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Antecedents of Fuel Efficiency

James A. Cotton

ANTECEDENTS OF FUEL EFFICIENCY

THESIS

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Abstract

Reducing the United States Air Force (USAF)'s fuel use is a major budgetary concern, as the USAF consumes more fuel than the Army, Navy, Marine Corps and all other Department of Defense (DoD) agencies combined. This research focused on fuel efficiency of C-130 Hercules Aircraft Commanders (ACs) by proposing, constructing, and testing a survey measure of behavioral drivers of discretionary pro-environmental professional behaviors among USAF pilots.

Dedication

To my wife and adventure copilot – you believed in me, you encouraged me,
and you waited for me all those long nights of research.
As I wandered into the wilderness of academia, I was never alone.

For all of the evers, I love you.

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I. INTRODUCTION

1.1 Problem Statement

Reducing the United States Air Force's fuel use is a budgetary concern for the Department of Defense (DoD) and for the nation. The USAF is the US government's largest petroleum customer, consuming more fuel than the Army, Navy, Marine Corps and all other DoD agencies combined. The USAF, in 2010, consumed 91% of all DoD petroleum-based fuels, and in turn, 58% of all petroleum-based fuels in the entire United States government (USAF 2010). The DoD's 2013 expenditures of petroleum, natural gas and aerospace energy were $15.4 billion (DLAe 2014), and the USAF was responsible for $8.1 billion of this fuel expense.

Are pilots who save more fuel than others motivated by professionalism, environmentalism, concerns about energy security, or command influence? What internal and social factors are at play when a pilot regularly demonstrates high fuel efficiency?

This thesis focuses on fuel efficiency of USAF cargo airlift Aircraft Commanders (ACs). We propose, construct, and test a survey instrument designed to identify correlations between motivators and actions. We start with Ajzen (1985) and the Theory of Planned Behavior (TPB), and modify it by incorporating Lülfs and Hahn's (2013, 2014) expansions, additional constructs, and demographics suggested by McDonald (2014) in order to best study discretional pro-environmental professional behavior. We intend to validate our measure for doing so, and expand the overall body of literature within a largely-unexplored field.

1.2 Background

There is very little literature dealing with discretional pro-environmental professional behavior. Discretional pro-environmental professional behavior is that which demonstrates willing engagement in job behavior that directly or indirectly benefits the local or global environment. Here, we focus on individuals whose professional behavior has a strong direct impact on the environment – i.e. aircraft commanders. Previous pro-environmental behavior literature discusses discretional consumer behavior; that is, actions such as recycling one's plastic, glass, and metal waste, turning off the lights, and choosing more fuel-efficient vehicles.

Human behavior is guided by three separate realms of psychological constructs: behavioral beliefs, normative beliefs, and control beliefs. Behavioral beliefs deal with consequences of behavior, normative beliefs deal with others' expectations, and control beliefs deal with factors which may help or hinder behavior (Ajzen, 1985).

A C-130 aircraft commander is in charge of a machine that averages over 5,300 pounds of fuel burned per flying hour (USAF, 1997). Understanding the antecedents that drive ACs' behavior, a previously unasked question, could prove particularly fruitful in reducing fuel consumption.

1.3 Research Objectives

Our goal in this research is to develop individual measures to discern which latent variables make fuel efficiency relevant to pilots in their motivations and actions. We conduct a review of the existing literature, construct survey instruments, and finally, pilot-test the instruments using pilots. The measures will be tailored to discern the psychological antecedents behind individual pilots' flying styles. We seek to use the resulting theory to pave the way towards a better understanding of motivation in professional behavior, and to help reduce the amount of jet fuel the USAF consumes.

1.4 Research Focus

Our focus is on studying the behavior that drives the human component of an Air Mobility Command (AMC) cargo transport sortie. The concept of a "sortie" can be broken down into three categories, each of which can then be applied to the mission of saving fuel. See Fig. 1 below for our model of sortie elements:

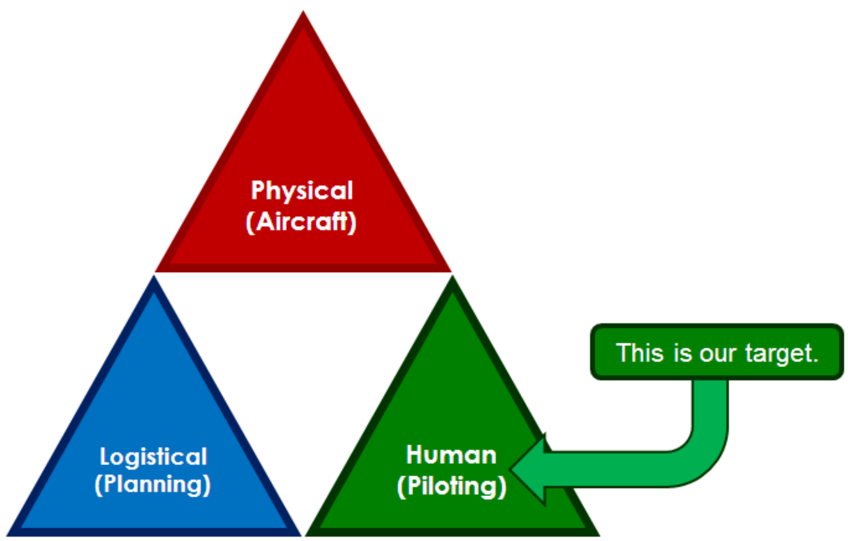


Figure 1: Model of Sortie Elements

The first element in our model is mechanical – the physical engineering performed upon the aircraft itself. Aerodynamics, engine tuning, maintenance and any other hardware requirements can all be optimized for fuel efficiency and cargo carrying.

The second element is logistical and deals with route and mission planning. These are the decisions, ranging from the abstract to the practical, that deal with how the machinery is used, and can themselves be optimized for maximum benefit.

The third element is the human element of a sortie. All AMC missions are flown on manned aircraft, and this human element deserves research to investigate any potential gains in fuel efficiency. This third category has seen the least research investment, a topic which we seek to offset.

1.5 Investigative Questions

1. Which theories are most pertinent to investigate discretionary fuel-saving flight in pilots?

2. What gaps or shortcomings exist in pro-environmental behavior theory when attempting to describe professional behavior rather than consumer behavior?

3. With the lack of literature on discretionary pro-environmental professional behavior, and the importance of specificity in a survey instrument, which USAF-focused concepts should we include to close the gaps in our model?

4. Which individual survey instruments ("construct measures") best demonstrate scientific rigor and comprehensiveness in measuring the USAF-focused concepts we discovered in the previous question?

5. Upon pilot-testing the survey, are our measures sound? What changes will the measures require?

1.6 Methodology

At the end of this research, we aim to have created reliable and scientifically rigorous measures which can then be used to test pilot motivation in fuel efficiency. To conclude this thesis, we will pilot test a survey whose target population consists of USAF Air Mobility Command (AMC) C-130 cargo airlift pilots. Once the survey has been tested, we will evaluate each construct measure's internal reliability and revise as needed.

Upon completion of this thesis, and validation of its component construct measures, the finished survey instrument will then be available for use as a research instrument. It aims to provide a reliable means to measure fuel efficiency; specifically, it will measure discretional, pro-environmental professional behavior in airlift pilots and test its findings vs. the difference between actual and planned fuel consumption.

1.7 Assumptions

Chiefly, we assume that the Theory of Planned Behavior is appropriate, and that our pilot test subjects represent the overall population of active duty aircraft commanders. By the same token, we also assume our behavioral model suitably encapsulates antecedents to fuel efficiency in such a way that the research can adequately test it.

1.8 Implications

We seek to better understand the as-yet-unexplored behavioral aspects of USAF cargo airlift pilots, as the human component of the sortie is the most difficult to put into quantifiable metrics. We also seek to illuminate any potential for future behavioral fuel efficiency research, whether in the private sector, such as civilian cargo airlift pilots and truck drivers, or in the USAF. We need to understand the antecedents to discretionary pro-environmental professional behavior in order to decide whether further research along this avenue is worthwhile. Aeronautics and logistical theory, by contrast, are quite well-documented in application in the USAF, and we intend to fill the comparative gap in understanding.

II. LITERATURE REVIEW

2.1 Introduction

The behavioral aspect of the human in the cockpit is both highly complex and poorly understood. As the USAF is the largest energy consumer in the DoD, and the majority of this energy comes from petroleum, it is imperative to investigate any path towards energy efficiency. Mechanical (aircraft optimization) and logistical (planning optimization) solutions are legion, but the human behavior aspect of USAF cargo transport is largely unexplored.

There are notable gaps in the body of literature when attempting to describe discretionary, pro-environmental professional behavior. To fill those gaps, we began the literature review process with an exploration of consumer behavior, using Ajzen's 1985 Theory of Planned Behavior (TPB). We then moved to multiple models of Voluntary Pro-environmental Behavior of Employees (VPBE), exploring the Comprehensive Action Determination Model (CADM), and the Norm-Activation Model (NAM). We incorporated research conducted by the Naval Postgraduate School (NPS) to better reflect military behavior.

This is a largely unexplored area of research for the United States Air Force. By contrast, much investment goes into training pilots and preparing them with the skills and expertise required to fly cargo aircraft. This research, therefore, represents an exciting opportunity for the USAF – an opportunity to learn how the more psychological aspects of flight interface and affect operational USAF culture, personnel, and our goal of reducing fuel consumption.

2.2 Literature Review

2.2.1 Introduction to the Theory of Planned Behavior

The Theory of Planned Behavior (TPB) frames behavior as a direct result of intent. According to the TPB, intent is guided by three kinds of considerations: beliefs about the likely consequences or other attributes of the behavior (behavioral beliefs), beliefs about the normative expectations of other people (normative beliefs), and beliefs about the presence of factors that may further or hinder performance of the behavior (control beliefs) (Ajzen 2002). They influence behavior via the path shown in Fig. 2:

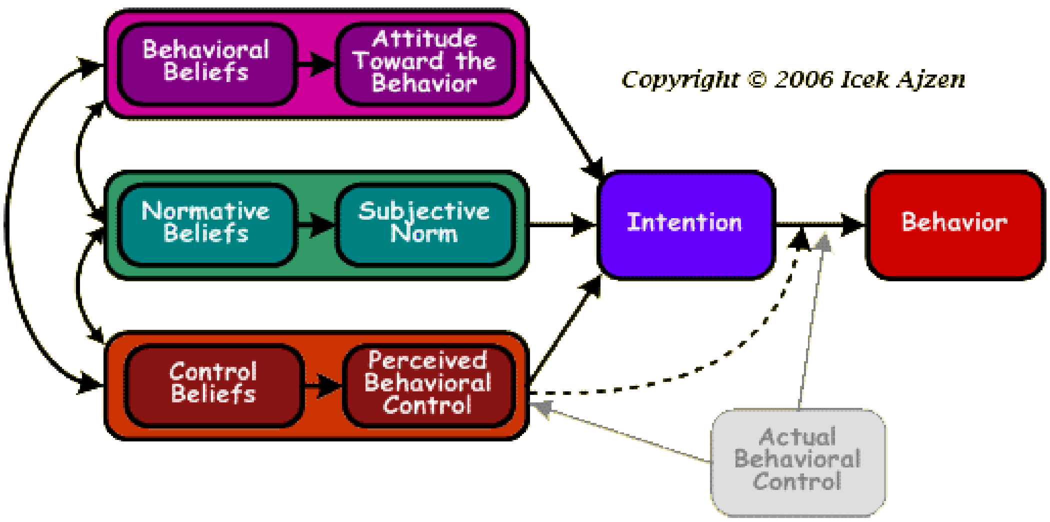


Figure 2: Theory of Planned Behavior
Source: http://people.umass.edu/aizen/tpb.diag.html

Ajzen defines behavior of interest "in terms of Target, Action, Context, and Time (TACT) elements" (Azjen 2002). In our context, fuel consumption is the target, piloting is the action, normal cargo airlift missions are the context, and time denotes when the behaviors in question are performed.

TPB is geared towards assessing behavior in progress, but research suggests the TPB alone is insufficient to explain work-in-progress behavior. Experiencing a different affective state while being assessed than the behavior of interest can disrupt the intention-behavior relation of the TPB pictured above (Ajzen 2011). This is significant because we cannot survey pilots while they are flying.

As intent is insufficient alone to predict behavior (Ajzen 1985), we will need to add additional constructs. Any construct added to our model must accurately describe latent variables such as pertinent behavioral, normative, and control beliefs, as those contain the most detailed substantive information about behavioral determination (Ajzen 2011). The TPB can be modified, but is very cautious with its inclusion of predictors. Intent is the strongest predictor, but is not holistic in its predictive abilities; whether intentions predict behavior depends in part on factors beyond the individual's control (Ajzen 2011). Actual control over the behavior strongly moderates intent. In the context of aircraft operation, an aircraft commander's control over the aircraft is not all-encompassing, and should not be treated as such. Many other factors outside the pilot's control play into aircraft operation, from logistical concerns (such as route planning and cargo load) to mechanical (type and condition of the aircraft being flown) to environmental (weather conditions, headwinds/tailwinds, etc.).

To properly add constructs to the TPB, Ajzen (2014) suggests five criteria that must be met: behavioral specificity, causal factor conception, conceptual independence, social applicability, and predictive capability.

Behavioral specificity refers to the TACT elements previously mentioned; the construct must be able to be defined and measured in terms of target, action, context, and time (Ajzen 2011). Our proposed constructs must be behavior-specific, sourced and created with the concept of USAF cargo airlift in mind. We canvassed pilots to describe in their own words the reasons they may or may not save fuel while flying, and sorted their responses into the appropriate constructs.

The second requirement of any new construct is that the construct must be a potential cause for determining intention and action (Ajzen 2011). All of our constructs must be as close to the context of cargo airlift and the action of fuel-efficient behavior as possible. This resulted in the removal or change of a number of constructs during the initial construction of the survey, in order to ensure they best fit the TACT factors.

Third is conceptual independence; the proposed addition should be conceptually independent of the theory's existing predictors (Ajzen 2011). This serves to ensure that no factor gets double-counted, which would negatively impact the validity of the analysis.

The fourth criterion is social applicability. Any factor considered should potentially apply to a wide range of behaviors studied by social scientists (Ajzen 2011). The waters muddy somewhat here, as the behavior in question is not consumer behavior (as most studies examine), but rather professional behavior. Nevertheless, much of the same behavior exists outside the specific context of USAF cargo airlift. Airlines and private logistics providers (such as FedEx and UPS) maintain their own fleets of aircraft and pilots, and encounter many of the same problems as the USAF. A proposed follow-on study would examine not only the validated survey instrument in the context of USAF pilots, but other logistics operators such as commercial airlift and trucking companies.

Finally, the fifth requirement is predictive capability. Any proposed latent variable should consistently improve prediction of intentions or behavior (Ajzen 2011). This is the purpose of the entire study – to find which factors are predictive.

It is important that the pilots are only evaluated on factors that are under their control. Factors such as weather and cargo load are not discretionary but have a huge effect on fuel efficiency. There is no “magic bullet” for behavioral analysis and modification. These are officers with years of flying experience who, by the nature of their job, must be acutely aware of mission and aircraft parameters, as well as able to autonomously make decisions.

2.2.2 Attitudes, Intention, and the TPB

An individual’s values influence behavior by affecting attitudes and, therefore, intention. Attitudes serve as a driving force, a source of energy behind behavior, and are both directly and indirectly capable of predicting work performance (Heslin and Caprar, 2013). Furthermore, attitude factors such as professionalism and organizational citizenship behavior were able to predict sales volume and performance ratings in a 1993 study (Barrick, Mount and Strauss, 1993). Variables such as self-efficacy influence the links between attitudes and performance outcomes (Heslin and Caprar, 2013). Ultimately all parts of the system, including attitudes, flow into behavior through intent. Intention, therefore, serves as a central “transmission” to link the disparate parts of our model to the system output at the individual's behavior.

Prior research on beliefs and attitudes influencing energy efficiency concentrates on discretionary pro-environmental consumer behavior, discretionary behavior which seeks to reduce the individual subject’s ecological impact. However, we hypothesize that in USAF pilots, environmentalism is not the sole reason behind fuel-efficient professional behavior. While environmentalism may play a part, its role will likely differ from subject to subject, as personal values and ideology strongly influence individual decision-making (Gromet et al., 2013). The literature on pro-environmental consumer behavior, with its focus on attitudes linking to behavior, nevertheless served as a starting point for further research into attitudes.

Ajzen's TPB identifies three realms of psychological constructs which guide human behavior. First of these are behavioral beliefs, which are beliefs about the likely results of the behavior (Ajzen, 2002), namely, rewards, punishments, and concepts such as externalities. In the context of fuel efficiency, a hypothetical organization could implement incentives and punishments geared towards influencing behavioral beliefs, or educate its employees about externalities such as financial consumption, energy security, or environmental effects as examples of negative externalities related to fuel consumption.

Second of Ajzen's realms is that of normative beliefs, or, those beliefs about the normative expectations that other people hold (Ajzen, 2002). Normative beliefs speak to what one perceives to be the expectations of others. In our hypothetical organization, these are represented as the idea of a "subjective norm," illustrated by the social pressure one's peers exert towards saving fuel – or conversely, social pressure to get home earlier, leading to rather liberal application of the throttle.

Finally, Ajzen's third realm is control beliefs, the presence of factors that may further or hinder performance of the behavior (Ajzen, 2002). These control beliefs precede the concept of perceived behavioral control, one factor that this research intends to test. Perhaps our example organization is poor at delivering feedback to its employees, or fails to invest in more modern equipment for its employees to use. Either way, both of these factors could lead to employees which feel as though external, mitigating factors render them unable to fully realize their intended professional behaviors.

The cornerstone of our research is where the three come together in the form of intention. So long as an individual holds sufficient actual control over their own behavior, we can safely assume intention is behavior's immediate antecedent (Ajzen, 2002). To understand the antecedents of fuel-efficient behavior, it is thus necessary to understand what drives intention.

2.2.3 Voluntary Pro-environmental Behavior of Employees

TPB alone is insufficient to capture all antecedents of discretionary pro-environmental consumer behavior (Lülfs and Hahn, 2013), and therefore we believe it is insufficient to capture all antecedents of discretionary pro-environmental professional behavior. The Voluntary Pro-environmental Behavior of Employees (VPBE) model in Fig. 3, proposed by Lülfs and Hahn in 2013, is an example of a model built atop existing theory. The authors argue that two existing theories, the Theory of Planned Behavior (TPB) and the Norm-Activation Model (NAM), are individually insufficient to entirely explain VPBE. To compose a more accurate explanation of VPBE, the TPB's basic assumptions must be modified by integrating habit and aspects of the NAM (Lülfs and Hahn, 2013). The Norm-Activation Model (NAM) argues that human behavior is initiated by external contact with social norms that trigger behaviors in humans. By contrast, the TPB argues that everything humans do is in some way self-focused or self-generated. We can view pro-environmental behavior as an altruistic action, motivated by internalized moral norms; these norms are grounded in values concerned with the welfare of others (Schultz and Zelezny, 1998). Lülfs and Hahn's model incorporates these social norms into antecedents of intention as shown in Fig. 3. Ajzen's Perceived Behavioral Control and Subjective Norm constructs are modified by organizational and social factors as seen below:

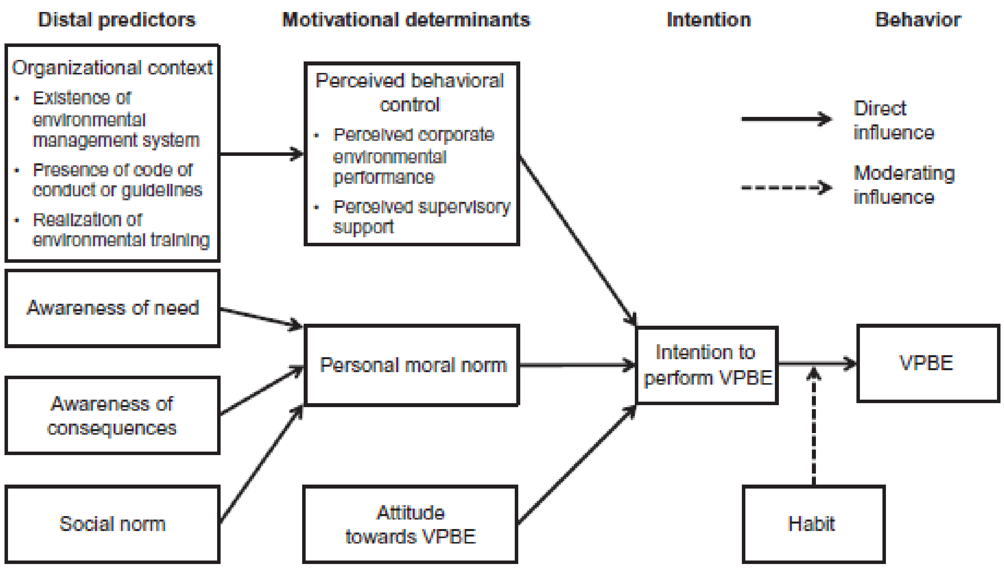


Figure 3: Lülfs and Hahn's (2013) VPBE Model
(Lülfs and Hahn, European Management Review, Vol. 10, 83-98, 2013)

Habit is behavior that is largely automatic, and reinforced by repeated cues of behavior (Verplanken & Wood 2006). Lülfs and Hahn's (2013) model also incorporates habit, which the literature strongly supports as a moderator between intention and behavior (Lülfs and Hahn, 2013). Routine, conscious behavior evolves into habitual behavior; any behavior performed as routine eventually ceases to be rational and purposive. Habits "limit the predictive power of intention" (pg. 89). As a moderator, habit can change behavior's intensity and direction, but ultimately, intention is still the strongest behavioral antecedent (Lülfs and Hahn 2013).

