DEVELOPMENT OF A FUEL EFFICIENCY MOTIVATION SURVEY

Graduate Research Paper

Cory E. Sanders, Captain, USAF

AFIT-ENS-MS-17-M-303

DEPARTMENT OF THE AIR FORCE
AIR UNIVERSITY

AIR FORCE INSTITUTE OF TECHNOLOGY

Wright-Patterson Air Force Base, Ohio

AFIT-ENS-MS-17-M-303

DEVELOPMENT OF A FUEL EFFICIENCY MOTIVATION SURVEY

Graduate Research Paper

Presented to the Faculty

Department of Operational Sciences

Graduate School of Engineering and Management

Air Force Institute of Technology

Air University

Air Education and Training Command

In Partial Fulfillment of the Requirements for the

Degree of Master of Science in Logistics

Cory E. Sanders, BS, MA

Captain, USAF

March 2017

AFIT-ENS-MS-17-M-303

DEVELOPMENT OF A FUEL EFFICIENCY MOTIVATION SURVEY

Cory E. Sanders, BS, MA

Captain, USAF

Committee Membership:

Dr. K. E. Schultz
Chair

Dr. G. Burns
Member

AFIT-ENS-MS-17-M-303

Abstract

To understand why US Air Force mobility pilots operate fuel efficiently, this research was aimed at developing a survey that measures constructs related to motivation according to the Self-Determination Theory framework (Ryan & Deci, 2000). The 40 item survey was administered to 24 Air Force mobility pilots. In addition to their item responses, their subjective feedback was collected to support face validity of the survey. Overall results of the study provided sufficient evidence the survey will be effective in a full-scale study of fuel efficiency motivation in the sampled population.

Acknowledgments

I would like to express my sincere appreciation to my faculty advisor, Dr. Schultz, and to Dr. Burns, for their guidance and support throughout the course of this research effort. The insight and experience was certainly appreciated. I would, also, like to thank my sponsor, the AMC/A3F team for both the support and latitude provided to me in this endeavor.

Cory E. Sanders

Table of Contents

Page

List of Figures

List of Tables

DEVELOPMENT OF A FUEL EFFICIENCY MOTIVATION SURVEY

I. Introduction

This research was aimed at developing a survey that measures 1) six motivation constructs (amotivation, external regulation-material, external regulation-social, introjected regulation, identified regulation, and intrinsic motivation) and 2) the extent to which individuals' three basic psychological needs (competence, relatedness, and autonomy) are satisfied by fuel efficiency behaviors in Air Force C-17 pilots. These concepts are central to Self-Determination Theory (Ryan & Deci, 2000) and were chosen because 1) they predict an array of organizational outcomes and 2) they will contribute to the theoretical literature.

The planned full scale study includes experimental conditions in which eight squadrons are assigned either a public or private feedback conditions. The feedback will tell each member how well he or she performed in fuel efficiency. The public group will see how well everyone performed and will be able to attribute the performance to specific pilots, whereas, the private group will not be able to link the performance data to other individuals, just their own. Over the course of the feedback period, the motivation and basic psychological needs surveys will be administered to determine if these variables explain the relationship between performance differences associated with the two experimental groups. Thus, the development of these surveys is essential to a successful experiment.

The reason Self-Determination Theory was chosen is because it provides an explanation as to why people are motivated in different ways to perform the same activity. They do this by detailing the differences between autonomous and controlled

motivation types. As for the practical implications, autonomous motivation yields good task performance and free task persistence as well as high individual well-being. Thus, if it is demonstrated that autonomous motivation can be achieved in fuel efficiency behavior in pilots through increased autonomy, there will be reason to apply the scenario to other working groups and tasks in the Air Force.

General Issue

The Air Force has taken measures to increase fuel efficient behavior by pilots. Currently, one method leaders use to accomplish this end is policy. The Air Force's regulation governing C-17 flight operations outlines the measures pilots *should* take to ensure fuel efficient operations, but these suggestions are bracketed by operational requirements (i.e. air refueling operations and cargo load balance policy), thereby de-emphasizing the importance of efficiency. Clearly, tactical effectiveness trumps tactical fuel efficiency. Additionally, the few lines dedicated to fuel efficiency in the 260-page document is practically insufficient to incite pilots' motivation to behave in a manner that will save fuel.

Personal incentives work against the Air Force's best interests by motivating pilots to fly inefficiently. Two examples of this are 1) the desire to get home sooner from a mission and 2) overloading on fuel to avert potential, however unlikely, circumstances. Compounding the situation, pilots are quite often forced to dump upwards of 100,000 pounds of fuel due to weight restrictions for landing, thereby eliciting a sense of futility in their fuel efficiency behavior (i.e. Why conserve 5,000 pounds of fuel by flying efficiently today when I just dumped 100,000 pounds yesterday so I could land?).

Another example of this motivation thwarting phenomenon is that they are sometimes scheduled for missions where only a fraction of the capacity of their aircraft is utilized thereby greatly increasing the gallon of fuel per ton-mile ratio. Thus, the complex situation creates an environment where it is likely difficult for pilots to behave fuel efficiently. This is supported by research that suggests if the personal incentives for being inefficient outweigh the personal incentives for being efficient, pilot behavior will likely not change in this respect (Benabou & Tirole, 2005).

The interaction of the social and personal situations are insufficient to incite a motivation to fly efficiently. Research has shown people are more likely to behave prosocially (in this case saving taxpayer money by conserving government fuel) when there is a personal incentive to do so (Ariely, Bracha, & Meier, 2009; Benabou & Tirole, 2005; Simpson & Willer, 2008). However, for pilots in the Air Force, there is no personal incentive to fly or plan conservatively because they are using government resources to execute missions for the government. In other words, pilots will likely derive very little personal benefit (e.g. money, esteem, enjoyment, etc.) for flying efficiently, as there is nothing in it for them. Consider, also, peer pressure adding to the incentive to fly inefficiently. As two experienced Air Force pilots indicated in an informal panel interview in which I was involved, other aircrew members sometimes pressure pilots to forgo fuel efficiency in favor of getting to the destination sooner. This creates a situation where people are unlikely to go against the wishes of their peers (Bonein & Denant-Boemont, 2015; Esteve, Urbig, Witteloostuijn, & Boyne, 2016).

Thus, to reach organizational fuel efficiency goals, we chose to focus on individual motivation. The complexity of the organizational environment should be

accounted for when developing fuel efficiency programs, and analyzing pilots on an individual level is warranted to provide a basis for the best performance the organization has the potential to garner.

Problem Statement

There are no existing instruments that measure elements of motivation or satisfaction of the basic psychological needs within the Self-Determination Theory framework (Ryan & Deci, 2000) in the context of fuel efficiency for Air Force pilots. The motivation scale development is important because it will enable a deeper understanding of pilot motivation toward the fuel efficiency, thereby informing decision makers so they may appropriately adjust their leadership tactics. The basic psychological needs satisfaction scale development is important because it will provide a basis for a theoretical contribution to motivation theory as the relationship between basic psychological needs and motivation type has not been empirically demonstrated in this context.

Research Objectives/Questions

The research objectives are to develop a scale that measures 1) motivation type and 2) basic psychological need satisfaction in relation to fuel efficiency of Air Force mobility pilots according to the Self-Determination Theory framework (Ryan & Deci, 2000). Within motivation type, the constructs that will be measured are: amotivation, external regulation, introjected regulation, identified regulation, and intrinsic motivation. Within basic psychological needs satisfaction, the constructs that will be measured are: competence, relatedness, and autonomy.

There are critical qualities that an instrument must possess in order to be considered usable. Particularly, it must be reliable and valid. Once these qualities are demonstrated in the instrument, support is garnered for its usability. Therefore, the research question of this endeavor is as follows: Do the items possess content and face validity as well as internal consistency? To be more specific, the following investigative questions (IQs) guided the research:

IQ1: Do experts believe the items measure the construct they intend to measure?

IQ2: Do pilot study participants feel the questions are legitimate?

IQ3: Do the items meet the internal consistency standard of $\alpha >= .70$ for each construct?

IQ4: Do all of the items indicate sufficient corrected item total correlation (>= .20)?

Methodology

To accomplish the research objective and answer the research and investigative questions, the following actions had to first take place: 1) Conduct literature review to determine which scales we should adapt, 2) adapt scale questions to be fuel efficient-specific and Air Force pilot-specific, 3) have experts review for content validity, 4) administer to a pilot group for item responses and request subjective input, 5) complete quantitative analysis (internal consistency and content validity) of item responses, 6) compare quantitative analysis with subjective responses and adjust the instrument accordingly. After completing these steps, the research questions will have been satisfied,

and either the instrument will be validated or there will be sufficient information to determine if adjustment or abandonment is necessary.

