January 2019

United States Coast Guard Aviation Safety: Relationship Between The Safety Survey And The Extent Of Hazard Reporting

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UNITED STATES COAST GUARD AVIATION SAFETY: RELATIONSHIP BETWEEN THE SAFETY SURVEY AND THE EXTENT OF HAZARD REPORTING

by

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Bachelor of Science, United States Coast Guard Academy, 2003

A Thesis

Submitted to the Graduate Faculty

of the

University of North Dakota

in partial fulfillment of the requirements

for the degree of

Master of Science in Aviation

Grand Forks, North Dakota

May
2019

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James Robert Cooley
April 12, 2019

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ACKNOWLEDGMENTS

I wish to express my sincere appreciation to the members of my thesis committee for their guidance. I appreciate all the wisdom imparted by all the faculty I have worked with throughout my master's program at the University of North Dakota.

ABSTRACT

Aviation safety outcomes, such as mishaps, are a product of an aviation organization's safety culture (Reason, 2008; Reiman & Pietikäinen, 2012). Safety cultures should be assessed in order to improve an organization's state of safety (Adjekum et al., 2015; Cooper, Collins, Bernard, Schwann, & Knox, 2019; Wiegmann, Zhang, von Thaden, Sharma, & Gibbons, 2004). Questionnaires are one of the best ways of obtaining information about an organization's safety culture (Wiegmann et al., 2004; Wald, Gray, & Eatough, 2018). Additionally, the extent to which aviation hazards are reported (hazreps) serve as an indicator of the health of an aviation Safety Management System (SMS) (Adjekum et al., 2015; Cooper et al., 2019) and as a marker of a proactive safety culture (Gu & Itoh, 2013; Reason, 2008; Reiman & Pietikäinen, 2012). Proactive safety cultures are linked to hazard mitigation amongst aviation organizations (Barach, 2000; Reiman & Pietikäinen, 2012). In light of this, and in an effort to have a proactive safety culture, the United States Coast Guard (USCG) wishes to know the extent of the relationship between its annual Operational Climate Survey (safety survey) and hazreps. The main research question for this thesis is: What is the extent of the relationship between USCG aviation safety survey data and the total of aviation hazards reported? First, an Exploratory Factor Analysis was conducted to determine the validity and reliability of the safety survey using data from FY 2015 to FY 2018 (n = 10,622) and to reduce the survey data to clusters of items within factors. The survey was found to be

statistically reliable. The averaged survey items within factors represented the survey in order to perform a Pearson's Correlation procedure between the survey data and hazrep totals per USCG air station (n = 28) per year. In addition, multiple regression procedures were carried out to determine if the safety survey was predictive of the extent to which hazards were reported. This research revealed that there was no statistically significant correlation between the safety survey and hazreps, and consequently, the safety survey was not predictive of hazreps.

CHAPTER I

INTRODUCTION

High risk industries such as aviation need to have safety-minded cultures in order to mitigate risks and hazards. Key to being safety-minded is the need for safety practitioners to assess the state of the organization and take action thereafter (Gu & Itoh, 2013). With such assessments, markers have been found to give an indication about how an organization's Safety Management System (SMS; defined later) is performing. One marker of safety culture performance is the existence and quality of a reporting system for accidents or close calls to be reported (Stolzer & Goglia, 2015).

The United States Coast Guard (USCG) administers an annual aviation questionnaire called the USCG Operational Climate Survey (hereafter referred to as "safety survey"). The safety survey is offered to all USCG personnel involved in aviation (pilots, rescue swimmers, flight crew, maintainers, and aviation leadership) and assesses the safety culture at each of the twenty-eight air stations. Several survey items pertain to the five USCG-defined safety cultures (USCG Office of Aviation Safety (CG-1311), 2016). The reporting culture is one of these wherein hazard reporting is key to the success of an organization's safety program. Reporting hazards involves individuals offering information pertaining to risks, close calls, or near-misses (USCG Office of Aviation Safety (CG-1311), 2016).

An organization's safety culture may be categorized as proactive or reactive. In order to catch hazards prior to their devolution into actual mishaps, there is emphasis on organizations to cultivate and sustain a proactive culture (Reason, 2008). Hazard reporting is characteristic of proactive safety cultures (Gu & Itoh, 2013; Reiman & Pietikäinen, 2012). The ability for members in an organization to report hazards and the extent to which this is done is linked to the health of an aviation safety culture (Cooper, Collins, Bernard, Schwann, & Knox, 2019; Adjekum et al., 2015). Hindsight and analysis of historic safety events is important to learn from previous mistakes; this practice also enhances a just safety culture, thereby reducing a culture of blame. Proactive safety management, however, is important in reducing accident rates by enabling organization leaders the ability to instate preventative safety measures preemptive to mishap occurrences (Barach, 2000).

Safety survey results are presently not used as a predictive tool at the USCG headquarters or air station levels. There is potential for the Coast Guard aviation safety survey data to act as a predictive tool if properly analyzed. The relationship between the safety survey and the extent to which hazards are reported is unknown (A. Carvalhais, C. Comperatore (USCG IRB), C. Wright (USCG Safety Programs Chief), A. Young, J. Cooley, personal communications, October 4-16, 2017). Determining the extent of this relationship is the purpose of this research.

USCG Safety Survey

The annual safety survey is "an in-depth audit of all phases of operations involving safety" (USCG Office of Aviation Safety (CG-1311), 2016, p. 20-3). With survey results, air station leaders can obtain information about safety practices and safety culture. The safety survey provides air station members the opportunity to anonymously communicate safety issues (USCG, 2016). In addition to air station benefits, the Office of Safety and Environmental Health (CG-113), a USCG Headquarters office, is responsible for evaluating air station safety posture, gathering feedback on safety issues, and understanding the efficacy of safety training programs and policy (USCG Office of Aviation Safety (CG-1311), 2016).

Analyzing survey data is advantageous to the assessment of safety cultures because survey respondents are free to provide opinions on their own perceptions of the organization's culture (Wreathall, 1995). Safety surveys provide leaders with a valuable tool to assess the likelihood that aircraft and lives may be lost. Therefore, leaders should treat survey results with thoughtful consideration in determining organizational safety policies and practices (Schimpf, 2004).

Hazard Reporting and the Health of SMS

The extent to which hazards are reported (hereafter referred to as hazreps) serve as a proactive marker of safety performance (Adjekum, et al., 2015; Cooper et al., 2019; Gu & Itoh, 2013). Individuals' knowledge of the reporting options, along with how to use each option is crucial to the health of the reporting culture (Stolzer & Goglia, 2015).

For this research, hazreps are drawn from USCG Class D mishaps. Class D mishaps are defined by the severity of injuries, cost, damage, as well as a sub-set of other events defined by USCG policy. Within this sub-set, there is a list of events that "reveal hazardous trends and underscore lessons learned…" and "must be reported to prevent recurrence of similar events that could result in much greater injury or damage" (USCG Office of Aviation Safety (CG-1311), 2016, p. 3-4). This list includes: "Any events that identify possible deficiencies in current operational policy or procedures; [issues with] Personal Protective Equipment (PPE); or [airframe] configuration or performance" (USCG Office of Aviation Safety (CG-1311), 2016, p. 3-5). Additionally, there is a more specific list of aviation-related hazards that should be reported. These hazards are (USCG Office of Aviation Safety (CG-1311), 2016, pp. 3-5, 3-6):

1. Aeromedical events
2. Precautionary landings
3. Power loss
4. Propeller wash
5. Rotor wash
6. Engine wash
7. Weather-related mishaps
8. Jettison
9. Hoist shear
10. Equipment drops
11. Things falling off aircraft
12. Laser exposure
13. Near midair collisions

Some hazards are subtle and require initiative on the behalf of aircrewmen and maintainers to report. Examples of such subtle hazards are (USCG Office of Aviation Safety (CG-1311), 2016, pp. 3-5, 3-6):

1. Unsafe work conditions
2. Resource gaps such as insufficient tools
3. Rogue aviators
4. Breakdowns in Crew Resource Management.

These hazards should be reported as they provide free lessons for USCG aviation at large (USCG, 2016). It is with hazreps such as these that change in organizational procedures are initiated (von Thaden, T. & Gibbons, A., 2008).

Coast Guard Air Stations

U.S. Coast Guard air stations range from 100 to 600 members. Air stations are throughout the country along the Pacific and Atlantic coasts, along the shores of the Gulf Mexico and the Great Lakes, in Alaska, Hawaii, and Puerto Rico. Air stations conduct varying missions that include homeland security protection, search and rescue, drug and migrant interdiction, and fisheries enforcement (USCG Office of Aviation Forces (CG-711), 2013).

The Relevance of this Research

Based on conversations with the Chief of Safety Programs (CG-113) and the U.S. Coast Guard Institutional Review Board, the relationship between the safety survey and the extent to which hazards are reported is presently unknown. This research investigated if there is any relationship between the safety survey and hazreps, if there is a correlation, or if the safety survey predicts hazreps (A. Carvalhais, C. Comperatore (USCG IRB), C. Wright (Safety Programs Chief), A. Young, J. Cooley, personal communications, October 4-16, 2017).

Safety Management Systems (SMS) are structures that enable the development of policies and systems to promote and assess safety practices within organizations (Stolzer & Goglia, 2015). Since hazreps are a proactive marker for the health of an SMS, it is beneficial to the U.S. Coast Guard to determine the extent of the relationship between the safety survey and hazreps (C. Wright, J. Cooley, personal communications, January 2, 2018). If there is a relationship, the safety survey can serve as an efficient means of determining the health of air station SMS's before hazards manifest into actual mishaps. This research is beneficial regardless of the outcome of the analysis. Results will be informative to USCG leaders whether there is a relationship revealed between variables or not.

There is a gap in research on this topic throughout the aviation industry. There exists a breadth of literature covering SMS assessment, including surveys and questionnaires, as well as numerous books and articles covering the reporting culture and its importance. However, there is a dearth of literature specifically assessing the relationships between questionnaires and hazard reporting. This research study will attempt to address this research gap in the aviation industry, while targeting a specific U.S. Coast Guard need.

Purpose of the Study

The purpose of this study is to determine the relationship between the USCG aviation safety survey and the extent to which hazards are reported. Additionally, this study will add to the body of research pertaining to the interaction between safety culture and hazard reporting.

