA and Normed Chi-Square criteria. Thus for purposes of parsimony, the preferred model is the full structural model without interaction effects. The preferred model with significant paths noted in blue is provided as Figure 13 below.

Comparing the models using Akaike's Information Criteria (AIC) and Bayesian Information Criteria (BIC) was considered. However, both calculations include the number of model parameters making them sensitive to parameter count. The moderation model required imputation to create the interaction variables resulting in a substantial variation in the number of parameters in the models. Thus, AIC and BIC were not used as measures of parsimony in this study.

Figure 13
Final Full Structural Model with Significant Paths in Blue



Summary

The focus of this chapter was to present the results of the analysis. The primary results relate to the pilot studies, modification of the instrument, the full scale data collection for the main study, analysis of the main study data, evaluation of the CFA and full structural models, and evaluation of the hypotheses. This section summarizes these results.

Pilot studies were completed to establish face validity of the initial instrument in addition to its reliability and validity. An initial SME review of the proposed instrument indicated there was sufficient face validity to proceed with a pilot study. The results of the first pilot study indicated that changes to the instrument were warranted. After minor changes to the initial instrument were made, a second pilot study was completed. The results of the second pilot study indicated more substantive changes to the instrument were warranted, primarily to improve validity. Therefore, a revised instrument was developed for the full scale data collection effort.

The full scale data collection for the main study was completed on a sampling frame which included respondents who were at least 18 years old with a U.S.-registered Amazon® Mechanical Turk® account. Responses to the HIT request which contained the revised main study instrument exceeded the number requested. The main data collection HIT requested 700 responses in order to accommodate the calculated minimum sample size (n = 460), and 788 total responses were collected.

Following analysis and culling of the raw full scale data, a net useable dataset of 714 cases was retained. Demographics results indicated that full scale data collection respondents were predominantly in the 20-40 year old traunch, were more highly educated, and earned more money than average for the U.S. population. The respondents were fairly representative of the U.S. population with regard to gender and environs. Race demographics for the full scale data collection showed that, in relation to the broader U.S. population, there was higher participation by those reporting to be Asian or White. Descriptive statistics were developed for the full scale data including measures of central tendency (mean, median, mode), dispersion (standard deviation) and symmetry (skewness, kurtosis).

Reliability and validity analyses of the full scale data were completed using results of the CFA model. For the full scale data, all measures (factor loadings, CR, Cronbach's alpha, AVE, MSV) indicated acceptable reliability and validity. However, the CFA model did not satisfy all GOF measures, which necessitated a post-hoc analysis.

The post-hoc analysis indicated that 13 cases were significant outliers. Upon removal of these outliers, the GOF measures improved marginally, but one measure remained unsatisfactory. Modification indices were then used to identify a covariance between error terms (e34 and e35) related to items BI2 and BI3. A covariance was added between the error terms. The resulting analysis with the revised CFA model indicated that all GOF measures were satisfactory.

The full structural model was then developed and executed. The results of the structural model were consistent with the revised CFA model with regard to acceptable GOF indices. An additional structural model was also developed to test for moderating interaction effects. The structural model including moderation effects was developed through multiple steps including regression imputation, variable standardization, and creation of interaction product variables. These two structural models were subsequently used for hypothesis testing.

Testing for hypotheses 1 though 8 was completed with the full structural model. Testing for hypotheses 9 through 13, which related to moderating interactions, was completed with the full structural model with interaction factors added. The results indicate there was support for four hypotheses (H1, H2, H4, and H7), while nine (H3, H5, H6, H8, H9, H10, H11, H12, and H13) were not supported.

Two of the unsupported hypotheses relate to relationships that were statistically significant but were not supported since the effect was opposite to that hypothesized (H8 and H13). The full structural model with moderating interaction effects was consistent with the unmodified full structural model in that it also supported the same four hypotheses (H1, H2, H4, and H7). The next chapter provides additional discussion, conclusions (including theoretical and practical contributions), the limitations of the study, and recommendations for extending this research.

Chapter V: Discussion, Conclusions, and Recommendations

The purpose of this research was to examine factors, as included in an extended theory of planned behavior, which influence individuals' intentions to complain about UAS noise. The research questions addressed were: 1) What factors influence individuals' intentions to complain about UAS noise? and 2) How do these factors affect individuals' intentions to complain about the UAS noise? In order to facilitate answers to these questions, a research design was determined, and an analytical model was developed.

Overall, the results indicated there was support for four hypotheses (H1, H2, H4, and H7) where statistically significant effects were noted. Two additional relationships (H8 and H13) were significant but in the opposite direction than initially hypothesized. The remainder of this chapter provides a discussion of the results, reveals conclusions substantiated by the findings, presents the limitations of the study, and provides recommendations for further research.

Discussion

In this section, three major topics are discussed. First, the study demographics are reviewed. Next, the factor results of the full structural models with and without moderating interaction effects are evaluated and related to the literature. Last, answers to the research questions posed are discussed.

Demographics Results

The study collected data for a number of demographic variables. The demographic data collected included age, gender, education level, race, environs (rural, suburban, or urban), and annual income. For the main full study dataset, each demographic variable is discussed and related to averages for the target population.

As noted in the previous chapter, the primary age group of respondents to the main study was 20-40 year olds (50.4%) followed by 40-60 year olds (34.0%). The mean, median, and mode were 42.63, 40.0, and 32.0, respectively, with a standard deviation of 13.934, skewness of 0.511, and kurtosis of -0.624 over a range of 70 spanning 18 to 88. Considering the study required participants to be at least 18 years old, the mean and median age of the respondents is generally consistent with 2019 U.S. Census data, which indicates the average age in the U.S. to be 38.4 years.

The gender demographic for the main study indicated slightly more female respondents (51.4%) than male respondents (47.8%) with the remaining reporting as other (0.7%). When compared to the U.S. population (Female = 50.8%, Male = 49.2%), the differences are arguably negligible.

The education level demographic indicated the majority of respondents were bachelor's degree holders (47.5%) followed by those who have completed high school (29.1%). This result is effectively opposite the measure of the broader U.S. population for bachelor's degree holders (21.3%) and high school graduates (56.1%). Master's degree holders were also more highly represented when compared to the U.S. population averages where survey respondents (20.3%) exceeded the average (9.0%).

Race demographics for the full scale data collection showed the group comprising the most respondents was white (74.3%). There was higher participation by those reporting to be Asian (11.0%) or White (74.3%) when compared to the broader U.S. population (Asian = 5.9%, White = 60.1%). Black or African American and Hispanic, Latino, or Spanish Origin of any Race participation was below their representation in the U.S. population (7.4% vs 13.4% and 3.7% vs 18.5%, respectively).

The environs demographic indicated the majority of respondents reported their environs as suburban (52.2%) followed by urban (27.8%) and then rural (19.8%). The environs demographics for the study align well with the broader U.S. population which reflects suburban (52%) followed by urban (27%) and then rural (21%).

The income demographic indicated the income range most represented by the respondents was from between $25,000-$50,000 per year (28.8%) followed by under $25,000 per year (27.2%) and then between $50,000-$75,000 (18.7%). The mean, median, and mode were $54,708.42, $45,000.00, and $50,000.00, respectively, with a standard deviation of 43,217, skewness of 1.966, and kurtosis of 7.892 over a range from $0 to $400,000. U.S. Census data for 2019 indicate average annual per capita income of $34,103.

Model Results

The model created for use in this study featured eight exogenous variables and one endogenous variable. Of the eight exogenous variables, three were from the traditional TPB (attitude toward the behavior, subjective norms, and perceived behavioral control), one was from the TAM (perceived usefulness), and four were gleaned from the literature (application type/use, privacy, risk-safety, and familiarity with UASs). The endogenous variable was also from the TPB (behavioral intent).

Thirteen hypotheses were evaluated in this study. The first eight hypotheses were related directly to exogenous factor relationships with the endogenous variable, while the remaining five were related to moderating interactions. Hypotheses 1 through 8 were tested with the full structural model. Hypotheses 9 through 13 were tested with the full structural model with moderating interaction factors added.