Lülfs and Hahn (2013) strongly support the inclusion of contextual aspects to properly describe and predict VPBE. The employees' perception of infrastructure, distinct from the infrastructure itself, is an essential determinant. The "infrastructure" in this case is the organization within which the subject operates. Elements such as perception of feedback, perception of organizational support, and perception of subjective norms all serve as context unique to the subjects' individual units. Formal elements are easy for the employee to observe, which influence their perception of organizational emphasis on environmental issues (Lülfs and Hahn 2013). Due to these contextual factors, we can assume the formal 'organizational infrastructure' influences employee perception of their company's environmental performance and supervisory support towards VPBE (Lülfs and Hahn 2013).

The impact of contextual factors was therefore incorporated into the Comprehensive Action Determination Model (CADM) by Klöckner and Blöbaum in 2010. Whereas the NAM argues the importance of external factors in behavior, the CADM goes one step further by arguing the importance of a subject's perception of external factors. To our research, the CADM contributes the importance of measuring internal contextual factors, whether those are normative-ethical or other types of social pressure. We arrive at "normative-ethical drivers" (such as subjective norms and internalized organizational citizenship behavior) as well as external factors such as legislation, stakeholder pressure, and economic opportunities (Lülfs and Hahn 2013). As seen in Fig. 4, the CADM uses the perception of an organizational climate friendly to the behavior in question as an antecedent for both intention and behavior (Klöckner and Blöbaum, 2010). In addition, the subject must be aware of both the need for the behavior in question as well as its consequences, both of which feed into the subject's personal moral norms.

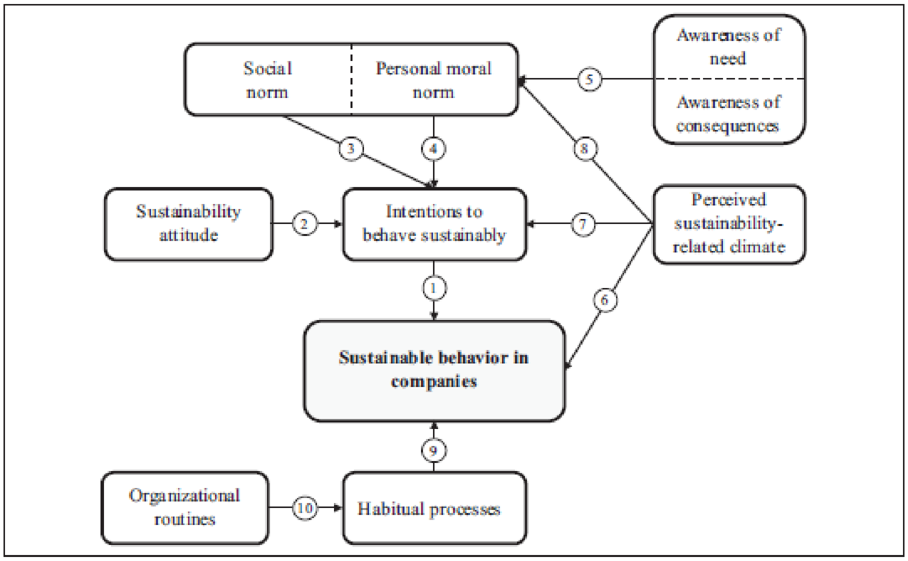


Figure 4: Comprehensive Action Determination Model, 2014
(Lülfs and Hahn, 2014, Organizations and Environment 7)

In addition to the context of private corporations, certain military examples support the CADM and NAM models that show organizational infrastructure influences pro-environmental behavior. The 2013 Naval Post-Graduate School (NPS) study found four factors that influenced Marines' pro-environmental behavior in a professional environment: awareness (how the organization pushes the technology), perception of functional risk (how the individuals fear repercussions if the technology fails), image of the technology (how the corporate climate feels about the technology), and relative advantage/disadvantage (how one's peers judge the risk vs. reward of the technology in question) (Ciarcia, 2013). Whereas beforehand, new technologies would have been perceived with disdain, Ciarcia recommends changing the organizational climate using ethical considerations (Ciarcia, 2013). A Marine participant in the study provides this perspective: “Tie it to our ethos. Marines understand the inherent danger of going down an IED ridden road for constant resupply of something that is a consumable. If they can reduce that, they reduce the amount of patrols and it is tied directly to force protection (Ciarcia 2013, pp. 28-29). The NPS study indicates the strength of ethical considerations towards organizational climate, but indirectly emphasizes the need for specificity. As Ajzen suggested, we must seek to understand the unique contextual factors of the organization being measured.

2.2.4 Furthering Specificity: The Need for Demographics in a TPB Model

Demographic factors build upon the TPB, the NAM, and the CADM by allowing us to introduce more specificity into our analysis. McDonald (2014) focuses on workplace pro-environmental behavior via three factors: intrapersonal, motivational, and interpersonal factors. Intrapersonal factors are those already covered in the TPB – such as environmental values, altruism, moral/ethical reasons, and other personal norms. Motivational factors echo the NPS study, the intrinsic/extrinsic motivation theory, goal-setting theory, incentivization, etc. Finally, interpersonal factors represent constructs such as social norms, perceptions, and other behavioral elements which reflect an interaction between one human and another in the system.

Demographic factors, such as level of education, gender, age, income, and place of residence have significant correlations to pro-environmental behavior (McDonald 2014). Therefore, demographics can serve to improve the accuracy of our model by improving specificity, something supported by the research of Lülfs and Hahn, 2013, and Ciarcia, 2013. Understandably, some of these demographics will not be differentiating factors between pilots. For example, their income will fall within a fairly narrow range vs. the US population. All are college-educated USAF officers between the ranks of O-3 (Captain) and O-6 (Colonel).

We have tailored our model to incorporate the core TPB with pertinent antecedents, shown in Fig. 5. We use the core TPB with Intention as the primary driver of behavior and Habit as a reinforcing factor. All other antecedents feed into the underlying TPB. In the next section, we will break the model down one factor at a time.

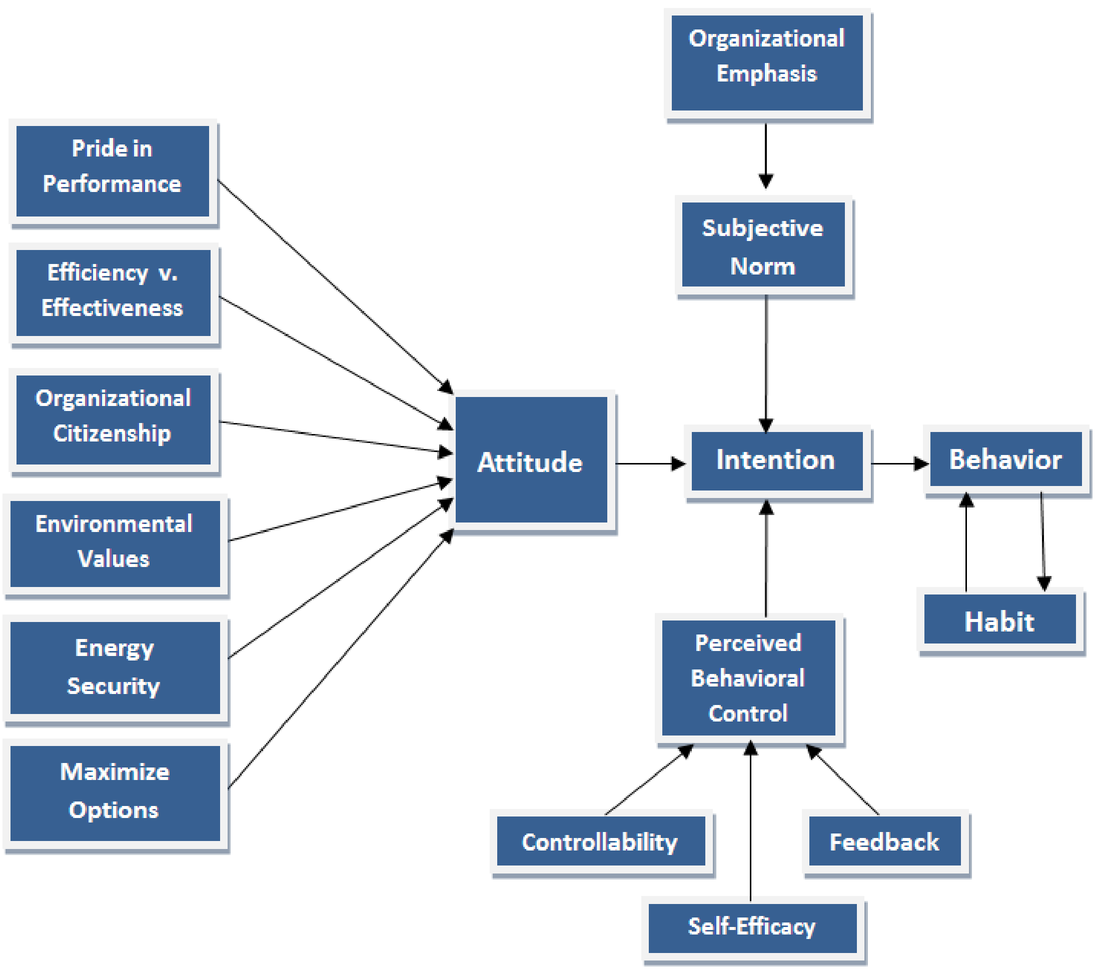


Figure 5: TPB Model of Discretionary Pro-Environmental Professional Behavior

III. METHODOLOGY

3.1 Introduction

The purpose of this chapter is to describe the methodology undertaken in the process of developing and evaluating our measures. We implemented a model based on Ajzen's TPB, incorporating changes from Lülfs and Hahn and McDonald's research. Both the Lülfs and Hahn and the McDonald models build atop the existing TPB and increase specificity and pertinence to their target population by incorporating additional antecedents. Lülfs and Hahn 2013 and McDonald 2014 incorporate many similar constructs, as shown in Fig. 6 and Fig. 7:

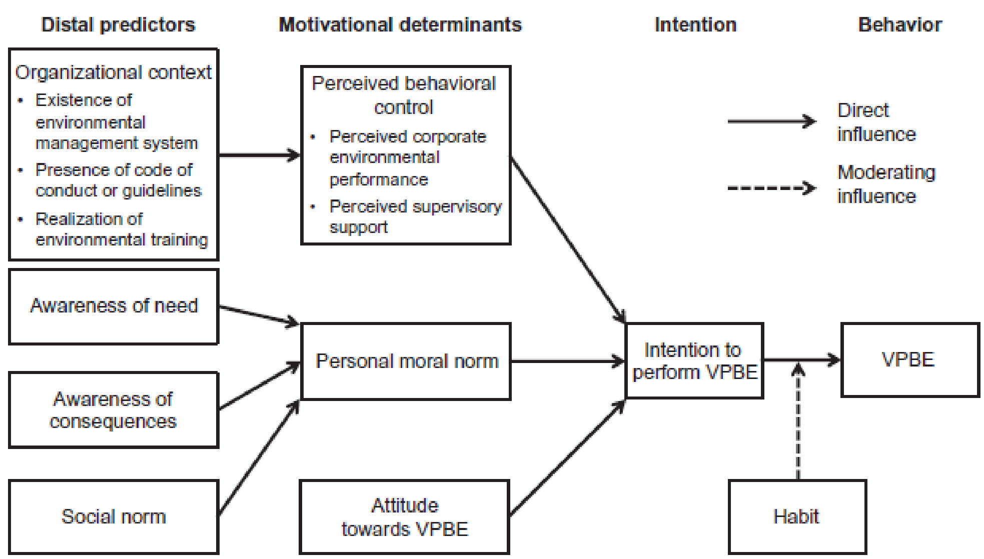


Figure 6: Lülfs and Hahn (2013) VPBE model
(Lülfs and Hahn, European Management Review, Vol. 10, 83-98, 2013)

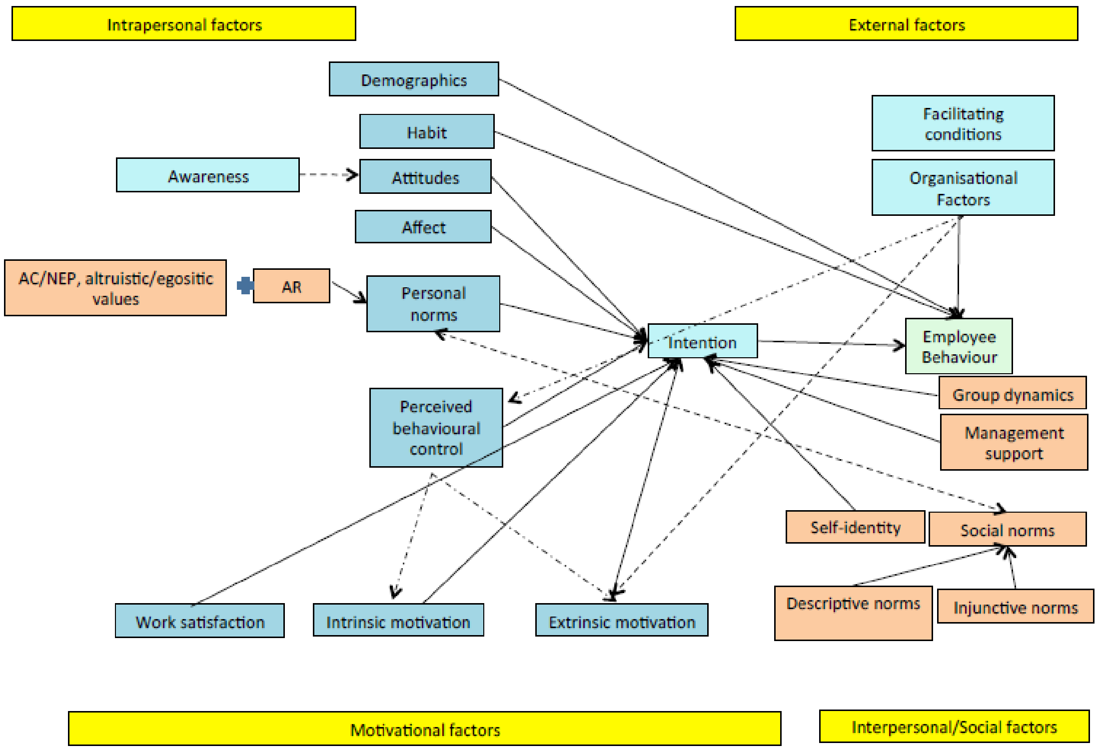


Figure 7: McDonald (2014) Integrated Model
(McDonald, Administrative Sciences, Vol. 4, pp. 295, 2014)

We based our study on the Lülfs and Hahn VPBE model (see Fig. 6) because it cleanly melds Ajzen’s TPB with the NAM, allowing for a model that captures the self-generated aspects of behavior as well as the influence of organizational and social norms. These organizational and social norms are part of the behavioral context, which is necessary to understand because of the large part that perception plays in determining behavior. The importance of organizational infrastructure is supported by examples from private industry and the military.

3.2 Method

The Lülfs and Hahn VPBE model provided a strong framework for our model, but we required more USAF pilot-specific antecedents. Our intent was to capture the full spectrum of behavioral, normative, and control beliefs (Ajzen 2002).

In our methodology, we used the following process:

1. **Develop Individual Construct Measures.** We referred to Lülfs and Hahn (2013, 2014) and McDonald (2014) while developing our construct measures to best increase specificity towards our target population of airlift pilots. To that end, we employed an informal survey to check for missed aspects of flight.

2. **Pre-Test Instruments**. Using an online data collection site, we pilot-tested each measure using an anonymous, 30min method.

3. **Analyze Individual Construct Measures.** Using Statistical Analysis Software™ (SAS™) and Microsoft™ Excel software, we checked for internal reliability (Cronbach Alpha) and cross-correlation (Excel's correlation matrix function). The purpose of the correlation matrix was not to measure inter-construct relationships, but to check for cross-correlation.

To accomplish our goal of furthering specificity in our model's construction, we incorporated construct measures derived from military-based studies such as Ciarcia 2013, expanding the antecedents behind "Attitude" into six separate and measurable construct measures. Please see Fig. 8:

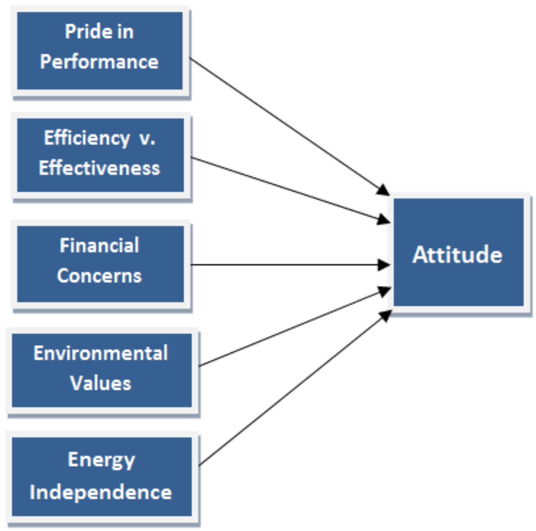


Figure 8: Early Antecedents to Attitude (before survey)

As seen above, our antecedents to Attitude were quite different. Most notably, we used a construct called "Financial Concerns" to describe altruistic, non-reward-motivated behavior on the part of pilots to save the government money. However, once we conducted the informal survey, we identified the need to expand this altruistic construct beyond financial concerns and into organizational citizenship behavior.

3.2.1 Informal Survey

As none of the researchers are themselves pilots, we identified the need to canvass many different types of pilots in order to ensure no potential factors were missed. We conducted an informal survey by asking seven pilots to respond in their own words to the following questions:

1. Beyond the safety aspects, do you think being fuel efficient while flying is important?
2. What influenced the formation of that attitude?

We grouped the responses into seven categories, each of which was assigned potential constructs based on the content and latent variables in the responses.

1. Stewardship of Resources

    a. 5 of 7 pilots noted that feeling personally responsible for consuming the taxpayers' resources, in the form of dollar value spent on fuel, positively impacted their motivation to save fuel. We consider this to be Organizational Citizenship Behavior.

2. Organizational Culture

    a. 3 of 7 pilots noted that the culture of their respective organizations positively impacted their motivation. 1 of 7 pilots indicated that their organizational culture negatively impacted their motivation towards fuel saving. This category mainly plays into Organizational Emphasis, but also supports the literature behind Feedback and Efficiency vs. Effectiveness.

3. More Options for Flight Crew

    a. 2 of 7 pilots described aspects of risk management while flying that positively impacted their motivation towards saving fuel, something none of the researchers had considered. They implied that mission completion is founded in fuel efficiency. Therefore, we needed to create a new construct based around risk avoidance, which led to the formation of Maximize Options. The concept of mission completion going hand-in-hand with efficiency will also be measured (in reverse) by Efficiency vs. Effectiveness.

4. Reducing Waste

    a. 2 of 7 pilots described waste reduction as a motivator for saving fuel. Depending on the antecedents for reducing waste, this can be represented in either Environmental Values or Organizational Citizenship Behavior.

5. Professionalism

    a. 1 of 7 pilots described a positive impact on fuel efficiency for "doing their job well," citing the third of the USAF Core Values ("excellence in all we do") as a motivator. This primarily lends support for Pride in Performance.

6. Environmentalism

    a. 1 of 7 pilots explicitly described environmentalism as a motivator for saving fuel. This supports the NEP and the Environmental Values construct.

7. Logistical Load

    a. 1 of 7 pilots described being motivated to save fuel by reducing the load on the supply chain. This motivation is best described by Organizational Citizenship Behavior.

At the end of the informal survey, we had arrived at the Maximize Options construct, which is unmotivated by ideology such as environmentalism or concerns over energy security. Maximize Options is a concern about risk aversion and was therefore incorporated into our model.

Secondly, we needed to expand Financial Concerns into Organizational Citizenship Behavior, in order to describe altruistic behavior towards one's organization. This construct now incorporates reducing logistical load and being a good steward of the government's resources. The literature supported this alteration.

Once the new constructs were incorporated, our "antecedents to attitude" model (shown in Fig. 9) was ready to be fitted to the overall behavioral model. The alterations to Attitude's antecedents concluded our model's development, and we had a finished model with each construct supported by survey questions. Please see Fig. 10.

In developing each construct, we used existing measures, supported by a previous body of research wherever possible. Please refer to Table 1.

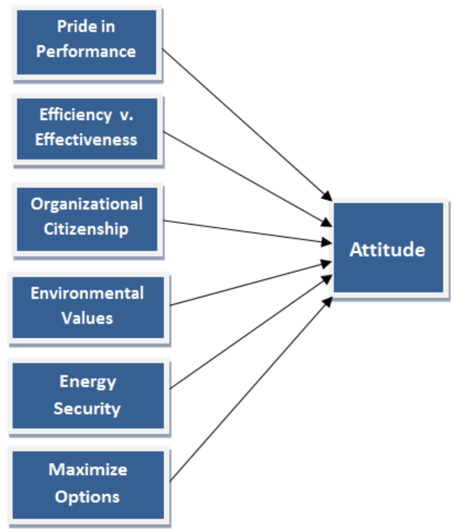


Figure 9: Revised Antecedents to Attitude.