Assumptions/Limitations

This research assumes that the question of motivation is important in Air Force pilot fuel efficiency. According to previous research of motivation in organizational settings, this assumption is well-supported (Gagne & Deci, 2005). A limitation of the study is that the sample population is small (n=24), and the relationships we find may not be reliable because of that. Nonetheless, the scope of the problem and the demonstrated reliability and validity of the parent measures (i.e. the MWMS and BPNS-W) create circumstances where this is an acceptable limitation for our purposes.

II. Literature Review

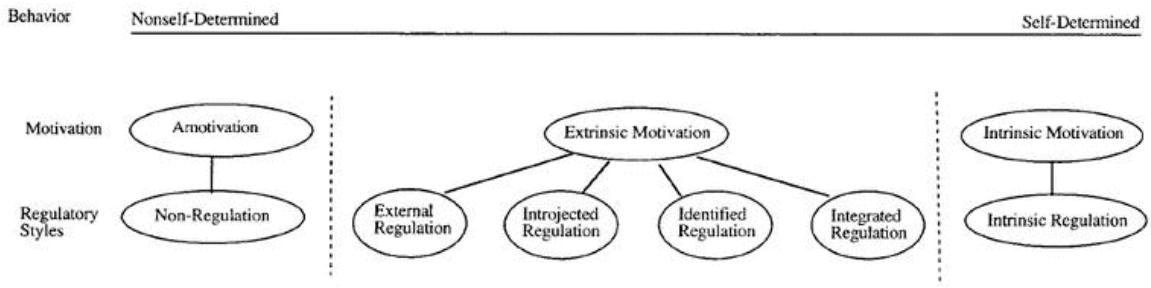
Chapter Overview

The purpose of this chapter is to provide an overview of Self-Determination Theory as it relates to fuel efficiency in Air Force pilots. I will cover the constructs relevant to this research including intrinsic motivation, amotivaiton, the four self-regulations, and satisfaction of the basic psychological needs (competence, relatedness, and autonomy). Additionally, I will provide a discussion of the relationships among the motivation constructs.

Self-Determination Theory

Self-determination Theory (SDT) is a means of understanding human motivation by distinguishing among different types of motivation. The concepts in SDT that are most applicable to pilot motivation to save fuel are the six motivation constructs (amotivation, external regulation-material, external regulation-social, introjected regulation, identified regulation, and intrinsic motivation) and the three basic psychological needs (competence, relatedness, and autonomy). Traditionally, SDT defines an additional motivation construct: integrated regulation (Ryan & Deci, 2000), but it was omitted from this research in favor of enhancing psychometric properties of the scale. In the development of the Multidimensional Work Motivation Scale (MWMS; Gagne, et al., 2015), the researchers found integrated regulation converged with identified regulation. Because the constructs represent a theoretically similar regulatory style, and because they predict outcomes largely indistinguishable from each other, integrated regulation was

omitted from the MWMS. The MWMS was the scale we adapted to meet our needs.



Therefore, this research excludes integrated regulation.

Motivation Type

The six types of motivation outlined by SDT include intrinsic motivation, amotivation, and the four self-regulations: external regulation, introjected regulation, identified regulation, and integrated regulation. Each of these constructs will be detailed herein, and an explanation of the two external regulations (social and material) used in the scale we developed are included. Finally, a theoretical discussion of the relationships between the variables in the context of control and autonomy is included.

Relationships between Behavior, Motivation, and Regulatory Styles

Figure 1: Motivation Model (Retrieved from Ryan & Deci, 2000)

Amotivation

Amotivation is characterized by individuals either not acting at all or acting without intent. These individuals, if acting, are simply going through the motions (Ryan & Deci, 2000). Outcomes associated with amotivation include greater ill-being, very poor performance, no free-task persistence, and unethical behavior (Gagne & Deci, 2005; Schweitzer, Ordonez, & Douma, 2004; Welsh & Ordonez, 2014). In the context of pilots

engaging in fuel efficiency behavior, this means that flying fuel-efficiently has little to no value to them, and they just go through the motions to "check the box".

Extrinsic Motivation (Self-Regulatory Styles)

Generally, self-regulation "concerns how people take in social values and extrinsic contingencies and progressively transform them into personal values and self-motivations" (Ryan & Deci, 2000, p. 69). There are four types of self-regulation (or regulations): external, introjected, identified, and integrated. External regulation has been divided into two types (material and social) in some research (Gagne, Forest, Vansteenkiste, Crevier-Braud, Van den Broeck, Aspeli, & Wang, 2014). Theoretically, the relationship between these regulatory styles is described as more controlled motivation (left of figure 1) to more autonomous (right of figure 1; Ryan & Deci, 2000). In this model, controlled motivation is the opposite of autonomous motivation. A more detailed discussion is included after definition of the remaining motivation constructs.

External Regulation

"[Externally regulated] behaviors are performed to satisfy an external demand or reward contingency," and are the least autonomous (Ryan & Deci, 2000, p. 72). An example of what this might look like is a pilot who flies his aircraft efficiently because if he does not, his peers would ostracize him. The pilot would focus on preventing the negative outcome of being ostracized instead of focusing on mastery or enjoyment of the task (intrinsic motivation) or having little to no focus on the task (amotivation).

External demands and rewards can be social or tangible in form, hence the separation of the social and material external regulation types used in Gagne's (et al., 2015) research. The example of a pilot being ostracized represents social external

regulation, as the demand comes from social pressure. An example of a situation where a tangible reward can drive external regulation would be a pilot who flies fuel efficiently to increase his chance of being stratified above his peers, thereby enhancing his chance for promotion and better pay. In this example, the pilot's focus is on the stratification as opposed to a social pressure.

The effects of external regulation on motivation outcomes are mixed, but clearly explained in Self-Determination Theory. In external regulation, it is not uncommon to see high performance toward a task. However, free task persistence and subjective well-being have been shown to be non-existent in these situations (Gagne & Deci, 2005). Additionally, research has demonstrated external regulation can result in unethical behavior as is found in amotivation (Schweitzer, Ordonez, & Douma, 2004; Welsh & Ordonez, 2014). The relationship between external regulation and these outcomes support the theory in that individuals do not experience externally regulated behaviors as positive, and, therefore, will not persist if the external stimuli are removed, or will use unethical shortcuts just to complete the task as quickly as possible.

Introjected Regulation

"Introjection involves taking in a regulation but not fully accepting it as one's own" (Ryan & Deci, 2000, p. 72). These behaviors are more autonomous than externally regulated behaviors, but less autonomous than those in identified regulation. In other words, introjection is the regulation in which individuals begin the process of identifying with the value of performing a task, but that identification partially defines the individual's self-worth. A hypothetical example of this would be a pilot who feels it is important to perform the task of fuel efficiency because success results in feelings of

pride, whereas, failure results in feelings of shame. The outcomes of introjected regulation have been shown to be the same as those of external regulation (Gagne & Deci, 2005, Ryan & Deci, 2000, Schweitzer, Ordonez, & Douma, 2004; Welsh & Ordonez, 2014). However, although the outcomes associated with the organizational context are empirically the same as those in external regulation, the regulatory style is characteristically different and can predict differentiated outcomes in different domains such as in clinical settings (Ryan & Deci, 2000).

Identified Regulation

"Regulation through identification reflects a conscious valuing of a behavioral goal or regulation, such that the action is accepted or owned as personally important" (Ryan & Deci, 2000, p. 72). These behaviors are more autonomous than behaviors in introjected regulation, but less than those in integrated regulation. An example of identified regulation would be a pilot who feels flying fuel efficiently is reflective of his personal values. This is where outcomes begin to shift from negative like those in amotivaiton, external regulation, and introjected regulation, to positive like those in intrinsic motivation. The outcomes are identical to those in intrinsic motivation, but the effects are generally weaker (Gagne & Deci, 2005).

Integrated Regulation

Finally, the most autonomous extrinsic motivation is integrated regulation. "Integration occurs when identified regulations are fully assimilated to the self, which means they have been evaluated and brought into congruence with one's other values and needs" (Ryan & Deci, 2000, p. 73). The distinction between integrated regulation and both identified regulation and intrinsic motivation has proven difficult to empirically

separate in organizational settings (Gagne, et al., 2015). Therefore, it will not be individually measured herein.