Four hypotheses (H1, H2, H4, and H7) were supported, and nine hypotheses (H3, H5, H6, H8, and H9-H13) were not. However, for two (H8 and H13) of the nine unsupported hypotheses, the model indicated statistically significant relationships but with effects opposite to the initially hypothesized direction. When the results of the unmodified FSM and the FSM with interaction effects compared, the results were consistent in that they both supported the same four hypotheses (H1, H2, H4, and H7).

Attitudes Toward the Behavior. In this study, the factor *Attitudes toward Behavior* (AB) refers to an individual's attitude toward complaining about UAS noise. It was hypothesized that individuals' attitudes toward complaining about UAS noise was positively related to individuals' behavioral intentions to complain about UAS noise. This hypothesized relationship was supported by the full structural model.

Such a result was not unexpected since AB is a foundational factor in the TPB (Ajzen, 1991). This result is consistent with the literature where attitudes toward a behavior were found to be related to intent to perform the behavior (Bertani et al., 2016; Chen et al., 2017; Delanoë et al., 2016; Donald et al., 2014; Droomers et al., 2016; Dunn et al., 2018; Fang et al., 2017; Goodson, 2002; Heerwegh & Loosveldt, 2009; Hsieh, 2015; Hummel et al., 2017; Lai et al., 2017; Lee & Choi, 2009; Ma et al., 2016; Pan & Truong, 2018; Park & Blenkinsopp, 2009; Rantanen et al., 2018; Teo, 2012). The result is also consistent with the literature where attitudes were found to be related more specifically to intention to complain (Lervik-Olsen et al., 2016; Wang et al., 2019). The results show that individuals with favorable attitudes toward complaining about UAS noise exhibit a greater intent to complain about UAS noise.

Subjective Norms. The factor *Subjective Norms* (SN) is defined as the "perceived social pressure to perform or not to perform the behavior" (Ajzen, 1991, p. 188). In this study, SN refers to an individual's perceived social pressure to complain about UAS noise. It was hypothesized that individuals' perceived social pressure to complain about UAS noise was positively related to their intentions to complain about UAS noise. This hypothesized relationship was supported by the full structural model.

Similar to AB, this result was not unexpected since SN is a foundational factor in the TPB (Ajzen, 1991). This result is consistent with the literature where subjective norms were found to be related to intent to perform the behaviors in question (Bertani et al., 2016; Chen et al., 2017; Delanoë et al., 2016; Dunn et al., 2018; Fang et al., 2017; Heerwegh & Loosveldt, 2009; Lai et al., 2017; Lee & Choi, 2009; Lervik-Olsen et al., 2016; Ma et al., 2016; Pan & Truong, 2018; Park & Blenkinsopp, 2009; Rantanen et al., 2018; Shrestha et al., 2012; Wang et al., 2019). The results of this study were at odds with the findings of Hummel et al. (2017), which indicated subjective norms were not a significant factor related to intent. The results show that participants perceived that others would approve of their act of complaining about UAS noise.

Perceived Behavioral Control. The factor *Perceived Behavioral Control* (PB) is defined as "the perceived ease or difficulty of performing the behavior and it is assumed to reflect past experience as well as anticipated impediments and obstacles' (Ajzen, 1991, p. 188). In this study, PB refers to individuals' perceived ease or difficulty of complaining about UAS noise. It was hypothesized that individuals' perceived ease of complaining about UAS noise was positively related to individuals' behavioral intentions to complain about UAS noise. The hypothesized effect was not supported by the results of the full structural model since the relationship was not statistically significant.

While PB is a foundational factor in the TPB, the literature is mixed with respect to the relevance of the PB factor. The results of the subject study are consistent with a portion of the literature which indicates that PB is not an important factor or that other factors not included in the TPB are more relevant (Aarts & Dijksterhuis, 2000; Bargh & Chartrand, 1999; Brandstatter et al., 2001; Donald et al., 2014; Greenwald & Banaii, 1995; Sniehotta et al., 2014; Uhlmann & Swanson, 2004; Wegner & Wheatley, 1999; Wegner, 2002). The results of the current study are at odds with literature that supports the notion that PB is a relevant factor in the determination of intent (Bertani et al., 2016; Chan et al., 2016; Cortoos et al., 2012; Dunn et al., 2018; Fang et al., 2017; Goodson, 2002; Heerwegh & Loosveldt, 2009; Hummel et al., 2017; Lee & Choi, 2009; Lervik-Olsen et al., 2016; Ma et al., 2016; Park & Blenkinsopp, 2009; Rantanen et al., 2018; Shrestha et al., 2012; Wang et al., 2019). The result of the current study suggests that an individual's perceived ease of complaining about UAS noise is not a significant factor in their behavioral intent to actually complain about UAS noise.

Perceived Usefulness of UASs. The factor *Perceived Usefulness of UASs* (PU) was incorporated into the subject study from the TAM. In the TAM, Davis (1989) proposed perceived usefulness as one of four primary factors related to technology acceptance. Over time, the TAM has become a widely used model in technology acceptance research (Marangunic & Granic, 2015).

In the current model, PU refers to an individual's perception regarding the usefulness of UASs. Since PU comprises an aspect of UAS acceptance, it was hypothesized to also be related to the intention to complain about UAS noise. In this research, it was hypothesized that as the perceived usefulness of UASs increases, the likelihood of an individual intending to complain about UAS noise would decrease. This hypothesized relationship was supported by the full structural model.

The results of the current study were consistent with the literature which indicates the PU is an important factor (Chuttur, 2009; Eißfeldt et al., 2020; Khan et al., 2019; Legris et al., 2003; Ma et al., 2016; Marangunic & Granic, 2015). The results suggest that as an individual's perception regarding the usefulness of UASs increases, their intent to complain about UAS noise decreases.

Application Type/Use of UASs. In this study, *Application Type/Use of UASs* (AT) refers to an individual's perception of the type, purpose, and use of UASs. It was hypothesized that an individual's perceptions of the application type or use of UASs is negatively related to their intention to complain about UAS noise. The hypothesized effect was not supported by the results of the full structural model since the relationship was not statistically significant.

The results of the current study appear to be inconsistent with the literature which notes that public opinion of UASs is often dependent on the perceived purpose, application type, or use of the UAS mission (Anbaroğlu, 2017; Aydin, 2019; Boucher, 2015; Clothier et al., 2015; Eißfeldt et al., 2020; Keller et al., 2018; Nelson et al., 2019; Reddy & DeLaurentis, 2016; Sakiyama et al., 2017, Thipphavong et al., 2018., Vincenzi et al., 2013). The notion behind the hypothesis was that as the perception of the application type or use of the UAS becomes more favorable, the desire to complain about the noise the UAS creates should be expected to decline. However, the result of the current study suggests that an individual's perceptions of the application type or use of UASs is not a significant factor in their behavioral intent to actually complain about UAS noise.

Privacy. For this study, *Privacy* (PR) is considered to be an individual's perception of the potential that UASs could invade their privacy. It was hypothesized that an individual's concerns regarding possible UAS violations of their privacy are positively related to their intent to complain about UAS noise. As the perception of the privacy risks associated with UASs increases, the desire to complain about the noise it creates was also expected to increase. The hypothesized effect was not supported by the results of the full structural model since the relationship was not statistically significant. It should be noted that the result was nearly statistically significant, and further research is recommended on this factor.

Privacy was included as a factor in this study since it was found to be prevalent in the UAS related literature (Aydin, 2019; Clothier et al., 2015; Khan et al., 2019; Lidynia et al., 2017; Motlagh et al., 2016; Nelson et al., 2019; Ramadan et al., 2017; Rao et al., 2016; Sakiyama et al., 2017; Susini, 2015; Thipphavong et al., 2018; Vattapparamban et al., 2016; Vincenzi et al., 2013). The results of the study are inconsistent with the literature where the public's perception of the potential for UAS, especially those with cameras (Aydin, 2019), to violate their privacy affects acceptance (Nelson et al., 2019). The results of the current study indicate that an individual's concerns regarding possible

UAS violations of their privacy are not related to their intent to complain about UAS noise.