Problem Statement

This study is intended to bolster the field of aviation safety culture research as well as meet the needs of the USCG Office of Aviation Safety (CG-1131). In the broadest sense, the purpose of this study is to improve USCG aviation pillars of safety. These pillars are Aviation Safety Policy, Risk Management, Assurance, and Promotion (USCG Office of Aviation Safety (CG-1311), 2016). This research focuses on the Safety Promotion pillar, specifically the safety and reporting cultures (USCG, 2015).

Reporting safety concerns come in different forms. Specifically, reporting hazards is an indicator of a positive SMS as a whole (Harris, 2016). The safety culture affects an organization's state of safety, which ultimately affects safety outcomes such as mishap occurrences and avoidance (Reason, 2008).

This research seeks to determine the extent of the relationship between the annual safety survey and hazard reporting. This knowledge will inform leaders at the air station level as well as fleetwide throughout the U.S. Coast Guard.

Literature Review

Hazard Reporting and its Effect on Proactive Safety Cultures

Reason (2008) has written about collective mindfulness, a state in which organizations are poised to optimally respond to mishaps. Organizations who have collective mindfulness attempt to learn from hazard reports in an effort to thwart larger scale hazards from turning into actual mishaps. Such organizations encourage the reporting culture by rewarding those people who make reports, especially reports pertaining to one's own mistakes or near misses. The importance of this reward schema is rooted in the premise that smaller incidents are relics of larger, potentially more hazardous, issues within the organization (Reason, 2008). Looking beyond the people who were proximal to a mishap, but instead, analyzing organizational influences that were antecedents to mishaps, paints a more complete picture of an organization's safety culture (Dekker, 2002).

Hazard reports are free lessons that provide insight into errors that may possess catastrophic potential. Identifying the right lessons from past events can be applied proactively, thereby reducing the quantity and severity of future mishaps. Organization members will only communicate hazards, however, if they feel it is safe to do so without fear of reciprocating punishment (Gu & Itoh, 2013; McMurtrie & Molesworth, 2018; Reason, 2008).

The extent to which hazards are reported is integral to the success of an organization's safety management (McMurtrie & Molesworth, 2018). Failed safety cultures are strongly connected to organizational accidents (Robertson, 2018). Hazards are reduced as much as practicable when organizations have strong safety cultures and advanced Safety Management Systems (Wang, 2011).

For an organization to proactively impose safety-related policy changes, leaders need to rely on those free lessons that arrive in the wake of near misses. While major mishaps may be denser with learned-lessons, they are too infrequent to use for regular, nimble, organizational change. Therefore, proactive organizations attempt to forecast major events by identifying hazardous factors, which in turn, aid in preventing these hazards from materializing into mishaps (Reason, 2008). Analyzing such leading indicators can increase organizational defenses against serious mishap potential in the future. Insight into which hazards culminate into larger mishaps can assist leaders in making decisions that steer the organization away from mishaps yet also continue to bolster those defenses that have previously been effective (Van der Schraaf, Lucas, & Hale, 1991). Reviewing historical data, such as hazreps, is a beneficial way to gain insights into a safety culture (Wreathall, 1995).

USCG Safety Survey

High-risk organizations' (such as a USCG air station) safety cultures need to be regularly assessed in order to improve upon (Wiegmann, Zhang, von Thaden, Sharma, & Gibbons, 2004). Case studies, surveys, field observations, interviews, and focus group discussions, in particular, provide safety leadership with a snapshot of the safety culture

(Patankar & Sabin, 2010). Such assessments reveal performance indicators of the organization's SMS (Cooper et al., 2019). If safety practitioners intend to understand the state of an organization's safety culture, questionnaires and surveys are one of the best means to do so (Wiegmann et al., 2004). Surveys are one of the best ways to gain perspective into people's opinions and beliefs (Wald, Gray, & Eatough, 2018).

The USCG annual safety survey is designed to identify and measure trends from one year to the next. Air station leaders glean safety-related information from the people who operate and maintain the air station's aircraft. Survey results provide leaders information relating to safety practices and the five USCG-defined safety sub-cultures (later defined). In taking the survey, respondents are provided an anonymous means to communicate safety issues such as mission scheduling practices, maintenance, leadership impact, morale, and resource (USCG, 2016).

Survey items cover the U.S. Coast Guard's five sub safety cultures as well as hazard potential, adequacy of training, proficiency, standardization, effectiveness of quality control, adequacy of resources, and physiological and psychological safety aspects (USCG Office of Aviation Safety (CG-1311), 2016).

USCG safety survey efficacy. A survey has existed in the USCG since the 1990's. It has changed form since then, but the exact dates of the current survey are unknown (A. Carvalhais, personal communication, November 28, 2018). There is conflicting information about the survey's tests of validity and reliability. It is unknown if either the survey was never validated and tested for reliability or was once tested but those results are located in an unknown location by USCG aviation safety officials (R. Figlock, personal communication, April 11, 2018, A. Carvalhais, personal communication, November 16, 2017). Because of this unknown, this research sets out to test validity and reliability.

Survey Validity and Reliability

Conducting a factor analysis helps determine survey validity, survey reliability, and reveals the structure of latent variables (Field, 2018). Survey validity is necessary to determine if an instrument is measuring what it sets out to measure (Rocco, 2011). Content validity ensures that survey items properly represent the desired dimension (Field, 2018). There is empirical grounding in using exploratory factor analyses to validate surveys relating to safety cultures (Adjekum, 2017; Edwards, Knight, Broome, & Flynn, 2010; Gibbons, von Thaden, & Wiegmann, 2006; Vinodkumara & Bhasib, 2010).

Survey reliability is an additional requirement in survey design which confirms the survey's ability to consistently measure the desired constructs and confirms if every time the instrument is used, similar results can be expected (Rocco, 2011). The Cronbach's alpha is a common measure of survey reliability (Field, 2018).

Safety Culture Definition

Human error can be viewed as the source of many accidents and mishaps, so it is worth inspecting the precursors of human error and see what is causal in the chain of events leading up to an accident (Dekker, 2002). While it is important to investigate why an error occurred, it is just as, if not more fruitful, to uncover other contributing factors that led up to the actual error or mishap. Embedded in this chain of events is safety culture (Dekker, 2002).

A culture sets the overall tone in an organization and can affect many aspects of work environments, including safety. Cultures are comprised of those shared rituals, goals, beliefs, and values of an organization and its members (Wiegmann et al., 2004). These values and beliefs are held by members at all levels of an organization and affect safety behaviors (Federal Aviation Administration, 2010).

Safety culture can be described through its characteristics. A healthy safety culture has features that enhance knowledge transfer, improve knowledge of risk management, and have a means of receiving and providing feedback (Pidgeon, 1991). Healthy safety cultures characteristically foster inclusion of all organizational members, buy-in from safety leaders, and perpetuate safety promotion (Palframan, 1994). Healthy safety cultures are free of blame (Palframan, 1994), augment safety motivation, are a means of communicating safety information (Reason, 1997), encourage reporting and learning safety information, and stand the test of time (Wiegmann, et al., 2004).

Safety culture importance and influence. Organizational culture is the foundation of safe operations (Stolzer & Goglia, 2015) and is tightly connected to operational safety (Wiegmann et al., 2004). Meanwhile, the extent of mishap occurrences is strongly linked with failed safety cultures (Robertson, 2018). Within positive safety cultures, not only are mishap occurrences kept at bay, but all the components of aviation Safety Management Systems perform seamlessly (Stolzer & Goglia, 2015). Policies and organizational cultures reside within SMSs (Stolzer & Goglia, 2015). Additionally, SMS implementation, management commitment, and safety promotion all influence safety cultures (Robertson, 2018).

USCG Safety Culture Sub-Components

The Safety and Environmental Health Manual is the primary guidance on all matters relating to USCG safety. This manual classifies and categorizes mishaps, describes hazard reporting, provides policy on the annual aviation safety survey, and defines the U.S. Coast Guard’s safety cultures (USCG, 2016). These safety cultures are the sub-components that comprise the greater safety culture and are summarized as follows (USCG Office of Aviation Safety (CG-1311), 2016):

1. Informed cultures have leaders who are knowledgeable about issues that affect organizational safety.
2. Flexible cultures adapt with new hazards or changes in operational pace.
3. Learning cultures are comprised of key members analyzing safety data and drawing conclusions in order to take further action.
4. Just cultures have members who trust their leaders to maintain accountability for unacceptable behavior and to learn from acceptable behavior. In turn, the organization’s members offer safety information without fear of reprisal.
5. Reporting cultures make it possible to report mistakes and hazards and further, are encouraged to do so.

Interaction of the Safety Culture Sub-Components

These sub-components interact with each other. Research conducted by Gerede (2015), in a Turkish aircraft maintenance organization, illustrated the extent to which safety culture sub-components were symbiotic. Reducing Gerede's (2015) findings on this topic to one statement: an organization cannot have one successful safety culture sub-component without the rest. Gerede (2015) wrote, "Unsuccessful reporting is likely to hamper hazard and risk analysis, risk mitigation measures, understanding the effects of mitigation, measurement of safety performance, monitoring safety over time, finding the root causes of factors that compromise safety, predicting the future and thus, taking measures for and management of change" (p. 235). This quote elucidates how all the safety culture components may degrade or augment each other.

The state of the just culture affects employees' willingness to speak up which affect the quality and quantity of safety information inputs (reporting culture) which is needed in order to enrich the learning culture (Gerede, 2015). A relic of a healthy safety culture is witnessed by the extent to which organization members report and learn from mistakes (Wiegmann et al., 2004).

Interaction of Just and Reporting Cultures. Removing blame from errors and mishaps will result in an enhancement of an organization's just culture. Just cultures promote the reporting of adverse events, mistakes, and hazards, which, in turn promotes the learning safety culture (Cooper et al., 2019; McMurtrie & Molesworth, 2018). Just cultures encapsulate reporting cultures. Edwards (2018) further emphasizes this point in a description of failed just cultures in U.S. hospitals. In the hospitals researched, blame and hostility were normalized; doctors' and nurses' careers were jeopardized if they were to report their own mistakes. In such a climate, safety culture progress is blunted (Edwards, 2018).

Another example of the detrimental effects of unjust cultures may be found in Liao's (2015) research on pilots employed with a major Chinese airline. This research exposed the negative impacts on reporting cultures due to pilot hierarchical power differentials coupled with pilots' intrinsic desires to maintain harmony within the cockpit. This unjust culture created a barrier to the communication of safety-related data and therefore inhibited the extent to which voluntary reports were made (Liao, 2015).

