3-2021

Examining Military Cargo Pilots' Eco-friendly Flying Intention

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THESIS

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AFIT-ENS-MS-21-M-161

DEPARTMENT OF THE AIR FORCE
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Wright-Patterson Air Force Base, Ohio

AFIT-ENS-MS-21-M-161

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THESIS

Presented to the Faculty

Department of Operational Sciences

Graduate School of Engineering and Management

Air Force Institute of Technology

Air University

Air Education and Training Command

In Partial Fulfillment of the Requirements for the

Degree of Master of Science in Logistics and Supply Chain Management

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January 2021

AFIT-ENS-MS-21-M-161

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AFIT-ENS-MS-21-M-161

Abstract

The US Air Force (USAF) is the largest operational energy consumer within the Department of Defense (DoD) primarily due to aviation fuel use. Military pilots can play important roles in saving aviation fuel by flying aircraft in an eco-friendly manner. According to the theory of planned behavior (TPB), intention is the major predictor of behavior. This study tests two models based on TPB for understanding cargo pilots' eco-friendly intentions when they conduct channel or logistics missions. While there is a growing number of studies examining psychological factors in transportation, comprehensive research examining military cargo pilots' eco-friendly intentions is limited. This study employs multivariate statistical models for analyzing survey data from cargo pilots in USAF and the Republic of Korea Air Force (ROKAF). The study found that all three antecedents to intention were significant in a multiple regression model with aggregated scales. Contrary to existing studies involving TPB, the impact of subjective norm was greater than that of attitude. This could be due to vertical organizational cultures, rules, and regulations in the military. Thus, when various Air Forces remove organizational barriers and promote eco-friendly attitudes, they can save fuels and reduce the environmental footprint. The theoretical and practical contributions of this study include confirming the applicability of TPB and finding the role of subjective norm toward intention. The major limitation of this study is the lack of measured behavioral outcomes, which warrants future study.

Acknowledgments

I would like to express my sincere appreciation to my thesis committee members, Dr. Seong-Jong Joo and Dr. Harry Joo for their mentorship and guidance throughout the challenging times that we have faced during 2020. In addition, I am grateful to Major James Cotton, USAF and Major Sangwon Jun, ROKAF for translating the survey questionnaire and collecting data. Without their sustained support, successful completion of this project would not have been possible. My sincere appreciation also goes to my wife and children, who have been my biggest supporters and motivators throughout this academic journey.

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EXAMINING MILITARY CARGO PILOTS' ECO-FRIENDLY FLYING INTENTION

I. Introduction

Background

In FY2014, Department of Defense (DoD) consumed 87.4 million barrels of fuel to deploy and sustain missions across the globe. According to the Office of the Assistant Secretary of Defense for Energy (2016), the United States Air Force (USAF) utilizes 57 percent of the fuel allocated for national defense. As the new weapon systems rely on fossil fuel and have higher burn rates than legacy platforms, the Air Force will continue to be DoD's largest fuel consumer (Guerrero, 2019). The Air Force's vision to make energy a consideration and enable Airmen to maximize the potential of weapon systems starts with increasing energy understanding and awareness (Maybury, 2012). Considering the large volume of aviation energy consumed by the USAF, small behavioral changes have the potential to significantly reduce fuel consumption at only a fraction of the costs of technological change. Nevertheless, behavioral change measures will succeed only if they are based on a clear understanding of individual reasoning and incorporate the realities of why pilots behave as they do. The purpose of this study is to understand military cargo pilots' eco-friendly intentions while carrying out logistics missions.

While there is a growing number of studies examining psychological factors in transportation, studies examining military cargo pilots' eco-friendly intentions and behaviors are rare. This study employs the theory of planned behavior (TPB) to better understand the antecedents of eco-friendly intention for cargo pilots in USAF and ROKAF. On a broader setting, eco-friendly intention is defined as one's willingness to adopt energy efficient behaviors geared toward reducing fuel use, which is related to acceleration and deceleration, anticipation, reducing top speeds, and coasting. For example, eco-friendly driving is credited with energy savings ranging from less than 5 percent to as high as 20 percent depending on the driving and experimental setting (Stillwater & Kurani, 2013).

Historically, the airlines have optimized their fuel economy with mostly technical solutions, such as upgrading systems, renewing fleets, and optimizing routes. Recently, the human factor has gained prominence. This "low hanging fruit" has the potential to generate tremendous savings at a significantly lower cost. Driving vehicles in an eco-friendly manner has received considerable research interest because it is a good strategy to enhance energy efficiency. In the aviation industry, the economic premise is that "money is earned in the air." Pilots are key personnel who could achieve the biggest savings for this expense item (Akgül, 2020). In a behavioral-science project, Virgin Atlantic Airways demonstrated how small interventions could change behavior and motivate pilots to use less fuel (Gosnell et al., 2016). In a similar manner, other companies with large fleets of aircraft are committed to promote a transformative fuel-saving culture (FedEx, 2018).

Explaining the complex human behavior is nevertheless a difficult undertaking. The theory of reasoned action (TRA) proposed by Fishbein and Ajzen (1975) argues that when behaviors do not present problems of control, they can be predicted from intentions. TRA's predictive accuracy diminishes when the possibility of failure is salient, and individual has limited control. The military is a prime example of environment where some individuals have limited control over external factors. In this case, the research must go beyond the TRA. The TPB extends the TRA model by adding the construct of perceived behavioral control (Ajzen, 1985). According to this framework, the intentions to perform behaviors can be accurately predicted based on three independent factors: attitudes (ATT), subjective norms (SN), and perceived behavioral control (PBC). The intentions and PBCs explain a considerable amount of variance in behavior (Ajzen, 1991). This study aims to test models within the TPB framework for understanding military cargo pilots' eco-friendly intentions while carrying out logistics missions.

Limitations and assumptions

The major limitation of this study is not including behavior that is the dependent variable in TPB. This study measures intention and its three antecedents. According to studies with TPB, intention and behavior show strong correlation (Ajzen, 1985). Thus, understanding intention and its antecedents can help us promote eco-friendly behavior. This study uses a relatively small sample due to a small population that consists of military cargo pilots who have flown logistics missions in USAF and ROKAF. This study also assumes that responses are not desirable but actual answers to the survey questions.

II. Literature Review

Chapter overview

TRA (Ajzen & Fishbein, 1980; Fishbein & Ajzen, 1975) has significantly contributed to behavioral studies. TRA has four main constructs: attitude, subjective norm, behavioral intention, and behavior. Under this model, attitude and SN influence one's intention to act. TPB expanded TRA by introducing PBC as the third determinant of intention (Ajzen, 1988 & 1991). The studies analyzed in this section indicate that intention to act is the most important indicator of actual behavior in general, and pro-environmental behavior in particular. Some studies argue that TPB is insufficient to explain pro-environmental intentions and advocate for augmenting it with additional variables or frameworks. The antecedents that determine pilots' intentions may offer avenues for identifying intervention measures geared toward changing behavior.