Risk/Safety of UASs. The factor *Risk/Safety of UASs* (RS) refers to an individual's perception of the risks to personal safety due to UASs. It was hypothesized that an individual's perceptions of UASs risks to safety are positively related to their intentions to complain about UAS noise. As the perception of risks to safety posed by UASs increases, the desire to complain about the noise they create was expected to increase. The hypothesized effect was supported by the results of the full structural model.

Risk and safety as a combined factor were included in the model used in this study due to its prevalence in the UAS related literature. The literature showed that concerns regarding the risks to safety are significant with respect to UASs (Aydin, 2019; Clothier et al., 2015; Keller et al., 2018; Khan et al., 2019; Lidynia et al., 2017; Ramadan et al., 2017; Rao et al., 2016; Reddy & DeLaurentis, 2016; Susini, 2015; Thipphavong et al., 2018; Vattapparamban et al., 2016; Vincenzi et al., 2013).

The results of the study are consistent with the literature. It suggests that one of the primary UAS related concerns is the perception of the risks to the safety of persons or property. The results suggest that as the perception of risks to safety posed by UASs increases, the desire to complain about the noise they create also increases.

Familiarity with UASs. The factor *Familiarity with UASs* (FW) refers to an individual's familiarity with UASs. It was hypothesized that an individual's familiarity with UASs is negatively related to their intentions to complain about UAS noise. As their familiarity with UASs increases, the desire to complain about the noise they create was expected to decrease. The hypothesized effect was not supported by the results of the full structural model because, although statistically significant, it was opposite to the direction hypothesized.

Familiarity with UASs was included as a factor in the model used in this study due to its prevalence in the UAS related literature. The literature provided multiple studies supporting the development of a factor related to familiarity with UASs (Aydin, 2019; Boucher, 2015; Eißfeldt et al., 2020; Keller et al., 2018; Nelson et al., 2019; Vincenzi et al., 2013). Familiarity with UASs has been demonstrated to be a factor related to UAS acceptance. As individuals gain greater familiarity with UASs, their acceptance of UASs would be expected to improve, and their propensity to complain about UAS noise would be diminished. Thus, familiarity with UASs was considered a viable factor in this study.

The results of the study are consistent with the literature in that the factor FW was confirmed to be related to individuals' intention to complain about UAS noise. The results were inconsistent with the literature with regard to the direction of the effect. The results suggest that as an individual's familiarity with UAS increase, their intent to complain about the noise they create also increases. A possible explanation might be that some individuals increase their familiarity through negative experiences with UAS, thus as their familiarity increases their propensity to complain about the noise UAS create would increase. It should be noted that the effect, while statistically significant, was not large. Further research is recommended on this factor.

Moderation Effects. The results showed that only one moderating interaction was statistically significant. The effect, however, was opposite to the direction predicted.

The original interaction prediction was that the negative relationship between familiarity with UASs and behavioral intention to complain about UAS noise would be strengthened by the moderating effect of attitude toward the behavior of complaining about UAS noise, where the intent to complain is further reduced as the attitude toward complaining increased. Said more simply, as an individual's attitude became more inclined to complaining about UAS noise, their intent to complain about UAS noise would be dampened as their familiarity with UAS increased.

The result suggests that the relationship between an individual's familiarity with UAS and their intention to complain about UAS noise is strengthened by their attitude toward complaining about UAS noise. An individual's attitude toward complaining about UAS noise strengthens the positive relationship between their familiarity with UAS and the intent to complain about UAS noise. An increase in an individual's attitude toward complaining leads to an increase in their intent to complain, as their familiarity with UAS increases.

Research Question Results

Two primary research questions were posed in this study. The first research question (RQ_1) asked what factors influence individuals' intentions to complain about UAS noise? The second research question (RQ_2) asked how do these factors affect individuals' intentions to complain about the UAS noise?

The answer to research question 1 is revealed in the model results for the first eight hypotheses. Since hypotheses H1, H2, H4, and H7 were supported and H8 was significant while opposite in direction than hypothesized, the model results indicate that five factors influence individuals' intentions to complain about UAS noise. Table 34 provides a summary of these factors.

Table 34

Research Question 1: Factors Which Influence Individuals' Intentions to Complain About UAS Noise

H#	Factor	Source
H1	Attitudes toward complaining about UAS noise	TPB - Attitude
H2	Perceived social pressure to complain about UAS noise	TPB - Subjective Norms
H4	Perceived Usefulness of UASs	TAM - Perceived Usefulness
H7	Perceptions of UASs Risks to Safety	Literature Review
H8	Familiarity with UASs	Literature Review

The model results for all hypotheses reveal the answer to research question 2. Hypotheses H1, H2, H4, and H7 were supported while H8 and H13 were significant while opposite in direction than hypothesized. These results can be categorized as direct (H1, H2, H4, H7, and H8) or moderating interaction (H13) effects.

The factor with the greatest magnitude (0.48) direct positive standardized effect on intention to complain about UAS noise is attitude toward complaining about UAS noise. Perceived social pressure (Subjective Norms) also has a substantial (0.259) direct positive effect on intention to complain about UAS noise. Perceived usefulness of UAS has a substantial (-0.116) negative direct effect on intention to complain about UAS noise. Perceptions of UASs risks to safety has a substantial (0.154) positive direct effect on intention to complain about UAS noise. Familiarity with UASs has a modest (0.073) positive effect on intention to complain about UAS noise.

Only one interaction effect was found to be statistically significant. The resulting effect was counter-intuitive and thus opposite in direction to the hypothesis. The interaction found showed that as familiarity with UAS increases, the positive relationship between attitude and intention is strengthened. Table 35 provides a summary of these factors and interaction effects.

Table 35

Research Question 2: How Factors Influence Individuals' Intentions to Complain About UAS Noise

H#	Factor or Interaction	Standardized Effect Size	Description
H1	Attitudes toward complaining about UAS noise	0.48	Attitude toward complaining about UAS noise has the greatest effect on intention to complain about UAS noise
H2	Perceived social pressure to complain about UAS noise	0.259	Perceived social pressure (Subjective Norms) has a substantial positive effect on intention to complain about UAS noise
H4	Perceived Usefulness of UASs	-0.116	Perceived usefulness of UAS has a substantial negative effect on intention to complain about UAS noise
H7	Perceptions of UASs Risks to Safety	0.154	Perceptions of UASs Risks to Safety has a substantial positive effect on intention to complain about UAS noise
H8	Familiarity with UASs	0.073	Familiarity with UASs has a modest positive effect on intention to complain about UAS noise
H13	Interaction: Attitude and Familiarity with UASs	0.058	As familiarity with UAS increases the positive relationship between attitude and intention is strengthened

Conclusions

An analysis of the results produced by the structural models indicates that five factors influence individuals' intentions to complain about UAS noise. These factors, in order of effect size are: individuals' attitudes toward complaining about UAS noise, perceived social pressure to complain about UAS noise, perceptions of UASs risks to safety, perceived usefulness of UASs, and familiarity with UASs. Other factors investigated which were not statistically significant are individuals' perceived behavioral control, application type/use of UAS, and privacy concerns.

The results of the structural model which included moderating interaction effects indicated that only one interaction was present at a statistically significant level. Attitude toward complaining about UAS noise and familiarity with UASs showed an interaction effect. As familiarity with UAS increases, the positive relationship between attitude toward complaining about UAS noise and intention to complain about UAS noise is strengthened.

The subject research created a capability which can be used to improve our understanding of individuals' intentions to complain about UAS noise and help identify significant contributing factors. There are important theoretical and practical contributions which flow from this effort.

Theoretical Contributions

The primary theoretical contribution of this research is the development of a new theoretical model. The theoretical model combines key factors from the TPB, TAM, and factors gleaned from the literature. The model's primary purpose is to evaluate factors affecting intention to complain about UAS noise.