Trust encourages the voluntary communication of safety information and is therefore requisite for just cultures to exist (Reason, 1997). The issue of voluntary or self-motivated reporting safety issues has gained prominence due to the implications on aviation safety management systems. In recent research, "fear of reprisal" was the leading reason why Australian commercial pilots did not provide voluntary safety reports (McMurtrie & Molesworth, 2018).

The Global Aviation Information Network provides guidance on creating and sustaining a reporting culture that is just with the following characteristics (2004, p. 292):

- Ease of making a safety report.
- Professional handling of investigations.
- Rapid feedback to the reporting community.

- Separation of the department collecting and analyzing safety reports from that with the authority to institute disciplinary proceedings and impose sanctions.
- Independence of the managers from the reporting system.
- Clear procedures for determining culpability and follow-up action.

Hazard Reporting and the Reporting Culture

In an effort to be proactive in mishap reduction, aviation organizations should measure what leading indicators that are available. One such leading indicator is the extent to which organization members are able to report hazards (Reiman & Pietikäinen, 2012). Such hazard reports provide leadership a means of knowing the health of their organization's safety culture and risks the organization faces. This is a proactive posture for leaders to assume. In being proactive, leaders can detect and trap errors before they surface as mishaps; however, members of the organization need practical skills necessary to stay vigilant and discover hazards. In turn, there needs to be clear knowledge on how to communicate hazards to leadership (Gu & Itoh, 2013; Reason, 2008).

Reason (2008) and Schein (2004) explain how leadership's commitment to safety is embodied by their reaction when safety-related information and hazards are reported. It is critical that leaders treat safety reports as vital components of an SMS, and not pursue any disciplinary action (Reason, 2008).

In order to find trends to make policy changes and operational decisions, hazards need to get in the hands of leaders and safety officers (ICAO, 2013). Since catastrophic aviation accidents are relatively infrequent, there is a resultant void in accessible data for organizations to use in order to be flexible in creating change necessary to enhance an aviation organization's safety. Meanwhile, near misses and hazards occur far more frequently and therefore, produce many more lessons worth informing aviation leaders about (Reason, 2008). Once hazards are communicated, safety personnel can take a proactive safety stance and attempt to be predictive with decisions thereafter (ICAO, 2013).

Major mishaps are comprised of those numerous, incremental risks that are realized in day-to-day hazards. Having an understanding of such near misses and hazards provide leadership with the ingredients that culminate and result in these infrequent major accidents. Knowing these ingredients provide leaders an opportunity to preemptively inject measures to reduce risk and mishap rates (Van der Schraaf et al., 1991).

Reactive safety postures, on the other hand, are more problematic than the mere tardiness of an aviation organization's mishap response. By having a reactive posture, safety personnel are influenced by their present-time retrospection. Despite safety analyzers best efforts, it is impossible to fully comprehend the real-time events when looking back to a later time. In this scenario, the best that safety personnel can do is respond with as much contextual understanding as practicable (Dekker, 2014).

USCG Hazard Reporting

There should be numerous systems in place for organization members to anonymously report hazards (Stolzer & Goglia, 2015). In the U.S. Coast Guard, hazards may be submitted via a hyperlink on the daily flight schedule (online via the USCG intranet), communicated verbally, or anonymously written down on paper and placed in locked boxes throughout the air station (USCG, 2016).

USCG guidance provides a description of what an ideal reporting culture looks like. In this ideal, there are numerous methods of communicating hazards; all air station members know what the reporting requirements are; hazard reports occur automatically without Flight Safety Officer (FSO) probing or initiation; leaders within the chain of command add insight to a mishap report as it gets routed for approval; and safety information is communicated with punctuality and timeliness (USCG, 2016).

The U.S. Coast Guard provides the following guidance to FSOs in cultivating hazard reporting (USCG, 2016, p. 42):

- Are there “Anymouse” boxes [similar to a suggestion box] throughout the base?
- Is there an anonymous reporting link on your air station's flight schedule?
- Does everyone know about these reporting boxes and link?
- Mention the importance of reporting in your closing remarks to every one of the numerous safety presentations you give.
- Is the safety office in a strategic location? Does everyone know where the FSO works?
- Ensure Aviation Engineering leadership buy-in.
- View the blue and pink sheets [mission flight log and aircraft discrepancy log, respectively] on the previous day's schedule to catch any mishaps. If there were

and you didn't hear about it, use this as an opportunity to educate aircrew on reporting and take further action to bolster your unit's reporting culture.

USCG reporting policy. The U.S. Coast Guard promulgated policy on the reporting culture. First, there is a requirement to have a means of anonymously reporting hazards. Anonymous reporting boxes must be located such that people may drop paper-based reports and retain as much privacy and discretion as practicable. There should also be a means of providing prompt feedback to show how the hazard was addressed or at a minimum, acknowledged. All the while, leadership should emphasize their focus on safety targets rather than seeking reprisal on those whom place hazard reports (USCG Office of Aviation Safety (CG-1311), 2016). USCG policy underscores the importance of hazard reporting within an SMS by stating, “The command must establish a clear safety message and achievable goals to create a positive command climate. These actions begin with the free flow of safety information and hazard reporting at all levels of the unit, and recognition for commitment to safety awareness and mishap prevention” (USCG Office of Aviation Safety (CG-1311), 2016, p. 1-5).

Research Questions

What is the extent of the relationship between U.S. Coast Guard aviation safety survey data and the total of aviation hazards reported?

1. How are hazards reported in the U.S. Coast Guard?
2. How is hazard reporting an indicator of the health of an organization’s safety culture?
3. How is it possible to determine if safety survey data predicts hazard reporting?

a. Does the safety survey predict hazard reporting?

4. If the current safety survey does not predict hazreps, what are the potential inhibiting limitations?

5. How can the safety survey be improved?

Hypotheses

H_1: USCG safety survey items that relate to safety culture all load onto one EFA factor.

H_2: The safety survey is reliable.

H_3: The safety survey correlates with hazreps.

H_4: The safety survey predicts hazreps.

CHAPTER II

METHODOLOGY

Purpose of the Study

The purpose of this study is to determine the relationship between the U.S. Coast Guard's aviation safety survey and the extent to which aviation hazards are reported. This study seeks to answer the following research questions:

What is the extent of the relationship between U.S. Coast Guard aviation safety survey data and the total of aviation hazards reported?

1. How are hazards reported in the U.S. Coast Guard?
2. How is hazard reporting an indicator of the health of an organization's safety culture?
3. How is it possible to determine if safety survey data predicts hazard reporting?
    a. Does the safety survey predict hazard reporting?
4. If the current safety survey does not predict hazreps, what are the potential inhibiting limitations?
5. How can the safety survey be improved?

Research Design

This research study used a quantitative sampling of data from October 1, 2014 to September 30, 2018 (Fiscal Year (FY)15 to FY18). The data came from two sources: the annual safety survey and the total number of hazard reports per air station per year. All statistical procedures were completed using IBM SPSS Statistics software, version 24. Figure 1 summarizes this research design and may be referenced to supplement the methodology explanation that follows.

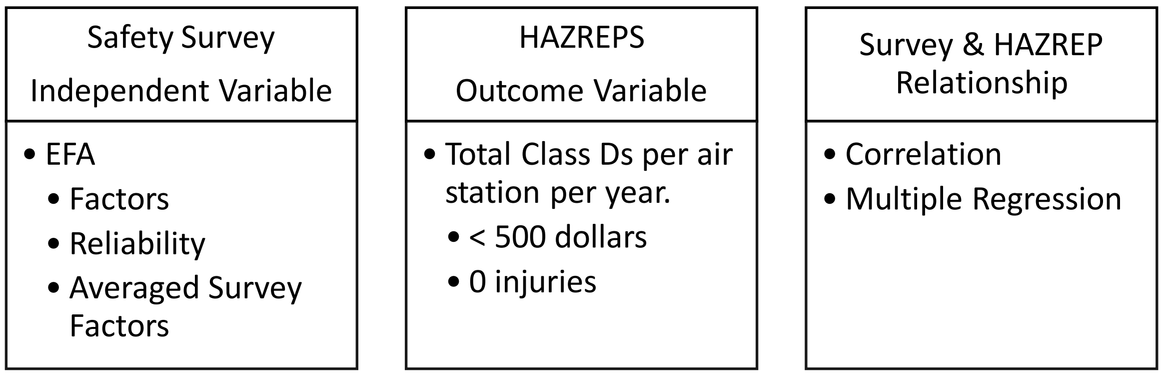

Figure 1. Research Design Summary.

Safety Survey

Survey responses were drawn from the entire U.S. Coast Guard for four years (FY15 – FY18). Surveys were taken by individuals whom, at the time of the survey, were stationed at one of the Coast Guard's air stations.

The U.S. Coast Guard uses an online service called Verint® to administer the survey. The survey data was saved within Verint®'s servers (USCG, 2016). The USCG Office of Aviation Safety (CG-1131) shared these data for the purpose of this research. This research required access to all survey results for FY15 – FY18. Appendix A contains the list of survey items.

At the survey's inception, the USCG conceived an 8-point Likert-style scale for most survey items. These response options are listed in Table 1.

Table 1. USCG Safety Survey Likert-Style Response Options

Selectable Response	Meaning
0	Not answerd
1	Strongly agree
2	Agree
3	Neutral
4	Disagree
5	Strongly disagree
6	Don’t know
7	N/A

The remaining survey items were multiple choice as well as open-ended. For the purpose of this research, these survey items were not used.

The survey also branched, allowing particular demographics to answer a bank of survey items, and disabling such items to other demographics. For example, some survey items were intended for pilots only, while others were only intended for aviation mechanics (USCG Office of Aviation Safety (CG-1131), 2018).

The survey had not previously been statistically validated or tested for reliability (R. Figlock, personal communication, April 11, 2018, A. Carvalhais, personal communication, November 16, 2017).

Participants. Participants in this study were drawn from a population of all ranks found at air stations throughout the USCG. The population of safety survey respondents were comprised of USCG pilots, maintenance personnel, and enlisted flight crew (rescue swimmers, navigators, sensor operators, etc.). Demographics were captured in the survey including rank, current job, which USCG asset the respondent was assigned to (model of aircraft), how long the respondent had been assigned to the current unit (air station), and recency of last deployment (USCG, 2016).

A purposive sampling strategy was used to elicit responses to the survey which was sent out via the internet. Participation in the survey was voluntary and Table 2 presents the number of survey respondents per fiscal year.