Intrinsic Motivation

Ryan and Deci (2000) define intrinsic motivation as "…the prototypic manifestation of the human tendency toward learning and creativity…" (p. 69). Within SDT, intrinsic motivation is viewed as optimal human functioning and is, to my knowledge, exclusively viewed as a positive construct. This view is supported by empirical outcomes on both the individual and organizational level.

Intrinsic motivation has been repeatedly demonstrated to predict high subjective well-being, high task performance, and free task persistence (Gagne & Deci, 2005; Cirasoli, Nicklin, & Ford, 2014). These outcomes are particularly desirable for the situation with the Air Force pilots in that it benefits both the pilots and the organization if they perform the task of flying efficiently better than they currently do, and if they persist in that behavior without leadership engagement. Furthermore, if the pilots experience high well-being while performing or when thinking about the task of flying fuel-efficiently, that would be preferable to the greater ill-being they would likely experience if they felt greater control from the organization (Ryan & Deci, 2000). Thus, it is important to better understand how pilots may become intrinsically motivated to save fuel.

Autonomous Versus Controlled Motivation

Self-Determination Theory (SDT) holds that as regulation progresses from regulation associated with amotivation to external, introjected, identified, and finally to task enjoyment, the motivation can be described as more controlled progressing to more

autonomous, respectively. Ryan and Deci (2000) explain that this is because when people assimilate regulatory processes toward activities to the self, they experience more autonomy. Conversely, the regulatory process associated with external regulation, for example, takes place when an individual perceives his behavior is being controlled by an external force, and the individual does not assimilate the value of that behavior to the self. Introjected regulation and external regulation similarly represent situations where the individual feels their behavior is controlled, hence, controlled motivation. Therefore, defining the prior three regulations within the model as controlled, and the latter three as autonomous (Figure 1) is a meaningful simplification that has been shown to be useful in multiple goal scenarios (Koestner, Otis, Powers, Pelletier, & Gagnon, 2008).

Basic Psychological Needs

There are three basic psychological needs outlined in SDT that, together, have been demonstrated to be necessary and sufficient for predicting well-being, and are described as the basic nutriments for optimal human functioning (Ryan & Deci, 2000). These needs are competence, relatedness, and autonomy. Theoretically, competence is the need of every individual to feel they are personally capable of performing an action (Deci & Ryan, 2008). Competence, in this context, is defined as pilots' feelings that they are capable and proficient at operating their aircraft efficiently.

Relatedness is the need for individuals to feel they have a connection with others, that they are needed, and that they have something in common with others (Deci & Ryan, 2008). Relatedness, for this research, is operationally defined as pilots' feelings that the task of operating efficiently brings them closer to others.

Autonomy is the need for individuals to feel they have the power and authority to determine their own behavior, as opposed to having someone or something else determining their behavior (Deci & Ryan, 2008). This need, serves as a unique point to Self-Determination Theory, as other motivation theories have not incorporated the idea of autonomy as a central component of motivation (Ryan and Deci, 2000). Although there is a temptation to focus on effects of autonomy satisfaction and support in Self-Determination Theory-related research, it is but one of the three needs, and all should be given diligence in a research effort. For this research, autonomy is defined as pilots' feelings that they have they have the authority to determine whether and how to approach the task of fuel efficient operations.

Basic psychological needs can be supported or thwarted by one's environment (Deci & Ryan, 2008). For example, a pilot might feel operating fuel efficiently thwarts his autonomy if leaders are being highly directive on the tasks or associated outcomes (e.g. you must fly more slowly, or you must save 4,000 pounds of fuel every flight). On the other hand, a pilot might feel operating efficiently supports his autonomy if he is given the latitude to either pursue or not pursue a fuel efficiency goal, depending on mission and safety considerations. Thus, the environment acts on the psychological needs, and that action can be negative or positive. The result of this action is each individual's satisfaction of their basic psychological needs, which will be measured by the scale developed herein.

Implications

By validating a survey that measures motivation type and basic psychological need satisfaction, this research will enable a better understanding of pilot fuel efficiency behavior. The MWMS will serve to provide an idea of motivation type, which can be used to make decisions regarding program structure and management style in regards to the task. Similarly, the BPNS-W will provide an idea on how well or poorly the task of fuel efficiency satisfies pilots' basic psychological needs. Because basic psychological needs are theoretically linked (positively) to optimal functioning (intrinsic motivation) measuring their satisfaction will serve to help explain which facet is lacking in the fuel efficiency task, so leaders have an target to enhance more autonomous forms of motivation.

III. Methodology

Chapter Overview

The purpose of this chapter is to outline the techniques used to validate the Multidimensional Work Motivation Scale (MWMS; Gagne, et at., 2014) and the Basic Psychological Needs at Work Scale (BPNS-W; Ryan & Deci, 2008) after they were adapted to suit the task of fuel efficiency in the Air Force C-17 pilot population. This validation was accomplished by 1) modifying the items and having experts review the items for content validity, 2) administering the instruments to a sample for quantitative responses and qualitative feedback, 3) reviewing the data and feedback for external validity and internal consistency.

Participants

Participants of this study include 25 Air Force Mobility pilots of varying experience levels, who were either entering a year-long master's in residence program or graduating from that same program at Fort Dix, New Jersey. This group was selected as a convenience sample, but represent similar demographics to the target population. There were, however, some differences. The primary differences were that 1) the sampled pilots flew an array of mobility aircraft, not just the C-17, and 2) they had less variance in experience than the population. These differences pose a limitation to the study in that their responses may not represent the population we intend to sample. Therefore, we must be conscious of potential differences when the survey is administered to larger samples of specifically C-17 pilots in the experimental study.

Techniques

To validate the survey, three steps were taken: item modification and review, administration, and data analysis. We paid careful attention to construct preservation, data collection, and analytical techniques to achieve an accurate assessment of the survey's reliability and validity.

First, the items of the MWMS and BPNS-W were modified and reviewed by experts. After conducting a thorough literature review to understand the constructs, I modified the items to focus them on fuel efficient operations. The items were previously focused on the work domain in general, and my modifications focused them on fuel efficiency for Air Force Pilots. For example, identified regulation item was changed from "Because putting efforts into my work aligns with my personal values," to "Because putting efforts into fuel efficiency aligns with my personal values." I learned this domain focus is theoretically sound for both the BPNS-W and the MWMS through discussions with the theory's co-founder and the lead researcher who developed the MWMS (Edward Deci and Marylene Gagne, respectively). Finally, both a logistics and a psychology professor as well as a logistics student reviewed the items for content validity. All concerns were relatively minor and were satisfied before the second step took place.

Second, the instruments were administered to the sample of 25 pilots, and qualitative information was requested of the participants as well as item responses. The 40 items were administered in a survey with 88 other items (128 items total) in paper form. The 40 items used a 5-point likert scale. All other items used either a 5 or 7-point likert scale. There was also space provided at the end of each scale as well as at the end of the entire survey for comments. The administrator encouraged participants to provide

written feedback anywhere on the survey. The administrator also split the survey where the 40 items of this research were administered, at random, either at the beginning or the end of the survey.

Third, the data was reviewed and analyzed to test for content and face validity as well as internal consistency. Content validity refers to the idea that the content of the items reflect the constructs we intend to measure with them. Face validity refers to the idea that a non-expert perceives the item accurately measures the intended concept. I Internal consistency is the reliability measure used to ensure the results will replicate in an empirical study.

Content Validity

In addition to the care taken to retain the content validity of each adapted item and having experts review these items, the techniques used to examine content and face validity consist of examining qualitative feedback from the sample and reviewing the corrected item total correlation using statistics software (SPSS). I carefully read all qualitative feedback once to detect themes, then carefully analyzed each statement to glean the applicable information from it. For example, one participant noted an intrinsic motivation item, “Because I have fun operating fuel-efficiently,” sounded “juvenile”. This not only added to the general theme that the groups had negative feelings toward the current fuel efficiency program, but it also led to me to address the item concern directly by altering the item to “Because I enjoy operating fuel efficiently”. In addition to the qualitative analysis, the item responses allowed for a quantitative analysis for validity also. We computed the corrected item total correlation to determine content validity of each item individually.

Internal Consistency

Cronbach's Alpha was used as the measure of internal consistency. Generally, a Cronbach's Alpha of .70 or higher indicates the construct possesses sufficient internal consistency (Cronbach, 1951). This is a measure that uses the number of test items and the average intercorrelation of the items within a construct, although I used SPSS to increase both the speed and accuracy of the data analysis.