In the context of this study, the model confirmed the relevance of two factors from the TPB (subjective norms and attitude toward the behavior) and also confirmed the relevance the perceived usefulness factor from the TAM. Of the proposed factors gleaned from the literature, the model confirmed two additional factors relevant to behavioral intent to complain about UAS noise. These two additional factors are an individual's perception of UASs risk to safety and an individual's familiarity with UASs.

The subject research expanded the body of knowledge related to the impacts more extensive exposure of UASs could have on the general public. It identified factors which affect an individual's intention to complain about UAS noise, which further expands the understanding of factors related to UAS acceptance. The study also expands the body of knowledge related to transportation noise generally and aviation related noise more specifically.

The body of knowledge related to the use of the theory of planned behavior is also expanded. This study appears to be the first time the TPB has been applied in an analysis of an individual's intention to complain about UAS noise. In addition, it confirms the validity of attitude and subjective norms as relevant factors in the TPB.

Practical Contributions

Understanding the factors which affect the public's attitude toward complaining about UAS noise informs both government and industry and allows the development of appropriate UAS-related regulations and UAS platforms, which foster the growth of the nascent UAS industry. This research provides a greater understanding of the public reaction to the noise UASs are likely to generate, which informs both government and industry (Eißfeldt, 2020).

Noise complaint behavior is a concern for the FAA and Governments at various levels and this study identifies factors which affect UAS noise complaint behavior. Leveraging that understanding in the development of policy and regulation could help mitigate noise complaint behavior caused by UAS noise. Regulators at the federal, state, and local levels can apply the results of this research to help develop policies related to providing the public information about UASs, aircraft certification standards (including noise), airspace use, aircraft routing, and restrictions to hours of operation.

The model results suggest that providing positive information to the public regarding the usefulness and safety of UAS could reduce UAS noise complaint behavior. Industry could leverage the results though marketing efforts which emphasize the positive effects of how individuals perceive UAS as useful. Industry could also actively help allay fears of the perceived risks UAS pose to safety. Establishing aircraft certification standards which limit noise and require more reliable UAS would lower noise exposure and address public concerns about UAS risks to safety. Routing away from densely populated areas or requiring flight at higher altitudes and limiting hours of operation would also limit noise exposure and subsequently complaint behavior related to UAS noise.

Industry is aware of the noise concerns of the FAA and those of other Governmental entities. Policies and regulations are expected to be enacted and activities undertaken which help limit noise complaint behavior. Understanding the factors which drive UAS noise complaint behavior allows industry to help minimize exposure to UAS noise and subsequently reduce complaint behavior. The industry can apply the results when developing strategies to optimize UAS package delivery routes, determine regulation-compliant locations of UAS small package delivery hubs, and design of small package delivery aircraft to minimize noise.

Limitations of the Findings

The research presented herein was subject to multiple limitations. This section provides a description of the limitations of the study. It also attempts to show how the limitations may have affected the results and provide possible ways to address them.

First, there was a temporal limitation which derives from the fact the survey was cross-sectional. The collection instrument was promulgated for a finite period of time and, as such, did not consider the possibility of respondents' responses changing over time. Additionally, the pilot and main surveys were issued prior to the advent of widespread small package delivery via UASs. Performance of additional studies could confirm the findings of this study and add a longitudinal dimension which would enable analysis of changes over time, especially as a greater portion of the population is exposed to UAS noise.

Second, there was a language-based limitation, which reflects that the survey was created and implemented only in English. Surveys in no other languages were distributed which limits the ability of the research to consider differences which might accrue related to speakers of other languages (Choi, 2013; Clothier et al., 2015). Promulgation of the survey in other languages could add additional dimensions to the results and improve generalizability.

Third, there was a geographic limitation which acknowledges the survey instrument was limited to participants from the United States. In the data collection phase, the survey instruments were only available to participants who accessed the survey instrument from accounts registered in the United States. This limits generalizability beyond the United States. Opening the survey to participants from other countries could add valuable insights regarding reactions to UAS noise in other counties and cultures.

Fourth, there was an access-based limitation which derives from the fact that respondents must have the ability to access an Amazon MTurk® account. However, some studies indicate that data obtained from MTurk® has been found to be equal to or better than data collected from students and professional panels (Kees, Berry, Burton, & Sheehan, 2017). Promulgation of the survey by other methods and via other platforms could help address possible access bias.

Fifth, selection bias was a concern when collecting the survey data (Vogt, Gardner, & Haeffele, 2012). For this research, each Amazon MTurk® participant chose to complete the HIT for the subject research which may have exposed the research to selection bias. Alternatively, some research indicates the use of internet-based data collection versus traditional methods can reduce bias (Gosling, Vazire, Srivastava, & John, 2004). In addition, the survey instrument was self-selected by respondents, which ensures their participation is voluntary. Voluntary participation is often an indicator that respondents will answer survey questions truthfully (Vogt et al., 2012).

Sixth, there was an age limitation which acknowledges the survey instrument was limited to only adult participants. In the data collection phase, the survey instruments were only available to participants who were aged 18 or over. This limits generalizability to only adults. Opening the survey to younger participants could add valuable insights regarding reactions to UAS noise by youth but would add complexities to the IRB process.

Seventh, there was a breadth limitation which manifests in the research design. The survey collected data relating to a finite number of latent factors. Other important factors and relationships could exist but were not investigated in this research. However, this research attempted to extend the breadth of factors beyond those in the TPB model by adding a factor from the TAM and additional factors revealed in the literature. Performing subsequent studies which include additional factors could provide additional insights.

Last, generalizability or external validity was a limitation resulting from the use of survey data (Vogt et al., 2012) and internet-based collection methods. This research relied exclusively on survey respondents from Amazon MTurk ®. Recent research somewhat mitigates these concerns as it indicates that the use of internet-based survey research can improve generalizability (Rice et al., 2017) when compared to traditional methods. Regardless, based on the stated limitations, the generalizability of subject research is limited to adult English speakers who hold, and can access, an Amazon MTurk ® account.

Recommendations

Based on the results, discussion, and conclusions drawn from this research, several recommendations follow. These recommendations are divided into two categories. First, recommendations are offered to stakeholders in the nascent UAS industry. Second, recommendations are offered related to future research.

Recommendations for UAS Stakeholders

The results of this research are relevant to two primary classes of UAS stakeholders - those that regulate UAS, and those that produce and operate UAS. In other words, government and industry. It is important that government and industry understand the factors which drive the public's attitude toward complaining about UAS noise. Such information enables the development of appropriate UAS-related policy, laws, and regulations from the government perspective and development of UAS platforms and operational schema from the industry perspective. Addressing factors a priori that could derail widespread UAS adoption could help foster growth of the nascent UAS industry.

The results indicated that certain factors influence individuals' intentions to complain about UAS noise: individuals' attitudes toward complaining about UAS noise, perceived social pressure to complain about UAS noise, perceived usefulness of UASs, and perceptions of UASs risks to safety. The two factors exhibiting the most influence on intention to complain about UAS noise are an individual's attitudes toward complaining about UAS noise and their perceived social pressure to complain about UAS noise. UAS stakeholders should work together to address public attitudes toward UAS noise. Governments should collaborate with industry to promulgate information relating to the benefits of UAS as a trade-off to the noise they create. Governments should also work to create noise policies, laws, and regulations which balance community concerns related to UAS noise and the benefits UASs provide.

Individual perceptions of the usefulness of UASs was shown to be negatively correlated with intention to complain about UAS noise. As the public perception of the usefulness of UAS increases, complaint behavior should decrease. Therefore, the industry should actively work to educate the public about the utility of UASs in order to ultimately reduce complaint behavior. As the public understands the many actual and conceived (see Table 1) uses for UAS, complaint behavior could be reduced.