Table 2. Number of Survey Participants Per Fiscal Year.

Fiscal Year	*n*
FY15	2,726
FY16	2,994
FY17	3,098
FY18	3,368

Likert-style scale and missing data. This particular Likert-style scale would pose problems for the EFA if left unattended. First, 0 = not answered, is a selectable item on the survey, but survey respondents could simply not answer the survey item, which would result in missing data. Missing data was excluded pairwise, merely not using data that was not existant. Since the survey data had such a large respondent number, ranging from n = 10,622 to n = 2,307 (based on branching logic), it is statistically acceptable to exclude pairwise cases. As such, excluding missing data by excluding the entire respondent's survey items, or by replacing the missing data with the mean, were unnecessary (Field, 2018).

Likert scale responses of 0, 6, and 7 were excluded from the Exploratory Factor Analysis because these answers would negatively impact the statistical procedure. By excluding 0 = "not answered," this was statistically the same as excluding pairwise cases for missing data. If respondents selected 6 or 7 (“Don’t know” and “N/A,” respectively), the mean for that survey item would erroneously increase, trending toward “strongly disagree.” Therefore, survey responses of 0, 6, and 7 were recoded to not factor into the EFA.

Exploratory Factor Analysis

An Exploratory Factor Analysis evaluates clusters of underlying constructs and may also suggest a reduction in the number of items in a survey (Field, 2018). This EFA used Principle Axis Factoring (PAF). Oblimin and varimax rotations were both initially performed for preliminary analysis. The oblimin was selected as the preferred rotation method because there were fewer cross-correlations between survey items than the varimax rotation. Sampling adequacy was evaluated using the Kaiser-Meyer-Olkin (KMO) test. Lastly, a reliability analysis evaluated the consistency of the survey scale items using the Cronbach’s alpha.

To determine survey validity, survey items were clustered into latent variables. These variables’ correlations were assessed, survey items that had low goodness of fit values were removed, and the survey was subsequently re-analyzed. In factor analysis, the process of extracting survey items may improve the survey’s validity and reliability (Field, 2018). PAF analysis was performed in order to obtain eigenvalues for each factor. The following items were analyzed using Field (2018)’s guidance:

1. The Scree plot along with the total variances’ eigenvalues to determine factor-retention based on the plot’s point of inflexion in combination with factor loadings.

2. The Determinant, an indication of multicollinearity. In general, if the Determinant is less than 0.00001, there may be a problem with multicollinearity. Multicollinearity is when multiple variables are too closely related. If multicollinearity exists, it may not be possible to determine the unique contribution of a variable to a factor.

3. The KMO value measures how suited data is for a factor analysis. The KMO should be greater than 0.5. The closer the KMO value is to 1, the more closely compact variables' patterns of correlations are, which indicates reliable, and distinct, factors from the factor analysis (Kaiser & Rice, 1974).

4. The Bartlett's test informs that correlations between variables are significantly different from zero.

5. The Pearson's correlation coefficients to confirm values between .3 and .9. Coefficients that are less than .3 are likely a poor fit between an item and the rest of the pool of items. Greater than .9, the items are representative of the whole scale.

Factors. Factors are those underlying dimensions that emerge from an EFA and are comprised of correlated survey items. An EFA provides a covariance matrix structure to ensure that items that are highly correlated cluster under a specific factor (Field, 2018). Factors with eigenvalues less than one were excluded from subsequent analysis. Factors were then treated as their own new variables for the correlation and multiple regression analysis discussed later.

Hazreps

In order to determine hazrep totals, Class D mishaps were categorized by summing the mishaps that cost less than 500 dollars and sustained zero injuries. These were totaled per air station per year. It was determined by the USCG's Office of Aviation Safety (CG-1131) that mishaps costing less than 500 dollars may be considered a hazrep for the purpose of this research. The rationale for this decision was that, since aircraft parts and maintenance labor hours are costly, most mishaps that cost 500 dollars or less were actually mere hazards that had collateral, residual cost (C. Wright, J. Cooley, personal communications, January 2, 2018). This point is illustrated in the following example of an aircraft conducting a precautionary landing due to a suspected issue. After landing, a maintenance inspection was performed which uncovered no aircraft issues. Due to the maintenance that was performed, there would still be maintenance labor hours (at a cost) associated with the inspection. This event may, however, still have a "free lesson" and therefore get reported as a Class D mishap, which the Office of Aviation Safety considers a hazard report (C. Wright, J. Cooley, personal communications, January 2, 2018).

Correlation and Regression Between the Safety Survey and Hazreps

A correlation was performed in order to determine the extent of the relationship between the safety survey and hazreps. Correlation is a statistical procedure that determines if variables are related positively or negatively, if at all (Field, 2018). A Pearson's correlation procedure was used for this research.

In order to establish if the safety survey variables predict hazrep variables, a linear regression procedure was performed at the air station level (as opposed to the individual survey respondent level). Using the equation for a line, $y = mx + b$, given any x, regression is used to predict y (Field, 2018). In the context of this research, hazreps were y, and the safety survey was x.

Data Collection

Survey data preparation. The survey responses were downloaded from Verint® into .sav files, the IBM SPSS Statistics software file format. The data was stored on a USCG-approved external hard drive (Imation Defender H200 + Bio 320GB) which requires a fingerprint to unlock. These data were then combined into one file in order to perform the Exploratory Factor Analysis.

Anonymity was assured through the use of the Verint® web-based questionnaire system which assigns an 18-digit identifier code to each set of responses. With safety survey data open in IBM SPSS Statistics software, the first column was deleted. This column contained all respondent 18-digit identifier codes. Working from the aforementioned hard drive with the identifier code deleted, respondents were disassociated with their responses from the files used for this research.

There were no survey items with reverse-phrasing. Therefore, there was no need to reverse-score the survey response data for any items.

Hazreps. There are multiple ways in which members of U.S. Coast Guard air stations may communicate a concern, a near-miss, or close call. Depending on criteria defined by USCG policy, however, hazreps may be published to the entire Coast Guard via the official mishap reporting system. This reporting system is called e-Aviatrs (USCG Office of Aviation Safety (CG-1311), 2016). For the purposes of this research, hazreps will be exclusively drawn from e-Aviatrs because it is the only means by which USCG hazreps are documented and stored and therefore, the only means by which hazrep data may be extracted (C. Wright, J. Cooley, personal communications, January 2, 2018).

USCG Class D mishaps were downloaded at the air station level for the same four years as the survey data (FY15 to FY18). This provided the total number of Class D mishaps per air station per year, which was needed to compare air station safety surveys with hazreps per year. Hazard reports were then parsed out of Class D mishaps.

After noting those Class D mishaps that were categorized as hazreps, these hazreps were then summed for each air station by fiscal year. The hazrep total then became the outcome variable for this research.

Data issue. An issue that might have impacted results is the unknown lag effect between any changes in safety cultural and resultant safety behavior. In other words, the safety survey may capture a safety culture that yields some result in hazrep totals, but it is unknown when those effects on hazrep totals would be realized. In the context of this research design, safety survey results and hazreps were analyzed within the same fiscal year. If there was a misalignment with an air station's safety survey and hazrep totals, the statistical analysis would be skewed.

Averaged Constructs to Represent the Safety Survey for Correlation/Regression

Each construct that emerged from the factor analysis became its own new variable. All survey item responses per factor for each air station, for each fiscal year, were summed, then divided by the number of answered survey items. This produced the average response value per factor per air station per year. To put in other words, all the responses for the survey items that comprised each PAF factor were averaged for each year at each air station. This resulted in new variables that were then used to conduct correlation and multiple regression procedures. This process is illustrated in Figure 2.

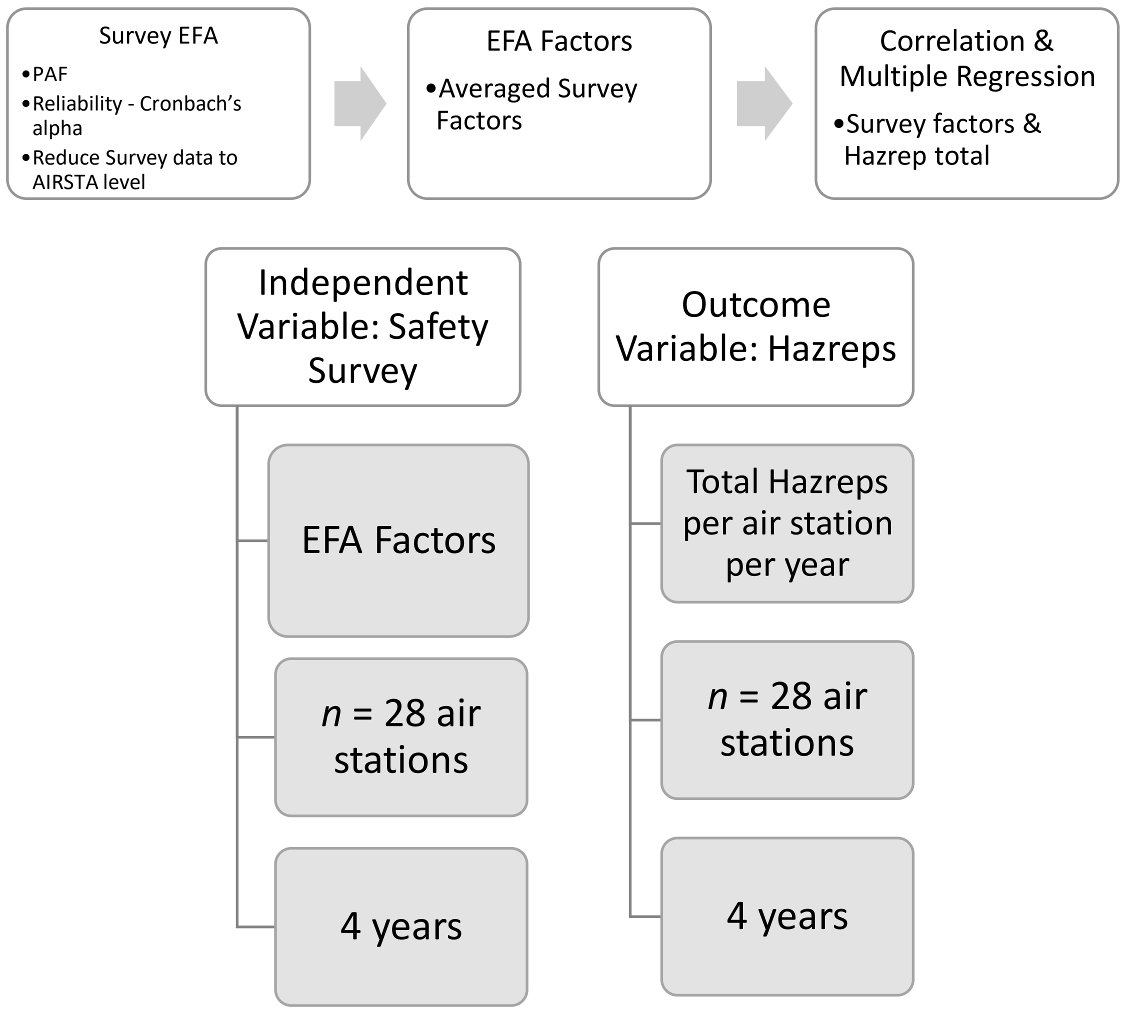

Figure 2. Research Design Process.