Summary

I used a mixed methods (qualitative and quantitative) approach to ensure a sufficient evaluation and validation of the MWMS and BPNS-W. This approach ensured that we had sufficient information to understand which constructs would likely perform well in an empirical study, why they might not perform well, and what should be changed before we invested time and effort into a large-scale study. In other words, we can reasonably expect the resulting instrument to possess sufficient internal and external validity after executing this methodology.

IV. Analysis and Results

Chapter Overview

This chapter is intended to provide the reader with the data obtained in this study and techniques used to analyze it. First, I discuss the results of the item modification from the original survey forms. This includes the results of the feedback I received from both the group of experts and the group of survey participants. Second, I cover the quantitative analysis including internal consistency, corrected item total correlation scores, and an exploratory look into factor loadings using factor analysis. Finally, I use the results to answer the investigative questions and provide a brief discussion of each answer.

Results Item Modification

Neither the MWMS nor the BPNS-W were in need of major modification to align with the fuel efficient flying domain. The stem question to the MWMS required changing from “Why do you or would you put efforts into your work?” to “Why do you or would you put efforts into flying fuel-efficiently?” The stem question format allowed me to keep some items in their original form as the context is addressed at the beginning of the survey. The BPNS-W does not use a stem question, so the item changes were necessary on every item to ensure domain specificity.

Item modifications ranged from not modified to significantly changed in content. For example, the external-social item from the MWMS, “Because others will respect me more”, did not require modification because it remained a valid measure of the construct and addressed the stem question appropriately. However, the autonomy (reverse coded) item from the BPNS-W, “Most of the things I do on my job feel like “I have to”, required

significant modification. I changed it to “I feel pressured to save fuel”, because the pressure or outside force aspect indicates a thwarting of the need for autonomy in both cases.

Additional modifications can be seen by comparing the original and modified versions in the included appendices. Generally, there were no questions of construct validity. Rather, reviewers mostly noticed issues of content validity. For example, one reviewer suggested changing items to be more military specific, so the content of the item aligned more closely with the context. This suggestion was implemented in some items, and the need for more military specific verbiage was indicated in the analysis of the qualitative information collected from the participants. Thus, the items evolved from being less to more specific to the military context.

Results from Quantitative Analysis

The quantitative analysis showed that most items performed sufficiently within their constructs. Initial Cronbach’s Alpha scores can be seen in Table 1. The items that performed below the .70 mark include External-Social, Competence, and Autonomy.

Table 1: Construct Reliability

Construct	Alpha	Number of Items
Amotivation	.911	3
External-Material	.833	3
External-Social	**.629**	3
External Combined	.836	6
Introjected	.796	4
Identified	.802	3
Intrinsic	.876	3
Competence	**.528**	6
Relatedness	.806	8
Autonomy	**.486**	7

The External-Social construct consisted of 3 items, and I am, therefore, unable to remove any items to improve alpha. However, the corrected item total correlation indicated that the item ExtSoc3 performed poorly. In review of the item, I attributed this poor performance to the context. The scale is being developed for a specific scenario where the pilots will be subject to a goal situation that will likely involve some normative pressures, and the pilots in this validation sample were not in that scenario. Therefore, they are unlikely to feel social pressure, thereby making the question a little out of context for the current sample.

The Competence construct performed quite poorly (alpha=.528), but after the removal of items five and six, it became closer to acceptable standards (alpha=.646). These items may have performed poorly because the constructs intend to measure how well the performance of fuel efficient flying satisfies their basic need for competence. Because of the contextual conflict described above, the questions may have seemed a little odd to ask. Although this was not indicated in the qualitative responses, it seems reasonable that pilots who have a fuel efficiency goal (as they will in the experimental study) will have a better intuition of how the question responses relate to their situation.

Lastly, the autonomy construct performed poorly (alpha=.486), but after removing items two and three, alpha was increased to within reasonable standards for the purpose of this study (.633). Again, in review of the questions, it would appear that the contextual conflict may be the problem with the items. Pilots who are not engaged in a group or individual goal with others in their units might feel the question, “I feel free to express my ideas and opinions about fuel efficiency” (item 3) is a little odd. Participants might have wondered, why would I express an idea or opinion about fuel efficiency? Whereas

the better performing item, “When it comes to saving fuel, I have to do what I am told” (item 4) was applicable to the current context as pilots indicated in their comments the current fuel efficiency program was bureaucratic and controlling. Thus, if the goal intervention is successful, the items will likely perform better due to context alignment.

Although the sample size is likely too small to perform a reliable factor analysis, I included the results of an analysis for the exploratory value. These relationships might indicate potential issues that will project to the experimental study. Thus, the below discussion should be viewed as exploratory exercise.

Factor analysis of the MWMS items indicated there were some unexpected relationships. After attempting both a five and six factor analysis, I found the external material and external social items loaded better together than they did apart. Therefore, I went with the five factor analysis. Even after this, the scree plot (Figure 2) did not show a sharp change of slope indicating there may not be distinct relationships among the data. In other words, the constructs did not seem distinct from each other. Additionally, the rotated factor matrix (varimax rotation used) indicated all constructs seemed supported, except introjection, which seemed to load in a split between intrinsic and identified regulation (see Table 2). However, it is not unusual to see introjected items loading poorly onto their own factor (Gagne, et al., 2015).

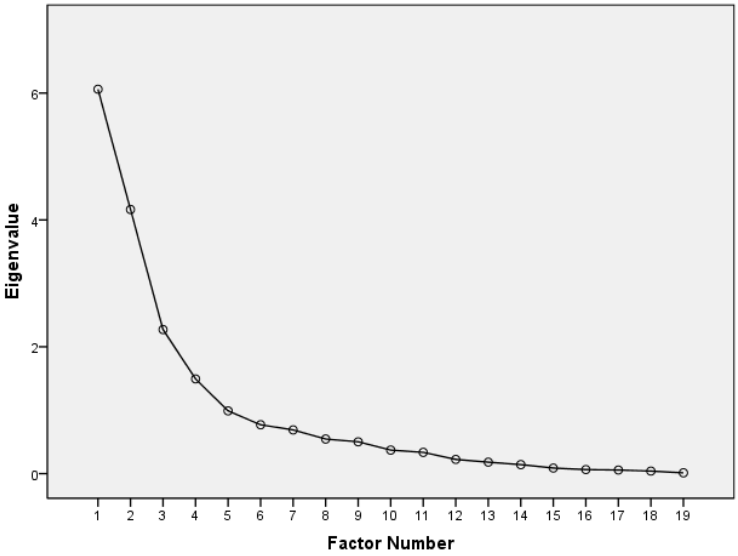


Figure 2: MWMS Scree Plot with Introjection

Table 2: MWMS Factor Matrix with Introjection

	Factor				
	1	2	3	4	5
Am1	-.274	.005	.874	-.112	-.136
Am2	-.138	.127	.951	-.178	-.015
Am3	-.018	.153	.769	-.084	.089
ExtMat1	-.249	.857	.207	.117	-.147
ExtMat2	-.036	.801	-.023	.132	.010
ExtMat3	-.046	.754	.200	-.200	.272
ExtSoc1	.111	.691	.131	.145	.117
ExtSoc2	.252	.638	-.061	.183	.701
ExtSoc3	-.367	.355	-.169	.251	.012
Ident1	.411	-.081	.082	.454	.113
Ident2	.334	-.072	-.275	.604	-.027
Ident3	.549	.393	-.185	.352	-.107
Intrin1	.879	-.123	-.270	.063	.047
Intrin2	.787	.022	-.229	.083	-.045
Intrin3	.808	-.130	.030	.178	.070
Introj1	.536	.002	-.066	.367	.216
Introj2	.639	.368	-.169	.449	.170
Introj3	.102	.305	-.107	.805	.369
Introj4	.124	.248	-.188	.828	-.169

Am=Amotivation, ExtMat=External-Material Regulation, ExtSoc=External-Social Regulation, Ident=Identified Regulation, Intrin=Intrinsic Motivation, Introj=Introjected Regulation *Red=Negative Indicator, Yellow=Positive Loading

This led me to analyze the data without the introjection items. The analysis using four factors (external items combined again) was much clearer in this case. First, the scree plot indicated that four factors were appropriate with this dataset as there was a sharp change in slope near that point and that change was near the eigenvalue of 1 (see Figure 3). Second, the items in the factor matrix loaded much more cleanly into their own factors supporting convergent and discriminant validity. Thus, without the introjection items, the MWMS appears to be a good tool to measure its intended constructs.