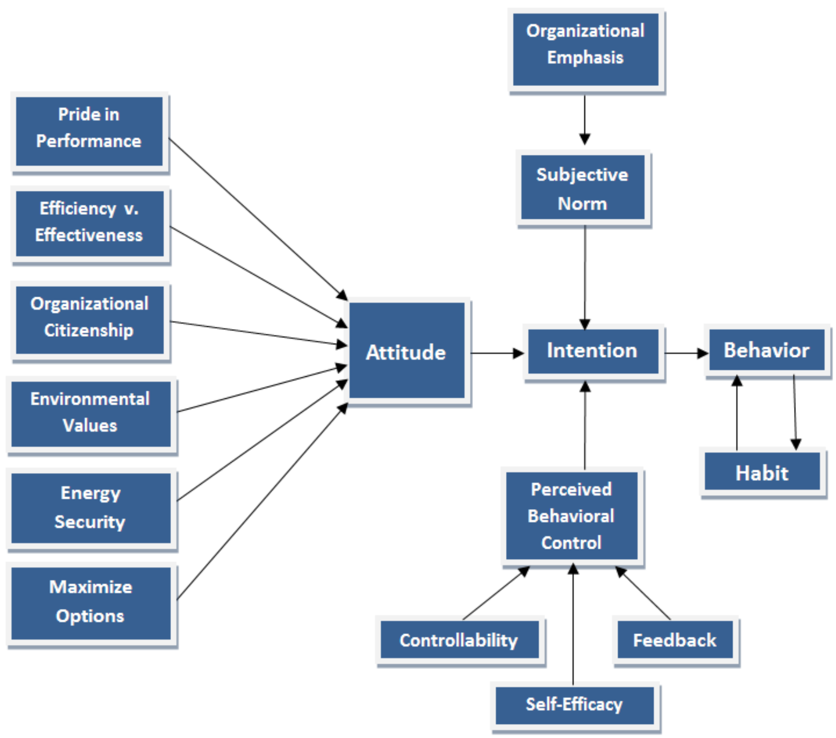


Figure 10: Completed Behavioral Model.

Table 1: Sources and Prior Research for Construct Development

Construct	Source(s)
Behavior	Ajzen, 1985, 1991, 2002, 2015
Habit	Ajzen, 2002, 2015 Verplanken & Aarts, 1999 Verplanken & Wood, 2006 Evans, 2003 Forgie et al., 2012
Intention	Ajzen, 1985, 1991, 2002, 2015
Attitude	Ajzen, 1985, 1991, 2002, 2015 Lülfs and Hahn, 2013
Subjective Norm	Ajzen, 1985, 1991, 2002, 2015 CHIRr.gov, 2015
Organizational Emphasis	McDonald, 2014
Perceived Behavioral Control	Ajzen, 2002 Bandura, 2013
Feedback	Schumacher, 2015
Organizational Citizenship Behavior	Organ, 1988
Efficiency vs. Effectiveness	Ciarcia, 2013
Pride in Performance	McDonald, 2014 USAF Core Values
Energy Security	Yergin, 2006 Chester, 2010 Löschel, Moslener, & Rübbelke, 2010 Sovacool & Mukherjee, 2011 Winzer, 2012 International Energy Agency, 2015
Environmental Values	Dunlap & Van Liere, 1978 Dunlap, Van Liere, Mertig, & Jones, 2000 Schultz & Zelezny, 1988
Maximize Options	Self-Developed Measure

3.2.2 Behavior

Behavior: The action a person does. We use a measurement of fuel efficiency per sortie, adjusted for factors the pilots can control, to numerically quantify behavior.

The behavior of interest, discretionary pro-environmental professional behavior, is quantified using our dependent variable, fuel efficiency per sortie. We measure this via the difference between planned and actual fuel consumption on Special Assignment Airlift Mission (SAAM), channel, and contingency missions. Ajzen defines behavior of interest in terms of Target, Action, Context, and Time (TACT) elements (Azjen 2002). In our context, fuel consumption is the target, piloting is the action, normal cargo airlift missions are the context, and time is when the behavior is performed. The Theory of Planned Behavior has Intention as a direct antecedent to Behavior**.** In other words, it states that individuals that desire a certain outcome more tend to display higher levels of behavior intended towards making that outcome a reality.

Behavior has two antecedents, Habit and Intention:

Habit as an Antecedent to Behavior: A stronger habit leads to more fuel-efficient behavior.

Intent as an Antecedent to Behavior. Stronger intentions towards saving fuel lead to more fuel-efficient behavior.

Measuring Behavior:

Behavior can be measured and quantified using the fuel efficiency metric developed by Schumacher (2015). We derive actual fuel consumption from historical data provided by the Fuels Data Tracker system. We derive planned fuel requirement from the Aircraft Flight Planner (ACFP) and adjusted for actual payload.

3.2.3 Habit

Habit: Automatic responses to specific cues (Verplanken & Aarts, 1999).

Habits are learned sequences of actions which have, over time, become automated in response to specific, stable behavioral cues; they serve to help the individual attain goals (Verplanken & Aarts, 1999, Verplanken & Wood, 2006).

Habit's importance comes from its direct influence on behavior, and as a result of many accumulated decisions which have become automatic processes. Habits can range from instinctive behaviors (such as a fight or flight response) to learned behaviors which become easier with practice and experience (like an experienced pilot operating an aircraft). The goal-seeking behaviors which reinforce habit are deliberate and reflective of abstract hypothetical thinking, such as that demonstrated by a novice pilot in flight school (Evans 2003).

Habit has one antecedent, which is Behavior.

Behavior as an Antecedent to Habit: More frequent fuel-efficient behavior leads to stronger habit.

Measuring Habit:

Adapted from Limayem & Hirt (2003), Verplanken & Orbell (2003), Forgie et al. (2012)

1. Paying attention to fuel efficiency has become a habit to me.
2. Being fuel-efficient seems natural to me.
3. I normally do my best to be fuel-efficient without explicitly planning to do so.
4. When I plan a flight, fuel efficiency is usually a priority.

3.2.4 Intention

Intention: Indications of how hard people are willing to try (Ajzen, 1991).

Intentions are indications of how hard people are willing to try and how much of an effort they are planning to exert in order to perform a certain behavior (Ajzen, 1991). Intention states that individuals who desire a certain outcome more than others will try harder to attain that outcome. Intentions are assumed to capture which motivational factors influence an individual's behavior (Ajzen, 1991), and therefore, Intention serves as an important antecedent to behavior.

Intention has three antecedents: Attitudes, Subjective Norm, and Perceived Behavioral Control.

Attitude as an Antecedent to Intent: Stronger attitudes and values towards fuel conservation lead to stronger intentions towards saving fuel.

Subjective Norm as an Antecedent to Intent: Stronger perceptions of social pressure to fly missions in a fuel-efficient manner lead to stronger intentions towards saving fuel.

Perceived Behavioral Control as an Antecedent to Intent: Perceived Behavioral Control will not affect Intent in a vacuum. Strong levels of PBC will require strong fuel-efficient attitudes OR strong social pressure to lead to stronger intentions towards saving fuel.

Measuring Intention:

Adapted from Ajzen (2002)

1. I expect to use less than ACFP expected fuel most of the time.
2. I prefer to fly in a fuel-efficient manner.
3. I intend to be fuel-efficient when I fly.

3.2.5 Attitude

Attitude: Overall evaluation of performing a behavior (Ajzen, 1991).

Attitude towards a behavior is a person's overall evaluation of performing it (Ajzen 1991), as well as an assessment of the advantages and disadvantages of performing that behavior (such as "saving fuel would benefit the USAF") (Lülfs & Hahn, 2013). Attitude, like Perceived Behavioral Control, may be split into two sub-constructs. One sub-construct is instrumental in nature, and is represented by such adjective pairs as valuable — worthless, and harmful — beneficial. The second component has a more experiential quality and is reflected in such scales as pleasant — unpleasant and enjoyable — unenjoyable (Ajzen, 2002).

Attitude has six antecedents: Pride in Performance, Efficiency v Effectiveness, Organizational Citizenship, Energy Security, Environmental Values, and Maximize Options.

Pride in Performance as an Antecedent to Attitude: Higher levels of pride in one's performance lead to stronger levels of fuel-saving attitudes.

Efficiency vs. Effectiveness as an Antecedent to Attitude: Lower levels of perceived conflict seen between fuel efficiency and mission effectiveness lead to stronger levels of fuel-saving attitudes.

Organizational Citizenship as an Antecedent to Attitude: Pilots who care about taking care of their organization, even in the absence of rewards for doing so, will show stronger levels of fuel-saving attitudes.

Environmental Values as an Antecedent to Attitude: Pilots who care more about the Earth's environment will show stronger levels of fuel-saving attitudes.

Energy Security as an Antecedent to Attitude: Pilots who care about the security of energy in the United States will show stronger levels of fuel-saving attitudes.

Maximize Options as an Antecedent to Attitude: Pilots who view unspent fuel as a safety measure or a type of insurance against the unplanned will show stronger levels of fuel-saving attitudes.

Measuring Attitude:

In order to measure overall attitude towards fuel efficiency in cargo missions, we have adapted Ajzen's 2002 Theory of Planned Behavior scale. Certain questions have been reverse-coded.

Adapted from Ajzen, I. (2002)

Saving fuel over the next dozen missions would be:

1. bad 1__:___2__:___3__:___4__:___5__:___6__:___7 good
2. pleasant 1__:___2__:___3__:___4__:___5__:___6__:___7 unpleasant
3. harmful 1__:___2__:___3__:___4__:___5__:___6__:___7 beneficial
4. worthless 1__:___2__:___3__:___4__:___5__:___6__:___7 valuable
5. enjoyable 1__:___2__:___3__:___4__:___5__:___6__:___7 unenjoyable

Flying at max range airspeed:

6. Does not save fuel 1__:___2__:___3__:___4__:___5__:___6__:___7 Saves fuel
7. Is Harmful 1__:___2__:___3__:___4__:___5__:___6__:___7 Beneficial
8. Is Good 1__:___2__:___3__:___4__:___5__:___6__:___7 Bad
9. Is Pleasant (for me) 1__:___2__:___3__:___4__:___5__:___6__:___7 Unpleasant (for me)
10. Is Worthless 1__:___2__:___3__:___4__:___5__:___6__:___7 Useful

3.2.6 Subjective Norm

Subjective Norm: Perceived social pressure to perform (or not perform) the behavior in question (Ajzen, 2002).

Subjective Norm is perceived social pressure to perform or not to perform a behavior (Ajzen, 1991) and is generated by normative beliefs. It is linked to intention, along with Attitude. Subjective norm questions should refer to individuals' beliefs about what ought to be done in a certain situation (Ajzen 2002). The measure of subjective norm should usually also capture whether individuals important to the subject in question also perform the behavior of interest (Finlay, Trafimow, Sheeran, and Norman, 1999). Subjective Norm has one antecedent: Organizational Emphasis.

Organizational Emphasis as an Antecedent to Subjective Norm: Strong organizational emphasis on flying fuel-efficiently leads to more social pressure to fly fuel-efficiently.

Measuring Subjective Norm:

Adapted from Ajzen, I. (1991).

1. Most people who are important to me think that I should fly in a fuel efficient manner.
2. It is expected that I fly routine missions fuel-efficiently.
3. I feel pressure from my peers to be as fuel-efficient as possible.
4. People who are important to me want me to be fuel efficient.
5. My passengers' assessment of my flying ability is important to me.
6. What my superiors think of my flying technique matters to me.
7. What other pilots do to conserve fuel is important to me.

3.2.7 Organizational Emphasis

Organizational Emphasis: Belief by the individual that the organization prioritizes the goal of fuel efficiency.

The Organizational Emphasis construct is defined as the extent to which the individual believes that their organization prioritizes a certain goal – in this case, fuel efficiency. People may pay more attention to fuel efficiency if they feel that it is important to their organization.

Measuring Organizational Emphasis:

1. It is important to the USAF that I save fuel when I can.
2. The USAF is serious about saving fuel.
3. Being fuel efficient when I fly supports AF goals.
4. My leadership wants me to fly efficiently.

3.2.8 Perceived Behavioral Control

Perceived Behavioral Control: Perceived ease or difficulty of performing the behavior in question (Azjen, 1991).

Perceived Behavioral Control (PBC) is the perceived ease or difficulty of performing a behavior, which is assumed to reflect both past experiences and anticipated impediments and obstacles (Ajzen, 1991). To measure PBC, an instrument should capture people's confidence that they are capable of performing the behavior under investigation (Ajzen, 2002).

A scale of PBC should contain both self-efficacy and controllability items, and it is important to ensure the scale has a high degree of internal consistency (Ajzen, 2002). Finally, PBC is determined by control beliefs, rather than behavioral beliefs.

Perceived Behavioral Control has three antecedents: Feedback, Self-Efficacy, and Controllability.

Feedback as an Antecedent to Perceived Behavioral Control: Pilots who perceive that their unit provides strong performance feedback will report that attempts at fuel-efficient flight are more likely to succeed.

Self-Efficacy as an Antecedent to Perceived Behavioral Control: Higher levels of Self-Efficacy lead to the belief that attempts at fuel-efficient flight are more likely to succeed.

Controllability as an Antecedent to Perceived Behavioral Control: Pilots who believe that their behavior is more within their control are more likely to report that it attempts at fuel-efficient flight are more likely to succeed.

Measuring Perceived Behavioral Control:

Self-efficacy sub-scale: Ajzen (2002) defines this as "the likelihood that the participant could do it."

Adapted from Ajzen (2002) and Bandura (2013)

1. I am confident that I could fly in a fuel-efficient manner if I wanted to.

2. For me to achieve fuel-efficient flight standards is easy.
3. As the aircraft commander, I can directly improve the overall fuel efficiency of my mission.
4. I have enough flexibility to influence how fuel efficient the flight is.

Controllability Ajzen (2002) states that this has to do with "…people's beliefs that they have control over the behavior, that its performance is or is not up to them."

Adapted from Ajzen (2002)

1. The decision to fly in a fuel-efficient way is beyond my control.
2. Whether or not I fly in a fuel-efficient way is not entirely up to me.
3. The routines and processes are in place to help me fly fuel efficiently.

3.2.9 Feedback

Feedback: How much an individual believes sufficient information is available to let them measure their behavior.

Feedback is defined as the extent to which pilots believe they have enough information to know when they have flown efficiently. Schumacher (2015) frames the USAF feedback system as a framework for performance evaluation and feedback; feedback is a private, formal communication a rater uses to tell a rate what is expected, and how well the rate is meeting those expectations (Schumacher ,2015).

Feedback is an integral component to USAF culture and the presence (or lack) thereof of a strong feedback system should be measured when taking perceived behavioral control into account.

Measuring Feedback:

1. I know when I have flown in a fuel efficient manner.
2. I receive enough information to determine if I have flown an efficient sortie.
3. The system regularly gives me enough information to know how efficiently I've flown.

3.2.10 Organizational Citizenship Behavior

Organizational Citizenship Behavior: Discretionary behavior, unrecognized by formal rewards, that benefits the organization (Organ, 1988).

Organizational Citizenship Behavior is discretionary individual behavior that is neither directly nor explicitly recognized by a formal reward system. In the aggregate, organizational citizenship behavior promotes the effective functioning of the organization. (Organ, 1988). It includes concern for the organization's financial and logistical health, even when engaging in behavior that looks out for these but does not directly benefit the individual in question.

Measuring Organizational Citizenship: (Maignan, Ferrell, & Hult, 1999):

1. My organization's financial health is important to me.
2. Saving the government money will be good for the country.
3. It is an important part of my job to reduce expenses.

3.2.11 Efficiency vs. Effectiveness

Efficiency vs. Effectiveness: Aversion to perceived inherent risk to mission in fuel-efficient flying.

The efficiency vs. effectiveness construct intends to capture the attitude that flying in a fuel-efficient manner runs the inherent risk of compromising the mission. Some pilots see a tradeoff between mission accomplishment (effectiveness) and saving fuel (efficiency.) To the extent they believe this; we expect fuel efficiency intention to decrease.

The importance of this construct was identified in two studies performed by the Naval Postgraduate School (NPS), which studied perceptions of Marines regarding willingness (or resistance) towards adopting new technology. It identified four types of risk that influence resistance: physical, economic, functional, and social (Ciarcia 2013). For our research, we are concerned with risk aversion as a whole, rather than its components.

Measuring Efficiency vs. Effectiveness:

1. Fuel efficiency and effectiveness both support safe mission accomplishment.
2. I can accomplish the mission safely and save fuel at the same time.
3. There is a strict tradeoff between saving fuel and flying effectively.

3.2.12 Pride in Performance

Pride in Performance: Extent to which an individual is willing to perform tasks to the utmost of their ability.

Pride in Performance is defined as a measure of professionalism; it is the extent to which an individual is willing to perform a task to the utmost of their ability. McDonald (2014) includes intrinsic and extrinsic motivation in her model. We believe one intrinsic motivator for fuel efficiency is the pilots' belief that flying efficiently is the mark of a good pilot. The USAF's organizational culture prioritizes Pride in Performance from the top down, including them in its core values of "Integrity First, Service Before Self, Excellence in All We Do." Perceived autonomy is important; motivations with a higher perception of autonomy are more internal and represent a higher quality of engagement (McDonald 2014). An aircraft commander must be able to function autonomously in the discharge of his/her duties; therefore, Pride in Performance should be measured and tested.

Measuring Pride in Performance:

1. The ability to fly efficiently is a mark of a good pilot.
2. Flying efficiently demonstrates my mastery of flying my aircraft.
3. Pilots who take pride in their skill will often fly using less fuel.
4. Doing my job well means flying efficiently.

3.2.13 Energy Security

Energy Security: Belief by the individual that the USA should be either energy-secure, reduce dependence on foreign sources of oil, or both.

The International Energy Agency defines Energy Security as the uninterrupted availability of energy sources at an affordable price (International Energy Agency, 2015). It bases its definition on three legs: the reliability, affordability, and availability of energy supplies. As such, it includes notions such as the market providing access to reasonable amounts of energy at reasonable prices, most of the time, but also an absolute ability to gain access to energy in emergencies.

A number of papers shed light on different, yet related, aspects of energy supply: Yergin (2006) uses the wartime definition of Churchill, updated from simply "diversification" to include three other principles, name resilience, global markets, and accurate information about the supply and demand for energy. Chester (2010) builds on the IEA definition, but adds considerations of the energy use mix, the strategic intent of nations, and the effects of time. Further papers add different measures of energy security (Löschel, Moslener, & Rübbelke, 2010), Sovacool and Mukherjee (2011) include sustainability and regulation, and provide indicators, and Winzer (2012) breaks down different types of threats to energy security.

Note that these definitions do not lend themselves to survey construction in this context. Our construct is the belief on the part of the individual that Energy Security is important.

Measuring Energy Security:

1. Energy security for the US is important to me.
2. It is important that energy continue to be affordable in the US.
3. The government should be concerned about securing our sources of energy.
4. Energy supplies to the US need to be reliable and affordable.
5. The US is too dependent on foreign sources of energy.
6. The United States should derive energy from sources plentiful here.
7. Domestic sources of energy should be preferred to foreign ones.
8. I should do what I can to reduce dependence on foreign energy.

3.2.14 Environmental Values

Environmental Values: Measurement of environmental concern, using the New Environmental Paradigm (NEP) scale.

The Environmental Values construct is the extent to which an individual cares about the Earth's environment. The metric for environmental values is based on Dunlap's "New Environmental Paradigm (NEP)" scale (Dunlap & Van Liere, 1978), and revised by Dunlap, Liere, Mertig, and Jones (2000). The NEP is the most widely used measure of the values behind environmental behavior. The original NEP (Dunlap & Van Liere, 1978) has been shown to have good internal reliability with US samples (Schultz & Zelezny, 1998).

The NEP is composed of five sub-constructs, but its measure is taken as a gestalt; one over-arching score on the NEP has been demonstrated to accurately predict one's concern for the environment.

Sub-Construct 1: Reality of Limits to Growth: This sub-construct gauges the subject's concern for resource scarcity vs. human expansion.

Sub-Construct 2: Anti-anthropocentrism: This sub-construct gauges the degree to which the subject perceives humans as distinct from, and superior to, other living things and to the natural environment.

Sub-Construct 3: Fragility of Nature's Balance: This sub-construct gauges how fragile the subject perceives nature and its balance.

Sub-Construct 4: Rejection of Exemptionalism: This sub-construct gauges how the subject perceives humanity as exempt from the negative consequences of our actions as a species.

Sub-Construct 5: Possibility of an Eco-Crisis: This sub-construct gauges the subject's perception that an ecological crisis could be imminent or unavoidable given humanity's present course.

Measuring Environmental Values:

Sourced from Dunlap, Liere, Mertig, and Jones (2000)

A. **Reality of Limits to Growth**
    1. We are approaching the limit of the number of people the earth can support.
    2. The earth has plenty of natural resources if we just learn how to develop them.
    3. The Earth is like a spaceship with very limited room and resources.
B. **Anti-anthropocentrism**
    1. Humans have the right to modify the natural environment to suit their needs.
    2. Plants and animals have as much right as humans to exist.
    3. Humans were meant to rule over the rest of nature.
C. **Fragility of Nature's Balance**
    1. When humans interfere with nature, it often produces disastrous consequences.
    2. The balance of nature is strong enough to cope with the impacts of modern industrial nations.
    3. The balance of nature is very delicate and easily upset.
D. **Rejection of Exemptionalism**
    1. Human ingenuity will ensure that we do NOT make the earth unlivable.
    2. Despite our special abilities, humans are still subject to the laws of nature.
    3. Humans will eventually learn enough about how nature works to be able to control it.
E. **Possibility of an Eco-Crisis**
    1. Humans are severely abusing the environment.
    2. The so-called "ecological crisis" facing humankind has been greatly exaggerated.
    3. If things continue on their present course, we will soon experience a major ecological catastrophe.

3.2.15 Maximize Options

Maximize Options: Belief by the individual that conserving fuel is important as a means of risk mitigation.