Correlation and Multiple Regression

In order to determine if the new independent variables (averaged survey factors) were significantly correlated with, or predictive of, the dependent variable (hazreps per air station per year), a multiple regression with forced entry procedures was performed. A correlation table is simultaneously produced as part of the multiple regression procedure in IBM SPSS Statistics software. Assumptions of independent errors, homoscedasticity, and linearity were tested by producing a plot of standard residuals. Missing data was excluded listwise.

Institutional Review Board (IRB)

University of North Dakota IRB approval was achieved on November 8, 2019. The IRB Project Number is IRB-201811-097. Since no human subjects were studied for this research, a UND IRB Existing Data Exempt Form was completed. U.S. Coast Guard IRB approval was also required and approved on November 28, 2018. Both IRB approval letters are included in Appendix B. Individual IRB training was completed on August 24, 2018.

Timeline

This topic was conceived jointly between the USCG Office of Safety and Environmental Health (CG-113) and the USCG IRB on October 4 and 5, 2017. Data was downloaded between June and October 2018. Expected graduation date is May 11, 2019.

CHAPTER III

RESULTS

To summarize all the data analyses for this thesis, an exploratory factor analysis of the U.S. Coast Guard's aviation safety survey was performed using principle axis factoring (PAF); then, the reliability of the survey was verified; using the resultant factors from the survey's factor analysis, statistical procedures were followed to determine if the survey was correlated with, or had a predictive relationship to, the extent to which hazards were reported. This chapter will describe the results for the PAF, survey reliability, correlation procedures, and the multiple regression.

PAF Results

All KMO values in this analysis were above 0.5 except those individual KMO values noted below. Also, all Bartlett's test values were highly significant, $p < .0001$.

Rationale for Two PAF/Reliability Iterations

Two PAF and reliability iterations will be discussed in this section. Through the process of analyzing the PAF, each iteration resulted in different values for the analysis criteria listed in Chapter II (Methodology). As such, subsequent PAF iterations were performed until the analysis was complete. This, however, resulted in a substantial number of extracted survey items throughout the PAF process.

The first iteration resulted in factor loadings with two (out of 52) survey items extracted. The final iteration was performed, after adherence to statistical procedures and PAF analysis criteria set forth by Field (2018), resulting in 32 survey items being extracted. Since following these procedures to completion resulted in a survey with merely 20 of the original 52 items, the first and the final PAF iterations will be discussed to provide a before-and-after comparison of survey validity and reliability results. Also, these two PAF iterations were used to perform correlation and multiple regression procedures with the hazrep outcome variable, resulting in two analyses.

In total, there were four iterations of PAF, incrementally eliminating items (detailed below). For each iteration of PAF, only the significant findings that resulted in item-extraction are noted.

First PAF Iteration – Close Factor Loading Between Two Items

After the first PAF iteration, two survey items had factor loadings that were too similar. These items, Q6R and Q7R, were subsequently extracted and not used in the first reliability analysis which resulted in seven factors. Appendix A shows the factor loadings after rotation, including eigenvalues and percent of variance per factor. Due to survey branching logic, descriptive statistics varied. The first PAF iteration descriptive statistics can be found in Appendix C.

Table 3. First PAF Summary.

	Factor						
	1	2	3	4	5	6	7
Eigenvalues	21.54	2.13	1.79	1.35	1.21	1.08	1.01
Percent of Variance	42.23	4.18	3.50	2.65	2.37	2.11	1.97
Item Quantity	7	6	6	3	11	9	4
α	.86	.80	.89	.80	.92	.89	.66
Extraction Method: Principal Axis Factoring. Rotation Method: Oblimin with Kaiser Normalization.							

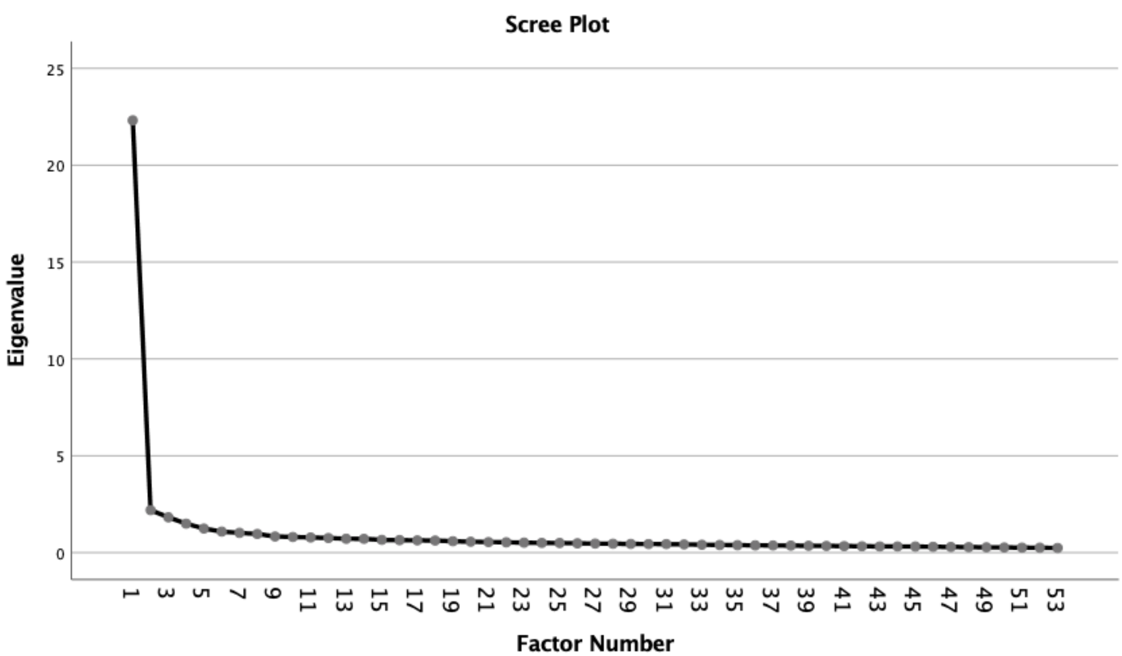

Figure 3. First PAF Scree Plot.

Factors 1, 3, 5, and 6 had a good factor structure because these factors had at least five items with factor loadings greater than 0.4 (Field, 2018). These factors represent flight skills & standardization evaluations, crew rest/workday, leadership & safety, and unit safety adoption. These factors explained the total variance by 42.1 percent, 3.44 percent, 2.34 percent, and 2.05 percent respectively.

Second PAF Iteration – Small Determinant & Poor Fit from Correlation Matrix

After the second PAF iteration, the Determinant was 5.67×10^{-14}, which is less than 0.00001. Three survey items, Q30R, Q113R, and Q118R all had Pearson's correlation coefficients less than 0.3 and were eliminated from further analysis.

Third PAF Iteration – Small Determinant & Individual KMO Values Less Than 0.5

After omitting Q30R, Q113R, and Q118R, the Determinant increased to 1.88×10^{-13} but was still less than 0.00001. Verifying the individual KMO statistics, there were twenty-nine more items to be eliminated. These eliminated survey items were: Q12R, Q14R, Q15R, Q16R, Q17R, Q21R, Q22R, Q25R, Q33R, Q33R-Q39R, Q28R, Q65R-Q71R, Q73R, Q74R, Q112R, Q114R, and Q129R.

Fourth and Final PAF Iteration

After excluding the aforementioned survey items, the Determinant increased to a suitable 0.001, the KMO value was 0.953 which was still above 0.5, Bartlett's test was still highly significant ($p < .0001$) and the individual KMO statistics were all greater than 0.5. These values signaled the conclusion of the PAF analysis.

Appendix B shows the factor loadings after rotation. Items that clustered onto the same factor suggested that factor 1 represented several topics including training quality, FSO perception, Crew Resource Management, standardization, and protective equipment. Factor 2 represented resources (time and experience). Factor 3 represented asset reliability and satisfaction with protective equipment. All descriptive statistics can be found in Appendix D. Based on the same criteria used in the first PAF iteration, factors 1 and 2 had a good factor structure while the third factor was weak. Total variances explained for factor 1 was 39.49 percent, factor 2 was 6.54 percent, and factor 3 was 5.28 percent.

Table 4. Final PAF Summary.