Theory of Reasoned Action

TRA attempts to explain various types of human behavior by identifying the causal antecedents of intentions leading to behavior. This theory assumes that humans usually behave in a sensible manner, evaluate available information, and consider the ramifications of their actions. According to this framework, behavior is determined by intention, which is determined by two factors. The first factor is termed attitude toward the behavior and is personal in nature. Attitudes are influenced by positive or negative beliefs regarding the likely outcomes of a specific behavior (Ajzen, 1985). Attitudes are evaluative in nature and could be inferred from the observable responses; they describe pilots' tendencies to behave in a conscientious manner and save fuel while flying an airplane. A hierarchical model of attitude views it as a multidimensional construct consisting of cognition, affect, and conation. According to this model, attitude is a second order construct while cognition, affect, and conation are first order constructs. While the first order constructs are correlated, some researchers argue that they may not be independent, and, thus, have no discriminant validity (Ajzen, 2005).

The second determinant of intentions is termed SN and reflects the social pressure exerted on the individual to perform or not perform a certain behavior. SNs derive from normative beliefs and motivations to comply with expectations of certain referent individuals (Ajzen, 1985). According to this model, behavioral intentions will often be better predictors of attempted than actual behavior. It is important to specify that a behavioral intention could translate into behavior only if this behavior is under volitional control, i.e. if the pilots can freely decide whether or not to perform the behavior (Ajzen, 1991). TRA's range of applications is greatly reduced when the behavior is controlled by situational factors other than intention (Kurisu, 2015). TRA is outlined in Figure 1.

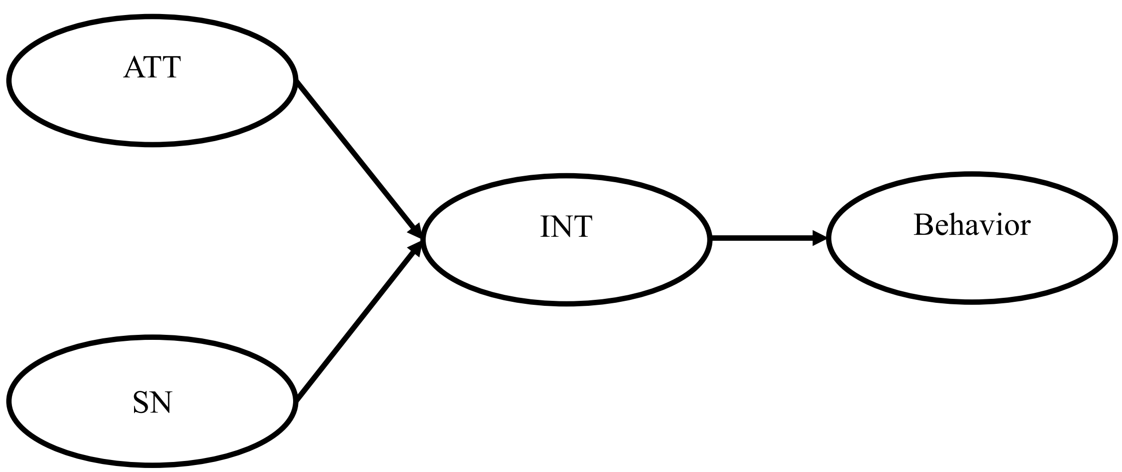

Figure 1 Theory of Reasoned Action

Theory of Planned Behavior

TPB has expanded TRA by adding PBC (Ajzen, 1988; 1991). This construct represents individual's perception of how much one can control his or her behavior. Ajzen (2002) has revealed that the concept of PBC includes two components: self-efficacy defined by the ease or difficulty of performing a specific behavior and controllability defined by one's ability to control performance. The control beliefs are antecedents of PBC and provide us with valuable insight regarding the personal or external factors that may facilitate or inhibit behavioral performance (Ajzen, 1985). When the individual considers the possibility of failure, their attitude toward trying will be determined by the attitude toward a successful attempt and the attitude toward a failed performance of the behavior. The new framework emerged as one of the most influential methods for predicting and explaining human behavior in specific settings (Ajzen, 2001). Figure 2 shows TPB.

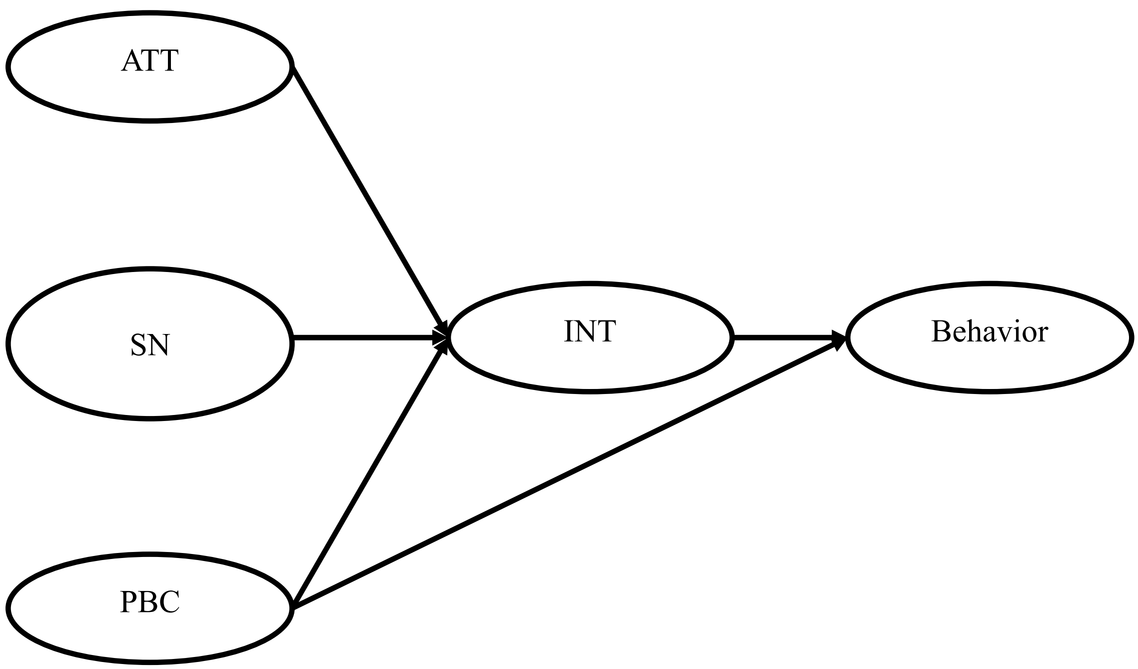

Figure 2 Theory of Planned Behavior

The central theme of TPB is individual's intention to perform a certain behavior. Intentions, also referred to as behavioral intentions, are considered viable indications of how hard people are willing to try, and how much effort they are planning to employ in order to achieve the behavior. A stronger intention, thus, constitutes a better predictor of successful performance (Ajzen, 1991). Previous studies in the psychological field have revealed that intention is a better predictor of behavior than attitude and perception (Ajzen, 1985, 1991; Fishbein & Ajzen, 1975). According to TPB, humans will attempt to carry out a certain behavior when the advantages of success outweigh the disadvantages of failure and when they believe that important referents with whom they are motivated to comply would approve of the attempt. Individuals will be successful in their pursuit when they have enough control over the internal and external factors influencing the attainment of the goal (Ajzen, 1985).