The Maximize Options construct is defined as the attitude an individual displays towards fuel conservation as a means of risk mitigation. A positive attitude displayed here indicates the individual views unspent fuel not as a burden, but a boon in case of events such as unplanned diversions or foul weather.

This construct was identified as necessary based on the results of an initial study designed to gauge pilot attitudes and ask them to describe in their own words their motivations for conserving fuel. A reoccurring theme in their responses (detailed in Chapter III) was the need to safeguard one's mission and crew against the unknown, and that conserved fuel was an important method of doing so.

Measuring Maximize Options:

1. I believe that conserving fuel while flying increases the safety of my flight crew.
2. I try to save enough fuel for an unexpected diversion.
3. I do not mind returning from missions with fuel unspent.
4. It is important to always conserve fuel in case my mission changes mid-flight.
5. The more fuel I can save vs. my mission profile, the more options I have while flying.
6. I have had to cut missions short due to fuel concerns.

3.3 Pilot Test and Correlation Matrix

Once the survey was complete, we pilot tested it on a population of 15 respondents. We collected responses via an online survey tool located here: https://www.surveymonkey.com/r/AFIT_fuel_efficiency_survey

We then used Excel to perform a correlation matrix, and used SAS to calculate Cronbach alpha of each construct measure to check for internal reliability scores higher than 0.7. Please see Table 2 for a sample of a correlation matrix and Cronbach alpha:

Table 2: Sample Correlation Matrix and Cronbach Alpha

PP1	PP2	PP3	PP4
The ability	Flying fue	Pilots whc	Doing my
7	5	6	7
2	4	4	5
5	5	6	6
1	1	1	5
6	6	5	6
3	5	5	5
1	1	2	2
1	1	1	2
4	5	5	4
5	5	5	5
5	3	3	5
5	5	5	5
3	3	3	4
1	1	1	1
7	7	7	7

Pride in Performance

1.00			
0.87	1.00		
0.87	0.97	1.00	
0.82	0.80	0.81	1.00

Cronbach Coefficient Alpha

Variables	Alpha
Raw	0.958369
Standardized	**0.959627**

The data on the left are the raw responses from each participant on the Pride in Performance construct measure questions. (The full analysis is in Chapter 4; this is an introduction to correlation matrices.) On the top right, Excel's Correlation add-in has calculated the internal correlation between questions PP1, PP2, PP3, and PP4 (one per row and column). The intersections denote how well each item correlates with each other item. PP1 (reading in column 1) correlates at 1.00 with itself, 0.87 with PP2, 0.87 with PP3, and 0.82 with PP4.

Below the correlation matrix is the SAS™ readout of the Cronbach alpha. As this Cronbach alpha is above our threshold of 0.7, this construct demonstrates strong internal reliability. The purpose of checking the construct measures' internal reliability is to verify that our question items are all measuring the same underlying factor. An outlying item may indicate a poor component to the overall construct instrument. When used with Excel's full 76 x 76 correlation matrix, the Cronbach alpha allows us to judge if an item is measuring a different factor entirely.

Finally, we completed our methodology by evaluating our Cronbach alpha results, looking for trends within the correlation matrix, and seeking to further understand and implement what would improve the measure. In construct measures with poor internal reliability, we reviewed each item and removed the ones which corresponded poorly to the overall construct.

IV. ANALYSIS AND FINDINGS

4.1 Introduction

4.1.1 Overview of Process

This chapter discusses the pilot-testing and analysis of our construct measures given in Chapter III. It describes the method used and provides sample calculations and findings. Once the instrument was constructed, we fielded it using an online survey hosting and data collection tool, www.surveymonkey.com/AFIT_fuel_efficiency_survey. The pilot test population consisted of 15 anonymous subjects. Finally, we analyzed the results, which allowed us to refine our survey measure.

4.1.2 Discussion of Method Used

Looking at any given construct, we want to make sure that each of its question items is related to that specific construct. We need to make sure that they are all highly correlated with each other, and not significantly highly correlated with other questions. If they are highly correlated with others, it suggests that we may not be looking at different constructs. Finally, we say a construct measure has strong internal reliability if its Cronbach alpha is greater than 0.7.

4.2 Discussion of Population Surveyed: Demographics and Results

Our sample population consisted of 15 subjects, and averages for their demographics are in Table 3. Since we avoided surveying flying squadrons (as those are the target population for the finished instrument), we have an older sample population and a small sample size. Ten reported as Majors, two reported as Lieutenant Colonels, and three did not report their rank. Thirteen reported flying USAF cargo airlift or tanker aircraft, one reported flying private aircraft, and one did not report which aircraft they flew. Fourteen reported as male; one did not report their gender. Average age among the pilots who reported age was 35.9 years, and average number of flying hours among those who reported was 2667.67.

Table 3: Demographics of Subjects in Pilot-Test

Ranks Reported	Lt. Col (2) Major (10) Did Not Report (3)
Average Age	35.9 years
Average No. Flying Hours	2667.67 Flying Hours
Aircraft Reported	C-17 Globemaster III (2) C-5 Galaxy (2) C-130 Hercules (All Variants): (5) KC-10 Extender (2) KC-135 Stratotanker (3) Pilatus PC-12 (1) Learjet C-21 (1) C-12 Huron (1) Private Aircraft (1)

Each question item was presented as a 7-point Likert scale, where “1” represented strongly negative affect, “4” represented neutrality, and “7” represented strongly positive affect. Certain items were reverse-coded. Table 4 summarizes the responses per construct measure in terms of average response and standard deviation:

Table 4: Summary of Average Responses Per Construct

Avg Response By Construct:	Construct Name	Std. Dev
4.92	**Habit**	1.69
4.65	**Intention**	1.61
5.23	**Attitude (Saving Fuel)**	1.89
4.85	**Attitude (Max Rng AS)**	1.69
4.80	**Subjective Norm**	1.69
5.30	**PBC (SE)**	1.20
4.02	**PBC (CN)**	1.57
4.36	**Feedback**	1.11
4.69	**Org Citizenship**	1.86
4.24	**Efficiency v Effect**	1.42
4.02	**Pride in Perf**	1.95
5.65	**Energy (Supply Security)**	1.35
5.03	**Energy (Domestic Source)**	1.27
3.60	**NEP1 (Growth)**	1.72
3.73	**NEP2 (Anthropocentrism)**	1.49
4.78	**NEP3 (Balance)**	1.38
5.09	**NEP4 (Exempt)**	1.31
4.69	**NEP5 (Crisis)**	1.76
5.13	**Org Emphasis**	1.72
5.18	**Max Options**	1.46

4.3 Analysis

4.3.1 Analysis Introduction

We were looking to validate each individual construct measure, which requires strong (> 0.7) internal reliability. If a construct used an existing measure, such as the NEP or Ajzen's scales, we used Cronbach alpha from the literature as our benchmark. We obtained examples for internal reliability from existing analyses of TPB-based scales and the NEP. As seen in Table 5 on the following page, certain construct measures scored higher than others when analyzed for internal reliability. Using a combination of the alpha score and the correlation matrix, we judged whether to keep or revise each construct measure for future revisions.

Table 5: Average Internal Correlation Per Construct

Construct	Source	Cronbach Alpha:	Cronbach Alpha (From Literature)
Habit	Limayem, Verplanken, Forgie et al.	**0.699**	N/A
Intention	Ajzen	**0.45**	**0.86**
Attitude (Saving Fuel)	Azjen	**0.67**	**0.8**
Attitude (Max Rng AS)	Ajzen	**0.85**	
Subjective Norm	Ajzen	**0.78**	**0.75**
PBC (SE)	Ajzen	**0.54**	**0.65**
PBC (CN)	Ajzen	**0.33**	
NEP1 (Growth)	Dunlap, Liere, Mertig, Jones	**0.86**	**0.81 (Overall)**
NEP2 (Anthro)	Dunlap, Liere, Mertig, Jones	**0.78**	
NEP3 (Balance)	Dunlap, Liere, Mertig, Jones	**0.86**	
NEP4 (Exempt)	Dunlap, Liere, Mertig, Jones	**0.68**	
NEP5 (Crisis)	Dunlap, Liere, Mertig, Jones	**0.94**	
Feedback	Written by AFIT	**0.94**	N/A
Org Citizenship	Pew (revised by AFIT)	**0.699**	N/A
Efficiency v Effect	Written by AFIT	**0.26**	N/A
Pride in Perf	Written by AFIT	**0.96**	N/A
Energy Security	Written by AFIT	**0.89**	N/A
Org Emphasis	Written by AFIT	**0.95**	N/A
Max Options	Written by AFIT	**0.56**	N/A

Key:	
Green	**Cronbach Alpha > 0.7** Statistically Significant Internal Correlation
Beige	**Cronbach Alpha between 0.6 and 0.7** Weak Internal Correlation
White	**Cronbach Alpha < 0.7** No Statistically Significant Internal Correlation
Blue	**Questions Written by AFIT**

4.3.2 Habit

Habit displayed internal reliability between 0.6 and 0.7 in our pilot study. Based on items adapted from three different studies, and hence possessing no overall Cronbach alpha, we intended to assess our instrument's ability to gauge a subject's habitual strength. Table 6 shows Habit has internal reliability > 0.7 if we remove HB3:

Table 6: Internal Reliability of Habit

Cronbach Coefficient Alpha

Variables	Alpha
Raw	0.696359
Standardized	0.694326

Cronbach Coefficient Alpha with Deleted Variable

Deleted Variable	Raw Variables		Standardized Variables		Label
	Correlation with Total	Alpha	Correlation with Total	Alpha	
HB1	0.513100	0.618881	0.494311	0.619581	HB1
HB2	0.693255	0.473409	0.712024	0.470141	HB2
HB3	0.364611	0.700000	0.337208	**0.714888**	**HB3**
HB4	0.385881	0.692607	0.398578	0.678855	HB4

We are uncertain as to why HB3 ("I normally do my best to be fuel-efficient without explicitly planning to do so") fits poorly with the other items. Upon review, HB4 ("When I plan a flight, fuel efficiency is usually a priority") seems to be the natural outlier, as it deals with planned behavior rather than autonomous behavior triggered by external behavioral cues. It could be that of the three different instruments we sourced from, the items were not meant to be used separately from the rest of their instrument. Perhaps adapting them to our study caused this anomaly.

4.3.3 Intention

Intention initially showed poor internal reliability. As seen in Table 7, its alpha score was lower than 0.7 by a large margin until IN1 was removed.

Table 7: Internal Reliability of Intention

Cronbach Coefficient Alpha

Variables	Alpha
Raw	0.439054
Standardized	**0.445365**

Cronbach Coefficient Alpha with Deleted Variable

Deleted Variable	Raw Variables		Standardized Variables		Label
	Correlation with Total	Alpha	Correlation with Total	Alpha	
IN1	0.082747	0.683544	0.031167	**0.732630**	**IN1**
IN2	0.577388	-.449251	0.653614	-.486312	IN2
IN3	0.251492	0.393272	0.241805	0.401234	IN3

All three items were sourced and adapted from Ajzen (2002), but IN1 ("I expect to use less than ACFP expected fuel most of the time") was the most heavily revised. This could explain its outlier status, and likely indicates a need for revision.

However, IN2 and IN3 showed an interesting interaction with Attitude, as shown in Table 8:

Table 8: Interaction of Intention and Attitude

	IN2	IN3
AT1	0.52	0.80
AT2	0.66	0.50
AT3	0.72	0.78
AT4	0.65	0.83

IN2: “I prefer to fly in a fuel-efficient manner.”

IN3: “I intend to be fuel-efficient when I fly.”

Attitude: “Saving fuel over the next dozen missions would be:”

AT1: bad/good

AT2: pleasant/unpleasant (reverse coded)

AT3: harmful/beneficial

AT4: worthless/valuable

AT5: enjoyable/unenjoyable (reverse coded)

While some of this interaction is perhaps attributable to the small sample population, it is nonetheless interesting that Intention correlated so well with Attitude. We cannot draw any conclusions from this correlation, so we must leave it at that. The TPB does show Attitude as an antecedent to Intention, but as for investigating this further, that is the subject of future dissertation research.

4.3.4 Attitude

Attitude, shown below in Table 9, showed a strong internal reliability, along the expected lines for a construct measure supported by a large body of research.

Table 9: Internal Reliability of Attitude

Cronbach Coefficient Alpha	
Variables	**Alpha**
Raw	0.864285
Standardized	**0.852115**

4.3.5 Subjective Norm

Subjective Norm showed strong internal reliability, as seen in Table 10.

Table 10: Internal Reliability of Subjective Norm

Cronbach Coefficient Alpha	
Variables	**Alpha**
Raw	0.781241
Standardized	**0.779232**

It does not, however, display strong internal correlation. Please see Table 11:

Table 11: Internal Correlation of Subjective Norm

	SN1	SN2	SN3	SN4	SN5	SN6
SN1	1.00					
SN2	0.40	1.00				
SN3	0.42	0.29	1.00			
SN4	0.12	0.59	0.31	1.00		
SN5	-0.02	0.05	0.47	0.19	1.00	
SN6	0.30	0.66	0.66	0.72	0.40	1.00

SN6 ("What other pilots do to conserve fuel is important to me") has the most correlation with other SN items, but when we consider the sample population size, the results are still too nebulous to draw any tangible conclusions.

Subjective Norm strongly correlates with Pride in Performance; however, Pride in Performance cross-correlates with a surprising number of other constructs, so this phenomenon will be covered in its own section.

4.3.6 Perceived Behavioral Control (PBC)

PBC displayed very poor internal reliability in its two sub-constructs, despite using tested items. This is likely a result of our small sample size. PBC is divided into two sub-constructs, "Self-Efficacy" and "Controllability," the first of which is shown below in Table 12.

Table 12: Internal Reliability of PBC Sub-Construct "Self-Efficacy"

Cronbach Coefficient Alpha

Variables	Alpha
Raw	0.466566
Standardized	**0.536866**

Cronbach Coefficient Alpha with Deleted Variable

Deleted Variable	Raw Variables Correlation with Total	Raw Variables Alpha	Standardized Variables Correlation with Total	Standardized Variables Alpha	Label
PBCSE1	0.459540	0.304928	0.476508	0.325348	PBCSE1
PBCSE2	0.284537	0.388430	0.338417	0.451964	PBCSE2
PBCSE3	0.323972	0.353896	0.376873	0.418026	PBCSE3
PBCSE4	0.136382	0.546067	0.129962	**0.619156**	PBCSE4

Self-Efficacy could benefit from the removal of PBCSE4 ("I have enough flexibility to influence how fuel-efficient the flight is"), but it is entirely likely that our small sample size influenced these results. However, since these items have been adapted from Ajzen's work, we cannot PBCSE4 out entirely. We will need to consider ways to reword PBCSE4 to eliminate this variance.

Table 13 shows the internal reliability of PBC's second sub-construct, "Controllability."

Table 13: Internal Reliability of PBC Sub-Construct "Controllability"

Cronbach Coefficient Alpha

Variables	Alpha
Raw	0.312883
Standardized	**0.330097**

Cronbach Coefficient Alpha with Deleted Variable

Deleted Variable	Raw Variables		Standardized Variables		Label
	Correlation with Total	Alpha	Correlation with Total	Alpha	
PBCCN1	0.341047	-.159744	0.365883	-.161093	PBCCN1
PBCCN2	-.049060	0.674797	-.050694	**0.676699**	PBCCN2
PBCCN3	0.304162	-.027548	0.311007	-.027563	PBCCN3

Controllability performed worse than Self-Efficacy, with an alpha of 0.33. Perhaps the double negative in PBCCN2 ("Whether or not I fly in a fuel-efficient way is not entirely up to me") caused confusion. We must re-evaluate our adaptation of Ajzen's questions and retry the instrument.

The poor alpha results from PBC were surprising because we expected PBC to show strong internal reliability, especially with a homogeneous population of pilots. We expected pilots would rate themselves both highly and consistently on PBC factors. Due to our small sample size, we must conduct additional testing.

Finally, PBC has no statistically significant cross-correlation.

4.3.7 Feedback

Feedback showed strong internal reliability. Please refer to Table 14:

Table 14: Internal Reliability of Feedback

Cronbach Coefficient Alpha	
Variables	**Alpha**
Raw	0.937004
Standardized	**0.938477**

However, as shown in Table 15 below, Feedback displayed an odd interaction with the second (and only the second) item under Habit:

Table 15: Cross-Correlation between Feedback and HB2

	HB2
FB1	0.75
FB2	0.73
FB3	0.70

HB2: “Being fuel-efficient seems natural to me.”

This is interesting because it is the only Habit item to show this kind of interaction. HB1 and HB3 ask if fuel efficiency is a “habit” or if it is “not explicitly planned.” This may be an artifact of our sample size, although it should be investigated further in future research. As Habit is likely to change (due to its poor internal correlation) it will be interesting to see if any factors of Habit display this interaction with Feedback.

4.3.8 Organizational Citizenship

Organizational Citizenship's alpha was marginally under our threshold of 0.7, but as Table 16 shows, removing OC2 raises its alpha to 0.92

Table 16: Internal Reliability of Organizational Citizenship

Cronbach Coefficient Alpha

Variables	**Alpha**
Raw	0.688974
Standardized	**0.699109**

Cronbach Coefficient Alpha with Deleted Variable

Deleted Variable	**Raw Variables**		**Standardized Variables**		**Label**
	Correlation with Total	**Alpha**	**Correlation with Total**	**Alpha**	
OC1	0.548761	0.535607	0.569795	0.537121	OC1
OC2	0.225383	0.924444	0.231562	**0.926148**	OC2
OC3	0.835894	0.147714	0.836749	0.147716	OC3

Let us compare OC1 and OC3 to OC2:

OC1: My organization's financial health is important to me.
OC2: Saving the government money will be good for the country.
OC3: It is an important part of my job to reduce expenses.

OC2 does not follow the traditional definition of "Organizational Citizenship," insofar as it does not deal directly with altruistic behavior towards one's organization. Also, OC2 violates Ajzen's rule of specificity in measuring attitudes.

OC1 is more specific towards the individual pilot, something it shares with OC3. OC3 deals with reducing expenses rather than big-picture ideals like saving the government or the nation money. Once OC2 was trimmed, we wrote three potential replacement items which attempt to be more in line with OC1 and OC2.

Proposed Organizational Citizenship Questions:

OC4: I can save the taxpayers money in an effective manner by saving fuel.
OC5: I try to be a "good steward" of the resources entrusted to me.
OC6: I would do my best to fly efficiently even if I received no tangible reward.

OC6 is optional. It may not be asking the same thing as the other items in this construct, but it is closer to the "book definition" of organizational citizenship. It may interact with Pride in Performance. We may include this item on the follow-up test.

4.3.9 Efficiency vs. Effectiveness

Efficiency vs. Effectiveness was included to capture the latent variable – identified in the literature – of being averse to an idea because of its perceived risk. Efficiency vs. Effectiveness showed poor internal reliability, nor did its items interact with those of any other construct measure. This implies that whatever its items are measuring, they are at least unique – but that they need refinement if we are to include them at all. See Table 17 below:

Table 17: Internal Reliability of Efficiency vs. Effectiveness

Cronbach Coefficient Alpha

Variables	Alpha
Raw	0.323314
Standardized	0.258196

Cronbach Coefficient Alpha with Deleted Variable

Deleted Variable	Raw Variables		Standardized Variables		Label
	Correlation with Total	Alpha	Correlation with Total	Alpha	
EE1	0.312765	-.106007	0.269930	-.124316	EE1
EE2	-.007097	0.490196	-.007928	**0.490321**	EE2
EE3	0.250775	0.074534	0.184125	0.087252	EE3

The poor internal reliability is likely a result of its items measuring different concepts, but it may in part be due to poor sample size. Below we examine the three questions which make up this construct:

EE1: “Fuel efficiency and effectiveness both support safe mission accomplishment.”

EE1 loads onto two Maximize Options items, MO1 and MO3. MO1 discusses fuel efficiency and safety of flight crew, so the two are likely measuring the same latent variable. However, EE1 also negatively loads onto MO3 (“I do not mind returning with fuel unspent”). It is entirely possible that this correlation is spurious in nature, although it is interesting to note the high number (1/3d of the population) of tanker pilots. Tankers dump fuel before landing in order to reach maximum safe landing weight; in these cases, safe mission accomplishment may indeed run counter to saving fuel.

EE2: “I can accomplish the mission safely and save fuel at the same time.”

Oddly, this item fails to significantly interact with any other item – despite seemingly asking the same thing as EE1. In addition, removing EE2 nearly doubles EE’s alpha. This could be an anomaly remediable with a larger sample size.

EE3: “There is a strict tradeoff between saving fuel and flying effectively.”

EE3 shows no significant correlation with any other item, even accounting for reverse coding. This makes EE3 a good candidate to use to rebuild the Efficiency vs. Effectiveness item, as it most cleanly points in its own direction. The importance of Efficiency vs. Effectiveness has already been highlighted in research such as Ciarcia 2013, and we will need to refine it for further testing.

Owing to the need to rebuild Efficiency vs. Effectiveness, all three items will require reworking. The follow-up test will incorporate lessons learned from this pilot test.

4.3.10 Pride in Performance

Pride in Performance displays strong internal reliability, but its most interesting attribute is that it shows significant cross-correlation with a number of separate constructs. Table 18 below shows its strong internal reliability:

Table 18: Internal Reliability of Pride in Performance

Cronbach Coefficient Alpha	
Variables	**Alpha**
Raw	0.958369
Standardized	**0.959627**

Pride in Performance was created to capture the professionalism element of being a USAF aircraft commander, as each is first and foremost a military officer. 14 of 15 respondents report being at least an O-4 Major, and have thus spent significant time in the military.