Survey Item	Factor		
	1	2	3
Eigenvalue	7.90	1.31	1.06
Percent of Variance	39.49	6.54	5.28
Item Quantity	11	5	4
α	.87	.79	.59
Extraction Method: Principal Axis Factoring. Rotation Method: Oblimin with Kaiser Normalization			

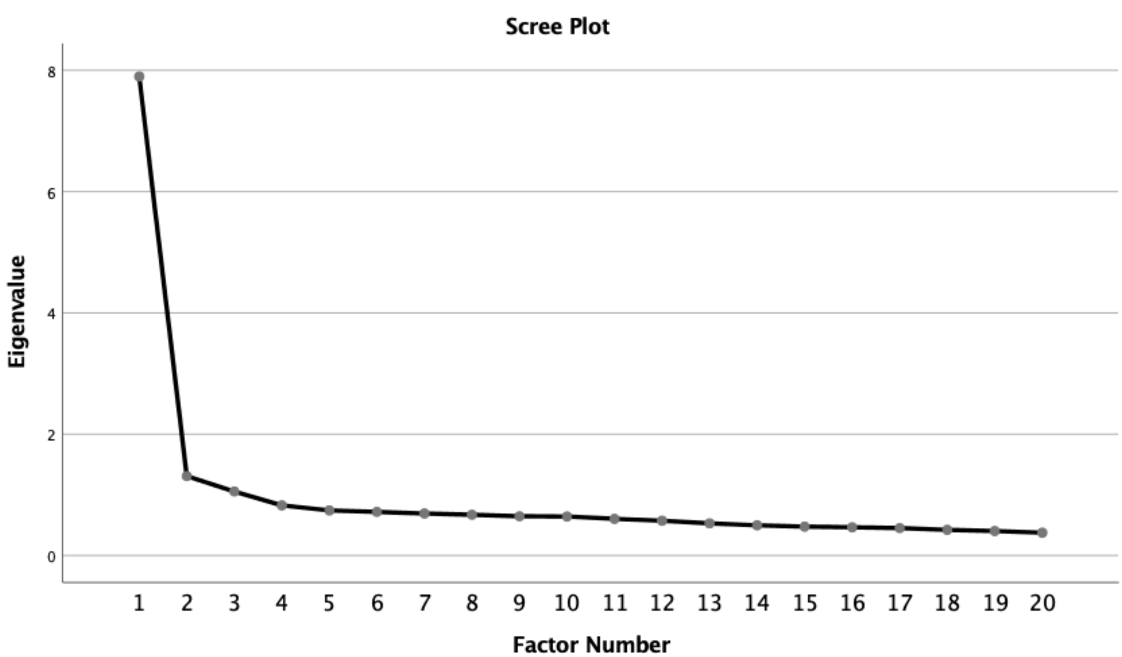

Figure 4. Final PAF Scree Plot.

First Reliability – All Original Survey Items Except Q6R and Q7R

The first reliability analysis was conducted using the first PAF iteration. Seven factors had initial eigenvalues greater than 1.0. All survey items correlated well with the overall scale (Field, 2018). As indicated in Table 3, all seven subscales' Cronbach's α were less than the requisite 1.0 and greater than .80, except Factor 7, Cronbach's α = .66.

Second Reliability – Complete PAF Survey Item Extraction Adherence

The three subscales from the fourth and final PAF were used for this reliability analysis. As indicated in Table 4, all three subscales' Cronbach's α's was less than 1.0. Factors 1 (α = .87), along with Factor 2 (α = .79) had high reliability. Factor 3 had a low reliability (α = .59).

The last two survey items found in the list in Appendix B (Q79R & Q78R) had common variance. However, if these items were extracted, there would only be two other remaining items in factor 3, thereby resulting in no Cronbach's α (no reliability metric) for Factor 3. For these reasons, this was the logical place to conclude the analysis.

Correlation and Multiple Regression Results

Table 5 shows the descriptive statistics used for the correlation and multiple regression analyses. There were 110 valid cases of hazrep data per air station per fiscal year. The missing data for two hazreps is due to Air Station Los Angeles being closed after FY16. A positive skewness is confirmed with the histogram plot (Figure 5) showing a trend of data to the left. There is a slight positive kurtosis, indicating a heavier-than-normal-tailed distribution.

Table 5. Hazrep Descriptive Statistics.

N	Valid	110
	Missing	2
Mean		9.14
Median		8.00
Variance		38.357
Skewness		.739
Std. Error of Skewness		.230
Kurtosis		.091
Std. Error of Kurtosis		.457
Minimum		0
Maximum		29

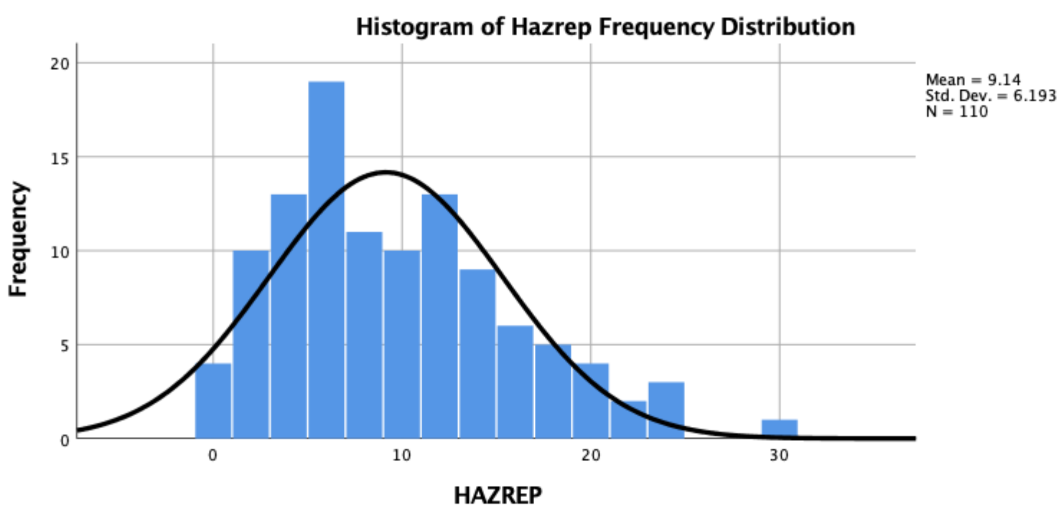

Figure 5. Hazrep Histogram.

Correlation Results

Factors drawn from the first PAF and last PAF were used to represent the safety survey at large. Since factors were a reduction in data, they served to represent this model's independent variables. Correlation procedures were performed concurrently with the multiple regression procedures. To summarize the correlation results, there was no significant correlation between the safety survey and hazreps.

The correlation matrix was checked for multicollinearity. Multicollinearity is indicated by independent variables correlating too highly, based on a threshold of $r > .9$ (Field, 2018). With this criterion, there was no multicollinearity amongst the survey factors (independent variables).

There were no independent variables (survey factors) that significantly correlated with the outcome variable (hazreps). Table 6 indicates the correlation coefficients and *p*-values for the first PAF. The most significant predictor amongst the first PAF analysis was Factor1 ($r = .151$, $p = .096$).

Table 6. Correlations Amongst Safety Survey First PAF Factors 1 to 7 and Hazreps.

		Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7
Pearson Correlation	HAZREP	0.151	-0.010	-0.033	-0.039	-0.006	-0.064	-0.061
	Factor1	1.000	0.578	0.726	0.629	0.699	0.784	0.614
	Factor2		1.000	0.522	0.650	0.593	0.716	0.552
	Factor3			1.000	0.558	0.639	0.756	0.472
	Factor4				1.000	0.822	0.658	0.719
	Factor5					1.000	0.712	0.724
	Factor6						1.000	0.570
	Factor7							1.000
Sig. (1-tailed)	HAZREP	0.096	0.466	0.390	0.370	0.481	0.290	0.299

For the last factor analysis iterations (Table 7), StrctFactor3 had the best correlation, albeit also non-significant ($r = .109$, $p = .175$).

Table 7. Correlations Amongst Safety Survey Fourth PAF Factors 1 to 3 and Hazreps.

		HAZREP	StrctFactor1	StrctFactor2	StrctFactor3
Pearson Correlation	HAZREP	1.000	0.029	-0.083	0.109
	StrctFactor1		1.000	0.527	0.632
	StrctFactor2			1.000	0.788
	StrctFactor3				1.000
Sig. (1-tailed)	HAZREP		0.402	0.238	0.175

Multiple Regression Results

Two iterations of multiple regression were performed; one using the first PAF's factors and the second iteration using the last PAF's factors.

In order to determine if the independent variables (survey factors) were predictive of the outcome variable (hazreps), a multiple regression was performed using forced entry procedures. Data was excluded listwise based on Field's (2018) recommendation (p. 302).

Assumptions of independent errors, homoscedasticity, and linearity were tested using plots of standard residuals (found in Appendix F). Also, probability-probability (P-P) plots for the residuals can be found in Appendix G. These plots portray the probability of a variable with the probability of the distribution and are useful to look for variance with skewness. These data were in compliance with all assumptions.

Factors 1 through 7 (first PAF) regression with hazreps. Factors 1 through 7 accounted for 14.7 percent of the variation in hazreps. The adjusted R^2 provides a value to determine how well the regression model generalizes. This model would account for approximately 8.8 percent less variance in the outcome if the model were consequent from the entire population. The quantity of this value indicates that the cross-validity of this model is insufficient (Field, 2018).

F-statistics indicate if the multiple regression model has a statistically significant improvement on predicting the outcome variable than if there were no independent variables (Field, 2018). Using survey factors 1 through 7, this model is not significantly better at predicting the outcome variable than the mean outcome, $F(7, 68) = 1.672$, $p = .131$.

Factor 1's *t*-statistic was significant, $t(68) = 3.20$, $p < .05$, but no other factors were significant predictors of hazreps. This indicates that Factor 1 was a significant predictor of hazreps. As Factor 1's values increased, the number of hazreps increased. Additionally, all but Factor 1's 95 percent confidence intervals contained zero. Confidence intervals that contain zero indicate that there may be zero (or a positive or negative) relationship between independent variables and the outcome variable. In other words, it is indeterminable what the magnitude or direction of the relationship is between survey factors 2 through 6 and hazreps.

Factors 1 through 3 (final PAF) regression with hazreps. The final PAF's factors 1 through 3 account for 8.8 percent of the variation in hazreps. The difference between R^2 and the adjusted R^2 indicates an insufficient cross-validity of this model.

Using the final PAF's survey factors 1 through 3, this model is not significantly better at predicting the outcome variable than the mean outcome, $F(3, 72) = 2.32$, $p = .082$. As was the case with the first PAF's factors 1 through 7, the *F*-statistic is not significant and therefore, this model also does not improve the ability to predict hazreps better than if the model were not used.

The final PAF's survey factors 2 and 3 were significant predictors of hazreps, $t(72) = -2.41$, $p < .05$ and $t(72) = 2.42$, $p < .05$, respectively.

Factor 1's 95 percent confidence interval also contained zero making it indeterminable what the magnitude or direction of the relationship is between survey factors 1 and hazreps.

CHAPTER IV

DISCUSSION

The purpose of this research was to answer the research question: What is the extent of the relationship between U.S. Coast Guard aviation safety survey data and the total of aviation hazards reported? Subordinate to this overarching research goal were the additional research questions and hypotheses. What follows is a summary of the answers to each research question and hypothesis, one-by-one.

Research Questions

The primary research question for this thesis:

What is the extent of the relationship between U.S. Coast Guard aviation safety survey data and the total of aviation hazards reported?