Armitage and Conner (2001) examined the efficacy of TPB with a meta-analysis study. They analyzed 185 empirical studies and discovered that TPB explained 27 percent and 39 percent of the variance in behavior and intention respectively. Their meta-analysis also revealed that the intention-behavior relationship was consistent but moderate in strength. This finding could explain why individuals with strong intentions could fail to translate their intentions into behaviors. They also discovered that PBC explained significant amounts of variance in intention and behavior while SN was as a weak predictor.

Application of TPB in sustainable transportation

TPB is a popular theory applied in behavioral studies (Jia, 2018). Currently, there is a growing body of literature that applies TPB to examining eco-friendly transportation behavior. Studies have discovered that attitudes, subjective norms, and PBC are viable predictors of intentions that lead to eco-friendly transportation behavior.

Dill et al. (2014) analyzed the effectiveness of TPB by including attitudes and other psychological factors in models for examining bicycling and walking from home. They found that the built environment and demographics were important in influencing the PBC, which in turn helped explain the transportation behavior. That is, interventions relying exclusively on improving the physical environment might not change behavior to the desired level. They also found that attitudes, SNs, and PBCs mediated the relationship between built environment and non-motorized travel (Dill et al., 2014).

Chaney et al. (2013) analyzed the active transportation (e.g., bicycling) behavior among college students. The purpose of the study was to apply the results toward promoting physical activity and community health. The three TPB constructs - attitude toward behavior, SN, and PBC - were used to derive behavioral intention. Behavioral intention was then used as predictor for the actual behavior. The regression analysis utilizing only the TPB constructs accounted for 11.58 percent variation in attitude. This indicated that there were other essential variables missing from the preliminary model. By including the additional variables age, transportation type, and destination, the final model resulted in 44.44 percent explained variation.

Thorhauge et al. (2019) studied the role of intention as mediator between certain latent effects and the decision to choose the departing time. The study revealed that attitude, subjective norms and PBC were statistically significant in explaining the intention toward arriving on time. TPB has also been successfully applied to explain the pro-environmental intentions toward motorized transportation, to include personal car use (Gardner & Abraham, 2010), activity travel in an urban setting (Adnan et al., 2019), public transit (Bamberg, 2000; Fu & Juan, 2017), and leisure air transportation use (Morten et al., 2018). Although TPB accounted for a significant portion of the variance in intentions, studies have revealed that the predictive utility of TPB might be improved by including additional variables (Morten et al., 2018).

Other researchers have extended the TPB framework to include habits and other variables to explain commuters' transport mode use. The majority of additional factors included in the models proved to be statistically significant. De Bruijn et al. (2009) studied the effects of habit in conjunction with the TPB in an effort to explain active transportation. By definition, habit is behavior that has been performed on a routine basis. Thus, the frequent bicycle use as a means of adult active transportation could become habitual. Habit strength acted as a strong moderator of the intention-behavior relationship regarding bicycle use. This implies that intentions became less relevant as actual bicycle use grew strongly habitual. Bamberg et al. (2003) analyzed the roles of past behavior, habit, and reasoned action in explaining the choice of travel mode. The authors used TPB as a conceptual framework for an intervention to affect behavioral change. Influencing intentions and behavior could be possible by designing an intervention that addresses the antecedent factors of attitudes, subjective norms, and PBC. The difficulties associated with influencing the travel mode are often attributed to ingrained habits. The study does not contradict the role of habit in shaping human action but emphasizes the necessity of developing a measure of habit that focuses on the specific behavior to be predicted (e.g., taking the bus). Additionally, it concluded that human social behavior is based on reason, although it may contain certain automatic elements. Finally, it revealed that past travel choice contributes to the prediction of future behavior only if the circumstances remain constant.

Donald et al. (2014) analyzed the factors affecting commuters' mode of transport choice by extending the TPB model. The most important factors that influenced whether participants drove or used public transportation were intention and habit. Additionally, the most important predictor of intentions was PBC. The results were enhanced by including additional variables that were not part of the TPB model: moral norm, descriptive norm, and environmental concern. The incremental validity of the later variables was mixed and varied according to transport mode. The analysis also concluded that factors determining one choice did not necessarily influence an alternative. As a result, campaigns aimed at changing behavior should encourage public transport use while different campaigns should target personal car use. Lastly, the research revealed the complex role of habit in transport mode choice. PBC was a good predictor of habit; in turn, habit determined personal car use but played no role in public transport use. This finding suggests that it may be necessary to break habits before implementing attitude-based campaigns. The overall results revealed that there was no single approach that could easily translate into moving people from car use to public transport.

Some studies went a step further by utilizing TPB and other behavioral theories in an integrated framework. Bamberg and Schmidt (2003) utilized TPB, the Norm-Activation Model and the Theory of Interpersonal Behavior (TIB) to compare the predictive power of these models in the context of students' car use. The three theories could be viewed as supplementary rather than alternative models; they have been developed in different research contexts and thus focus on different facets of the social behavior. The results of this study proved that TPB was a more parsimonious approach that explained the vast majority of variance. This theory suggested that attitude, SN, and PBC mediate the influence of different types of outcomes on intention. TIB was a more complex approach; one variable in this model – car use habit – increased the predictive power of the TPB. The central variable of Norm-Activation Model – personal norm – did not exert any direct effect on intention or behavior. Initially rooted in the conscious considerations about advantages and disadvantages, the choice of travel mode became more habitual. Although there were a growing number of studies demonstrating empirically that habit was an important predictor of behavior, they believed that altering the behavioral intentions was not sufficient to change behavior. Rather, new intentions must prevail against the strong habitualized behavior patterns (Bamberg & Schmidt, 2003).

Davison et al. (2014) employed TPB and the Norm-Activation Model to better understand attitudes and behavioral intentions relating to air travel, and investigated how this differed by individual segments. Jia (2018) combined TPB and the theory of complex environmental behavior to explain residential green travel behavior in an urban setting. Forward (2014) augmented TPB with the trans-theoretical model in an attempt to predict people's intentions to utilize biking as a mode of transportation. Lai (2015) analyzed the bus companies, which consume millions of liters of fuel every year and have operating expenses of millions of US dollars. The study employed behavioral theory and encouraged drivers to adopt eco-driving behaviors through the use of a financial reward system. Upon analyzing the fuel-efficiency data collected before and after implementing the reward system, the study revealed an improvement of more than 10 percent.