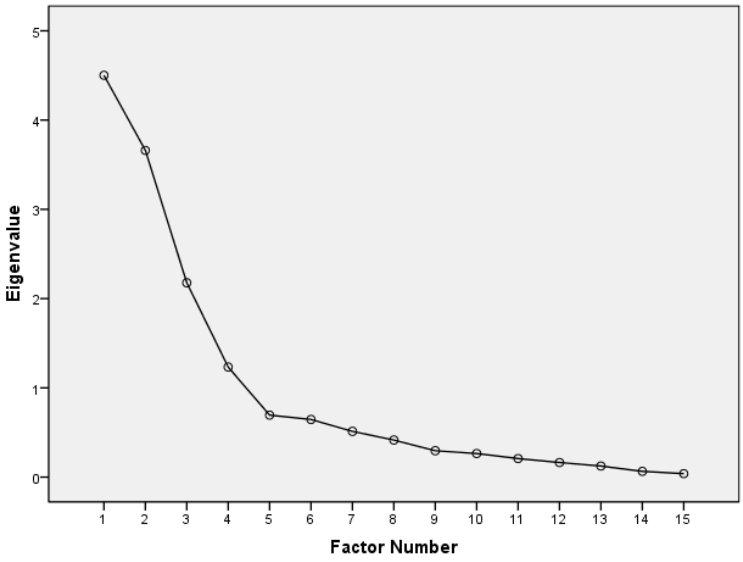


Figure 3: MWMS Scree Plot without Introjection

Table 3: MWMS Factor Matrix without Introjection

	Factor			
	1	2	3	4
Am1	-.027	.891	-.261	-.057
Am2	.107	.951	-.142	-.165
Am3	.160	.781	.009	-.029
ExtMat1	.797	.195	-.288	-.088
ExtMat2	.834	-.023	-.038	.045
ExtMat3	.734	.229	-.086	-.068
ExtSoc1	.744	.107	.079	.025
ExtSoc2	.683	-.077	.216	.194
ExtSoc3	.404	-.222	-.357	-.072
Ident1	-.033	.114	.246	.961
Ident2	.005	-.315	.164	.701
Ident3	.411	-.179	.443	.495
Intrin1	-.069	-.257	.955	.130
Intrin2	.062	-.226	.691	.251
Intrin3	-.067	.006	.791	.154

Am=Amotivation, ExtMat=External-Material Regulation, ExtSoc=External-Social Regulation, Ident=Identified Regulation, Intrin=Intrinsic Motivation *Red=Negative Indicator, Yellow=Positive Loading

The item analysis of the BPNS-W proved more elusive. With all items included, both the scree plot and the factor matrix indicated the items are indiscernible with three factors (Figure 4, Table 4). Even after removing the items that performed poorly, there were still major issues of discriminant and convergent validity (Figure 5, Table 5). These issues may have arisen from either an issue with how the participants interpreted the question (e.g. being out of context), or perhaps the questions did not address the constructs clearly enough. From my research, this is the first attempt to measure these constructs at the task level. Thus, satisfaction of needs may just not occur at the task level in a way that can be measured by a survey instrument.

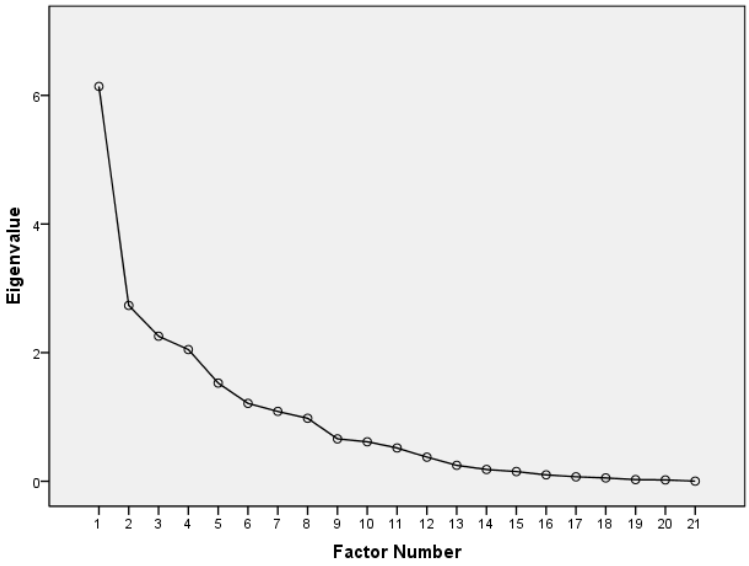


Figure 4: BPNS-W Scree Plot

Table 4: BPNS-W Factor Matrix

	Factor		
	1	2	3
Aut1	.343	.145	.105
Aut2R	-.581	-.326	.096
Aut3	.902	-.160	.248
Aut4R	.217	.153	.308
Aut5	.207	.421	-.032
Aut6	.264	.270	.153
Aut7R	-.329	-.028	-.108
Com1R	.128	.444	-.090
Com2	.323	.367	.233
Com3	.471	.696	-.025
Com4	.046	.492	-.007
Com5R	.519	-.195	-.438
Com6R	.035	.145	-.309
Rel1	.387	.704	.379
Rel2	.438	.761	.438
Rel3R	.092	.209	.516
Rel4	.654	.424	-.141
Rel5	.834	.441	-.088
Rel6R	.050	-.002	.956
Rel7R	-.264	.602	.049
Rel8	.056	.507	.198
Aut=Autonomy, Com=Competence, Rel=Relatedness *R=reverse coded item			

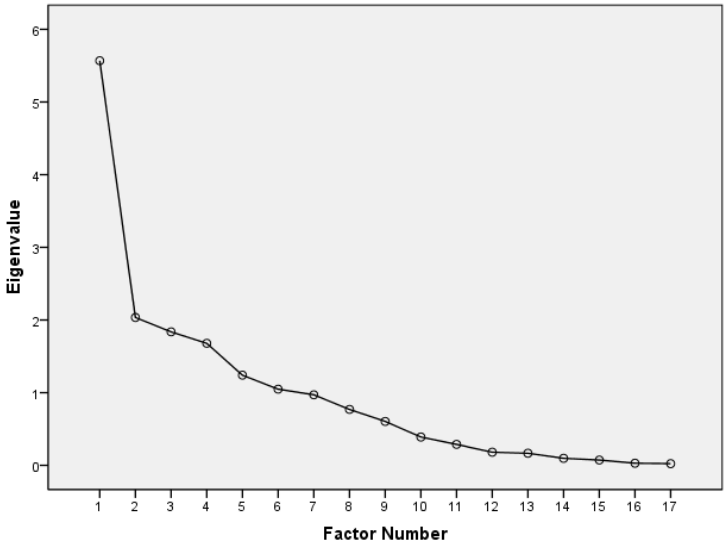


Figure 5: BPNS-W Scree Plot—Items Dropped

Table 5: BPNS-W Factor Matrix—Items Dropped

	Factor		
	1	2	3
Aut1	.606	-.367	.336
Aut4R	.372	-.136	.380
Aut5	.405	.238	.038
Aut6	.352	.054	.218
Aut7R	-.010	-.421	.083
Com1R	.286	.413	-.113
Com2	.472	.152	.343
Com3	.688	.474	.087
Com4	.113	.555	.020
Rel1	.483	.587	.443
Rel2	.576	.615	.538
Rel3R	.141	.045	.589
Rel4	.799	.191	-.068
Rel5	.824	.302	-.002
Rel6R	-.108	.101	.817
Rel7R	.084	.375	.103
Rel8	.098	.509	.243

Aut=Autonomy, Com=Competence, Rel=Relatedness *R=reverse coded item **Red=Negative Indicator, Yellow=Positive Loading

Investigative Questions Answered

IQ1: Do experts believe the items measure the construct they intend to measure?

Yes. Initially, the three experts on the topic (I/O Psychologist, Behavioral Operations Professor, Logistics PhD Student) had minor concerns with the scale. However, after revision, the experts agreed the items measured their intended construct.

IQ2: Do pilot study participants feel the questions are legitimate?

Mostly. Qualitative feedback from the pilots indicated they felt there were a few minor issues with the questions in the survey (i.e. question wording "juvenile", changing wording for mission types). The rest of the concerns the pilots indicated were with the fuel efficiency program itself, which although the concerns are interesting, their analysis is not the purpose of this project. I addressed the concerns the pilots had by modifying some items, and those modifications were agreed upon by the experts listed above.

IQ3: Do the items meet the internal consistency standard of $\alpha >= .70$ for each construct?