Many other items load onto Pride in Performance. In Table 19, we see how Pride in Performance interacts with items from Habit, Attitude, Subjective Norm, Perceived Behavioral Control, Feedback, and Organizational Citizenship.

Table 19: External Interactions of Pride in Performance

	HB1	HB2	AT2	AT9	SN3	SN6	OC3
PP1	0.62	0.67	0.58	0.80	0.61	0.75	0.80
PP2	0.76	0.72	0.61	0.83	0.75	0.79	0.79
PP3	0.65	0.69	0.63	0.80	0.76	0.79	0.79
PP4	0.70	0.68	0.73	0.66	0.75	0.90	0.91

This was an unexpected finding, especially considering Pride in Performance's status as an antecedent to Attitude. As such, we did not expect it to cross-correlate with so many different elements of the TPB model. Only Attitude is directly linked to Pride in Performance via the model, whereas Subjective Norm, Habit, and Perceived Behavioral Control are all very separate entities.

An analysis of which is an antecedent to which would require ensuring there are indeed different latent variables here, but also a structural equations model, which will likely be the topic of a doctoral dissertation.

PP1: The ability to fly efficiently is a mark of a good pilot.

PP2: Flying efficiently demonstrates my mastery of flying my aircraft

PP3: Pilots who take pride in their skill will often fly using less fuel.

PP4: Doing my job well means flying efficiently.

The chief interactions here are with AT9, SN3, SN6, and OC3:

AT9: Flying at max range airspeed is (pleasant/unpleasant), reverse coded

SN3: I feel under pressure from my peers to be as fuel-efficient as possible.

SN6: What other pilots do to conserve fuel is important to me.

OC3: It is an important part of my job to reduce expenses.

Are the questions above measuring the same latent variable? We cannot be sure at this time, although it is more likely that as these are seasoned pilots with thousands of hours, they have adapted to slower, more efficient cruising at altitude as opposed to opening up the throttle to arrive home sooner. PP2 correlates with similar items and factors as PP1, but shows stronger correlation with HB1 and HB2, which respectively deal with efficiency as "a habit" and "natural to me." We suspect this increase (vs. PP1, 3, 4) is spurious in nature due to our small sample population.

Overall, this is the most interesting result from our research. If future research shows professionalism has such far-reaching effects in USAF pilot culture, it could pave the way for a more far-reaching study encompassing pilots outside the USAF.

4.3.11 Energy Security

Energy Security showed strong internal reliability. Its appearance on the correlation matrix seemed to imply we should divide it into two sub-constructs, it demonstrated sufficient internal reliability to remain a single construct measure. See Table 20 for Energy Security's alpha, and Table 21 for its internal correlation:

Table 20: Internal Reliability of Energy Security

Cronbach Coefficient Alpha	
Variables	**Alpha**
Raw	0.881293
Standardized	**0.889945**

Table 21: Energy Security Internal Correlation

Energy Security							
1.00							
0.81	1.00						
0.94	0.93	1.00					
0.87	0.96	0.96	1.00				
0.64	0.62	0.61	0.67	1.00			
0.33	0.28	0.25	0.29	0.63	1.00		
0.18	-0.13	0.00	-0.06	0.28	0.61	1.00	
0.51	0.29	0.30	0.24	0.54	0.64	0.90	1.00

Despite what appear to be two distinct blocks of internal correlation within this construct, they may be spurious due to our small sample size, and the measure demonstrated strong internal reliability. We decided to keep Energy Security as a single construct measure.

4.3.12 Environmentalism

Environmentalism uses the New Ecological Paradigm, a measure of a subject's overall ecological concern, composed of five sub-constructs. Their individual Cronbach alphas are shown below in Tables 22, 23, 24, 25, and 26:

Table 22: Environmentalism Sub-Construct "Reality of Limits to Growth"

Cronbach Coefficient Alpha	
Variables	**Alpha**
Raw	0.860002
Standardized	**0.859893**

Table 23: Environmentalism Sub-Construct "Anti-Anthropocentrism"

Cronbach Coefficient Alpha	
Variables	**Alpha**
Raw	0.788328
Standardized	**0.783181**

Table 24: Environmentalism Sub-Construct "Fragility of Nature's Balance"

Cronbach Coefficient Alpha	
Variables	**Alpha**
Raw	0.885390
Standardized	**0.885860**

Table 25: Environmentalism Sub-Construct "Rejection of Exemptionalism"

Cronbach Coefficient Alpha	
Variables	**Alpha**
Raw	0.657303
Standardized	**0.684272**

Table 26: Environmentalism Sub-Construct "Possibility of an Eco-Crisis"

Cronbach Coefficient Alpha	
Variables	**Alpha**
Raw	0.928544
Standardized	**0.940943**

All sub-constructs but one, "Rejection of Exemptionalism," showed strong internal reliability. As the NEP has been widely used and repeatedly subjected to testing and refinement, the alpha of "Rejection of Exemptionalism" was likely due to poor sample size. As a result, we will conduct the second pilot test with the NEP unchanged.

4.3.13 Organizational Emphasis

Organizational Emphasis, the sole antecedent to Subjective Norm, showed very strong internal reliability, shown in Table 27 below:

Table 27: Internal Reliability of Organizational Emphasis

Cronbach Coefficient Alpha	
Variables	**Alpha**
Raw	0.937222
Standardized	**0.951476**

Organizational Emphasis showed little cross-correlation with its descendant Subjective Norm. On one hand, this is important as it shows that both sets of items measure different concepts; on the other, we expected more interaction between the two. It is possible that this lack of cross-correlation is spurious due to small sample size.

However, as shown in Table 28, Organizational Emphasis has an interesting correlation to Habit's HB1:

Table 28: Organizational Emphasis vs. HB1

	HB1
OE1	0.83
OE2	0.76
OE3	0.83
OE4	0.81

HB1: Paying attention to fuel efficiency has become a habit to me.
OE1: It is important to the USAF that I save fuel when I can.
OE2: The USAF is serious about saving fuel.
OE3: Being fuel efficient when I fly supports AF goals.
OE4: My leadership wants me to fly efficiently.

More interesting, however, is that Organizational Emphasis has no statistically significant interaction with any other Habit item:

HB2: Being fuel-efficient seems natural to me.

HB3: I normally do my best to be fuel-efficient without explicitly planning to do so.

HB1 displays an oddly strong correlation to all four OE questions, even considering the poor sample size. Is it possible that the OE items are somehow measuring an aspect of Habit that we had not considered?

4.3.14 Maximize Options

The final construct we measured was Maximize Options, shown in Table 29, which displayed poor internal reliability until MO1 was removed:

Table 29: Internal Reliability of Maximize Options

Cronbach Coefficient Alpha

Variables	Alpha
Raw	0.398213
Standardized	**0.555968**

Cronbach Coefficient Alpha with Deleted Variable

Deleted Variable	Raw Variables		Standardized Variables		Label
	Correlation with Total	Alpha	Correlation with Total	Alpha	
MO1	-.220269	0.652036	-.165708	**0.696575**	MO1
MO2	0.473946	0.220078	0.508000	0.406918	MO2
MO3	-.135894	0.530966	-.080792	0.666342	MO3
MO4	0.756125	-.023930	0.744196	0.275109	MO4
MO5	0.669046	0.161542	0.681424	0.311837	MO5
MO6	0.226941	0.329961	0.339704	0.490624	MO6

Upon examining MO, shown below in Table 30, we noticed that MO5 looked like the strongest item in MO, as it correlated with MO2 and MO4.

Table 30: Internal Correlation of Maximize Options

Maximize Options					
1.00					
0.07	1.00				
-0.37	0.10	1.00			
0.05	0.34	0.22	1.00		
0.02	0.61	-0.12	0.70	1.00	
-0.33	0.27	-0.09	0.58	0.55	1.00

Our intent while composing this construct measure was to capture attitude towards fuel efficiency as active risk mitigation behavior. Why, then, would MO5 correlate with MO2 and MO4 when they fail to correlate well with one another? With these results, we looked at MO's items, seeking to understand why they tested inconsistently:

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 always conserve fuel in case my mission changes mid-flight.
MO5: The more fuel I can save vs. my mission profile, the more options I have while flying.
MO6: I have had to cut missions short due to fuel concerns.

MO5 is the strongest item because it specifically targets a few factors of active risk mitigation while flying. One, it specifically mentions "mission profile," indicating the mission the pilot is given (influenced by variables such as weather, whose status at the time of mission creation may change during mission execution). Second, it makes a comparison, and talks about saving more fuel than the mission profile anticipates. Third, it specifically mentions options, which could provoke a stronger attitude of risk mitigation.

MO1 specifically mentions safety, rather than specifically mentioning "maximizing options." Both MO1 and EE1 ("Fuel efficiency and effectiveness both support safe mission accomplishment") seem to target the same concept. MO1, does not measure what MO5 is measuring.

MO2 weakly correlates with MO5, insofar as it mentions risk mitigation and dealing with unexpected variables.

MO3 does not deal with the same factor as the rest, and the heavy presence of tanker pilots in our group (who must often dump fuel at mission conclusion in order to make landing weight) likely influenced the responses this item received.

MO4 largely deals with the same factor as MO2, except it specifically mentions "mission changing mid-flight," which links it closer to the "mission profile" aspect of MO5. This could explain the greater correlation between MO4 and MO5 than between MO2 and MO5.

MO6 does not deal with the same factors as MO5, 2, and 4. It asks experiences rather than attitude. It may indirectly deal with the unexpected – considering the unlikeliness of mission failure on the part of poor fuel management by the pilot – but also the severe nature of the consequences of running out of fuel in-flight.

After this analysis, we decided to reevaluate Maximize Options, reviewed the strongest aspects of the MO items, and created two new items to replace weaker questions such as MO1, MO3, and MO6:

Proposed Maximize Options Questions:

MO7: The mission profile can fail to account for the unexpected.
MO8: While flying, I look for ways that my mission may unexpectedly change.

Both new items aim to target active risk mitigation while flying. We run the risk of poor correlations once more, however, as the new items do not specifically address efficiency (and the first does not address behavior).

4.4 Summary of Findings

Of the eighteen construct measures we tested, ten of them displayed strong (alpha greater than 0.7) internal reliability. Three displayed weak (between 0.6 and 0.7) internal reliability. Five displayed internal reliability lower than 0.6.

We considered rebuilding constructs if they met all three of these criteria:

1. The items for the construct measure were written by the researchers.
2. The construct measure displayed an internal correlation less than 0.7.
3. The researchers evaluated all items within the construct measure, and found any to be incongruent with either the latent variables measured by the construct measure, or the functioning items.

Only three construct measures met these criteria: Organizational Citizienship, Efficiency vs. Effectiveness, and Maximize Options. The SAS analysis showed that removing certain items would raise their alphas.

Organizational Citizenship saw an increase from 0.699 to 0.93 by removing one item. We will write its replacement before the follow-up test.

Efficiency vs. Effectiveness will need to be reworked. Its importance was highlighted in the literature, and the correlation matrix shows it is not measuring the same concept as other construct measures.

Maximize Options saw an improvement from 0.56 to 0.699, which is close enough to 0.7 that it could be a statistical anomaly. However, this construct measure will receive a rework to weed out confusing questions before we re-run the test.

Table 31 provides a full rundown of all construct measures and their correlations. Any measure able to be "maximized" by removing items is shown as such; however, this does not mean we will remove questions from pre-built measures.

Table 31: Internal Correlations Before and After Removing Questions

Construct Measure	Source	Maximized?	Cronbach Alpha:	Cronbach Alpha (Maximized)	Cronbach Alpha (From Literature)
Habit	Limayem, Verplanken, Forgie et al.	N	0.699	0.71	N/A
Intention	Ajzen	N	0.45	0.73	0.86
Attitude	Azjen	Y	0.85	0.85	0.8
Subjective Norm	Ajzen	Y	0.78	0.78	0.75
PBC (SE)	Ajzen	N	0.54	0.62	0.65
PBC (CN)	Ajzen	N	0.33	0.68	
NEP1 (Growth)	Dunlap, Liere, Mertig, Jones	N/A	0.86	0.86	0.81 (Overall)
NEP2 (Anthro)	Dunlap, Liere, Mertig, Jones	N/A	0.78	0.78	
NEP3 (Balance)	Dunlap, Liere, Mertig, Jones	N/A	0.86	0.89	
NEP4 (Exempt)	Dunlap, Liere, Mertig, Jones	N/A	0.68	0.68	
NEP5 (Crisis)	Dunlap, Liere, Mertig, Jones	N/A	0.94	0.94	
Feedback	Written by AFIT	Y	0.94	0.94	N/A
Org Citizenship	Pew (revised by AFIT)	N	0.699	0.93	N/A
Efficiency v Effect	Written by AFIT	N	0.26	0.49	N/A
Pride in Perf	Written by AFIT	Y	0.96	0.96	N/A
Energy Security	Written by AFIT	Y	0.89	0.89	N/A
Org Emphasis	Written by AFIT	Y	0.95	0.95	N/A
Max Options	Written by AFIT	N	0.56	0.699	N/A

Key:	
Green	**Cronbach Alpha > 0.7** Strong Internal Reliability
Beige	**Cronbach Alpha between 0.6 and 0.7** Tentatively Acceptable
White	**Cronbach Alpha < 0.7** Poor Internal Reliability
Blue	**Questions Written by AFIT**

V. DISCUSSION

5.1 Introduction

The pilot test revealed the strengths of certain measures and weaknesses in others. The intent was to validate eighteen construct measures. Ten construct measures were validated with a Cronbach alpha greater than 0.7. Three showed Cronbach alphas between 0.6 and 0.7; one was not an existing metric, so it could have items removed to bring its alpha above 0.7. Five had alphas lower than 0.6.

We have established several metrics which can be used to measure behavioral factors in the context of discretionary pro-environmental professional behavior in USAF pilots. Our next step is to further refine and improve the instrument in preparation to deploy it.

5.2 Investigative Questions Answered

Investigative Question 1: Which theories are most pertinent to investigate discretionary fuel-saving flight in pilots?

The most applicable theory was the TPB because of its strong focus on internalized antecedents of behavior. In our example of an airlift pilot, the behavior of one aircraft commander can have a great impact on overall fuel consumption (Schumacher 2015). The research of Lülfs and Hahn (2013, 2014) and McDonald (2014) allowed us to build a model that captured many factors of pilot behavior.

Investigative Question 2: What gaps or shortcomings exist in pro-environmental behavior theory when attempting to describe professional behavior rather than consumer behavior?

We quickly identified the main gaps in pro-environmental behavior theory were an over-reliance on individual attitude factors, such as environmentalism or concern for energy security. While we did not discard these factors, research such as Ciarcia (2013) identified the need for attitude factors and social factors outside the scope of consumer behavior. Specifically, the current theory fails to account for the strong subjective norm factor present in military culture, and the importance of organizational emphasis.

In addition, our pilot test revealed a strong undercurrent of "Pride in Performance," which seemed to register on many different construct measures. We were not testing for relationships between constructs, and we can make no inter-construct conclusions at this stage in our research. However, we can re-examine our measures with special attention paid to the significant positive correlations between Pride in Performance and many other construct measures. In time, perhaps in a future survey experiment, we can compare the influence of professionalism on USAF pilots with the influence of professionalism on other populations, such as civilian airlift pilots and ground logistics providers.

Investigative Question 3: With the lack of literature on discretionary pro-environmental professional behavior, and the importance of specificity in a survey instrument, which USAF-focused concepts should we include to close the gaps in our model?

We used multiple methods to increase specificity in our model. As mentioned in IQ2, Ciarcia (2013) identified the need to measure aversion to adoption of new and potentially risky ideas. Secondly, our informal survey generated one new construct measure (Maximize Options) and one heavily revised construct measure (Organizational Citizenship). While the idea of organizational citizenship as an altruistic behavior comes up occasionally in literature, we did not find any examples of it being used as discretionary pro-environmental professional behavior. Maximize Options, by contrast, was generated almost solely based on input from actual pilots, as risk mitigation while flying is an important matter.

Investigative Question 4: Which individual survey instruments ("construct measures") best demonstrate scientific rigor and comprehensiveness in measuring the USAF-focused concepts we discovered in the previous question?

We strove to use existing measures wherever possible, in order to back our research with the weight of prior experiences and data. On the occasions where we were not able to use existing measures, we used the pilot test as an opportunity to discover what elements of items work and what elements should be discarded. As an example, we use the items from Maximize Options. The key to the validity of its items appears, at the conclusion of this thesis, to be that it makes a comparison between a pilot's individual behavior and the unreliability of mission profiles. Instead of asking about safety (which another construct attempted to do, with little success), Maximize Options appears strongest when it explores individual behavior.

Investigative Question 5: Upon pilot testing the survey, are our measures sound? What changes will the measures require?

IQ5 looks forward, to the future of this survey instrument. As we will discuss in the "Future Research" section, our instrument must evolve from this first iteration. As we did in Chapter 4, we will take what worked in individual construct measures and explore the reasons why that element worked. Similarly, we will learn from what did not work. It would be naïve to assume the instrument would be sound in its first iteration, and we expected to make changes here. The Antecedents of Fuel Efficiency survey instrument must carve out a new area of the theory, and it will understandably run into pitfalls. We suspect that further investigation will be required to fully understand what Pride in Performance is measuring, and why it correlates so strongly with other constructs.

5.3 Future Research

Validating ten out of eighteen measures is a good start, but more work will need to be done to refine our instrument. Specifically, we will need to retest the survey with a greater sample population of more than fifteen subjects, in order to check for anomalies in this initial test. For that reason, we will not alter any of the "pre-packaged" measures, such as the NEP or Ajzen's construct measures.

The Habit measure is a special case apart from the pre-packaged measures; we did not write its items, but they are operating outside the survey instruments they were written for. Habit shows strong cross-correlations with other constructs, and we may choose to use a purely pre-packaged measure for the follow-up test.

Regarding the measures we wrote ourselves, all but three were immediately validated. Of those three, Maximize Options emerged with the strongest internal reliability, but will require additional items and retesting for validation. It will focus more clearly upon individual behavioral choices and how those can affect an individual's goals of risk mitigation while flying.

Efficiency vs. Effectiveness will require a redesign. Ciarcia (2013) still highlights the importance of measuring "adoption aversion," or unwillingness to adopt fuel-efficient behavior, but our current research shows nebulous results. Evidently, the items for this measure were measuring some latent variable, as they show no significant correlation with any other items, but we must write new items for retesting.

Finally, Organizational Citizenship will require new items. We have examined which factors work in the measure – the idea of individual behavior while flying, viewed through the lens of altruism – and which do not, such as sweeping big picture ideals that do not tie cleanly to individual behavior. Our revision to this measure will move it towards the personal, but still retain its focus on altruistic behavior.

The ultimate goal of this thesis and its follow up testing will be the finalized Antecedents of Fuel Efficiency survey instrument. Future goals for this research involve testing a large (>1500) population of active duty aircraft commanders and publishing our results for future decision-making models to use. In addition, we hope to expand the testing population for our instrument to populations in commercial air logistics (UPS, FedEx, etc.) and commercial ground logistics, such as the trucking industry. We seek to help the USAF and the greater military community better understand the behavioral factors of the human in the cockpit, and any potential value they may hold to reducing the USAF's fuel consumption.

APPENDICES

Appendix A: IRB Exemption Request Memorandum

17 December 2015

MEMORANDUM FOR AFIT EXEMPT DETERMINATION OFFICIAL

FROM: AFIT/ENS
2950 Hobson Way
Wright Patterson AFB OH 45433-7765

SUBJECT: Request for exemption from human experimentation requirements (32 CFR 219, DoDD 3216.2 and AFI 40-402) for a survey to research antecedents of fuel-efficient behavior.

1. The purpose of this study is to research psychological antecedents to fuel-efficient behavior in C-130 Hercules cargo airlift pilots. It seeks to determine why certain pilots perform their duties in a more fuel-efficient manner than others, given the same aircraft and missions. This is a research project focused on the Theory of Planned Behavior (TPB); we intend to publish the results in an academic journal.

2. This request is based on the Code of Federal Regulations, title 32, part 219, section 101, paragraph (b) (2) Research activities that involve the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior unless: (i) Information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) Any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, or reputation.

3. The following information is provided to show cause for such an exemption:

a) Equipment and facilities: The study will take place in the participants' current place of employment. It will involve a web-based survey of attitudes, values, and demographics, and in keeping with the principle of privacy, all responses will be kept confidential.

b) Subjects: The subjects for this experiment are current active duty C-130 Hercules cargo airlift aircraft commanders in the United States Air Force. All subjects have years of pilot training, flying experience and hundreds of flying hours. The source of subjects will be Air Mobility Command's C-130 cargo airlift population. In total, there is a pool of 1000 potential subjects from the sample population. The subjects' ages range from 30-50 years of age and include both genders. All subjects will be intimately familiar with the operation and command of the C-130 aircraft.

c) Timeframe: The experiment will be conducted January 15, 2016 to January 15, 2017. The survey will require approximately 30 minutes of each individual's time.

d) Data collected: Information to be gathered through this experiment includes name, age, gender, rank, flying hours, and unit (flying squadron). Subjects will answer these questions after the completion of the survey (See Attachment 1 for the data collection questions). To address the problem of duplicate last names, we will use surnames and flying squadron together to identify subjects. The variables to be examined are the behavioral constructs and the relationships between each construct and the overall behavior of the subjects (using data available via Fuels Data Tracker database). Once collected, the data will be analyzed using a structural equations model to determine the strength of the relationships between the constructs and behavior.

e) Data Security: Steps will be taken to minimize risk should files be compromised. As soon as practical, the survey file will be de-identified by replacing names with codes. The code key will be kept separately and not distributed. Analysis will be done with a de-identified data file.

f) Risks to subjects: Subjects will not meet any additional risks uncommon to their daily tasks of aircraft command. Participants will complete the survey via web-based data collection; the survey will make it clear to all potential participants that the survey is voluntary in nature. The disclosure of personal identifiable information will be the main risk; to mitigate this, we will exclude social security numbers in the collection of data. If a subject's future response reasonably places them at risk of criminal or civil liability or is damaging to their financial standing, employability, or reputation, I understand that I am required to immediately file an adverse event report with the IRB office.

g) Informed consent: All subjects must be willing participants of this study. All subjects are self-selected to volunteer to participate in the survey. No adverse action is taken against those who choose not to participate. Subjects are made aware of the nature and purpose of the research, sponsors of the research, and disposition of the survey results. A copy of the Privacy Act Statement of 1974 is presented for their review.