The results show that as an individual's perceptions of the risks UASs pose to their safety increase their attitude toward complaining about UAS noise increases. It is therefore recommended that both government and industry act to address this issue. Government should develop appropriate guidance for aircraft certification standards (including noise), airspace use, aircraft routing, restrictions to hours of operations, and locations of deliver hubs. The industry should develop strategies to optimize UAS package delivery routes to minimize flight time and flights over people and vehicles. The industry should also determine low impact, regulation-compliant locations for small package delivery hubs and verti-ports, and employ noise reduction design methods for their UAS in order to minimize noise.

Recommendations for Future Research

As with many such efforts, this research revealed opportunities for additional research. This section discusses possible future research indicated by the study results or research which could address limitations imposed on the current study. Eight recommendations for future research are offered.

First, perform a longitudinal study to ascertain potential changes in the factors influencing an individual's intention to complain about UAS noise. Such an effort would overcome the temporal limitation of the current cross-sectional study. The collection instrument was promulgated for a finite period of time and did not consider possible changes in participant responses over time. A longitudinal study would enable an analysis of such changes, as the population is exposed to increased UAS operations.

Second, promulgate the survey in other languages and other countries. Doing so could add additional dimensions to the results. Such results could add valuable international, regional, and cultural dimensions. Alternatively, a more expansive population of respondents could result in an indication of wider generalizability.

Third, refine the analytical model. One possible model refinement is the reduction of the number of items per factor from four to three. Retaining at least three items per factor is recommended (Hair et al., 2013). Such a refinement would reduce the number of questions to which the participants must respond and presumably reduce the average time to complete the instrument which, in turn, could improve the completion rate. One rationale for determining which items to retain is only keeping items with the highest factor loadings within each factor. Additionally, based on the existing model and data, the GOF indices could be improved, and additional effects could become statistically significant (e.g., PR, effect (0.053), ($p = 0.065$) while not significant, was close).

Fourth, include additional factors which were discovered in the literature review but were not included in the current study. The factors which were included in the current study were those that were most prevalently mentioned in the literature. Other factors could be included which were mentioned less often in the literature but still may be worthy of consideration. Examples of additional factors noted in the literature which could be included in subsequent studies include public information about UAS technologies, intention to purchase or use UAS, attitudes toward personal use or willingness to personally use, general attitude toward UAS, perceived ease of use, attitudes toward UAS routing, knowledge of UAS rules and regulations, drone personification, environment, visual disturbance, cybersecurity, and design or platform type.

The survey instrument lacked any items reflecting UAS experience. Thus, the fifth recommendation for future research is to query the respondents regarding prior experience with UAS. Including such an item (or items), perhaps as a control variable, would enable comparative analysis of responses from respondents with UAS experience and those with no UAS experience and could provide useful insights.

The data analysis performed in this effort did not include comparisons of the results broken down by the various demographic variables collected. The sixth recommendation is to perform such an analysis as a follow-on study. Such information might provide additional insight into UAS noise complaint behavior and acceptance.

Five factors were determined to influence individuals UAS noise complaint behavior. These factors were identified as: individuals' attitudes toward complaining about UAS noise, perceived social pressure to complain about UAS noise, perceived usefulness of UASs, perceptions of UASs risks to safety, and familiarity with UASs. The seventh recommendation for further research is to conduct further investigation into these factors using an experimental design. Performing such an experiment would allow the research effort to behaviorally examine intention to complain about UAS noise.

The last recommendation for future research pertains to delving deeper into the statistically significant result which was contrary to the direction originally hypothesized. The factor Familiarity with UAS was hypothesized to have an effect on behavioral intention to complain about UAS noise. Hypothesizing such a relationship was consistent with Wang et al. (2019) where participant information level exhibited a strong relationship to attitudes toward complaining. Further, the direction of the effect was hypothesized such that higher familiarity with UAS would manifest as a favorable attitude toward UAS. For the current study, a relationship was shown to exist, but it was in an opposite direction than hypothesized. Additional research could reveal a greater understanding of how familiarity with UAS influences individual attitudes and actions.

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Appendix A

Permission to Conduct Research

Embry-Riddle Aeronautical University
Application for IRB Approval
EXEMPT Determination Form

Principal Investigator: Robert Brents

Other Investigators: Dr. Scott R. Winter

Role: Student **Campus:** Worldwide **College:** Aviation/Aeronauti

Project Title: Investigating intention to complain about UAS noise using an extended theory of planned behavior

Review Board Use Only

Initial Reviewer: Teri Gabriel **Date:** 08/26/2020 **Approval#:** 21-008

Determination: Exempt

Dr. Beth Blickensderfer Elizabeth L. Blickensderfer, Ph.D. Digitally signed by Elizabeth L. Blickensderfer, Ph.D. Date: 2020.09.01 15:30:08 -04'00'
IRB Chair Signature: **Date:** September 1, 2020

Brief Description:

The purpose of this study is to examine factors, as included in an extended theory of planned behavior, which influence individuals' intentions to complain about UAS noise. This study intends to utilize cross-sectional survey data to identify factors related to individuals' intent to complain about UAS noise. An internet-based platform (The Amazon Corporation's Mechanical Turk® [MTurk®] capability) will be used to manage administration of the electronic questionnaire used as the data collection instrument.

This research falls under the **EXEMPT** category as per 45 CFR 46.104:

☑ (2) Research that only includes interactions involving educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior (including visual or auditory recording) if at least one of the following criteria is met (Applies to Subpart B [Pregnant Women, Human Fetuses and Neonates] and does not apply for Subpart C [Prisoners] except for research aimed at involving a broader subject population that only incidentally includes prisoners.)

EMBRY-RIDDLE
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26 August 2020

Human Subject Protocol Application

Campus:	**Worldwide**	College:	**COA**
Applicant:	**Robert Brents**	Degree Level:	**Doctorate**
ERAU ID:		ERAU Affiliation:	**Student**

Project Title:	**Investigating intention to complain about UAS noise using an extended theory of planned behavior**
Principal Investigator:	**Robert Brents**
Other Investigators:	**Dr. Scott R. Winter**

Submission Date:	**07/28/2020**
Beginning Date:	**09/01/2020**
Type of Project:	**Survey**
Type of Funding Support (if any):	

Questions:

1. Background and Purpose: Briefly describe the background and purpose of the research.

   Aircraft noise has a long history as a source of public annoyance and a driver of noise complaints. The impending large-scale use of unmanned aircraft systems (UAS) for small package delivery and urban air mobility (UAM) is likely to expose a broader cross-section of the public to a newtype of aircraft noise. Because of the potential proliferation of UAS and their attendant noise, understanding public reaction would inform both government and industry. While the literature notes some reactions to UAS noise, no rigorous analyses of public intention to complain about UAS noise have been found. The purpose of this study is to examine factors, as included in an extended theory of planned behavior, which influence individuals' intentions to complain about UAS noise.

2. Time: Approximately how much time will be required of each participant?

   It is expected that each participant will require approximately 10-15 minutes to complete the survey. This time estimate includes the time to acknowledge the consent form, the time to respond to the demographic questions, and the time to respond to the items specific to the study itself.

3. Design, Procedures and Methods: Describe the details of the procedure(s) to be used and the type of data that will be collected.

This study intends to utilize cross-sectional survey data to identify factors related to individuals' intent to complain about UAS noise. An internet-based platform (The Amazon Corporation's Mechanical Turk® [MTurk®] capability) will be used to manage administration of the electronic questionnaire used as the data collection instrument. Participant responses will be retrieved from the internet-based platform and statistical data analysis will be accomplished using structural equation modeling (SEM) techniques. In addition to questions regarding factors relating to intent to complain about UAS noise, demographic data will be collected. The demographic data will include age, gender, race, education level, population density of their domicile (rural, suburban, urban) and income. No personal identifying data will be collected. Anonymity and confidentiality will be maintained.