In the airline industry, fuel is the second largest operating cost component after labor (IATA, 2020), encompassing an average of 32 percent of airlines' operating expenses (Gosnell et al., 2016). Thus, the companies have an intrinsic motivation to adopt more fuel-efficient operations because the savings achieved could significantly enhance the bottom line. Airline captains operating in the aviation industry have a considerable amount of autonomy in making fuel and flight decisions. For captains and their co-pilots, in-flight efficiency is regular part of business while ensuring that safety remains the top priority. Virgin Atlantic undertook the first study to understand how the behavior of airline captains influenced fuel efficiency, and how cost-effective interventions could influence the eco-flying behavior. After studying 355 pilots across 42,012 flights, the company observed that monthly tailored feedback, performance-based targets, and prosocial incentives could drive behavioral change (Gosnell et al., 2016).

The captains who operated the Virgin Atlantic fleet could influence the fuel efficiency outcomes by means of three levers: Optimal Fuel Load, Efficient Flight, and Efficient Taxiing. The first lever was a pre-flight consideration. Approximately 90 minutes before each flight, captains utilized the flight plan information and their own professional judgement to calculate the amount by which they should increase or decrease fuel load. The second lever tracked whether captains used less fuel than allotted in the updated flight plan. Captains could make fuel-efficient decisions between takeoff and landing by requesting and executing optimal altitudes and shortcuts, maintaining optimal speeds, adjusting to weather updates, and ensuring proper aerodynamic settings for flaps and landing gear. By accessing the third lever, captains could choose to shut down a number of engines in order to decrease the fuel burn per minute spent taxiing. This field experiment revealed that the vast majority of captains engaged in more fuel-efficient decision-making after being informed that their behavior was being monitored. Upon conclusion of the study, captains displayed longer-term fuel-efficient behaviors that lasted at least six months. Additionally, by adding a personal goal that challenged the expectation for satisfactory job performance, the captains adjusted their behaviors and delivered additional gains. Furthermore, the study revealed that captains' well-being and job satisfaction were positively influenced by prosocial incentives and job performance. Changes in their behavior saved an estimated 5.4 million US dollars in fuel costs. By employing the behavioral science principles, organizations could provide pilots with meaningful performance-based goals and find ways to facilitate reaching these targets (Gosnell et al., 2016).

Similar to Virgin Atlantic, other companies with large fleets of aircraft are committed to stimulate fuel-efficient flying habits. FedEx acknowledged that ingrained habits and culture were the hardest elements to change in an organization. The company has been striving to reduce the use of jet fuel by implementing a comprehensive communications program and fostering a fuel-saving culture. The ground staff and crew members were receptive to save fuel in order to generate lower fares for the customers. As part of its "reduce," "replace," and "revolutionize" approach, FedEx saved 250 million of gallons of jet fuel during the fiscal year of 2019 (FedEx, 2018).

Similar studies investigated the extent to which human resource management (HRM) could improve the environmental performance of airline pilots. Green performance has become a significantly important performance indicator for the civil aviation industry. The decisions made by the captain during flight can significantly influence the amount of fuel utilized. As pilots have tremendous opportunities to directly affect the environmental performance of airline industry, the HRM could positively impact their attitudes toward pro-environmental goals. By taking a direct approach, the HRM could implement training programs or generate policies that target achieving optimum flight performance levels. HRM could also contribute indirectly to the environmental performance of pilots by improving job satisfaction, organizational commitment, and engagement (Harvey et al., 2013). Furthermore, the International Air Transport Association (IATA) is working with the airlines worldwide to reduce the amount of fuel required by the industry. In support of this initiative, it has set a target of mitigating the CO2 emissions from the air by improving fuel efficiency by 1.5 percent per year from 2009 to 2020. As a long-term goal, IATA required strong commitment from the aviation industry and advocated for more efficient aircraft operations to reduce the fuel and carbon emissions (IATA, 2020).

Summary

Pilots have unmatched opportunities to impact the energy consumption and environmental performance of the aircraft fleet (Harvey et al., 2013). Companies have implemented fuel saving initiatives by targeting the employees' attitudes and habits while working on changing the culture (FedEx, 2018). Ajzen (1991) states that both intention and PBC can make significant contributions to the prediction of behavior but only one of the two predictors may be needed in any given application. In this study, we assume that the stronger the eco-friendly intention, the more likely a pilot will engage in saving fuel while flying logistics missions. Thus, effective policies and interventions can be designed by understanding the specific intentions that lead to behaviors. According to TPB, the three antecedents to intention are ATT, SN, and PBC. ATT is the positive or negative evaluation of performing the behavior. SN assesses if others think one should perform the behavior or not. Lastly, PBC is the perceived ease or difficulty of engaging in a certain behavior (Ajzen, 1991).

III. Methodology

Chapter overview

This chapter discusses sampling processes, methods, and preliminary data analyses. Exploratory and confirmatory factor analyses are conducted before applying structural equation modeling to data.

Data collection

Data was collected by using a TPB-based questionnaire designed by Cotton (2020) and listed in Appendix. The major constructs in the questionnaire included intention (INT) and its three antecedents such as subjective norms (SN), attitudes (ATT), and perceived behavioral control (PBC). SN had one antecedent: organization emphasis (OE). ATT came with five antecedents such as efficiency versus effectiveness (EVE), pride in performance (PP), energy security (ES), environmental values (NEP), and maximizing options (MO). In addition, ATT consisted of items in instrumental and experiential categories. PBC included three types of items on self-efficacy, controllability, and feedback. In accordance with TPB, when pilots believed that they had the resources and opportunities (e.g., skills, time, and leadership approval), and that the obstacles encountered were manageable, they would have confidence in their ability to perform the fuel-saving behavior, and, thus, display a high degree of PBC (Ajzen, 2002).

The questionnaire was distributed to 415 cargo pilots in USAF and 100 cargo pilots in ROKAF. For the pilots in ROKAF, the questionnaire was translated in Korean and translated back in English by two bilingual authors. There was no difference between the two language versions. 108 useable responses were collected: 62 from USAF and 46 from ROKAF. Overall response rate was 19.6 percent. During the data collection period, the responses received in the first month were compared to those received after the first month for testing non-response bias. There was no significant difference between the two data set.

Proposed models

Based on TPB and related studies, this study tested two models: the intention model and the attitude model with four antecedents. Figure 3 presents the intention model that is similar to TPB without behavior.