4. If you have any questions about this request, please contact Dr. Kenneth Schultz at 785-3636, ext. 4725 or via email at kenneth.schultz@afit.edu.

Dr. Kenneth L. Schultz
Principal Investigator

Attachments:
1. Survey Instrument: Antecedents of Fuel Efficiency

Appendix B: IRB Exemption Approval

DEPARTMENT OF THE AIR FORCE
AIR FORCE INSTITUTE OF TECHNOLOGY
WRIGHT-PATTERSON AIR FORCE BASE OHIO

13 January 2016

MEMORANDUM FOR Dr. Kenneth Shultz

FROM: Brett J. Borghetti, Ph.D.
AFIT IRB Exempt Determination Official
2950 Hobson Way
Wright-Patterson AFB, OH 45433-7765

SUBJECT: Approval for exemption request from human experimentation requirements (32 CFR 219, DoDD 3216.2 and AFI 40-402) for "A Survey to Research Antecedents of Fuel-Efficient Behavior", dated 17 December 2015 (revision 1: 12 Jan 2016)

1. Your request was for exemption based on the Code of Federal Regulations, title 32, part 219, section 101, paragraph (b) (2) Research activities that involve the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior unless: (i) Information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) Any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, or reputation.

2. While the information you are collecting could potentially damage the subjects' employability or reputation, your study **qualifies for this exemption** because you are de-identifying all identifiable information in both the collected data and the analysis portions of your research.

3. This determination pertains only to the Federal, Department of Defense, and Air Force regulations that govern the use of human subjects in research. Further, if a subject's future response reasonably places them at risk of criminal or civil liability or is damaging to their financial standing, employability, or reputation, you are required to file an adverse event report with this office immediately.

1/13/2016

X

Signed by: BORGHETTI.BRETT.J.1009082820
BRETT J. BORGHETTI, Ph.D.
AFIT Exempt Determination Official

Appendix C: Informed Consent Document

INFORMATION PROTECTED BY THE PRIVACY ACT OF 1974

Informed Consent Document
For
Antecedents of Fuel Efficiency

Principal Investigator: Dr. Kenneth Schultz, DSN 255-6565
Air Force Institute of Technology, ENS
Kenneth.Schultz@afit.edu

Associate Investigators: Captain James A. Cotton, DSN 255-6565
Air Force Institute of Technology, ENS
james.cotton@afit.edu

1. **Nature and purpose:** We offer you the opportunity to participate in the "Antecedents of Fuel Efficiency" research study, which will be conducted online using a web-based data collection method. The purpose of this research is to evaluate attitudes and values and their relationship to fuel-efficient behavior while flying the C-130 Hercules aircraft. In total, there will be approximately 1530 subjects.

2. **Experimental procedures:** If you decide to participate, we ask that you complete a web-based survey found at: https://www.surveymonkey.com/r/AFIT_fuel_efficiency_survey. It should take approximately 30 minutes to complete.

3. **Discomfort and risks:** There should be no discomforts or risks associated with this survey.

4. **Benefits:** You are not expected to benefit directly from participation in this research study. Indirectly, we aim to use this research to benefit the USAF by reducing the amount of jet fuel used, benefiting our nation's finances, taxpayers, and environment.

5. **Compensation:** Active duty military will receive normal pay.

6. **Alternatives:** You may choose not to participate in this study. Refusal to participate will involve no penalty or loss of benefits to which you are otherwise entitled.

7. **Entitlements and confidentiality:**

a. Short of a court order, the only people who will be privy to both your name and your answers will be the academic research team listed here: Capt. James Cotton, Dr. Kenneth Schultz, Dr. Reidar Hagtvedt, Dr. Joshua Strakos, and Dr. Adam Reiman. Records of your participation in this study will be protected according to federal law, including the Federal Privacy Act, 5 U.S.C. 552a, and its implementing regulations and the Health Insurance Portability and Accountability Act (HIPAA), and its implementing regulations, when applicable, and the Freedom of Information Act, 5 U.S.C. Sec 552, and its implementing regulations when applicable. Any information provided will be transferred to a system that masks your personal identifiable information. All data collected will be gathered and given a unique designator that will in no way be linked back to you. As intended, the only people having access to your Personally Identifiable Information (PII) will be the researchers named above, the AFRL Wright Site IRB, the Air Force Surgeon General's Research Compliance office, the Director of Defense Research and Engineering office or any other IRB involved in the review and approval of this protocol. When no longer needed for research purposes your information will be destroyed in a secure manner through electronic means.

c. The decision to participate in this research is completely voluntary on your part. No one may coerce or intimidate you into participating in this program. If you have any further questions, you may contact Captain James Cotton at (678) 313-6743. Capt. Cotton or an associate will be available to answer any questions concerning procedures throughout this study. You will be informed if significant new findings develop during the course of this research, which may relate to your decision to continue participate or may affect the risk involved. Refusal to participate will involve no penalty or loss of benefits to which you are otherwise entitled. You may discontinue participation at any time without penalty or loss of benefits to which you are otherwise entitled. If you have any questions or concerns about your participation in this study or your rights as a research subject, please contact Kim London at (937) 656 – 5688 or kim.london.1@us.af.mil.

d. Your participation in this study will not be photographed, filmed or audio/videotaped.

YOU ARE MAKING A DECISION WHETHER OR NOT TO PARTICIPATE. YOUR SIGNATURE INDICATES THAT YOU HAVE DECIDED TO PARTICIPATE HAVING READ THE INFORMATION PROVIDED ABOVE.

SUBJECTS MUST SIGN **PRIOR** TO PARTICIPATION.

Volunteer Signature____**Date**_______________

Volunteer Name (printed)____

Advising Investigator Signature ______________________ **Date** _________________

Investigator Name (printed)____

Witness Signature __________________________________**Date** _________________

Witness Name (printed)____

Privacy Act Statement

Authority: We are requesting disclosure of personal information.. Researchers are authorized to collect personal information on research subjects under The Privacy Act-5 USC 552a, 10 USC 55, 10 USC 8013, 32 CFR 219, 45
CFR Part 46, and EO 9397, November 1943.
Purpose: It is possible that latent risks or injuries inherent in this experiment will not be discovered until some time in the future. The purpose of collecting this information is to aid researchers in locating you at a future date if further disclosures are appropriate.
Routine Uses: Information may be furnished to Federal, State and local agencies for any uses published by the Air Force in the Federal Register, 52 FR 16431, to include, furtherance of the research involved with this study and to provide medical care.
Disclosure: Disclosure of the requested information is voluntary. No adverse action whatsoever will be taken against you, and no privilege will be denied you based on the fact you do not disclose this information. However, your participation in this study may be impacted by a refusal to provide this information.

Appendix D: Antecedents of Fuel Efficiency Survey

Air Force Institute of Technology

Antecedents to Fuel Efficiency Survey Instrument

Capt. James Cotton

Dr. Kenneth Schultz

Dr. Reidar Hagtvedt

Dr. Joshua Strakos

Dr. Adam Reiman

https://www.surveymonkey.com/r/AFIT_fuel_efficiency_survey

Habit:

Adapted from Limayem & Hirt (2003), Verplanken & Orbell (2003), Forgie et al. (2012)

1. Paying attention to fuel efficiency has become a habit to me.
2. Being fuel-efficient seems natural to me.
3. I normally do my best to be fuel-efficient without explicitly planning to do so.
4. When I plan a flight, fuel efficiency is usually a priority.

Intention:

Adapted from Ajzen (2002)

5. I expect to use less than ACFP expected fuel most of the time.
6. I prefer to fly in a fuel-efficient manner.
7. I intend to be fuel-efficient when I fly.

Attitude (Saving Fuel):

Adapted from Ajzen, I. (1991)

Saving fuel over the next dozen missions would be:

8. bad 1__:___2__:___3__:___4__:___5__:___6__:___7 good
9. pleasant 1__:___2__:___3__:___4__:___5__:___6__:___7 unpleasant
10. harmful 1__:___2__:___3__:___4__:___5__:___6__:___7 beneficial
11. worthless 1__:___2__:___3__:___4__:___5__:___6__:___7 valuable
12. enjoyable 1__:___2__:___3__:___4__:___5__:___6__:___7 unenjoyable

Attitude (Max Range Airspeed):

Flying at max range airspeed:

13. Does not save fuel 1__:___2__:___3__:___4__:___5__:___6__:___7 Saves fuel
14. Is Harmful 1__:___2__:___3__:___4__:___5__:___6__:___7 Beneficial
15. Is Good 1__:___2__:___3__:___4__:___5__:___6__:___7 Bad
16. Pleasant (for me) 1__:___2__:___3__:___4__:___5__:___6__:___7 Unpleasant (for me)
17. Is Worthless 1__:___2__:___3__:___4__:___5__:___6__:___7 Useful

Subjective Norm:

Adapted from Ajzen, I. (1991).

18. Most people who are important to me think that I should fly in a fuel efficient manner.
19. It is expected that I fly routine missions fuel-efficiently.
20. I feel pressure from my peers to be as fuel-efficient as possible
21. People who are important to me want me to be fuel efficient
22. My passengers' assessment of my flying ability is important to me
23. What my superiors think of my flying technique matters to me
24. What other pilots do to conserve fuel is important to me

Perceived Behavioral Control (Self-Efficacy):

Adapted from Ajzen (2002) and Bandura (2013)

25. I am confident that I could fly in a fuel-efficient manner if I wanted to.
26. For me to achieve fuel-efficient flight standards is easy.
27. As the aircraft commander, I can directly improve the overall fuel efficiency of my mission.
28. I have enough flexibility to influence how fuel efficient the flight is.

Perceived Behavioral Control (Controllability):

Adapted from Ajzen (2002)

29. The decision to fly in a fuel-efficient way is beyond my control.
30. Whether or not I fly in a fuel-efficient way is not entirely up to me.
31. The routines and processes are in place to help me fly fuel efficiently.

Feedback:

32. I know when I have flown in a fuel efficient manner.
33. I receive enough information to determine if I have flown an efficient sortie.
34. The system regularly gives me enough information to know how efficiently I've flown.

Organizational Citizenship:

Adapted from questions sourced from Pew Research (pewresearch.org), 2015

35. My organization's financial health is important to me.
36. Saving the government money will be good for the country.
37. It is an important part of my job to reduce expenses.

Efficiency vs. Effectiveness:

38. Fuel efficiency and effectiveness both support safe mission accomplishment.
39. I can accomplish the mission safely and save fuel at the same time.
40. There is a strict tradeoff between saving fuel and flying effectively.

Pride in Performance:

41. The ability to fly efficiently is a mark of a good pilot.
42. Flying efficiently demonstrates my mastery of flying my aircraft.
43. Pilots who take pride in their skill will often fly using less fuel.
44. Doing my job well means flying efficiently.

Energy Security:

45. Energy security for the US is important to me.
46. It is important that energy continue to be affordable in the US.
47. The government should be concerned about the securing our sources of energy.
48. Energy supplies to the US need to be reliable and affordable.
49. The US is too dependent on foreign sources of energy.
50. The United States should derive energy from sources plentiful here.
51. Domestic sources of energy should be preferred to foreign ones.
52. I should do what I can to reduce dependence on foreign energy.

Environmentalism (New Ecological Paradigm):

Sourced from Dunlap, Liere, Mertig, and Jones (2000)

Reality of Limits to Growth:

53. We are approaching the limit of the number of people the earth can support.
54. The earth has plenty of natural resources if we just learn how to develop them.
55. The Earth is like a spaceship with very limited room and resources.

Anti-Anthropocentrism:

56. Humans have the right to modify the natural environment to suit their needs.
57. Plants and animals have as much right as humans to exist.
58. Humans were meant to rule over the rest of nature.

Fragility of Nature's Balance

59. When humans interfere with nature, it often produces disastrous consequences.
60. The balance of nature is strong enough to cope with the impacts of modern industrial nations.
61. The balance of nature is very delicate and easily upset.

Rejection of Exemptionalism:

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

Possibility of an Eco-Crisis:

65. Humans are severely abusing the environment.
66. The so-called “ecological crisis” facing humankind has been greatly exaggerated.
67. If things continue on their present course, we will soon experience a major ecological catastrophe.

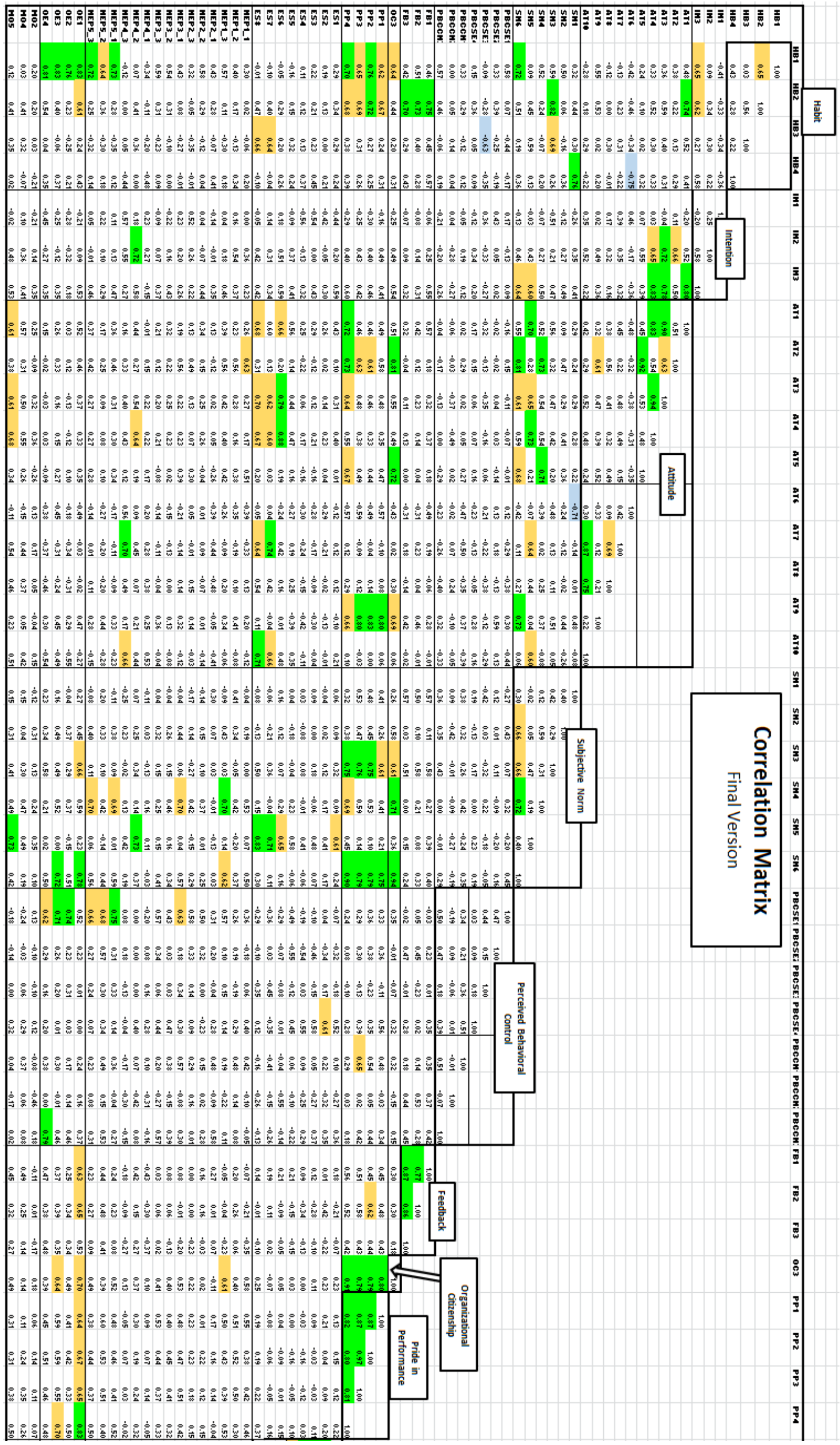
Organizational Emphasis:

68. It is important to the USAF that I save fuel when I can.
69. The USAF is serious about saving fuel.
70. Being fuel efficient when I fly supports AF goals.
71. My leadership wants me to fly efficiently.

Maximize Options:

72. I believe that conserving fuel while flying increases the safety of my flight crew.
73. I try to save enough fuel for an unexpected diversion.
74. I do not mind returning from missions with fuel unspent.
75. It is important to always conserve fuel in case my mission changes mid-flight.
76. The more fuel I can save vs. my mission profile, the more options I have while flying.
77. I have had to cut missions short due to fuel concerns.

Appendix E: Correlation Matrix



Energy Security

Environmentalism

Organizational Emphasis

Maximize Options

ES1	ES2	ES3	ES4	ES5	ES6	ES7	ES8	MEP1_1	MEP1_2	MEP1_3	MEP2_1	MEP2_2	MEP2_3	MEP3_1	MEP3_2	MEP3_3	MEP4_1	MEP4_2	MEP4_3	MEP5_1	MEP5_2	MEP5_3	OE1	OE2	OE3	OE4	MO2	MO4	MO5
1.00																													
0.81	1.00																												
0.94	0.93	1.00																											
0.87	0.96	0.96	1.00																										
0.64	0.62	0.61	0.67	1.00																									
0.33	0.28	0.25	0.29	0.63	1.00																								
0.18	-0.13	0.00	-0.06	0.28	0.61	1.00																							
0.51	0.29	0.30	0.24	0.54	0.64	0.90	1.00																						
0.24	0.44	0.29	0.23	0.37	0.06	-0.22	0.08	1.00																					
0.01	-0.03	-0.04	-0.14	0.19	0.03	-0.29	-0.20	0.66	1.00																				
0.20	0.43	0.21	0.16	0.19	0.23	-0.17	0.06	0.77	0.59	1.00																			
0.40	0.38	0.50	0.44	0.23	0.16	-0.11	-0.13	0.32	0.43	0.24	1.00																		
0.22	0.04	0.07	0.02	0.03	0.18	0.26	0.13	0.19	0.28	0.44	0.58	1.00																	
0.00	0.00	-0.12	-0.23	0.15	0.00	-0.12	-0.11	0.75	0.75	0.69	0.42	0.63	1.00																
0.17	0.35	0.10	0.07	0.20	0.09	-0.27	0.03	0.77	0.62	0.82	0.33	0.43	0.77	1.00															
0.58	0.59	0.56	0.51	0.47	0.14	-0.25	0.14	0.60	0.54	0.70	0.48	0.46	0.58	0.72	1.00														
0.42	0.55	0.48	0.37	0.12	0.09	-0.28	0.04	0.46	0.41	0.75	0.43	0.32	0.41	0.64	0.81	1.00													
0.02	0.16	-0.16	-0.05	0.26	0.33	-0.05	0.29	0.05	0.02	0.15	-0.41	-0.35	-0.09	0.22	0.21	0.19	1.00												
0.42	0.16	0.25	0.16	0.41	0.56	0.38	0.51	0.06	0.06	0.00	-0.08	-0.12	-0.07	0.07	0.18	0.14	0.21	1.00											
0.17	-0.15	-0.17	-0.30	0.15	0.38	0.47	0.50	0.01	0.14	0.14	-0.24	0.18	0.30	0.24	0.22	0.14	0.48	0.57	1.00										
0.11	0.20	0.04	0.01	0.04	0.10	-0.20	-0.09	0.61	0.57	0.85	0.40	0.68	0.77	0.78	0.66	0.63	-0.13	0.07	0.08	1.00									
-0.05	0.09	-0.03	-0.09	-0.08	-0.06	-0.39	-0.30	0.45	0.66	0.65	0.47	0.41	0.66	0.72	0.59	0.70	-0.08	0.05	-0.04	0.81	1.00								
0.17	0.24	0.10	0.06	0.06	0.05	-0.18	-0.06	0.51	0.50	0.87	0.32	0.68	0.71	0.78	0.70	0.68	-0.07	-0.05	0.10	0.94	0.78	1.00							
0.03	0.01	0.00	-0.09	-0.16	-0.04	0.05	0.05	0.30	0.28	0.50	0.17	0.41	0.27	0.41	0.27	0.35	-0.45	0.13	-0.18	0.66	0.61	0.65	1.00						
-0.04	0.10	0.03	-0.01	-0.44	-0.43	-0.43	-0.40	0.22	0.12	0.49	0.16	0.32	0.23	0.35	0.29	0.46	-0.45	-0.15	-0.37	0.66	0.61	0.66	0.77	1.00					
-0.03	0.11	0.03	-0.03	-0.34	-0.17	-0.21	-0.18	0.35	0.21	0.58	0.24	0.36	0.25	0.45	0.27	0.45	-0.43	-0.05	-0.34	0.70	0.63	0.66	0.91	0.91	1.00				
0.27	0.29	0.32	0.26	-0.29	-0.23	-0.21	-0.15	0.10	0.02	0.27	0.49	0.39	0.03	0.25	0.32	0.47	-0.52	0.00	-0.41	0.48	0.52	0.46	0.74	0.81	0.83	1.00			
0.45	0.38	0.39	0.38	0.40	0.37	0.04	0.30	0.08	0.09	0.38	0.05	0.15	0.00	0.27	0.70	0.60	0.44	0.39	0.45	0.22	0.17	0.32	0.00	0.00	-0.03	0.03	1.00		
0.41	0.26	0.17	0.24	0.71	0.59	0.43	0.59	0.11	0.17	0.10	0.09	0.25	0.16	0.36	0.39	0.05	0.41	0.41	0.41	0.14	0.10	0.20	0.05	-0.36	-0.22	-0.14	0.34	1.00	
0.41	0.31	0.25	0.26	0.61	0.58	0.31	0.57	0.09	0.07	0.25	-0.29	-0.13	-0.11	0.27	0.38	0.26	0.51	0.69	0.48	0.12	0.11	0.22	0.22	-0.11	-0.02	-0.08	0.61	0.70	1.00