4. Measures and Observations: What measures or observations will be taken in the study?

The survey instrument will collect data intended to measure respondent opinions vis-a-vis the questions posed in the study. Participants will answer questions based on the theory of planned behavior (TPB) and additional factors which were gleaned from the literature. The standard factors used from the TPB include attitude toward behavior, subjective norms, perceived behavioral control, and behavioral intent. Additional factors gleaned from the literature include perceived usefulness of UAS, application type or use of UAS, privacy, risk and safety of UAS, and familiarity with UAS. The exogenous latent factors (independent variables) will each be measured with four questions associated with manifest variables. Attitudes toward Behavior (AB) questions will relate to manifest variables AB1, AB2, AB3, AB4. Subjective Norms (SN) questions will relate to manifest variables SN1, SN2, SN3, SN4. Perceived Behavioral Control (PB) questions will relate to manifest variables PB1, PB2, PB3, PB4. Perceived Usefulness of UAS (PU) questions will relate to manifest variables PU1, PU2, PU3, PU4. Application Type/Use of UAS (AT) questions will relate to manifest variables AT1, AT2, AT3, AT4. Privacy (PR) questions will relate to manifest variables PR1, PR2, PR3, PR4. Risk/Safety of UAS (RS) questions will relate to manifest variables RS1, RS2, RS3, RS4. Familiarity with UAS (FW) questions will relate to manifest variables FW1, FW2, FW3, FW4. The endogenous latent factor (dependent variable) is Behavioral Intention (BI) to complain about UAS noise and will be measured by four questions which relate to manifest variables BI1, BI2, BI3, BI4.

5. Participant Population and Recruitment Procedures: Who will be recruited to be participants and how will they be recruited. Any recruitment email, flyer or document(s) must be reviewed by the IRB. Note that except for anonymous surveys, participants must be at least 18 years of age to participate.

The participant population which represents the sampling frame will consist of those who respond to a human intelligence task from Amazon's MTurk®. The study employs two screening criteria which require that the participant be at least 18 years old and that their MTurk® account is based in the United States. If either of these criteria are not met, the participant will not be allowed to complete the survey. The study has a minimum requirement of at least 460 participants.

6. Risks or Discomforts: Describe any potential risks to the dignity, rights, health or welfare of the human subjects. All other possible options should be examined to minimize any risks to the participants.

The risks of participating in this study are no more than what is experienced in daily life.

7. Benefits: Assess the potential benefits to be gained by the subjects as well as to society in general as a result of this project.

The primary benefit of this study is to increase knowledge about individuals' intentions to complain about UAS noise. There are no known personal benefits to the participant from completing the study.

8. Informed Consent: Describe the procedure you will use to obtain informed consent of the subjects. How and where will you obtain consent? See Informed Consent Guidelines for more information on Informed Consent requirements.

The survey instrument begins with an introduction and background of the study with an informed consent notice. The informed consent notice allows the participant to confirm their participation by clicking on a soft-button specifying either an affirmative or negative response. Participants are required to respond either yes-giving their consent or no-withholding their consent. Participants are not allowed to proceed to the remainder of the survey if they do not give an affirmative response. If consent is not received the survey will be exited. Survey respondents are also informed that their participation is voluntary, and they are allowed to stop participating at any point in time with no consequences to them.

9. Confidentiality of Records: Will participant information be anonymous (not even the researcher can match data with names), confidential (Names or any other identifying demographics can be matched, but only members of the research team will have access to that information. Publication of the data will not include any identifying information.), or public (Names and data will be matched and individuals outside of the research team will have either direct or indirect access. Publication of the data will allow either directly or indirectly, identification of the participants.)?

Anonymous

9b. Justify the classification and describe how privacy will be ensured/protected.

All data collected during this study will be anonymous. Other than basic demographics, no identifiable personal information will be collected. As a result, there is no way for the researcher to learn a participant's true identity. Identification numbers will be generated to represent the participants within the data management systems. All data will be password protected and all raw data will be destroyed after the data analysis is concluded.

10. Privacy: Describe the safeguards (including confidentiality safeguards) you will use to minimize risks. **Indicate what will happen to data collected from participants that choose to "opt out" during the research process.** If video/audio recordings are part of the research, describe how long that data will be stored and when it will be destroyed.

Anonymity of all data will be maintained there will be no method by which individual participants could be identified. If a participant makes the choice to withdraw from the survey prior to completing the questionnaire, the data for that participant will be removed from the study and destroyed. All data will be destroyed after the analysis is completed.

11. Economic Considerations: Are participants going to be paid for their participation?

Yes

11b. What will the compensation be?
Describe your policy for dealing with participants who 1) Show up for research, but refuse informed consent; 2) Start but fail to complete research.

Participants will have the ability to receive remuneration via MTurk®. Only respondents who complete the survey will be paid. The MTurk® system generates a verification code which the respondent then uses to claim their compensation. Participant compensation will be $0.50.

By submitting this application, you are signing that the Principal Investigator and any other investigators certify the following:
1. The information in this application is accurate and complete
2. All procedures performed during this project will be conducted by individuals legally and responsibly entitled to do so
3. I/we will comply with all federal, state, and institutional policies and procedures to protect human subjects in research
4. I/we will assure that the consent process and research procedures as described herein are followed with every participant in the research
5. That any significant systematic deviation from the submitted protocol (for example, a change in the principal investigator, sponsorship, research purposes, participant recruitment procedures, research methodology, risks and benefits, or consent procedures) will be submitted to the IRB for approval prior to its implementation
6. I/we will promptly report any adverse events to the IRB

Electronic Signature:

Robert Brents

Appendix B

Questionnaire

Intention to Complain about UAS Noise Survey

Section 1: CONSENT FORM

Thank you for participating in the “Intention to Complain about UAS Noise” Survey.

You are participating in a research study about factors that influence individuals’ intentions to complain about UAS noise.

PURPOSE. The purpose of the research is to investigate factors that influence individuals’ intentions to complain about UAS noise.

ELIGIBILITY. Your eligibility to take part in this study requires that you must be at least 18 years and your MTurk® worker account must be registered in the United States.

PROCEDURES. As part of the survey process you will be asked a question regarding your consent to continue with the study. Choosing ‘Yes’ will grant access to the remainder of the study, choosing ‘No’ will automatically end the study.

If you consent to participate in the study the next section presented will contain screening questions to confirm that your MTurk® account is registered in the United States and that you are at least 18 years of age. Answering ‘No’ to either of the questions will automatically exit the study.

You will then be presented with routine demographic questions before proceeding to complete a series of questions about your opinions regarding UAS and complaining about the noise they create.

When you have completed the survey, you will be asked to create verification code which could be used to receive your reward from the MTurk® website.

DURATION OF PARTICIPATION. The questionnaire is expected to take approximately 10 minutes to complete.

RISKS. Completing this survey presents no known risks to you as a person other than the normal risks from your everyday activities.

BENEFITS. The primary benefit of this study is to increase knowledge about individuals' intentions to complain about UAS noise. There are no known benefits to you personally from completing the study. Your completion of the study will also benefit the researcher by providing data to support the completion of a PhD program.

COMPENSATION. You will be provided a small monetary reward after you have successfully completed the study.

CONFIDENTIALITY AND PRIVACY. All data collected during this study will be anonymous and confidential. Other than basic demographics, no identifiable personal information will be collected. As a result, there is no way for the researcher to learn your true identity. All survey information will be kept securely, and all raw data will be destroyed after the data analysis is concluded.

VOLUNTARY PARTICIPATION. Please note that your participation in the study is entirely voluntary. At any time you may choose to decline to participate without consequence. In addition, you may choose to not answer any question for any reason. Choosing to not participate or to not answer any question will not be held against you. If you choose to withdraw from the study prior to completing the questionnaire, the data collected will be removed and will be destroyed.

CONTACT INFORMATION. If you have any questions about this research project, contact Bob Brents at brentsr@my.erau.edu. If you have concerns about the treatment of research participants, you can contact the IRB Administrator, Teri Gabriel at hollerat@erau.edu or call 386-226-7179.

CONSENT.

Choosing “Yes” below means that you understand the information on this form, that any questions you may have about this study have been answered, and that you are eligible and voluntarily agree to participate in this survey. Choosing “No” will end the survey.