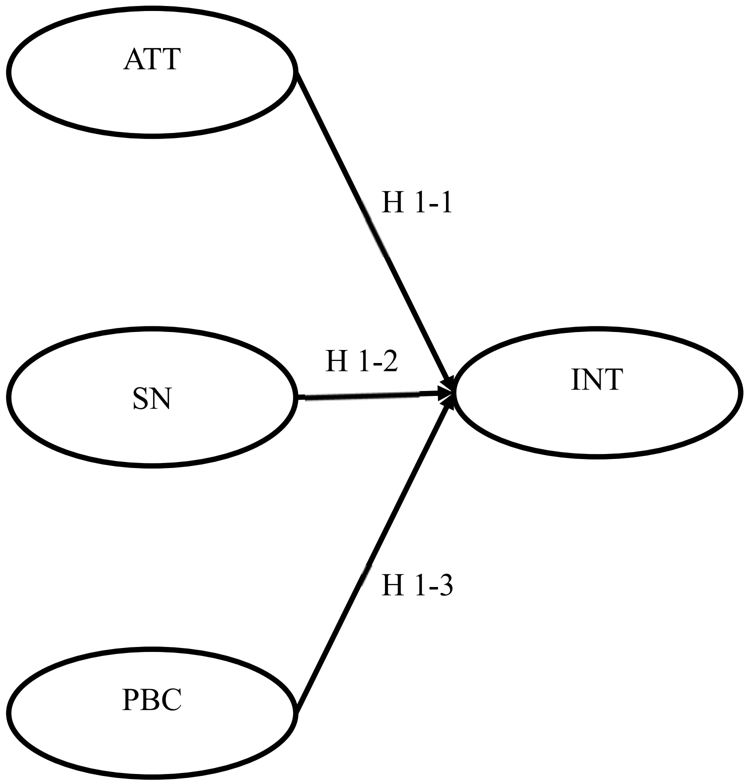

Figure 3 Intention Model

The hypotheses of the present study examined the influence of ATT, SN, and PBC on pilots' intentions. In the first model, we hypothesize that

H1-1: Pilots' attitude toward energy conservation positively affects their intention to save fuel;

H1-2: Pilots' subjective norm positively affects their intention to save fuel;

H1-3: Pilots' perceived behavioral control positively affects their intention to save fuel.

In the second model, this study included attitude and its four antecedents to understand the factors that would explain attitudes. Figure 4 presents the attitude model with the four antecedents:

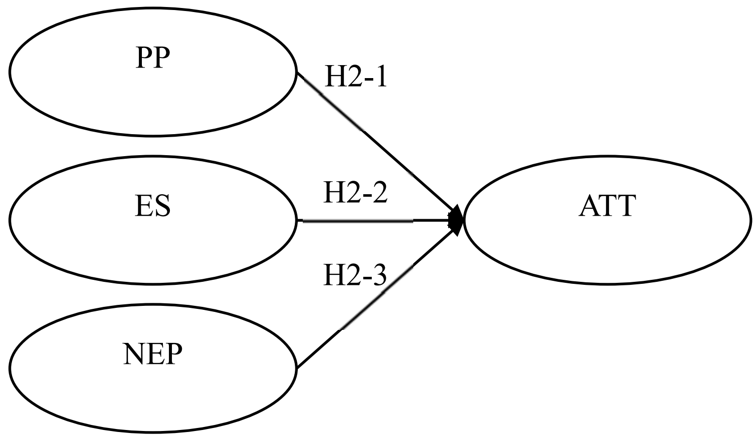

Figure 4 Attitude Model

The hypotheses in the second model examine the influence of PP, ES, and NEP on pilots' attitudes toward saving fuel. The following hypotheses are proposed:

H2-1: Pilots who feel pride in performance exhibit a positive attitude toward saving fuel;

H2-2: Pilots who are concerned about energy security will have a positive attitude toward fuel saving;

H2-3: Pilots in favor of the New Ecological Paradigm will display a positive attitude toward fuel saving;

Statistical Methods

This study employs structural equation modeling (SEM), which is a multivariate technique that allows researchers to assess relationships among constructs in a model. It could be viewed as an estimation technique for a series of separate multiple regression equations assessed simultaneously. SEM consists of the structural model and the measurement model. The structural model is a path model, which combines theory with experience to indicate the independent variables predicting each dependent variable. The measurement model enables the researchers to assign several variables for a single independent or dependent variable (Hair et al., 2019, p. 27). For SEM, preliminary analyses are required for structural equation modeling. First, convergent validity for items is assessed with EFA. Next, discriminant validity for constructs or latent variables is examined using CFA.

EFA is an unguided approach for building theory. This statistical method is utilized when the links between the observed and latent variables are unknown or uncertain. Typically, a researcher desires to identify the smallest number of factors that account for covariation among the observed variables while keeping the information loss to a minimum (Byrne, 2016). EFA can be used to analyze interrelationships among a large number of variables and to condense the information into a parsimonious set of factors (Hair et al., 2019, p. 25). Reliability is the degree to which a set of variables is consistent in what it is intended to measure. EFA assesses construct reliability using Cronbach's alpha values. According to Koufteros et al. (2001), Cronbach's alpha values are extensively used for measuring construct's reliability. Table 1 shows EFA results for the Intention Model.

Table 1 EFA Results for the Intention Model

Construct	Item	Factor Loading	t-value	Cronbach's Alpha
Attitude	ATTEX2	0.816	5.650	0.770
	ATTEX3	0.826	5.609	
	ATTEX5	0.812	-	
Subjective Norm	SN1	0.827	9.183	0.870
	SN2	0.826	8.140	
	SN4	0.825	7.680	
	SN7	0.823	-	
	PBCSE1	0.749	4.965	0.737
	PBCSE3	0.837	4.987	

Perceived Behavioral Control	PBCSE4	0.795	-	
Intention	INT2	0.862	6.138	0.784
	INT3	0.906	6.604	
	INT4	0.740	-	

Missing values were handled with mean substitution. Loadings were all significant at α = 0.01. Crobach's Alpha values were greater than the threshold value of 0.7. Harman's one-factor test was performed to evaluate the likelihood of common method bias (Hair et al., 2019, p. 744). The first factor explained 28.03 percent of total variance. As this value is less than the benchmark value of 50 percent, we can conclude that the common method bias isn't a serious problem (Podsakoff et al., 2003).

Table 2 EFA results for the Attitude Model

Construct	Item	Factor Loading	t-value	Cronbach's Alpha
Pride in Performance	PP1	0.857	9.359	0.888
	PP2	0.868	9.394	
	PP3	0.845	8.170	
	PP4	0.819	-	
Energy Security	ES2	0.895	13.105	0.914
	ES3	0.916	12.274	
	ES4	0.924	-	
New Ecological Paradigm	NEP1	0.780	7.817	0.859
	NEP3	0.843	9.366	
	NEP13	0.803	8.742	
	NEP14	0.733	7.456	
	NEP15	0.872	-	

Similar to the results of the Intention Model, factor loadings and Cronbach's alpha values are above 0.7. The first factor explained 29.9 percent of total variance. Accordingly, common method bias does not constitute a significant issue.

CFA is necessary for examining construct validity. CFA is typically utilized when the researcher has some knowledge about the underlying variable structure. CFA is a guided approach that aims to determine if the number of factors confirm to what is expected based on the established theory (Gaskin, 2018). CFA was conducted for examining construct validity such as discriminant validity and reliability. Discriminant validity represents the degree of independence for constructs in a model. The constructs should be independent so that they could represent unique meanings. Discriminant validity was evaluated by comparing the Average Variance Extracted (AVE) with the squared correlation between constructs. Table 3 outlines construct validity for the Intention Model.