Appendix F: Cronbach Alpha Calculations

The SAS System

The CORR Procedure

4 Variables: HB1 HB2 HB3 HB4

Simple Statistics

Variable	N	Mean	Std Dev	Sum	Minimum	Maximum	Label
HB1	15	5.80000	1.42428	87.00000	2.00000	7.00000	HB1
HB2	15	4.93333	1.83095	74.00000	1.00000	7.00000	HB2
HB3	15	4.66667	1.58865	70.00000	1.00000	6.00000	HB3
HB4	15	4.26667	1.70992	64.00000	1.00000	7.00000	HB4

Cronbach Coefficient Alpha

Variables	Alpha
Raw	0.696359
Standardized	0.694326

Cronbach Coefficient Alpha with Deleted Variable

Deleted Variable	Raw Variables		Standardized Variables		Label
	Correlation with Total	Alpha	Correlation with Total	Alpha	
HB1	0.513100	0.618881	0.494311	0.619581	HB1
HB2	0.693255	0.473409	0.712024	0.470141	HB2
HB3	0.364611	0.700000	0.337208	**0.714888**	**HB3**
HB4	0.385881	0.692607	0.398578	0.678855	HB4

Pearson Correlation Coefficients, N = 15
Prob > |r| under H0: Rho=0

	HB1	HB2	HB3	HB4
HB1	1.00000	0.65189	0.03157	0.43407
HB1		0.0085	0.9111	0.1060
HB2	0.65189	1.00000	0.55661	0.27986

Pearson Correlation Coefficients, N = 15
Prob > |r| under H0: Rho=0

	HB1	HB2	HB3	HB4
HB2	0.0085		0.0312	0.3124
HB3	0.03157	0.55661	1.00000	0.21912
HB3	0.9111	0.0312		0.4327
HB4	0.43407	0.27986	0.21912	1.00000
HB4	0.1060	0.3124	0.4327	

The SAS System

The CORR Procedure

3 Variables: IN1 IN2 IN3

Simple Statistics

Variable	N	Mean	Std Dev	Sum	Minimum	Maximum	Label
IN1	14	3.42857	1.50457	48.00000	1.00000	6.00000	IN1
IN2	15	4.93333	1.57963	74.00000	2.00000	7.00000	IN2
IN3	15	5.60000	0.98561	84.00000	4.00000	7.00000	IN3

Cronbach Coefficient Alpha

Variables	Alpha
Raw	0.439054
Standardized	**0.445365**

Cronbach Coefficient Alpha with Deleted Variable

Deleted Variable	Raw Variables		Standardized Variables		Label
	Correlation with Total	Alpha	Correlation with Total	Alpha	
IN1	0.082747	0.683544	0.031167	**0.732630**	IN1
IN2	0.577388	-.449251	0.653614	-.486312	IN2
IN3	0.251492	0.393272	0.241805	0.401234	IN3

Pearson Correlation Coefficients
Prob > |r| under H0: Rho=0
Number of Observations

	IN1	IN2	IN3
IN1	1.00000	0.25097	-0.19560
IN1		0.3868	0.5028
	14	14	14
IN2	0.25097	1.00000	0.57807

Pearson Correlation Coefficients
Prob > |r| under H0: Rho=0
Number of Observations

	IN1	IN2	IN3
IN2	0.3868		0.0240
	14	15	15
IN3	-0.19560	0.57807	1.00000
IN3	0.5028	0.0240	
	14	15	15

The SAS System

The CORR Procedure

10 Variables: AT1 AT2 AT3 AT4 AT5 AT6 AT7 AT8 AT9 AT10

Simple Statistics

Variable	N	Mean	Std Dev	Sum	Minimum	Maximum	Label
AT1	15	6.06667	1.48645	91.00000	2.00000	7.00000	AT1
AT2	15	4.60000	2.09762	69.00000	1.00000	7.00000	AT2
AT3	15	5.80000	1.56753	87.00000	2.00000	7.00000	AT3
AT4	15	5.53333	1.76743	83.00000	2.00000	7.00000	AT4
AT5	15	4.13333	1.99523	62.00000	1.00000	7.00000	AT5
AT6	15	5.93333	1.09978	89.00000	4.00000	7.00000	AT6
AT7	15	5.40000	1.45406	81.00000	2.00000	7.00000	AT7
AT8	15	4.86667	1.40746	73.00000	2.00000	7.00000	AT8
AT9	15	3.13333	1.76743	47.00000	1.00000	6.00000	AT9
AT10	15	4.93333	1.48645	74.00000	2.00000	7.00000	AT10

Cronbach Coefficient Alpha

Variables	Alpha
Raw	0.864285
Standardized	**0.852115**

Cronbach Coefficient Alpha with Deleted Variable

Deleted Variable	Raw Variables		Standardized Variables		Label
	Correlation with Total	Alpha	Correlation with Total	Alpha	
AT1	0.676153	0.844103	0.646538	0.830025	AT1
AT2	0.726332	0.837675	0.679528	0.827018	AT2
AT3	0.808804	0.832571	0.782806	0.817419	AT3
AT4	0.730662	0.837537	0.718904	0.823392	AT4
AT5	0.635029	0.846911	0.582414	0.835786	AT5

Cronbach Coefficient Alpha with Deleted Variable

Deleted Variable	Raw Variables		Standardized Variables		Label
	Correlation with Total	Alpha	Correlation with Total	Alpha	
AT6	-.235212	0.895090	-.203980	0.898114	AT6
AT7	0.595912	0.850318	0.666602	0.828200	AT7
AT8	0.648610	0.846818	0.665872	0.828266	AT8
AT9	0.464176	0.861348	0.418381	0.850036	AT9
AT10	0.643252	0.846606	0.704312	0.824741	AT10

Pearson Correlation Coefficients, N = 15
Prob > |r| under H0: Rho=0

	AT1	AT2	AT3	AT4	AT5	AT6	AT7	AT8	AT9	AT10
AT1	1.00000	0.51315	0.89514	0.82833	0.45439	-0.47771	0.44945	0.38011	0.32263	0.42241
AT1		0.0504	<.0001	0.0001	0.0888	0.0717	0.0928	0.1622	0.2409	0.1168
AT2	0.51315	1.00000	0.62564	0.54332	0.91819	-0.32201	0.22014	0.56130	0.61268	0.28865
AT2	0.0504		0.0126	0.0363	<.0001	0.2418	0.4305	0.0295	0.0152	0.2968
AT3	0.89514	0.62564	1.00000	0.94362	0.53442	-0.38119	0.47634	0.40793	0.47439	0.51501
AT3	<.0001	0.0126		<.0001	0.0401	0.1610	0.0726	0.1312	0.0740	0.0495
AT4	0.82833	0.54332	0.94362	1.00000	0.48477	-0.31113	0.49473	0.31777	0.38720	0.47670
AT4	0.0001	0.0363	<.0001		0.0670	0.2590	0.0608	0.2484	0.1539	0.0724

Pearson Correlation Coefficients, N = 15
Prob > |r| under H0: Rho=0

	AT1	AT2	AT3	AT4	AT5	AT6	AT7	AT8	AT9	AT10
AT5	0.45439	0.91819	0.53442	0.48477	1.00000	-0.35373	0.15265	0.49006	0.52123	0.24405
AT5	0.0888	<.0001	0.0401	0.0670		0.1959	0.5871	0.0637	0.0463	0.3807
AT6	-0.47771	-0.32201	-0.38119	-0.31113	-0.35373	1.00000	0.41987	0.08614	-0.32582	0.30294
AT6	0.0717	0.2418	0.1610	0.2590	0.1959		0.1192	0.7602	0.2360	0.2724
AT7	0.44945	0.22014	0.47634	0.49473	0.15265	0.41987	1.00000	0.69106	0.11673	0.87246
AT7	0.0928	0.4305	0.0726	0.0608	0.5871	0.1192		0.0043	0.6786	<.0001
AT8	0.38011	0.56130	0.40793	0.31777	0.49006	0.08614	0.69106	1.00000	0.20865	0.74657
AT8	0.1622	0.0295	0.1312	0.2484	0.0637	0.7602	0.0043		0.4555	0.0014
AT9	0.32263	0.61268	0.47439	0.38720	0.52123	-0.32582	0.11673	0.20865	1.00000	0.22113
AT9	0.2409	0.0152	0.0740	0.1539	0.0463	0.2360	0.6786	0.4555		0.4284
AT10	0.42241	0.28865	0.51501	0.47670	0.24405	0.30294	0.87246	0.74657	0.22113	1.00000
AT10	0.1168	0.2968	0.0495	0.0724	0.3807	0.2724	<.0001	0.0014	0.4284	

The SAS System

The CORR Procedure

6 Variables: SN1 SN2 SN3 SN4 SN5 SN6

Simple Statistics

Variable	N	Mean	Std Dev	Sum	Minimum	Maximum	Label
SN1	15	4.66667	1.39728	70.00000	2.00000	7.00000	SN1
SN2	15	5.80000	1.14642	87.00000	3.00000	7.00000	SN2
SN3	15	3.53333	1.40746	53.00000	1.00000	5.00000	SN3
SN4	15	4.53333	2.06559	68.00000	1.00000	7.00000	SN4
SN5	15	5.93333	1.03280	89.00000	4.00000	7.00000	SN5
SN6	15	4.33333	1.79947	65.00000	1.00000	7.00000	SN6

Cronbach Coefficient Alpha

Variables	Alpha
Raw	0.781241
Standardized	0.779232

Cronbach Coefficient Alpha with Deleted Variable

Deleted Variable	Raw Variables		Standardized Variables		Label
	Correlation with Total	Alpha	Correlation with Total	Alpha	
SN1	0.319566	0.794324	0.332036	0.792373	SN1
SN2	0.621225	0.736307	0.571613	0.734745	SN2
SN3	0.607188	0.730699	0.627397	0.720385	SN3
SN4	0.564648	0.750896	0.548830	0.740506	SN4
SN5	0.303089	0.792441	0.289902	0.801852	SN5
SN6	0.852294	0.648289	0.837839	0.662843	SN6

Pearson Correlation Coefficients, N = 15
Prob > |r| under H0: Rho=0

SN1	SN2	SN3	SN4	SN5	SN6

Pearson Correlation Coefficients, N = 15
Prob > |r| under H0: Rho=0

	SN1	SN2	SN3	SN4	SN5	SN6
SN1	1.00000	0.40132	0.42374	0.11549	-0.01650	0.30302
SN1		0.1382	0.1155	0.6819	0.9535	0.2723
SN2	0.40132	1.00000	0.29217	0.59121	0.04826	0.65786
SN2	0.1382		0.2907	0.0203	0.8644	0.0077
SN3	0.42374	0.29217	1.00000	0.31285	0.46845	0.65806
SN3	0.1155	0.2907		0.2562	0.0782	0.0077
SN4	0.11549	0.59121	0.31285	1.00000	0.18527	0.71743
SN4	0.6819	0.0203	0.2562		0.5086	0.0026
SN5	-0.01650	0.04826	0.46845	0.18527	1.00000	0.39715
SN5	0.9535	0.8644	0.0782	0.5086		0.1427
SN6	0.30302	0.65786	0.65806	0.71743	0.39715	1.00000
SN6	0.2723	0.0077	0.0077	0.0026	0.1427	

The SAS System

The CORR Procedure

4 Variables: PBCSE1 PBCSE2 PBCSE3 PBCSE4

Simple Statistics

Variable	N	Mean	Std Dev	Sum	Minimum	Maximum	Label
PBCSE1	15	6.13333	0.63994	92.00000	5.00000	7.00000	PBCSE1
PBCSE2	15	4.40000	1.24212	66.00000	2.00000	7.00000	PBCSE2
PBCSE3	15	5.80000	0.86189	87.00000	4.00000	7.00000	PBCSE3
PBCSE4	15	4.86667	1.18723	73.00000	3.00000	7.00000	PBCSE4

Cronbach Coefficient Alpha

Variables	Alpha
Raw	0.466566
Standardized	**0.536866**

Cronbach Coefficient Alpha with Deleted Variable

Deleted Variable	Raw Variables		Standardized Variables		Label
	Correlation with Total	Alpha	Correlation with Total	Alpha	
PBCSE1	0.459540	0.304928	0.476508	0.325348	PBCSE1
PBCSE2	0.284537	0.388430	0.338417	0.451964	PBCSE2
PBCSE3	0.323972	0.353896	0.376873	0.418026	PBCSE3
PBCSE4	0.136382	0.546067	0.129962	**0.619156**	PBCSE4

Pearson Correlation Coefficients, N = 15
Prob > |r| under H0: Rho=0

	PBCSE1	PBCSE2	PBCSE3	PBCSE4
PBCSE1	1.00000	0.46728	0.44031	0.02507
PBCSE1		0.0791	0.1005	0.9293
PBCSE2	0.46728	1.00000	0.14678	0.08719

Pearson Correlation Coefficients, N = 15
Prob > |r| under H0: Rho=0

	PBCSE1	PBCSE2	PBCSE3	PBCSE4
PBCSE2	0.0791		0.6017	0.7573
PBCSE3	0.44031	0.14678	1.00000	0.18149
PBCSE3	0.1005	0.6017		0.5174
PBCSE4	0.02507	0.08719	0.18149	1.00000
PBCSE4	0.9293	0.7573	0.5174	

The SAS System

The CORR Procedure

3 Variables: PBCCN1 PBCCN2 PBCCN3

Simple Statistics

Variable	N	Mean	Std Dev	Sum	Minimum	Maximum	Label
PBCCN1	15	4.53333	1.30201	68.00000	2.00000	7.00000	PBCCN1
PBCCN2	15	2.66667	1.34519	40.00000	1.00000	5.00000	PBCCN2
PBCCN3	15	4.86667	1.18723	73.00000	2.00000	6.00000	PBCCN3

Cronbach Coefficient Alpha

Variables	Alpha
Raw	0.312883
Standardized	**0.330097**

Cronbach Coefficient Alpha with Deleted Variable

Deleted Variable	Raw Variables		Standardized Variables		Label
	Correlation with Total	Alpha	Correlation with Total	Alpha	
PBCCN1	0.341047	-.159744	0.365883	-.161093	PBCCN1
PBCCN2	-.049060	0.674797	-.050694	**0.676699**	PBCCN2
PBCCN3	0.304162	-.027548	0.311007	-.027563	PBCCN3

Pearson Correlation Coefficients, N = 15
Prob > |r| under H0: Rho=0

	PBCCN1	PBCCN2	PBCCN3
PBCCN1	1.00000	-0.01359	0.51137
PBCCN1		0.9616	0.0514
PBCCN2	-0.01359	1.00000	-0.07454
PBCCN2	0.9616		0.7918

Pearson Correlation Coefficients, N = 15
Prob > |r| under H0: Rho=0

	PBCCN1	PBCCN2	PBCCN3
PBCCN3	0.51137	-0.07454	1.00000
PBCCN3	0.0514	0.7918	

The SAS System

The CORR Procedure

3 Variables: FB1 FB2 FB3

Simple Statistics

Variable	N	Mean	Std Dev	Sum	Minimum	Maximum	Label
FB1	14	4.28571	1.06904	60.00000	2.00000	6.00000	FB1
FB2	14	4.57143	1.08941	64.00000	2.00000	6.00000	FB2
FB3	14	4.21429	1.25137	59.00000	2.00000	6.00000	FB3

Cronbach Coefficient Alpha

Variables	Alpha
Raw	0.937004
Standardized	**0.938477**

Cronbach Coefficient Alpha with Deleted Variable

Deleted Variable	Raw Variables		Standardized Variables		Label
	Correlation with Total	Alpha	Correlation with Total	Alpha	
FB1	0.855359	0.921421	0.852032	0.926181	FB1
FB2	0.849337	0.924755	0.845912	0.930897	FB2
FB3	0.920192	0.872340	0.920238	0.872428	FB3

Pearson Correlation Coefficients, N = 14
Prob > |r| under H0: Rho=0

	FB1	FB2	FB3
FB1	1.00000	0.77372	0.87073
FB1		0.0012	<.0001
FB2	0.77372	1.00000	0.86251
FB2	0.0012		<.0001

Pearson Correlation Coefficients, N = 14
Prob > |r| under H0: Rho=0

	FB1	FB2	FB3
FB3	0.87073	0.86251	1.00000
FB3	<.0001	<.0001	

The SAS System

The CORR Procedure

3 Variables: OC1 OC2 OC3

Simple Statistics

Variable	N	Mean	Std Dev	Sum	Minimum	Maximum	Label
OC1	15	4.80000	1.93465	72.00000	1.00000	7.00000	OC1
OC2	15	5.06667	1.94447	76.00000	2.00000	7.00000	OC2
OC3	15	4.20000	1.78085	63.00000	1.00000	7.00000	OC3

Cronbach Coefficient Alpha

Variables	Alpha
Raw	0.688974
Standardized	**0.699109**

Cronbach Coefficient Alpha with Deleted Variable

Deleted Variable	Raw Variables		Standardized Variables		Label
	Correlation with Total	Alpha	Correlation with Total	Alpha	
OC1	0.548761	0.535607	0.569795	0.537121	OC1
OC2	0.225383	0.924444	0.231562	**0.926148**	OC2
OC3	0.835894	0.147714	0.836749	0.147716	OC3

Pearson Correlation Coefficients, N = 15
Prob > |r| under H0: Rho=0

	OC1	OC2	OC3
OC1	1.00000	0.07975	0.86245
OC1		0.7775	<.0001
OC2	0.07975	1.00000	0.36717
OC2	0.7775		0.1782

Pearson Correlation Coefficients, N = 15
Prob > |r| under H0: Rho=0

	OC1	OC2	OC3
OC3	0.86245	0.36717	1.00000
OC3	<.0001	0.1782	

The SAS System

The CORR Procedure

3 Variables: EE1 EE2 EE3

Simple Statistics

Variable	N	Mean	Std Dev	Sum	Minimum	Maximum	Label
EE1	15	3.60000	1.50238	54.00000	1.00000	6.00000	EE1
EE2	15	5.13333	0.83381	77.00000	4.00000	6.00000	EE2
EE3	15	4.00000	1.46385	60.00000	1.00000	6.00000	EE3

Cronbach Coefficient Alpha

Variables	Alpha
Raw	0.323314
Standardized	0.258196

Cronbach Coefficient Alpha with Deleted Variable

Deleted Variable	Raw Variables		Standardized Variables		Label
	Correlation with Total	Alpha	Correlation with Total	Alpha	
EE1	0.312765	-.106007	0.269930	-.124316	EE1
EE2	-.007097	0.490196	-.007928	**0.490321**	EE2
EE3	0.250775	0.074534	0.184125	0.087252	EE3

Pearson Correlation Coefficients, N = 15
Prob > |r| under H0: Rho=0

	EE1	**EE2**	**EE3**
EE1	1.00000	0.04562	0.32478
EE1		0.8718	0.2376
EE2	0.04562	1.00000	-0.05852
EE2	0.8718		0.8359

Pearson Correlation Coefficients, N = 15
Prob > |r| under H0: Rho=0

	EE1	EE2	EE3
EE3	0.32478	-0.05852	1.00000
EE3	0.2376	0.8359	

The SAS System

The CORR Procedure

4 Variables: PP1 PP2 PP3 PP4

Simple Statistics

Variable	N	Mean	Std Dev	Sum	Minimum	Maximum	Label
PP1	15	3.73333	2.18654	56.00000	1.00000	7.00000	PP1
PP2	15	3.80000	2.00713	57.00000	1.00000	7.00000	PP2
PP3	15	3.93333	1.98086	59.00000	1.00000	7.00000	PP3
PP4	15	4.60000	1.76473	69.00000	1.00000	7.00000	PP4

Cronbach Coefficient Alpha

Variables	Alpha
Raw	0.958369
Standardized	0.959627

Cronbach Coefficient Alpha with Deleted Variable

Deleted Variable	Raw Variables		Standardized Variables		Label
	Correlation with Total	Alpha	Correlation with Total	Alpha	
PP1	0.895202	0.948418	0.895461	0.948301	PP1
PP2	0.933012	0.934538	0.931537	0.937600	PP2
PP3	0.938105	0.933142	0.936405	0.936142	PP3
PP4	0.840386	0.962765	0.839486	0.964550	PP4

Pearson Correlation Coefficients, N = 15
Prob > |r| under H0: Rho=0

	PP1	PP2	PP3	PP4
PP1	1.00000	0.86587	0.86965	0.82190
PP1		<.0001	<.0001	0.0002
PP2	0.86587	1.00000	0.96655	0.80260

Pearson Correlation Coefficients, N = 15
Prob > |r| under H0: Rho=0

	PP1	PP2	PP3	PP4
PP2	<.0001		<.0001	0.0003
PP3	0.86965	0.96655	1.00000	0.80916
PP3	<.0001	<.0001		0.0003
PP4	0.82190	0.80260	0.80916	1.00000
PP4	0.0002	0.0003	0.0003	