Using this study's research design, there was no statistically significant correlation or predictive measures between the safety survey and hazreps. Based on the literature review, a significant relationship may very well exist between the safety survey and hazreps if the survey were improved upon and if hazard reporting data were captured differently. Recommendations on how the safety survey and hazard reporting may be improved, and how that may affect the outcome of this, or similar follow-on studies, are discussed later.

Next, the subordinate research questions:

1. *How are hazards reported in the U.S. Coast Guard?*

Hazards are reported in numerous ways. In the U.S. Coast Guard, hazards may be submitted via a hyperlink on the daily flight schedule (online), communicated verbally, or anonymously written down on paper and placed in locked boxes throughout the air station (USCG, 2016). While these methods of reporting are in compliance with the body of literature's recommendations, this particular research would have been enhanced if hazard reporting were improved from the status quo. Such suggested improvements are addressed below research question 4.

2. *How is hazard reporting an indicator of the health of an organization's safety culture?*

This question was also answered within the literature review. The extent to which aviation hazards are reported serve as an indicator of the health of an aviation Safety Management System (Adjekum et al., 2015; Cooper et al., 2019) and as a marker of a proactive safety culture (Gu & Itoh, 2013; Reason, 2008; Reiman & Pietikäinen, 2012). Proactive safety cultures are linked to hazard-mitigation strategies amongst aviation organizations (Barach, 2000; Reiman & Pietikäinen, 2012).

3. *How is it possible to determine if safety survey data predicts hazard reporting?*

Figure 6 below is a recap of this study's methodology to help with this question's lucidity. To summarize the methodology of this body of work, survey data was the independent variable and hazreps were the outcome variable. In order to reduce the survey into data that was useable for correlation and regression procedures, an exploratory factor analysis was performed which reduced the survey into factors, or underlying constructs, which thereafter, represented of the survey as a whole.

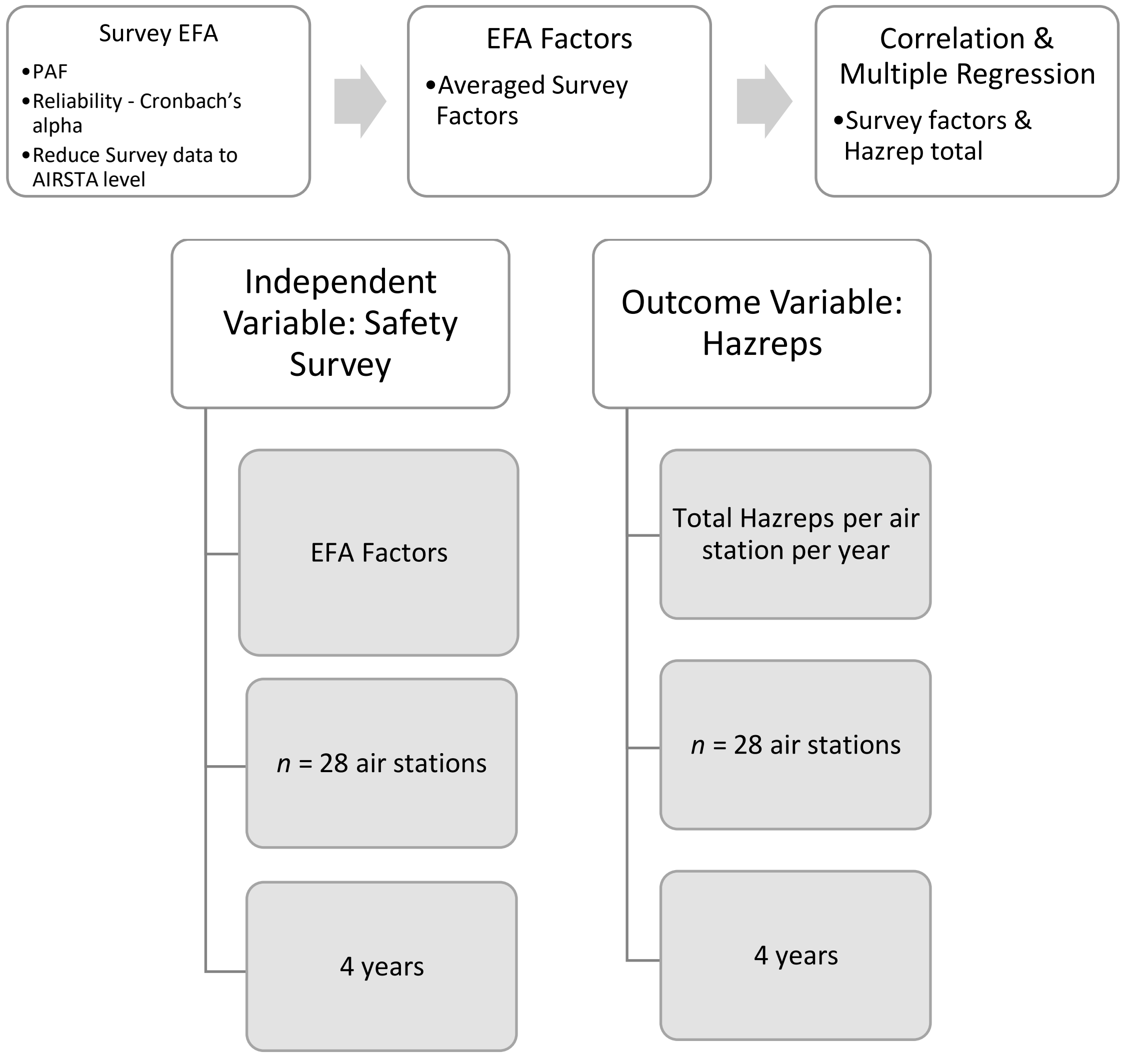

Figure 6. Research Design Process.

a. Does the safety survey predict hazard reporting?

The safety survey is not predictive of hazreps, PAF factors 1-7: $F(7, 68) = 1.672$, $p = .131$; PAF last factors: $F(3, 72) = 2.32$, $p = .082$.

4. *If the current safety survey does not predict hazreps, what are the potential inhibiting limitations?*

In answering this question, two main points of improvement have surfaced; first, the safety survey and second, the method and extent to which hazreps are documented. These are addressed below.

USCG Safety Survey Limitations

After excluding just two items, the initial 52-item survey had validity and reliability with mixed results. The first iteration of PAF, factors 1, 3, 5, and 6 had good factor structures and high reliability. From this point in the analysis, USCG safety officers may consider omitting the rest of the survey items that are not included in these factors. However, factor 1, pertaining to flight skills and standardization evaluations, account for 42.23 percent of the survey's total variance. Whereas factor 5's latent variable is associated with safety leadership and safety culture, two seemingly important topics, but only account for a mere 2.37 percent total variance explained. Based on this paper's literature review addressing safety culture assessments, it is plausible for a safety officer to retain the survey items within factor 5, despite the low variances explained. It appears as though survey items are not adequately sensitive to the explanatory construct of safety culture as compared to flight skills and standardization evaluation. This point suggests a need for rewording and re-validation for content and criterion thereby making the survey more sensitive to safety culture.

After the final iteration of PAF, the survey resulted in only 20 out of 52 original items. Since following all analyses with strict adherence resulted in a survey that only partially resembled the originally-designed survey, great scrutiny should be applied to what USCG leadership wishes to measure and how that information is attempted to be obtained with this survey. For instance, factor 1 implied a good factor structure with high reliability, but the survey item topics varied and lacked obvious themes. However, factor 2, had an obvious theme and resulted in high reliability. With this incongruence, USCG leadership may consider rewording these survey items.

Through each iteration of extracting survey items, the survey's validity improved in terms of multicollinearity, factor loading similarity, item fit, and variable correlations. This improvement in the survey's validity comes at a cost of losing information USCG leaders may desire.

As indicated in Tables 3 and 4, the survey's reliability is currently high. Through item extraction, survey reliability is less discernable given the first factor's varying themes as well as the general scarcity in number of factors.

These results are important for USCG safety leadership to better understand the quality of the safety survey in order to know if it is measuring what is intended. This knowledge will assist leaders in sustaining a robust safety culture assessment protocol. Ultimately, assessing aviation safety culture is vital in reducing mishaps.

USCG Hazard Reporting Limitations

Hazreps were extracted from Class D mishaps if the mishap cost less than 500 dollars and sustained zero injuries. 500 dollars seemed like a reasonable threshold for USCG aviation safety leadership (C. Wright, J. Cooley, personal communications, January 2, 2018), however, it is an arbitrary threshold. Perhaps, some hazreps cost more than 500 dollars but were rich with learned-lessons. This would result in missing data that was in the spirit of the research question. On the contrary, there may have been mishaps that cost less than 500 dollars that were comparatively pedestrian. Ideally, there would be a separation between Class D mishaps and hazreps. Class D mishaps could be kept within the criteria similar to Class A, B, and C, namely, severity of injuries, cost, and damage. Hazreps, on the other hand, could be comprised of voluntarily-reported items or learned lessons. Hazreps could then better "reveal hazardous trends and underscore lessons learned…" and get "reported to prevent recurrence of similar events that could result in much greater injury or damage" (USCG Office of Aviation Safety (CG-1311), 2016, p. 3-4). If hazreps were separate from mishap classification, research such as this would reveal trends with more distinction.

Presently, there is no method for Flight Safety Officers to track hazard reports unless they meet Class D mishap criteria. If there were a means of tracking those hazards that got reported by verbal means, via the anonymous hazreps link on the flight schedule, or via the Anymouse (suggestion) box, hazrep data would be enriched with quantity and quality because bureaucratic barriers associated with formal Class D hazard reports would not exist.

5. *How can the safety survey be improved?*

Design and Planning

When drafting survey items, the point of continual reference should be research questions. Research questions should exist to help the survey owners retain focus on what it is they are trying to measure (Blair, Czaja, & Blair, 2014). It is unknown if the U.S. Coast Guard Office of Aviation Safety developed research questions during the survey design phase. The survey, however, covers the topics of aviation safety, motor vehicle safety, and recreational safety which adds to the survey's complexity, length, and confusion, all of which, degrade the validity of the survey as a whole (Blair, Czaja, & Blair, 2014).

Pre-Testing

Pre-testing is the process of verifying that respondents comprehend, understand, and are willing to answer survey items. This step is important to survey quality in order to make necessary edits and to reveal concealed ambiguity before the survey is in use. Response error is attributed to a lack of pre-testing and may affect response rates and response quality (Blair, Czaja, & Blair, 2014). It is unknown if the USCG pre-tested the current safety survey. If pre-testing has not occurred, the survey could be improved by conducting pre-test processes.