Table 3 Construct Validity for the Intention Model

	CR	AVE	MSV	MaxR(H)	PBC	INT	ATT	SN
PBC	0.752	0.511	0.265	0.821	**0.715**			
INT	0.573	0.573	0.265	0.573	0.515	**0.757**		
ATT	0.771	0.530	0.056	0.774	0.081	0.113	**0.728**	
SN	0.868	0.622	0.133	0.879	0.365	0.724	0.237	**0.789**

All AVEs are above 0.5 and greater than the MSV. The square roots of AVEs are greater than the correlations between constructs, which confirms discriminant validity. However, the composite reliability measure of INT is less than 0.7. Although there is no firm threshold value for this measure, it is low. Because Cronbach's alpha value for this construct was 0.784, there could be an issue on data or variables. Nonetheless, this study progressed to the next steps and tried to measure against this issue. For CFA, it is necessary to check models' fit indices. The absolute fit indices are a direct measure of how well the models reproduce the observed data. Chi-square (χ^2) is the most important absolute fit index and provides a test of statistical significance. An additional measure of fit is the normed chi-square, which is defined by the ratio of chi-square to the degrees of freedom ratio (χ^2/df). However, there is no universal agreement as to what constitutes a good and a bad fitting model (Kenny, 2020). Additionally, χ^2 tends to reject models with a larger sample size or models containing many observed variables. While RMSEA value of 0.08 or less is preferred, it is not an absolute measure (Hair et al., 2019: p. 637). Instead, lower RMSEA values indicate better fit. CFI is an incremental fit index, which ranges from 0 to 1; CFI values closer to one indicate a better fit (Hair et al., 2019: p. 639). The summary fit indices for the CFA results for the intention model are as follows: χ^2 = 99.25 with p-value, 0.001; χ^2/df = 1.68; CFI = 0.929; RMSEA = 0.080.

Table 4 Construct Validity for the Attitude Model

	CR	**AVE**	**MSV**	**MaxR(H)**	**NEP**	**ATT**	**PP**	**ES**
NEP	0.872	0.579	0.015	0.884	**0.761**			
ATT	0.634	0.634	0.000	0.634	0.012	**0.796**		
PP	0.880	0.648	0.107	0.884	-0.071	0.381	**0.805**	
ES	0.916	0.785	0.107	0.922	0.121	-0.018	0.327	**0.886**

Discriminant validity for the constructs in the attitude model is confirmed. However, the composite reliability of ATT is lower than 0.70. The summary fit indices for the CFA results for the attitude model are as follows: χ^2 = 145.21 with p-value, 0.000; χ^2/df = 1.73; CFI = 0.926; RMSEA = 0.083.

Summary

Two models were proposed for testing the hypotheses on military cargo pilots who carried logistics missions. EFA was conducted for ensuring convergent validity. CFA was employed for examining the discriminant validity of the constructs in the models. The constructs with acceptable validity results were selected for the next analyses.

IV. Results and Discussion

Chapter overview

This chapter presents SEM results and discusses test results of the hypotheses. Two SEM models were tested for the hypotheses. In addition, a multi-group comparison was conducted for the data set from two sources such as USAF and ROKAF.

Structural models and hypothesis tests

For testing the intention model, the presence of SN changed the leading sign of ATT from positive to negative and made ATT insignificant. These results could be a symptom of multicollinearity. When a test for group differences between USAF and ROKAF was conducted, a measure to handle this issue was addressed. Table 3 displays the results of the intention model without SN.

Table 5 Intention Model

Paths	Hypothesis	Coefficient	Standard Error	Critical Ratio	Significance
ATT → Intention	H1-1	-0.060	0.089	-0.673	0.501
SN → Intention	H1-2	0.500	0.107	4.667	0.000***
PBC → Intention	H1-3	0.371	0.139	2.661	0.008***

***: significant at 0.01; **: significant at 0.05; *: significant at 0.10

Model fit indices were as follows: χ^2 = 99.247 with p-value, 0.001; χ^2/df = 1.68; CFI = 0.929; RMSEA = 0.080; PCLOS = 0.043. Attitude was not significant in the intention model. SN and PBC were significant at α = 0.01. However, when SN was dropped from the model, ATT became positive and significant. The significant results of ATT and PBC were congruent with previous studies such as Armitage and Conner (2001). For military cargo pilots who carry out logistics missions, ATT and PBC could be influential constructs for promoting eco-friendly intention that leads to eco-friendly behavior.

Because ATT was significant for explaining intention, it would be beneficial for commanders to understand factors that influence ATT. For this purpose, the ATT model was tested. The ATT model included ATT and its four antecedents. Table 6 presents the result of the ATT model.

Table 6 Attitude Model

Hypothesized Path	Hypothesis	Coefficient	Standard Deviation	Critical Ratio	Significance (p-value)
Pride in Performance → Attitude	H2-1	0.311	0.094	3.317	0.000***
Energy Security → Attitude	H2-2	-0.163	0.113	-1.435	0.151
New Ecological Paradigm → Attitude	H2-3	0.048	0.083	0.573	0.567

***: significant at 0.01; **: significant at 0.05; *: significant at 0.10

Model fit indices were as follows: $\chi^2 = 145.21$ with p-value, 0.000; $\chi^2/df = 1.73$; CFI = 0.926; RMSEA = 0.083; PCLOS = 0.013. In this model, pride in performance (PP) was significant for explaining ATT ~~in the attitude model~~. Accordingly, H2-1 was supported. Meanwhile, H2-2 and H2-3 were inconclusive. In the future, the constructs in the intention and attitude models could be pooled for testing the hypotheses.

Multi-group comparison

The minimum data requirement for a multi-group comparison using SEM is about 100 observations in each group. Considering the relatively small sample size of 108 observations, this study chose a multiple regression model for examining a group difference between USAF and ROKAF. A categorical or dummy variable, which identified pilots in USAF or ROKAF, was added in the multiple regression model. Based on the structural models, scales for the dependent and independent variables were aggregated for the regression model. The dependent variable was INT, and the independent variables were ATT, SN, PBC, and USAF (1 for USAF; 0 for ROKAF). Table 5 reveals the result of the regression model for group comparison.

Table 7 Multiple Regression Results for a Group Comparison

	Model 1 (SN absent)	Model 2 (ATT absent)	Model 3 (SN and ATT)
ATT	0.282^{***}		0.078
SN		0.577^{***}	0.541^{***}
PBC	0.452^{***}	0.215^{***}	0.227^{***}
USAF	0.088	0.019	0.018
Adjusted R^2	0.270	0.469	0.469

***: significant at 0.01; **: significant at 0.05; *: significant at 0.10

Attitude was significant when SN was absent. Although collinearity diagnostics didn't show any issues, SN and ATT were interacting in the full model or Model 3. This result is similar to the SEM results in the previous section. To handle this issue, SN was transformed by taking its negative reciprocal and including it in the model. Table 6 shows the results of the regression model with the transformed SN.