The SAS System

The CORR Procedure

8 Variables: ES1 ES2 ES3 ES4 ES5 ES6 ES7 ES8

Simple Statistics

Variable	N	Mean	Std Dev	Sum	Minimum	Maximum	Label
ES1	15	5.86667	1.12546	88.00000	3.00000	7.00000	ES1
ES2	15	5.80000	1.14642	87.00000	3.00000	7.00000	ES2
ES3	14	6.00000	1.24035	84.00000	3.00000	7.00000	ES3
ES4	14	5.85714	1.23146	82.00000	3.00000	7.00000	ES4
ES5	14	4.71429	1.72888	66.00000	1.00000	7.00000	ES5
ES6	14	5.28571	0.99449	74.00000	4.00000	7.00000	ES6
ES7	14	4.85714	1.35062	68.00000	2.00000	7.00000	ES7
ES8	15	4.93333	1.48645	74.00000	2.00000	7.00000	ES8

Cronbach Coefficient Alpha

Variables	Alpha
Raw	0.881293
Standardized	**0.889945**

Cronbach Coefficient Alpha with Deleted Variable

Deleted Variable	Raw Variables		Standardized Variables		Label
	Correlation with Total	Alpha	Correlation with Total	Alpha	
ES1	0.825381	0.851230	0.829674	0.859572	ES1
ES2	0.699937	0.862342	0.712623	0.871364	ES2
ES3	0.743651	0.857065	0.764750	0.866166	ES3
ES4	0.730884	0.858433	0.749659	0.867680	ES4
ES5	0.752261	0.857016	0.763621	0.866279	ES5
ES6	0.590420	0.873131	0.562845	0.885832	ES6
ES7	0.327800	0.898587	0.316540	0.908163	ES7

Cronbach Coefficient Alpha with Deleted Variable

Deleted Variable	Raw Variables Correlation with Total	Raw Variables Alpha	Standardized Variables Correlation with Total	Standardized Variables Alpha	Label
ES8	0.629333	0.869373	0.643524	0.878124	ES8

Pearson Correlation Coefficients
Prob > \|r\| under H0: Rho=0
Number of Observations

	ES1	ES2	ES3	ES4	ES5	ES6	ES7	ES8
ES 1 ES1	1.0000 0 15	0.80826 0.0003 15	0.9399 0 <.0001 14	0.86713 <.0001 14	0.6403 1 0.0136 14	0.3349 3 0.2418 14	0.18134 0.5350 14	0.5066 6 0.0539 15
ES 2 ES2	0.8082 6 0.0003 15	1.00000 15	0.9258 5 <.0001 14	0.95605 <.0001 14	0.6195 8 0.0181 14	0.2814 1 0.3297 14	- 0.12861 0.6613 14	0.2850 3 0.3032 15
ES 3 ES3	0.9399 0 <.0001 14	0.92585 <.0001 14	1.0000 0 14	0.95686 <.0001 14	0.6098 2 0.0206 14	0.2494 4 0.3898 14	0.00000 1.0000 14	0.3048 8 0.2892 14
ES 4 ES4	0.8671 3 <.0001 14	0.95605 <.0001 14	0.9568 6 <.0001 14	1.00000 14	0.6658 3 0.0093 14	0.2871 4 0.3196 14	- 0.05946 0.8400 14	0.2444 1 0.3997 14
ES 5 ES5	0.6403 1 0.0136 14	0.61958 0.0181 14	0.6098 2 0.0206 14	0.66583 0.0093 14	1.0000 0 14	0.6327 5 0.0152 14	0.27766 0.3365 14	0.5356 7 0.0484 14
ES	0.3349	0.28141	0.2494	0.28714	0.6327	1.0000	0.60542	0.6441

Pearson Correlation Coefficients
Prob > |r| under H0: Rho=0
Number of Observations

	ES1	ES2	ES3	ES4	ES5	ES6	ES7	ES8
6	3	0.3297	4	0.3196	5	0	0.0218	1
ES6	0.2418	14	0.3898	14	0.0152		14	0.0129
	14		14		14	14		14
ES 7	0.1813 4	- 0.12861	0.0000 0	- 0.05946	0.2776 6	0.6054 2	1.00000	0.9028 3
ES7	0.5350	0.6613	1.0000	0.8400	0.3365	0.0218	14	<.0001
	14	14	14	14	14	14		14
ES 8	0.5066 6	0.28503 0.3032	0.3048 8	0.24441 0.3997	0.5356 7	0.6441 1	0.90283 <.0001	1.0000 0
ES8	0.0539	15	0.2892	14	0.0484	0.0129	14	
	15		14		14	14		15

The SAS System

The CORR Procedure

3 Variables: NEP1_1 NEP1_2 NEP1_3

Simple Statistics

Variable	N	Mean	Std Dev	Sum	Minimum	Maximum	Label
NEP1_1	15	3.73333	1.70992	56.00000	1.00000	6.00000	NEP1_1
NEP1_2	15	3.06667	1.66762	46.00000	1.00000	7.00000	NEP1_2
NEP1_3	14	4.00000	1.83973	56.00000	1.00000	6.00000	NEP1_3

Cronbach Coefficient Alpha

Variables	Alpha
Raw	0.860002
Standardized	0.859893

Cronbach Coefficient Alpha with Deleted Variable

Deleted Variable	Raw Variables		Standardized Variables		Label
	Correlation with Total	Alpha	Correlation with Total	Alpha	
NEP1_1	0.814351	0.729277	0.801809	0.739517	NEP1_1
NEP1_2	0.652277	0.876655	0.661461	0.870295	NEP1_2
NEP1_3	0.747799	0.793555	0.745243	0.793705	NEP1_3

Pearson Correlation Coefficients
Prob > |r| under H0: Rho=0
Number of Observations

	NEP1_1	NEP1_2	NEP1_3
NEP1_1	1.00000	0.65797	0.77037
NEP1_1		0.0077	0.0013
	15	15	14
NEP1_2	0.65797	1.00000	0.58669

Pearson Correlation Coefficients
Prob > |r| under H0: Rho=0
Number of Observations

	NEP1_1	NEP1_2	NEP1_3
NEP1_2	0.0077		0.0274
	15	15	14
NEP1_3	0.77037	0.58669	1.00000
NEP1_3	0.0013	0.0274	
	14	14	14

The SAS System

The CORR Procedure

3 Variables: NEP2_1 NEP2_2 NEP2_3

Simple Statistics

Variable	N	Mean	Std Dev	Sum	Minimum	Maximum	Label
NEP2_1	15	3.80000	1.20712	57.00000	2.00000	6.00000	NEP2_1
NEP2_2	15	4.33333	1.63299	65.00000	1.00000	7.00000	NEP2_2
NEP2_3	14	3.07143	1.49174	43.00000	1.00000	6.00000	NEP2_3

Cronbach Coefficient Alpha

Variables	Alpha
Raw	0.788328
Standardized	**0.783181**

Cronbach Coefficient Alpha with Deleted Variable

Deleted Variable	Raw Variables		Standardized Variables		Label
	Correlation with Total	Alpha	Correlation with Total	Alpha	
NEP2_1	0.560497	0.788937	0.555593	0.776290	NEP2_1
NEP2_2	0.731795	0.595263	0.719267	0.596219	NEP2_2
NEP2_3	0.628503	0.713224	0.595832	0.733994	NEP2_3

Pearson Correlation Coefficients
Prob > |r| under H0: Rho=0
Number of Observations

	NEP2_1	NEP2_2	NEP2_3
NEP2_1	1.00000	0.57977	0.42472
NEP2_1		0.0235	0.1301
	15	15	14
NEP2_2	0.57977	1.00000	0.63437

Pearson Correlation Coefficients
Prob > |r| under H0: Rho=0
Number of Observations

	NEP2_1	**NEP2_2**	**NEP2_3**
NEP2_2	0.0235		0.0148
	15	15	14
NEP2_3	0.42472	0.63437	1.00000
NEP2_3	0.1301	0.0148	
	14	14	14

The SAS System

The CORR Procedure

3 Variables: NEP3_1 NEP3_2 NEP3_3

Simple Statistics

Variable	N	Mean	Std Dev	Sum	Minimum	Maximum	Label
NEP3_1	15	4.80000	1.32017	72.00000	2.00000	7.00000	NEP3_1
NEP3_2	15	4.53333	1.55226	68.00000	2.00000	7.00000	NEP3_2
NEP3_3	15	5.00000	1.36277	75.00000	3.00000	7.00000	NEP3_3

Cronbach Coefficient Alpha

Variables	Alpha
Raw	0.885390
Standardized	**0.885860**

Cronbach Coefficient Alpha with Deleted Variable

Deleted Variable	Raw Variables		Standardized Variables		Label
	Correlation with Total	Alpha	Correlation with Total	Alpha	
NEP3_1	0.713857	0.891089	0.711186	0.895267	NEP3_1
NEP3_2	0.845944	0.776699	0.845157	0.776939	NEP3_2
NEP3_3	0.787093	0.829530	0.779879	0.835876	NEP3_3

Pearson Correlation Coefficients, N = 15
Prob > |r| under H0: Rho=0

	NEP3_1	NEP3_2	NEP3_3
NEP3_1	1.00000	0.71803	0.63524
NEP3_1		0.0026	0.0109
NEP3_2	0.71803	1.00000	0.81039
NEP3_2	0.0026		0.0002

Pearson Correlation Coefficients, N = 15
Prob > |r| under H0: Rho=0

	NEP3_1	NEP3_2	NEP3_3
NEP3_3	0.63524	0.81039	1.00000
NEP3_3	0.0109	0.0002	

The SAS System

The CORR Procedure

3 Variables: NEP4_1 NEP4_2 NEP4_3

Simple Statistics

Variable	N	Mean	Std Dev	Sum	Minimum	Maximum	Label
NEP4_1	15	4.20000	1.37321	63.00000	2.00000	7.00000	NEP4_1
NEP4_2	15	6.00000	0.75593	90.00000	5.00000	7.00000	NEP4_2
NEP4_3	15	5.06667	1.16292	76.00000	3.00000	7.00000	NEP4_3

Cronbach Coefficient Alpha

Variables	Alpha
Raw	0.657303
Standardized	**0.684272**

Cronbach Coefficient Alpha with Deleted Variable

Deleted Variable	Raw Variables		Standardized Variables		Label
	Correlation with Total	Alpha	Correlation with Total	Alpha	
NEP4_1	0.419796	0.684039	0.389259	0.725119	NEP4_1
NEP4_2	0.432149	0.645418	0.450112	0.651444	NEP4_2
NEP4_3	0.643600	0.297030	0.677149	0.342217	NEP4_3

Pearson Correlation Coefficients, N = 15
Prob > |r| under H0: Rho=0

	NEP4_1	NEP4_2	NEP4_3
NEP4_1	1.00000	0.20643	0.48307
NEP4_1		0.4604	0.0681
NEP4_2	0.20643	1.00000	0.56877
NEP4_2	0.4604		0.0269

Pearson Correlation Coefficients, N = 15
Prob > |r| under H0: Rho=0

	NEP4_1	**NEP4_2**	**NEP4_3**
NEP4_3	0.48307	0.56877	1.00000
NEP4_3	0.0681	0.0269	

The SAS System

The CORR Procedure

3 Variables: NEP5_1 NEP5_2 NEP5_3

Simple Statistics

Variable	N	Mean	Std Dev	Sum	Minimum	Maximum	Label
NEP5_1	15	5.20000	1.42428	78.00000	2.00000	7.00000	NEP5_1
NEP5_2	15	4.26667	1.86956	64.00000	1.00000	7.00000	NEP5_2
NEP5_3	15	4.60000	1.99284	69.00000	1.00000	7.00000	NEP5_3

Cronbach Coefficient Alpha

Variables	Alpha
Raw	0.928544
Standardized	0.940943

Cronbach Coefficient Alpha with Deleted Variable

Deleted Variable	Raw Variables		Standardized Variables		Label
	Correlation with Total	Alpha	Correlation with Total	Alpha	
NEP5_1	0.928017	0.874372	0.925942	0.875375	NEP5_1
NEP5_2	0.804180	0.939394	0.807231	0.967023	NEP5_2
NEP5_3	0.889043	0.877057	0.901105	0.895096	NEP5_3

Pearson Correlation Coefficients, N = 15
Prob > |r| under H0: Rho=0

	NEP5_1	NEP5_2	NEP5_3
NEP5_1	1.00000	0.81011	0.93615
NEP5_1		0.0003	<.0001
NEP5_2	0.81011	1.00000	0.77837
NEP5_2	0.0003		0.0006

Pearson Correlation Coefficients, N = 15
Prob > |r| under H0: Rho=0

	NEP5_1	NEP5_2	NEP5_3
NEP5_3	0.93615	0.77837	1.00000
NEP5_3	<.0001	0.0006	

The SAS System

The CORR Procedure

4 Variables: OE1 OE2 OE3 OE4

Simple Statistics

Variable	N	Mean	Std Dev	Sum	Minimum	Maximum	Label
OE1	15	5.06667	2.12020	76.00000	1.00000	7.00000	OE1
OE2	15	4.93333	1.83095	74.00000	1.00000	7.00000	OE2
OE3	15	5.13333	1.84649	77.00000	1.00000	7.00000	OE3
OE4	15	5.40000	1.12122	81.00000	3.00000	7.00000	OE4

Cronbach Coefficient Alpha

Variables	Alpha
Raw	0.937222
Standardized	**0.951476**

Cronbach Coefficient Alpha with Deleted Variable

Deleted Variable	Raw Variables		Standardized Variables		Label
	Correlation with Total	Alpha	Correlation with Total	Alpha	
OE1	0.857103	0.926691	0.850270	0.945868	OE1
OE2	0.878510	0.909091	0.885491	0.935229	OE2
OE3	0.967216	0.878414	0.960002	0.912128	OE3
OE4	0.832136	0.947319	0.834511	0.950570	OE4

Pearson Correlation Coefficients, N = 15
Prob > |r| under H0: Rho=0

	OE1	OE2	OE3	OE4
OE1	1.00000	0.77403	0.90983	0.73916
OE1		0.0007	<.0001	0.0016
OE2	0.77403	1.00000	0.91130	0.81418

Pearson Correlation Coefficients, N = 15
Prob > |r| under H0: Rho=0

	OE1	**OE2**	**OE3**	**OE4**
OE2	0.0007		<.0001	0.0002
OE3	0.90983	0.91130	1.00000	0.83493
OE3	<.0001	<.0001		0.0001
OE4	0.73916	0.81418	0.83493	1.00000
OE4	0.0016	0.0002	0.0001	

The SAS System

The CORR Procedure

6 Variables: MO1 MO2 MO3 MO4 MO5 MO6

Simple Statistics

Variable	N	Mean	Std Dev	Sum	Minimum	Maximum	Label
MO1	15	3.66667	1.67616	55.00000	1.00000	6.00000	MO1
MO2	15	5.93333	0.96115	89.00000	4.00000	7.00000	MO2
MO3	15	5.66667	1.23443	85.00000	3.00000	7.00000	MO3
MO4	15	5.26667	1.16292	79.00000	3.00000	7.00000	MO4
MO5	15	5.66667	0.81650	85.00000	4.00000	7.00000	MO5
MO6	15	4.86667	1.64172	73.00000	1.00000	7.00000	MO6

Cronbach Coefficient Alpha

Variables	Alpha
Raw	0.398213
Standardized	**0.555968**

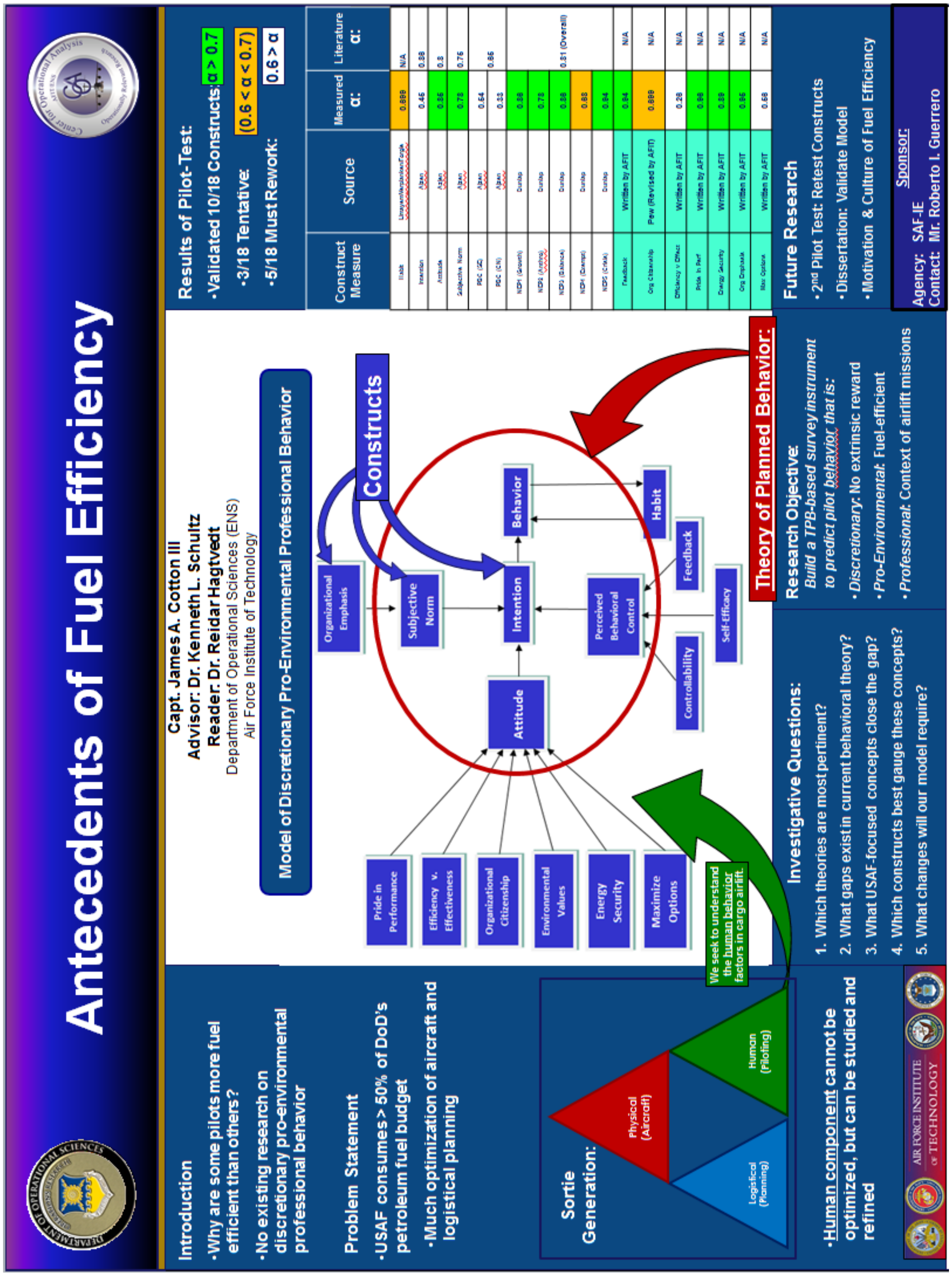
Cronbach Coefficient Alpha with Deleted Variable

Deleted Variable	Raw Variables		Standardized Variables		Label
	Correlation with Total	Alpha	Correlation with Total	Alpha	
MO1	-.220269	0.652036	-.165708	**0.696575**	MO1
MO2	0.473946	0.220078	0.508000	0.406918	MO2
MO3	-.135894	0.530966	-.080792	0.666342	MO3
MO4	0.756125	-.023930	0.744196	0.275109	MO4
MO5	0.669046	0.161542	0.681424	0.311837	MO5
MO6	0.226941	0.329961	0.339704	0.490624	MO6

Pearson Correlation Coefficients, N = 15
Prob > |r| under H0: Rho=0

	MO1	MO2	MO3	MO4	MO5	MO6
MO1	1.00000	0.07389	-0.36823	0.04886	0.01740	-0.32879
MO1		0.7935	0.1769	0.8627	0.9509	0.2315
MO2	0.07389	1.00000	0.10034	0.33656	0.60679	0.26557
MO2	0.7935		0.7220	0.2200	0.0165	0.3388
MO3	-0.36823	0.10034	1.00000	0.21562	-0.11811	-0.09399
MO3	0.1769	0.7220		0.4402	0.6750	0.7390
MO4	0.04886	0.33656	0.21562	1.00000	0.70211	0.58115
MO4	0.8627	0.2200	0.4402		0.0035	0.0231
MO5	0.01740	0.60679	-0.11811	0.70211	1.00000	0.55063
MO5	0.9509	0.0165	0.6750	0.0035		0.0334
MO6	-0.32879	0.26557	-0.09399	0.58115	0.55063	1.00000
MO6	0.2315	0.3388	0.7390	0.0231	0.0334	

Appendix G: Story Board



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14. ABSTRACT
Reducing the USAF's fuel use is a major budgetary concern, as the AF consumes more fuel than the Army, Navy, Marine Corps and all other Department of Defense (DoD) agencies combined. This research focused on fuel efficiency of C-130 Hercules Aircraft Commanders (ACs) by proposing, constructing, and testing a survey measure of behavioral drivers of discretionary pro-environmental professional behaviors among USAF pilots.

15. KEYWORDS
Behavior, energy, pilots, survey, environment, organizational

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