○ Yes, I would like to participate. (Please start the survey)

○ No, I do not want to participate. (Please end the survey)

Section 2: INSTRUCTIONS AND ELIGIBILITY QUESTIONS.

This section will present screening questions to confirm your country of registration as an MTurk® worker and to confirm that you are above 18 years of age. Answering ‘No’ to either question will automatically exit the study.

Following this, you will then be asked some demographic questions before proceeding to complete a series of questions about your opinions towards technology uses at airports.

When you have completed the survey, you will be asked to generate a verification code number which could be used to receive your reward from the MTurk® website

2.1 Are you currently registered as an MTurk® worker in the United States?
○ Yes (Please continue the survey) ○ No (Please exit the survey)

2.2 Are you at least 18 years?
○ Yes (Please continue the survey) ○ No (Please exit the survey)

Section 3: Demographic Information

3.1 Age: Please enter your age in years

[ ]

3.2 Gender: Please select your gender

◯ Male ◯ Female

3.3 Education: Please select your highest level of education attained

◯ High school ◯ Bachelor's Degree

◯ Master's Degree ◯ Doctorate Degree

3.4 Please indicate your ethnicity

◯ American Indian or Alaska Native ◯ Asian

◯ Black or African American ◯ Hispanic, Latino, or Spanish Origin of any race

◯ Native Hawaiian or Other Pacific Islander

◯ White ◯ Two or more

3.5 Would you consider where you live to be _________?:

◯ Rural ◯ Suburban

◯ Urban

3.6 Please indicate your annual total income in USD

Section 4: Factors influencing individuals' intentions to complain about UAS noise.

INFORMATION FOR SCENARIO AND FOLLOWING STATEMENTS

Some suggest that soon there will be large-scale use of unmanned aircraft systems (UAS), sometimes called *drones*, which will be used for small package delivery and personal transportation (so-called *urban air mobility*). This will likely expose many people to a new type of noise.

When considering your responses to the statements which follow, imagine the UAS (drones) that you are likely to encounter in the future such as those used for package delivery or larger autonomous air taxis. Given this scenario, please respond to the following statements:

4.1

Item Number	Statement	Strongly Disagree (-2)	Disagree (-1)	Neutral (0)	Agree (+1)	Strongly Agree (+2)
AB1	Complaining about UAS noise is a good idea	○	○	○	○	○
AB2	I think complaining about UAS noise is desirable	○	○	○	○	○
AB3	I like the idea of complaining about the noise UAS create	○	○	○	○	○
AB4	I would feel good about submitting a complaint about UAS noise	○	○	○	○	○

4.2

Item Number	Statement	Strongly Disagree (-2)	Disagree (-1)	Neutral (0)	Agree (+1)	Strongly Agree (+2)
SN1	People who influence me would think that I should complain about UAS noise	○	○	○	○	○
SN2	People who are important to me would think that I should complain about UAS noise	○	○	○	○	○
SN3	People whose opinions I value would prefer me to complain about UAS noise	○	○	○	○	○
SN4	My personal beliefs and values support me complaining about UAS noise	○	○	○	○	○

4.3

Item Number	Statement	Strongly Disagree (-2)	Disagree (-1)	Neutral (0)	Agree (+1)	Strongly Agree (+2)
PB1	I would be able to complain about UAS noise	○	○	○	○	○
PB2	Complaining about UAS noise is entirely within my control	○	○	○	○	○
PB3	If I want to, I can complain about UAS noise	○	○	○	○	○
PB4	It is up to me to decide if I want to complain about UAS noise	○	○	○	○	○

4.4

Item Number	Statement	Strongly Disagree (-2)	Disagree (-1)	Neutral (0)	Agree (+1)	Strongly Agree (+2)
PU1	I think UAS are useful	○	○	○	○	○
PU2	UAS have many beneficial uses	○	○	○	○	○
PU3	UAS can be a more efficient way to get certain things done	○	○	○	○	○
PU4	Some tasks might be easier to do using UAS	○	○	○	○	○

4.5

Item Number	Statement	Strongly Disagree (-2)	Disagree (-1)	Neutral (0)	Agree (+1)	Strongly Agree (+2)
AT1	I prefer types of UAS that are used for reasons I like	○	○	○	○	○
AT2	I approve of UAS when they are used to benefit people	○	○	○	○	○
AT3	Knowing what a UAS is doing is important to me	○	○	○	○	○
AT4	When I see a UAS I would like to know why it is there	○	○	○	○	○

4.6

Item Number	Statement	Strongly Disagree (-2)	Disagree (-1)	Neutral (0)	Agree (+1)	Strongly Agree (+2)
PR1	I am concerned that UAS could gather private information about me	○	○	○	○	○
PR2	I am concerned that private information about me collected by UAS could be shared or sold	○	○	○	○	○
PR3	I value my privacy and UAS could violate it	○	○	○	○	○
PR4	I do not like that UAS could gather private information about me	○	○	○	○	○

4.7

Item Number	Statement	Strongly Disagree (-2)	Disagree (-1)	Neutral (0)	Agree (+1)	Strongly Agree (+2)
RS1	I think UAS are risky	○	○	○	○	○
RS2	I am concerned that UAS might increase my risk of injury	○	○	○	○	○
RS3	I think UAS are unsafe	○	○	○	○	○
RS4	I am concerned that UAS might crash into people, cars, and buildings	○	○	○	○	○

4.8

Item Number	Statement	Strongly Disagree (-2)	Disagree (-1)	Neutral (0)	Agree (+1)	Strongly Agree (+2)
FW1	I am familiar with UAS	○	○	○	○	○
FW2	I know a fair amount about UAS	○	○	○	○	○
FW3	I generally understand UAS	○	○	○	○	○
FW4	If I owned a UAS I would like them more	○	○	○	○	○

4.9

Item Number	Statement	Strongly Disagree (-2)	Disagree (-1)	Neutral (0)	Agree (+1)	Strongly Agree (+2)
BI1	I would complain about UAS noise	○	○	○	○	○
BI2	If motivated by the noise, I intend to complain about UAS noise in the future	○	○	○	○	○
BI3	I plan to complain about UAS noise	○	○	○	○	○
BI4	I would recommend complaining about UAS noise to my friends and relatives	○	○	○	○	○

4.10 Please state any additional comments you may have on the use of UAS.

Section 5: Conclusion

Thank you for completing the survey! You are finished.

To create your unique MTurk® code - In the box below please input your initials followed by your age with no spaces. For example, if your name is Fred Jones and you are 31 years old, then you should input: FJ31

Please return to MTurk® and enter this code into the appropriate place so that you can be paid for your time.