No. Although most constructs met the standard, external-social regulation, competence satisfaction, and relatedness satisfaction did not meet the standards. This issue was addressed by modifying some of the items. Additionally, I reasoned that 1) the items will likely perform better in the context of the experimental study, 2) the competence and relatedness satisfaction constructs have the leeway to drop some of their poorly performing items, and 3) external-social can be combined with external-material and it will still maintain theoretical integrity.

Table 6: Corrected Reliability and IQ3

Construct	Alpha	Alpha after item removal	>=.70?
Amotivation	.911		Yes
External-Material	.833		Yes
External-Social	**.629**		No
External Combined	.836		Yes
Introjected	.796		Yes
Identified	.802		Yes
Intrinsic	.876		Yes
Competence	**.528**	.646 (items 5, 6)	No
Relatedness	.806		Yes
Autonomy	**.486**	.630 (items 2, 3)	No

IQ4: Do all of the items indicate sufficient corrected item total correlation (>=.20)?

No. All items that were removed to improve internal consistency showed low corrected item total correlation. The rest of the items were above .20 and most of them were quite high, especially in the MWMS. Table 7 below shows the poorly performing items and their associated correlation. The corrections listed in the discussion associated with IQ3 should provide some improvement to these items when the survey is administered in the experimental study.

Table 7: Corrected Item Total Correlations <.20

Item	Corrected Item Total Correlation
Aut2R	-.115
Aut3	.004
Aut5	.183
Com5R	.080
Com6R	.027

Summary

In summary, the investigative questions were answered sufficiently utilizing the methods prescribed in the initial stages of the research. Although some of the items performed poorly, the contextual differences between the sample in this study and the sample that will take the survey in the experimental study should improve the performance of the items. Additionally, the corrections made to some of the items should add to the improved results I expect in the future administration. Finally, the exploratory analysis included may provide some ideas on how to handle unexpected results from the experimental study.

V. Conclusions and Recommendations

Chapter Overview

The Multidimensional Work Motivation Scale (MWMS; Gagne, et al., 2015) and the Basic Psychological Needs at Work (BPNS-W; Ryan & Deci, 2008) performed sufficiently for the purposes of developing a survey for use in an experimental study of C-17 pilots in a fuel efficiency task. The contributions of this research include not only the validated survey, but also the new perspective of the task-based view using the Self-Determination Theory constructs of motivation type and basic psychological need satisfaction. Finally, I not only recommend using the validated instruments located in the appendix herein, but I also recommend researchers pursuing more task-based research using motivation type and basic psychological need satisfaction, particularly in the work domain.

Conclusions of Research

The Multidimensional Work Motivation Scale (MWMS; Gagne, et al., 2015) and the Basic Psychological Needs at Work (BPNS-W; Ryan & Deci, 2008) proved to be good templates for adaptation to the Air Force pilot fuel efficiency context, both theoretically and empirically. They were both already focused on the work context, which is appropriate for our situation. They were both developed from Self Determination Theory (Ryan & Deci, 2000), which helps ensure theoretically coherent relationships among the constructs. Additionally, the scales were both tested in multiple contexts and demonstrated sufficient psychometric properties (e.g. Gagne, et al., 2015; Ryan & Deci, 1998).

In the research presented herein, the scales performed quite well with only a few exceptions. All except three constructs possessed internal consistency below the a priori standard of $\alpha >= .70$. However, considering our purpose, which is survey development, it is important we do not lose sight of the facts that 1) the circumstances under which the experimental group answers the questions will be different from those of the sample used for this analysis, and 2) the poor empirical performance may be partially attributed to the small sample size. For these reasons, and because the poorly performing items seem to be situationally unique to the expected conditions the experimental group will experience, the internal consistencies of $\alpha > .60$ we achieved for the three constructs in question are sufficient to advance the surveys to the experimental group with the modification discussed in chapter four.

Significance of Research

This research will have direct application to the planned experimental study of C-17 pilots' motivation to fly fuel efficiently. The instruments developed herein provide a means of measuring motivation type and basic psychological needs in this context. Clearly, the related constructs would be quite difficult to measure through any other means, so validation of survey instruments was a critical step to advancing the experiment.

This research is also significant because it is the first time Self-Determination Theory's (SDT) basic psychological needs or motivation types have been measured at the task level. Although, there has been SDT research in many other domains, such as in video gaming (Ryan, Rigby, & Przybylski, 2006) and sports (Hagger & Chatzisarantis,

2007), these are more comparable to the work domain. Fuel efficiency is a single task, secondary to many other tasks pilots must perform. The concept of measuring how well performing a particular work-related task satisfies one's basic psychological needs and what motivation or regulation is used to accomplish the task did not appear to be previously done in my literature review. This signifies this research as contributing a new approach to SDT research: the view that motivation type and basic psychological need satisfaction, *overall*, in one domain (e.g. work) may be empirically related to the culmination of motivation types and basic psychological need satisfaction of the *tasks* that make up that domain. In addition to the theoretical contribution I just described, this perspective could open a great deal of applied research possibilities in the realms of (for example) job and task structure.

Recommendations for Action

Because the surveys performed adequately for our purposes, and the sampled group and experts provided consistent feedback that was addressed and verified by the experts, I recommend administering the modified (post-analysis) surveys in the experimental conditions. If there is then an internal consistency problem with the competence and/or autonomy satisfaction, it can likely be concluded task level measurement of these constructs is either inappropriate or the method is subject to too much measurement error.

Recommendations for Future Research

In addition to using these instruments in the planned experimental study, I recommend more research of motivation type and basic psychological need satisfaction

in the work domain. The goal of this research stream should be consistent with SDT in that it aims to benefit the individual through enhanced well-being and to benefit the organization through an improved bottom line. Additionally, it would be interesting to see adaptations of the task-specific view applied to other domains such as sports, exercise, relationships, and home life.

Summary

In summary, the MWMS and BPNS-W performed sufficiently for the purposes of developing a survey for use in a larger scale. The contributions include not only the validated survey, but also the new perspective of the task-based view using the SDT constructs. Finally, I recommend using the validated instruments located in the appendix, and I also recommend researchers pursuing more task-based research using motivation type and basic psychological need satisfaction.

Appendix A: MWMS

Original

Amotivation
Am1 I don't, because I really feel that I'm wasting my time at work.
Am2 I do little because I don't think this work is worth putting efforts into.
Am3 I don't know why I'm doing this job, it's pointless work.
Extrinsic regulation—social
Ext-Soc1 To get others' approval (e.g., supervisor, colleagues, family, clients …).
Ext-Soc2 Because others will respect me more (e.g., supervisor, colleagues, family, clients …).
Ext-Soc3 To avoid being criticized by others (e.g., supervisor, colleagues, family, clients …).
Extrinsic regulation—material
Ext-Mat1 Because others will reward me financially only if I put enough effort in my job (e.g., employer, supervisor …).
Ext-Mat2 Because others offer me greater job security if I put enough effort in my job (e.g., employer, supervisor …).
Ext-Mat3 Because I risk losing my job if I don't put enough effort in it.
Introjected regulation
Introj1 Because I have to prove to myself that I can.
Introj2 Because it makes me feel proud of myself.
Introj3 Because otherwise I will feel ashamed of myself.
Introj4 Because otherwise I will feel bad about myself.
Identified regulation
Ident1 Because I personally consider it important to put efforts in this job.
Ident2 Because putting efforts in this job aligns with my personal values.
Ident3 Because putting efforts in this job has personal significance to me.
Intrinsic motivation
Intrin1 Because I have fun doing my job.
Intrin2 Because what I do in my work is exciting.
Intrin3 Because the work I do is interesting.

The stem is "Why do you or would you put efforts into your current job?" and is accompanied by the scale: 1 = "not at all", 2 = "very little", 3 = "a little", 4 = "moderately", 5 = "strongly", 6 = "very strongly", 7= "completely".

Modified (Pre-analysis)

Construct	Item no.	Item
Am1	10	I don't, because I really feel that I would be wasting my time trying to operate fuel-efficiently.