Table 8 Multiple Regression Results with the Transformed SN

	Unstandardized Coefficient	Standard Error	Standardized Coefficient	t	Significance
Constant	2.902	.621		4.673	.000
ATT	.203	.073	.208	2.766	.007
PBC	.363	.079	.348	4.596	.000
SN	3.436	.645	.410	5.328	.000
USAF	.111	.181	.046	.613	.541

The adjusted R^2 for this model was 0.422. By transforming SN, we could find true relationships between independent and dependent variables. All three antecedents to intention were significant. Thus, H1-1, H1-2, and H1-3 were supported. The standardized coefficient of SN was greater than attitude. This contradicts the claim made by Ajzen (1991), which argued that the magnitude of SN would be smaller than that of attitude. The findings of this study could be explained by vertical organizational cultures, stringent rules, and military regulations. Thus, the Air Forces can enhance cargo pilots' ecofriendly intention by modifying subjective norms and promoting attitude toward ecofriendly behavior. Finally, the dummy variable or USAF that identified pilots in USAF and ROKAF was not significant in all models. Accordingly, this study confirms that the difference between USAF and ROKAF is inconclusive.

Summary

Two structural models were employed for testing the hypotheses. Findings were the significant roles of Attitude and Perceived Behavioral Control for explaining Intention toward eco-friendly behavior. When a measure against multicollinearity was taken, multiple regression results confirmed the significance of three antecedents to intention. The group comparison between USAF and ROKAF using three multiple regression models revealed that the two groups were not statistically different.

V. Conclusion

Overview

This chapter summarizes findings of this study. Findings, recommendations, and future directions are presented.

Summary of findings

Military cargo pilots play essential roles in enhancing fuel efficiency by flying in an eco-friendly manner while carrying out logistics missions. TPB (Ajzen, 1991) is a theory that explains the complexity of human behavior (Ajzen, 1991). According to this theory, the most immediate predictor of behavior is behavioral intention, which indicates the person's motivation to pursue a certain behavior (Ajzen, 1991; Morten et al., 2018). This study hypothesized that attitude, subjective norm, and perceived behavioral control affect pilots' intention toward eco-friendly behavior using TPB.

This study found that attitude and perceived behavioral control were significant for explaining intention toward eco-friendly behavior in a structural model. Each of these two factors could serve as a lever in attempts to change the cargo pilots' fuel-saving behavior. In the attitude model, pride in performance was significant for explaining attitude. When scales were aggregated, all three antecedents to intention were significant in the multiple regression model. Because subjective norm is related to organizational cultures, it is necessary to pay attention to promoting eco-friendly military cultures. In addition, promoting attitude toward ecofriendly behavior by recognizing pride in ecofriendly performance will strengthen ecofriendly intention. Since data were collected from USAF and ROKAF, this study conducted a group comparison using multiple regression models and failed to find differences between two military groups. Because the Air Force consumes a significant amount of fuel, the major contribution of this study is investigating Air Force cargo pilots' eco-friendly intention, which can lead to actual eco-friendly behavior. Like automobiles, cargo aircraft are subject to how they are controlled. This study is applicable to cargo and passenger pilots in both military and airline industry.

Recommendations for action

Because the pilots surveyed constitute a representative sample of the cargo community, the results can be replicated for the entire population. The findings are an interesting starting point for developing practical intervening actions aimed to encourage fuel-saving behavior. Energy conservation is a shared responsibility. Building an energy-aware culture requires appealing to the target populations through the right channels. Fuel efficiency metrics could be employed to provide timely feedback, enhance energy awareness, and drive behavior change. Promoting pride in ecofriendly performance based on the fuel efficiency metrics is recommended as it can change pilots' attitude. In addition, enhancing perceived behavioral control is recommended by removing or reducing barriers that hinder perceived behavioral control. Lastly, it is necessary to consider the potential trade-off relationship between fuel efficient behaviors and flight safety concerns as suggested by Akgül (2020).

Future direction

This study investigated military cargo pilots' energy saving intentions for carrying out logistics missions. To advance this topic, it would be useful to collect data on actual eco-friendly behavior. Future studies could investigate the pilots' actual fuel saving behavior and evaluate the relationship between eco-friendly flying intention and actual eco-friendly flying behavior (Gao et al., 2017). In addition, to increase sample size, collecting data from pilots in allied countries is highly recommended.

Summary

Attitude and perceived behavioral control were significant for explaining intention toward eco-friendly behavior among the military cargo pilots who flew channel or logistics missions. Courses of action were suggested based on the findings. Future studies needed to include measures of actual eco-friendly behavior.

VI. Acknowledgement

This work is sponsored by SAF/IE and funded by AFMC/A4.

Appendix: Fuel Efficiency Questionnaire (Cotton, 2020)

Intention: adapted from Ajzen (2002)
IN1: I expect to use less than Aircraft Fuel Planner (ACFP) expected fuel most of the time.
IN2: I prefer to fly in a fuel-efficient manner.
IN3: I intend to be fuel-efficient when I fly.
IN4*: I do not think about fuel efficiency before I fly.

Attitude (Saving Fuel): adapted from Ajzen (2002)
Saving fuel over the next dozen missions would be:

bad	1	2	3	4	5	6	7	good
pleasant	1	2	3	4	5	6	7	unpleasant*
harmful	1	2	3	4	5	6	7	beneficial
worthless	1	2	3	4	5	6	7	valuable
enjoyable	1	2	3	4	5	6	7	unenjoyable*

Ajzen (2002). Constructing a TPB questionnaire: conceptual and methodological considerations:
http://chuang.epage.au.edu.tw/ezfiles/168/1168/attach/20/pta_41176_7688352_57138.pdf
, accessed on December 18, 2018.

Attitude (Max Range Airspeed): adapted from Ajzen (2002)
Flying at max range airspeed (i.e. the airspeed which achieves the best range, without compromising safety or timeliness)

Does not save fuel	1	2	3	4	5	6	7	Saves Fuel
Is Harmful	1	2	3	4	5	6	7	Is Beneficial
Is Good	1	2	3	4	5	6	7	Is Bad*
Is Pleasant for Me	1	2	3	4	5	6	7	Is Unpleasant for Me*
Is Worthless	1	2	3	4	5	6	7	Is Useful

Subjective Norm: adapted from Ajzen (1991)
SN1: Pilots I respect think I should fly in a fuel efficient manner.
SN2: It is expected that I fly routine missions fuel-efficiently.
SN3: I feel pressure from my peers to be as fuel-efficient as possible.
SN4: People who are important to me want me to be fuel efficient.
SN5: My passengers' assessment of my flying ability is important to me.
SN6: What my superiors think of my flying technique matters to me.
SN7: What other pilots do to conserve fuel is important to me.