Appendix C

Variables, Definitions, and Original Items Used

Construct / Variable	Operational Definition/ Description	Survey Items	Adapted From
Attitudes toward Behavior (AB)	Individuals' attitude toward complaining about UAS noise	AB1: Complaining about UAS noise is a good idea AB2: I think complaining about UAS noise is desirable AB3: I like the idea of complaining about the noise UAS create AB4: I would feel good about submitting a complaint about UAS noise	Ajzen, 2009; Cheon, Lee, Crooks, & Song, 2012; Wang et al., 2019
Subjective Norms (SN)	Individuals' perceived social pressure to complain about UAS noise	SN1: People who influence me would think that I should complain about UAS noise SN2: People who are important to me would think that I should complain about UAS noise SN3: People whose opinions I value would prefer me to complain about UAS noise SN4: My personal beliefs and values support me complaining about UAS noise	Ajzen, 2009; Cheon et al, 2012; Chen, 2016; Chen et al., 2014; Rantanen et al., 2018; Wang et al., 2019
Perceived Behavioral control (PB)	Individuals' perceived ease of complaining about UAS noise.	PB1: I would be able to complain about UAS noise PB2: Complaining about UAS noise is entirely within my control PB3: If I want to, I can complain about UAS noise PB4: It is up to me to decide if I want to complain about UAS noise	Ajzen, 2009; Cheon et al, 2012; Chen, 2016; Chen et al., 2014; Pan et al., 2018; Rantanen et al., 2018; Wang et al., 2019
Perceived Usefulness of UAS (PU)	Individuals' perception regarding the usefulness of UAS	PU1: I think UAS are useful PU2: UAS have many beneficial uses PU3: UAS can be a more efficient way to get certain things done PU4: Some tasks might be easier to do using UAS	Cheon et al, 2012; Chuttur, 2009; Davis, 1985; Keller et al., 2018
Application Type/Use of UAS (AT)	Individuals' perception of the type, purpose, and use of UAS	AT1: I prefer types of UAS that are used for reasons I like AT2: I approve of UAS when they are used to benefit people AT3: Knowing what a UAS is doing is important to me AT4: When I see a UAS I would like to know why it is there	Anbaroğlu, 2017; Aydin, 2019; Boucher, 2015; Clothier et al., 2015; Eißfeldt et al., 2020; Keller et al., 2018; Nelson et al., 2019; Reddy et al., 2016; Sakiyama et al., 2017; Thipphavong et al., 2018., Vincenzi et al., 2013
Privacy (PR)	Individual's perception of the potential that UAS will	PR1: I am concerned that UAS could gather private information about me	Aydin, 2019; Clothier et al., 2015; Khan et al., 2019; Lidynia et al., 2017; Motlagh et al.,2016; Nelson et al., 2019; Ramadan et

Construct / Variable	Operational Definition/ Description	Survey Items	Adapted From
	invade their privacy	PR2: I am concerned that private information about me collected by UAS could be shared or sold PR3: I value my privacy and UAS could violate it PR4: I do not like that UAS could gather private information about me	al., 2017; Rao et al.,2016; Sakiyama et al., 2017; Susini, 2015; Thipphavong et al., 2018; Vattapparamban et al., 2016; Vincenzi et al., 2013
Risk/Safety of UAS (RS)	Individuals' perception of the risks to personal safety due to UAS	RS1: I think UAS are risky RS2: I am concerned that UAS might increase my risk of injury RS3: I think UAS are unsafe RS4: I am concerned that UAS might crash into people, cars, and buildings	Aydin, 2019; Clothier et al., 2015; Keller et al., 2018; Khan et al., 2019; Lidynia et al., 2017; Ramadan et al., 2017; Rao et al., 2016; Reddy et al., 2016; Susini, 2015; Thipphavong et al., 2018; Vattapparamban et al., 2016; Vincenzi et al., 2013; Wang et al., 2019
Familiarity with UAS (FW)	Individuals' familiarity with UAS	FW1: I am familiar with UAS FW2: I know a fair amount about UAS FW3: I generally understand UAS FW4: If I owned a UAS I would like them more	Aydin, 2019; Boucher, 2015; Eißfeldt et al., 2020; Keller et al., 2018; Nelson et al., 2019; Vincenzi et al., 2013
Behavioral Intention (BI) to complain about UAS noise	Individuals' behavioral intention to complain about UAS noise	BI1: I would complain about UAS noise BI2: If motivated by the noise, I intend to complain about UAS noise in the future BI3: I plan to complain about UAS noise BI4: I would recommend complaining about UAS noise to my friends and relatives	Ajzen, 2009; Cheon et al, 2012; Chen et al., 2014; Rantanen et al., 2018; Wang et al., 2019

Appendix D

Revised Items: Main Study

Construct / Variable	Operational Definition/ Description	Survey Items	Adapted From
Attitudes toward Behavior (AB)	Individuals' attitude toward complaining about UAS noise	AB1: I feel it is a good idea to complain about UAS noise AB2: To me, it is desirable to complain about UAS noise AB3: I like the idea of complaining about UAS noise AB4: I would feel good about complaining about UAS noise	Ajzen, 2009; Cheon, Lee, Crooks, & Song, 2012; Wang et al., 2019
Subjective Norms (SN)	Individuals' perceived social pressure to complain about UAS noise	SN1: People who influence me would think that I should complain about UAS noise SN2: People who are important to me would think that I should complain about UAS noise SN3: People whose opinions I value would prefer me to complain about UAS noise SN4: My personal beliefs and values support me complaining about UAS noise	Ajzen, 2009; Cheon et al, 2012; Chen, 2016; Chen et al., 2014; Rantanen et al., 2018; Wang et al., 2019
Perceived Behavioral control (PB)	Individuals' perceived ease of complaining about UAS noise.	PB1: I would be able to complain about UAS noise PB2: Complaining about UAS noise is entirely within my control PB3: If I want to, I can complain about UAS noise PB4: It is up to me to decide if I want to complain about UAS noise	Ajzen, 2009; Cheon et al, 2012; Chen, 2016; Chen et al., 2014; Pan et al., 2018; Rantanen et al., 2018; Wang et al., 2019
Perceived Usefulness of UAS (PU)	Individuals' perception regarding the usefulness of UAS	PU1: I think UAS are useful PU2: Using UAS can improve productivity for some tasks PU3: Using UAS can be a more efficient way to get certain things done PU4: Using UAS can make it easier to do some jobs	Cheon et al, 2012; Chuttur, 2009; Davis, 1985; Keller et al., 2018
Application Type/Use of UAS (AT)	Individuals' perception of the type, purpose, and use of UAS	AT1: I only like the types of UAS that are doing something I approve of AT2: I only like the types of UAS that do things which benefit people AT3:I only like the types of UAS that do something positive AT4: I only like the types of UAS that do things I think are worthwhile	Anbaroğlu, 2017; Aydin, 2019; Boucher, 2015; Clothier et al., 2015; Eißfeldt et al., 2020; Keller et al., 2018; Nelson et al., 2019; Reddy et al., 2016; Sakiyama et al., 2017; Thipphavong et al., 2018., Vincenzi et al., 2013
Privacy (PR)	Individual's perception of the potential that UAS will	PR1: I am concerned that UAS could gather private information about me	Aydin, 2019; Clothier et al., 2015; Khan et al., 2019; Lidynia et al., 2017; Motlagh et al.,2016; Nelson et al., 2019; Ramadan et

Construct / Variable	Operational Definition/ Description	Survey Items	Adapted From
	invade their privacy	PR2: I am concerned that private information about me collected by UAS could be shared or sold PR3: I value my privacy and UAS could violate it PR4: I do not like that UAS could gather private information about me	al., 2017; Rao et al.,2016; Sakiyama et al., 2017; Susini, 2015; Thipphavong et al., 2018; Vattapparamban et al., 2016; Vincenzi et al., 2013
Risk/Safety of UAS (RS)	Individuals' perception of the risks to personal safety due to UAS	RS1: I think UAS are risky RS2: I am concerned that UAS might increase my risk of injury RS3: I think UAS are unsafe RS4: I am concerned that UAS might crash into people, cars, and buildings	Aydin, 2019; Clothier et al., 2015; Keller et al., 2018; Khan et al., 2019; Lidynia et al., 2017; Ramadan et al., 2017; Rao et al., 2016; Reddy et al., 2016; Susini, 2015; Thipphavong et al., 2018; Vattapparamban et al., 2016; Vincenzi et al., 2013; Wang et al., 2019
Familiarity with UAS (FW)	Individuals' familiarity with UAS	FW1: I am familiar with UAS FW2: I know a fair amount about UAS FW3: I generally understand UAS FW4: If I owned a UAS I would like them more	Aydin, 2019; Boucher, 2015; Eißfeldt et al., 2020; Keller et al., 2018; Nelson et al., 2019; Vincenzi et al., 2013
Behavioral Intention (BI) to complain about UAS noise	Individuals' behavioral intention to complain about UAS noise	BI1:I will probably complain about UAS noise BI2: I intend to complain about UAS noise BI3: I plan to complain about UAS noise BI4: I expect to complain about UAS noise	Ajzen, 2009; Cheon et al, 2012; Chen et al., 2014; Rantanen et al., 2018; Wang et al., 2019