Am2	13	I do little because I don't think fuel-efficiency is worth putting effort into.
Am3	17	I don't know why I would operate fuel-efficiently, it's pointless.
Ext – Mat3	16	Because I risk losing my job if I don't put enough effort in it.
Ext -Soc2	11	Because others will respect me more (e.g., supervisor, colleagues, family...).
Ext –Soc3	12	To avoid being criticized by others (e.g., supervisor, colleagues, family,...).
Ext-Mat1	19	Because others will reward me financially only if I put enough effort into fuel efficiency (e.g., employer, supervisor...).
Ext-Mat2	7	Because others offer me greater job security if I put enough effort into fuel efficiency (e.g., employer, supervisor…).
Ext-Soc1	4	To get others' approval (e.g., supervisor, colleagues, family, clients...).
Ident1	6	Because I personally consider it important to put efforts into fuel efficiency.
Ident2	1	Because putting efforts in fuel efficiency aligns with my personal values.
Ident3	8	Because putting efforts into fuel-efficiency has personal significance to me.
Intrin1	3	Because I have fun operating fuel-efficiently.
Intrin2	5	Because operating fuel-efficiently is exciting.
Intrin3	9	Because operating fuel-efficiently is interesting.
Introj1	18	Because I have to prove to myself that I can.
Introj2	14	Because it makes me feel proud of myself.
Introj3	15	Because otherwise I will feel ashamed of myself.
Introj4	2	Because otherwise I will feel bad about myself.

Modified (Post-Analysis)

Construct	**Item no.**	**Item**
Am1	10	I don't, because I really feel that I would be wasting my time trying to operate fuel-efficiently.
Am2	13	I do little because I don't think fuel-efficiency is worth putting effort into.
Am3	17	I don't know why I would operate fuel-efficiently, it's pointless.
Ext –Mat3	16	Because I risk losing my job if I don't put enough effort in it.
Ext -Soc2	11	Because others will respect me more (e.g., supervisor, colleagues, friends...).

Ext –Soc3	12	To avoid being criticized by others (e.g., supervisor, colleagues, friends...).
Ext-Mat1	19	Because it will adversely affect my career if I do not put enough effort into saving fuel.
Ext-Mat2	7	Because putting enough effort into fuel efficiency enhances my promotion potential.
Ext-Soc1	4	Because it will adversely affect my reputation at work if I do not put enough effort into saving fuel.
Ident1	6	Because I personally consider it important to put efforts into saving fuel.
Ident2	1	Because putting efforts in fuel efficiency aligns with my personal values.
Ident3	8	Because putting efforts into fuel-efficiency has personal significance to me.
Intrin1	3	Because I enjoy operating fuel-efficiently.
Intrin2	5	Because operating fuel-efficiently is exciting.
Intrin3	9	Because operating fuel-efficiently is interesting.
Introj1	18	Because I have to prove to myself that I can.
Introj2	14	Because it makes me feel proud of myself.
Introj3	15	Because otherwise I will feel ashamed of myself.
Introj4	2	Because otherwise I will feel bad about myself.

Appendix B: BPNS-W

Original

1. I feel like I can make a lot of inputs to deciding how my job gets done.
2. I really like the people I work with.
3. I do not feel very competent when I am at work.
4. People at work tell me I am good at what I do.
5. I feel pressured at work.
6. I get along with people at work.
7. I pretty much keep to myself when I am at work.
8. I am free to express my ideas and opinions on the job.
9. I consider the people I work with to be my friends.
10. I have been able to learn interesting new skills on my job.
11. When I am at work, I have to do what I am told.
12. Most days I feel a sense of accomplishment from working.
13. My feelings are taken into consideration at work.
14. On my job I do not get much of a chance to show how capable I am.
15. People at work care about me.
16. There are not many people at work that I am close to.
17. I feel like I can pretty much be myself at work.
18. The people I work with do not seem to like me much.
19. When I am working I often do not feel very capable.
20. There is not much opportunity for me to decide for myself how to go about my work.
21. People at work are pretty friendly towards me.

Autonomy:
1, 5(R), 8, 11(R), 13, 17, 20(R)
Competence:
3(R), 4, 10, 12, 14(R), 19(R)
Relatedness:
2, 6, 7(R), 9, 15, 16(R), 18(R), 21

Modified (Pre-Analysis)

Construct	**Item no.**	**Item**
Aut	1	I feel like I can provide a lot of input into deciding how to save fuel.
Rel	2	Discussing fuel efficiency brings me closer to people at work.
Com ®	3	I do not feel very competent at saving fuel.
Com	4	People at work tell me I am good at saving fuel.
Aut ®	5	I feel pressured to save fuel.

Rel	6	I enjoy talking with co-workers about saving fuel.
Rel ®	7	I pretty much keep to myself about fuel efficiency.
Aut	8	I feel free to express my ideas and opinions about fuel efficiency.
Rel	9	I consider the people I discuss fuel efficiency with to be my friends.
Com	10	I have been able to learn interesting new skills regarding fuel efficiency.
Aut ®	11	When it comes to saving fuel, I have to do what I am told.
Com	12	Most days I feel a sense of accomplishment because I flew fuel efficiently.
Aut	13	My thoughts and feelings regarding fuel efficiency are taken into consideration at work.
Com ®	14	On my job I do not get much of a chance to show how capable I am.
Rel	15	People with whom I discuss fuel-efficiency care about me.
Rel ®	16	There are not many people with whom I discuss fuel efficiency that I am close to.
Aut	17	I feel like I can pretty much be myself around people with whom I discuss fuel efficiency.
Rel ®	18	The people with whom I discuss fuel efficiency do not seem to like me much.
Com ®	19	I often do not feel very capable of saving fuel.
Aut ®	20	There is not much opportunity for me to decide for myself how to go about saving fuel.
Rel	21	When I discuss fuel efficiency with co-workers, they are pretty friendly towards me.

Modified (Post-Analysis)

Construct	**Item no.**	**Item**
Aut	1	I feel like I can provide a lot of input into deciding how to save fuel.
Rel	2	Discussing fuel efficiency brings me closer to people at work.
Com ®	3	I do not feel very competent at saving fuel.
Com	4	People at work tell me I am good at saving fuel.
Aut ®	5	I feel pressured to save fuel.
Rel	6	I enjoy talking with co-workers about saving fuel.
Rel ®	7	I pretty much keep to myself about fuel efficiency.

Aut	8	I feel free to express my ideas and opinions about fuel efficiency.
Rel	9	I consider the people I discuss fuel efficiency with to be my friends.
Com	10	I have been able to learn interesting new skills regarding fuel efficiency.
Aut ®	11	When it comes to saving fuel, I have to do what I am told.
Com	12	During most SAAM and/or channel missions I feel a sense of accomplishment because my efforts saved fuel.
Aut	13	My thoughts and feelings regarding fuel efficiency are taken into consideration at work.
Com ®	14	On my job I do not get much of a chance to show how capable I am at fuel efficient flying.
Rel	15	People with whom I discuss fuel-efficiency care about me.
Rel ®	16	There are not many people with whom I discuss fuel efficiency that I am close to.
Aut	17	I feel like I can pretty much be myself around people with whom I discuss fuel efficiency.
Rel ®	18	The people with whom I discuss fuel efficiency do not seem to like me much.
Com ®	19	I often do not feel very capable of saving fuel.
Aut ®	20	There is not much opportunity for me to decide for myself how to go about saving fuel.
Rel	21	When I discuss fuel efficiency with co-workers, they are pretty friendly towards me.

Appendix C: Item Statistics

Amotivation

	Mean	Minimum	Maximum	Range	Maximum / Minimum	Variance	N of Items
Inter-Item Correlations	.774	.666	.892	.226	1.340	.010	3

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Am1	4.58	6.167	.839	.796	.859
Am2	4.50	5.130	.911	.848	.798
Am3	5.00	7.043	.739	.588	.939

External Regulation-Combined

	Mean	Minimum	Maximum	Range	Maximum / Minimum	Variance	N of Items
Inter-Item Correlations	.485	.198	.706	.508	3.567	.022	6

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
ExtMat3	11.08	19.819	.691	.582	.799
ExtSoc2	10.54	19.389	.571	.524	.817
ExtSoc3	9.67	19.884	.383	.192	.863
ExtMat1	10.96	17.085	.680	.615	.795
ExtMat2	10.92	18.601	.749	.625	.784
ExtSoc1	9.96	18.911	.702	.557	.793

External-Social Regulation

	Mean	Minimum	Maximum	Range	Maximum / Minimum	Variance	N of Items
Inter-Item Correlations	.384	.198	.570	.372	2.880	.028	3

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
ExtSoc2	5.63	4.071	.430	.325	.541
ExtSoc3	4.75	3.761	.324	.148	.724
ExtSoc1	5.04	3.781	.604	.401	.326

External-Material Regulation

	Mean	Minimum	Maximum	Range	Maximum / Minimum	Variance	N of Items
Inter-Item Correlations	.639	.573	.706	.133	1.231	.004	3