Perceived Behavioral Control-Self-Efficacy: adapted from Ajzen (2002) and Bandura (2006)
PBC-SE1: I could fly in a fuel-efficient manner if I wanted to.
PBC-SE2: It is easy for me to achieve fuel-efficient flight standards.

PBC-SE3: As the aircraft commander, I can directly improve the overall fuel efficiency of my mission.
PBC-SE4: I have enough flexibility to influence the fuel efficiency of my flights.

Perceived Behavioral Control-Controllability: adapted from Ajzen (2002) and Bandura (2006)
PBC-CN1: The decision to fly in a fuel-efficient way is beyond my control.
PBC-CN2: Flying in a fuel-efficient manner is not entirely up to me.
PBC-CN3: The routines and processes are in place to help me fly fuel efficiently.

Perceived Behavioral Control-Feedback: adopted from Cotton, Schultz, Hagtvedt, Reiman, and Strakos (2015)
PBC-FB1: I know when I have flown in a fuel efficient manner.
PBC-FB2: I receive enough information to determine if I have flown a fuel-efficient sortie.
PBC-FB3: The system regularly gives me enough information to know I've flown fuel-efficiently.

Organizational Citizenship Behavior: adapted from Pew Research Center (pewresearch.org, accessed on January 15, 2015) and Maignan, Ferrell, and Hult (1999)
OC1: Fuel-efficient flying directly benefits my country's financial health.
OC2: Saving on petroleum expenses will be good for the country.
OC3: It is an important part of my job to reduce expenses.

Efficiency vs. Effectiveness: adopted from Cotton, Schultz, Hagtvedt, Reiman, and Strakos (2015)
EVE1: Fuel efficiency supports safe mission accomplishment.
EVE2: I can accomplish the mission safely and save fuel at the same time.
EVE3: There is a strict tradeoff between saving fuel and flying effectively.

Pride in Performance: adopted from Cotton, Schultz, Hagtvedt, Reiman, and Strakos (2015)
PP1: The ability to fly efficiently is the mark of a good pilot.
PP2: Flying efficiently is an important part of demonstrating mastery of my aircraft.
PP3: Pilots who take pride in their skill will often fly using less fuel.
PP4: Doing my job well includes flying efficiently.

Energy Security: adopted from Cotton, Schultz, Hagtvedt, Reiman, and Strakos (2015)
ES1: Energy security for my country is important to me.
ES2: It is important that energy continue to be affordable.
ES3: The government should be concerned about securing our energy sources.
ES4: Energy supplies to my country need to be reliable.
ES5: My country is too dependent on foreign sources of energy.
ES6: My country should derive energy from sources plentiful there.
ES7: Domestic sources of energy should be preferred to foreign ones.

ES8: I should do what I can to reduce dependence on foreign energy.

Environmental Values (New Ecological Paradigm): adopted from Dunlap (2000)
Reality of Limits to Growth:
NEP1: We are approaching the limit of the number of people the earth can support.
NEP2: The earth has plenty of natural resources if we just learn how to develop them.
NEP3: The Earth is like a spaceship with very limited room and resources.

Anti-Anthropocentrism:
NEP4: Humans have the right to modify the natural environment to suit their needs.
NEP5: Plants and animals have as much right as humans to exist
NEP6: Humans were meant to rule over the rest of nature.

Fragility of Nature's Balance
NEP7: When humans interfere with nature, it often produces disastrous consequences.
NEP8: The balance of nature is strong enough to cope with the impacts of modern industrial nations.
NEP9: The balance of nature is very delicate and easily upset.

Rejection of Exemptions:
NEP10: Human ingenuity will ensure that we do NOT make the earth unlivable.
NEP11: Despite our special abilities, humans are still subject to the laws of nature.
NEP12: Humans will eventually learn enough about how nature works to be able to control it.

Possibility of an Eco-Crisis:
NEP13: Humans are severely abusing the environment.
NEP14: The so-called "ecological crisis" facing humankind has been greatly exaggerated.
NEP15: If things continue on their present course, we will soon experience a major ecological catastrophe.

Organizational Emphasis: adopted from Cotton, Schultz, Hagtvedt, Reiman, and Strakos (2015)
OE1: It is important to the Air Force that I save fuel when I can.
OE2: The Air Force is serious about saving fuel.
OE3: Being fuel-efficient when I fly supports Air Force goals.
OE4: My leadership wants me to fly efficiently.

Maximize Options: adopted from Cotton, Schultz, Hagtvedt, Reiman, and Strakos (2015)
MO1: I believe that conserving fuel while flying increases the safety of my flight crew.
MO2: I try to save enough fuel for an unexpected diversion.
MO3: I do not mind returning from missions with fuel unspent.
MO4: It is important to conserve fuel in case my mission changes mid-flight.
MO5: The more fuel I can save, the more options I have while flying.

MO6: I have had to cut missions short due to fuel concerns.

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REPORT DOCUMENTATION PAGE	Form Approved OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*	**2. REPORT TYPE**	**3. DATES COVERED** *(From - To)*
25/03/2021	Master's Thesis	Aug 2019 - March 2021

4. TITLE AND SUBTITLE
Examining Military Cargo Pilots' Eco-friendly Flying Intention

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
Ioan A. Gaitan, Capt, USAF

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Air Force Institute of Technology
Graduate School of Engineering and Management (AFIT/EN)
2950 Hobson Way
Wright-Patterson AFB OH 45433-7765

8. PERFORMING ORGANIZATION REPORT NUMBER
AFIT-ENS-MS-21-M-161

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Air Force Operational Energy Office (SAF/IEN)
Roberto I. Guerrero, SES
1665 Air Force Pentagon
Washington, DC 20330-1665
(571)-256-4711

10. SPONSOR/MONITOR'S ACRONYM(S)
SAF/IE, AFMC/A4

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Distribution Statement A. Approved for Public Release; Distribution Unlimited.

13. SUPPLEMENTARY NOTES
This work is declared a work of the U.S. Government and is not subject to copyright protection in the United States.

14. ABSTRACT
The US Air Force is the largest operational energy consumer within the Department of Defense primarily due to aviation fuel use. Military pilots can play important roles in saving aviation fuel by flying aircraft in an eco-friendly manner. According to the theory of planned behavior (TPB), intention is the major predictor of behavior. This study tests two models based on TPB for understanding cargo pilots' eco-friendly intentions when they conduct channel or logistics missions. The study found that attitude, subjective norm, and perceived behavior control were significant antecedents to intention in a multiple regression with aggregated scales.

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			**17. LIMITATION OF ABSTRACT**	**18. NUMBER OF PAGES**	**19a. NAME OF RESPONSIBLE PERSON**
a. REPORT	**b. ABSTRACT**	**c. THIS PAGE**			Seong-Jong Joo, PhD, AFIT
					19b. TELEPHONE NUMBER *(Include area code)*
U	U	U	UU	48	(937) 255-3636 x 4761 (seong-jong.joo@afit.edu)