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
ExtMat1	3.25	3.065	.760	.579	.726
ExtMat2	3.21	4.259	.717	.523	.749
ExtMat3	3.38	4.853	.659	.437	.812

Identified Regulation

	Mean	Minimum	Maximum	Range	Maximum / Minimum	Variance	N of Items
Inter-Item Correlations	.585	.525	.678	.153	1.292	.005	3

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Ident1	6.04	3.433	.704	.512	.688
Ident2	6.17	2.928	.674	.492	.703
Ident3	7.04	3.172	.585	.346	.800

Intrinsic Motivaiton

	Mean	Minimum	Maximum	Range	Maximum / Minimum	Variance	N of Items
Inter-Item Correlations	.710	.605	.778	.173	1.286	.007	3

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Intrin1	3.58	3.297	.851	.725	.738
Intrin2	4.13	4.375	.714	.558	.875
Intrin3	3.71	3.346	.749	.607	.845

Introjected Regulation

	Mean	Minimum	Maximum	Range	Maximum / Minimum	Variance	N of Items
Inter-Item Correlations	.538	.430	.723	.294	1.683	.012	4

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Introj1	5.33	4.754	.544	.303	.788
Introj2	5.21	4.172	.656	.454	.729
Introj3	5.79	5.737	.709	.605	.728
Introj4	5.67	5.536	.639	.541	.739

Autonomy Satisfaction

	Mean	Minimum	Maximum	Range	Maximum / Minimum	Variance	N of Items
Inter-Item Correlations	.123	-.415	.496	.912	-1.196	.066	7

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Aut1	17.96	11.498	.324	.548	.403
Aut2R	17.83	14.787	-.115	.575	.611
Aut3	16.87	14.300	.004	.389	.533
Aut4R	18.13	10.482	.525	.408	.310
Aut5	18.04	13.043	.183	.178	.467
Aut6	17.22	10.905	.401	.444	.364
Aut7R	17.87	10.573	.422	.647	.349

Relatedness Satisfaction

	Mean	Minimum	Maximum	Range	Maximum / Minimum	Variance	N of Items
Inter-Item Correlations	.326	-.090	.796	.887	-8.838	.048	8

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Rel1	21.21	15.824	.700	.731	.753
Rel2	21.04	14.563	.879	.831	.717
Rel3R	20.58	19.297	.433	.377	.796
Rel4	19.83	18.493	.492	.733	.788
Rel5	20.08	17.732	.562	.804	.778
Rel6R	20.17	19.971	.291	.527	.816
Rel7R	19.25	20.196	.362	.461	.804
Rel8	19.71	19.694	.416	.377	.798

Competence Satisfaction

	Mean	Minimum	Maximum	Range	Maximum / Minimum	Variance	N of Items
Inter-Item Correlations	.143	-.234	.473	.707	-2.022	.051	6

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Com1R	14.21	7.737	.403	.334	.423
Com2	15.96	8.216	.259	.333	.491
Com3	15.21	5.563	.638	.456	.237
Com4	16.04	8.216	.287	.253	.478
Com5R	14.25	9.239	.080	.048	.573
Com6R	14.33	9.797	.027	.344	.582

References

Ariely, D., Bracha, A., and Meier, S. (2009). Doing good or doing well? Image motivation and monetary incentives in behaving prosocially. The American economic review, 99(1), 544-555.

Benabou, R., and Tirole, J. (2003). Intrinsic and extrinsic motivation. The Review of Economic Studies, 70(3), 489-520.

Bénabou, R., and Tirole, J. (2005). Incentives and prosocial behavior (No. w11535). National Bureau of Economic Research.

Bonein, A., and Denant-Boèmont, L. (2015). Self-control, commitment and peer pressure: a laboratory experiment. Experimental Economics, 18(4), 543-568.

Cerasoli, C. P., Nicklin, J. M., and Ford, M. T. (2014). Intrinsic motivation and extrinsic incentives jointly predict performance: A 40-year meta-analysis. Psychological Bulletin, 140(4), 980.

Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. Psychometrika, 16, 297-334.

Esteve, M., Urbig, D., van Witteloostuijn, A., and Boyne, G. (2016). Prosocial Behavior and Public Service Motivation. Public Administration Review, 76(1), 177-187.

Gagné, M. (Ed.). (2014). The Oxford handbook of work engagement, motivation, and self-determination theory. Oxford University Press.

Gagné, M., and Deci, E. L. (2005). Self-determination theory and work motivation. Journal of Organizational Behavior, 26(4), 331-362.

Gagné, M., Forest, J., Vansteenkiste, M., Crevier-Braud, L., Van den Broeck, A., Aspeli, A.K., Bellerose, J., Benabou, C., Chemolli, E., Güntert, S.T. and Halvari, H., (2015). The

multidimensional work motivation scale: Validation evidence in seven languages and nine countries. European Journal of Work and Organizational Psychology, 24(2), 178-196.

Hagger, M. S., & Chatzisarantis, N. L. (2007). Intrinsic motivation and self-determination in exercise and sport. Human Kinetics.

Koestner, R., Otis, N., Powers, T. A., Pelletier, L., & Gagnon, H. (2008). Autonomous motivation, controlled motivation, and goal progress. Journal of Personality, 76(5), 1201-1230.

Ryan, R M., & Deci, E. L. (1998). The basic psychological needs scale-work. Downloaded from http://www.psych.rochester.edu/SDT/measures/needs_scl.html.

Ryan, R. M., & Deci, E. L. (2008). Self-determination theory and the role of basic psychological needs in personality and the organization of behavior. Handbook of personality: Theory and research, 3, 654-678.

Ryan, R. M., Rigby, C. S., & Przybylski, A. (2006). The motivational pull of video games: A self-determination theory approach. Motivation and emotion, 30(4), 344-360.

Schweitzer, M. E., Ordóñez, L., & Douma, B. (2004). Goal setting as a motivator of unethical behavior. Academy of Management Journal, 47(3), 422-432.

Simpson, B., and Willer, R. (2008). Altruism and indirect reciprocity: The interaction of person and situation in prosocial behavior. Social Psychology Quarterly, 71(1), 37-52.

Welsh, D. T., & Ordóñez, L. D. (2014). The dark side of consecutive high performance goals: Linking goal setting, depletion, and unethical behavior. Organizational Behavior and Human Decision Processes, 123(2), 79-89.

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 074-0188

1. REPORT DATE *(DD-MM-YYYY)*	**2. REPORT TYPE**	**3. DATES COVERED** *(From – To)*
23-03-2017	Graduate Research Project	October 2015 – March 2017

TITLE AND SUBTITLE

Development of a Fuel Efficiency Motivation Survey

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

Sanders, Cory E., Captain, USAF

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAMES(S) AND ADDRESS(S)
Air Force Institute of Technology
Graduate School of Engineering and Management (AFIT/EN)
2950 Hobson Way, Building 640
WPAFB OH 45433-8865

8. PERFORMING ORGANIZATION REPORT NUMBER

AFIT-ENS-MS-17-M-303

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
AMC A3F Fuel Efficiency Division
402 Scott Drive, Unit 3A1
Scott AFB IL 62225-5252
Col Laurel Burkel
Laurel.Burkel@us.af.mil

10. SPONSOR/MONITOR'S ACRONYM(S)
AMC/A3F

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

12. DISTRIBUTION/AVAILABILITY STATEMENT
DISTRUBTION STATEMENT A. APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED.

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

14. ABSTRACT

To understand why US Air Force mobility pilots operate fuel efficiently, this research was aimed at developing a survey that measures constructs related to motivation according to the Self-Determination Theory framework. The 40 item survey was administered to 24 Air Force mobility pilots. In addition to their item responses, their subjective feedback was collected to support face validity of the survey. Overall results of the study provided sufficient evidence the survey will be effective in a full-scale study of fuel efficiency motivation in the sampled population.

15. SUBJECT TERMS
Motivation, Basic Psychological Needs, Autonomous Motivation, Intrinsic Motivation, Controlled Motivation, Survey Development

16. SECURITY CLASSIFICATION OF: Unclassified			**17. LIMITATION OF ABSTRACT**	**18. NUMBER OF PAGES**	**19a. NAME OF RESPONSIBLE PERSON**
a. REPORT	**b. ABSTRACT**	**c. THIS PAGE**			Kenneth L. Schultz, AFIT/ENS
U	**U**	**U**	**UU**	60	**19b. TELEPHONE NUMBER** *(Include area code)* (937) 255-6565, ext 4725 (Kenneth.schultz@afit.edu)

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std. Z39-18