Survey Item Sequence

When the order of items is carefully considered, survey validity and reliability is improved (Wald, Gray, & Eatough, 2018). Blair, Czaja, & Blair (2014) suggest placing survey items relevant to the survey's purpose early on. Doing so helps the respondent get into the mindset of the survey's topic while garnering interest in the survey. Then, while respondents are still engaged, the most important and challenging questions should be next (Wald, Gray, & Eatough, 2018). In the USCG survey, demographics are the first string of survey items.

The most sensitive survey items should be toward the end of the survey, after rapport has been established and the respondent feels more comfortable (Krosnick & Presser, 2010; Wald, Gray, & Eatough, 2018). Lastly, similarly-themed survey items should be grouped together in the survey. This makes the survey cognitively easier for respondents. (Krosnick & Presser, 2010).

In review of the safety survey, there does not appear to be much grouping of similarly-themed items nor are there more (or less) sensitive items toward the survey's end. It appears as though more consideration should be applied to the USCG's survey item sequence.

Survey Item Quality

The wording of survey items affects the quality of the survey as a whole (Blair, Czaja, & Blair, 2010). Web surveys, in particular, should be clear because there is no interviewer or proctor to consult if the respondent has a clarification question. This clarity directly affects a survey's success (Wald, Gray, Eatough, 2018). Blair, Czaja, & Blair (2010) cite the following obstacles which degrade a respondent's ability to answer survey items: "Verbose, too many conditions, ambiguous wording, combining two questions into one, asking respondents to distinguish between subtleties, having categories that overlap (Don't know & N/A and 0=did not answer & actually not answering)" (p. 176). The USCG safety survey contains items that present all of these obstacles.

Blair, Czaja, & Blair (2010) also suggest that specific terminology may not be understood by all survey respondents. The safety survey contains jargon that may be understood by many respondents, but perhaps not understood by all, especially those respondents new to their positions and who lack experience. For instance, the first question (after basic demographics) states, "1. Standards (unit ORGMAN, COMDT policies, MPCs, etc.) are clearly defined for the job I do" (USCG Office of Aviation Safety (CG-1131), 2018). Respondents may not know that ORGMAN is the acronym for Organization Manual or what that manual's purpose is. Similarly, new pilots may not know what MPCs (maintenance procedure cards) are because pilots do not use MPCs and new pilots may lack the on-the-job experience to have learned about MPCs.

Shadish, Cook, & Campbell (2002) suggest direct, simple wording in survey items. In fact, each item's wording should be tightly connected with a survey's research question (Blair, Czaja, & Blair, 2014). Addressing multiple research questions, or the use of double-barreled items, contribute to ambiguity over what interpretation is intended and therefore degrades the quality of that survey items' validity (Blair, Czaja, Blair, 2014; Shadish, Cook, & Campbell, 2002). An example of this is, and one that is quite applicable to this research is, "21. Leaders/supervisors in my unit encourage reporting safety violations, unsafe behaviors, near-miss events, or hazardous conditions without fear of reprisal" (USCG Office of Aviation Safety (CG-1131), 2018). It is unclear if the survey item is emphasizing the encouragement of hazard reporting or emphasizing a lack of fear of reprisal. Furthermore, survey analysts will not know what underlying dimension the respondent was addressing when there are more than one dimensions included in a singular survey item (Blair, Czaja, Blair, 2014).

Another obstacle in addressing survey items involves including too many conditions per survey item (Blair, Czaja, & Blair, 2014). An example from the USCG's survey is, "10. Our unit members' life style, behavior, and judgment allow them to obtain sufficient rest to perform their jobs" (USCG Office of Aviation Safety (CG-1131), 2018). This item includes three conditions, which in turn, limit the respondents' ability to address this item if, for instance, the respondent's rest is affected by other conditions not mentioned here. There is more ambiguity in this item in that job performance may indeed be affected by lifestyle, behavior, and judgement, but perhaps, not via rest. Ambiguity is yet another obstacle that affects respondents' ability to address survey items (Blair, Czaja, & Blair, 2014).

Loaded questions (items) should be avoided. These arrive in different forms (Blair, Czaja, & Blair, 2014) and plague the USCG safety survey. Even though many items' response scale is on an agree/disagree continuum, some survey items are still asking yes/no-type responses. For example, "31. My unit has sufficient experienced personnel to operate safely" (USCG Office of Aviation Safety (CG-1131), 2018) elicits a yes/no opinion and therefore, a bias towards yea-saying will impact this survey data (Blair, Czaja, & Blair, 2014). Alternatively, this survey item could be reworded and offer a continuum of experience, or safety, for instance.

Krosnick (1999) recommends that item scales should be divided evenly along the response-continuum. All of the survey items used in this research contained an odd number of sustentative responses, ranging from strongly agree to strongly disagree, including "3 = neutral." Additionally, the safety survey used a "Don't know" and an "N/A" option. All of these options may reduce survey reliability and validity because those responses introduce bias associated with neutral answers (Krosnick, 1999). Including such responses should be carefully and specifically considered for each survey item, as opposed to the blanket decision to include such responses for all survey items (Blair, Czaja, Blair, 2014). Lastly, the agree-disagree response format injects bias into the responses and does not perform as well as item-specific response types (Saris, Revilla, Krosnick, Shaeffer, 2010). The USCG uses agree-disagree responses for the majority of the survey.

Survey Revision vs. Historical Data Analysis

Enacting these suggested amendments to the U.S. Coast Guard's safety survey, there is a risk of losing historical analytical power. With years of survey data, analyzing trends over many years may become restricted if the safety survey sustains a complete overhaul. Survey items, however, may still maintain measurement objectives through careful revision (Blair, Czaja, Blair, 2014). Perhaps the greater gain involves losing historical trend analysis potential in the way of having a new survey which accurately measures U.S. Coast Guard safety practitioners' research needs. If the safety survey gets revised, it is widely suggested that survey authors should use survey items from validated, reliable, pre-tested, existing surveys (Blair, Czaja, Blair, 2014; Krosnick & Presser, 2010; Wald, Gray, & Eatough, 2018).

Hypotheses

H_1: USCG safety survey items that relate to safety culture all load onto one EFA factor.

H_1 was hypothesized because safety culture is one of many topics addressed in the USCG safety survey. Furthermore, the safety survey contains items that seemingly relate to elements of safety culture (i.e., survey item 21., "Leaders/supervisors in my unit encourage reporting safety violations, unsafe behaviors, near-miss events, or hazardous conditions without fear of reprisal," (USCG Office of Aviation Safety (CG-1131), 2018) which addresses the reporting and just cultures). However, after each iteration of factor analysis, safety culture survey items did not necessarily cluster together, nor remain within the same factor. The first PAF somewhat resembled this hypothesis, however. Specifically, factor 5 had the following survey items cluster together:

22. Leaders/supervisors set a good example for following rules and adhering to standards.

20. Leaders/supervisors in my unit care about members' quality of life.

24. Leaders/Supervisors in my unit react well to unexpected changes.

25. Leaders trust subordinates to manage routine operations.

23. Leaders/Supervisors in my unit discourage cutting corners to get the job done.

21. Leaders/supervisors in my unit encourage reporting safety violations, unsafe behaviors, near-miss events, or hazardous conditions without fear of reprisal.

26. Leaders/supervisors are actively engaged in the promotion and management of the safety program.

14. Individuals are comfortable approaching supervisors about personal problems or illness.

19. Safety-conscious decision-making is positively recognized by leadership, regardless of outcome.

2. My Command effectively applies risk management (RM) principles and makes prudent risk vs. gain decisions.

11. I have the authority to halt unsafe activities until the hazards/risks are addressed

These items are related leadership, which is closely tied to safety culture. However, there are other safety-culture-related items that clustered onto other factors, such as the following items:

5. Effective communication flow exists within my unit.

6. Effective communication flow exists with external units.

3. My unit recognizes individual safety acts through awards and incentives.

18. The Safety Officer/Safety Manager position is a desirable position in my unit.

9. The unit Safety Officer(s) is/are effective at promoting safety at my unit.

13. Safety stand downs are effective in my unit.

Lastly, after the final PAF iteration, no items relating to safety culture remained. For instance, the entire list of factor 5 (first PAF) items involving leadership had been extracted. To address H_1, the final PAF iteration did not have safety culture survey items load onto one EFA factor because there were no longer any survey items related to safety culture left remaining.

H_2: The safety survey is reliable.

As addressed in the results section and research question 4 above, the safety survey is considered reliable.

H_3: The safety survey correlates with hazreps.

The safety survey does not have a statistically significant correlation with hazreps. This holds true after analyzing the survey with the first and final PAF.

The normal distribution of hazreps (Figure 5) implies that using Class D mishaps that cost less than 500 dollars with zero injuries is a reasonable way of obtaining hazreps to use as the outcome variable for follow-on research. If hazreps were documented every time they were submitted via other, none Class D mishap means, however, (verbally, via the flight schedule hazrep link, using the Anymouse box), then hazrep data would be denser with quality and quantity.

If this research were repeated, a correlation between the safety survey and hazreps may be uncovered if both the survey and hazrep data were improved.

H_4: The safety survey predicts hazreps.

Based on this research, methodology, and analysis, the safety survey is not predictive of the extent to which hazards are reported.

Follow-On Research After Safety Survey and Hazrep Improvement

Through the course of analyzing the U.S. Coast Guard's safety survey and the means by which hazards are documented, it is clear that the outcome of this research could have different results if the survey were upgraded and if hazreps were documented beyond the use of Class D mishap classification. Even if the methodology of this research were kept the same, the correlation and regression outcomes may be different than these results. As it presently stands, the safety survey is not compliant with colloquial standards for questionnaires. It is therefore recommended that the safety survey be reworded, pre-tested, and validated. In so doing, USCG leaders may glean answers to their own research questions, including those about safety culture, from the survey results. With those results, this research could be repeated to determine if the survey is predictive of other leading indicators of the health of a safety management system. In turn, this provides leaders the opportunity to leverage the survey as a proactive tool.

This Research at the Individual-Level

There is additional potential to capitalize on the current safety data setup. The data's potency could increase by a factor of 96.5. The thought involves each air station member being assigned an identification code, as is the case each year when the safety survey is administered. If that user ID could be associated with an individual during that member's entire tenure at an air station (3 to 4 years), this research could stay at the individual-level as opposed to analyzing the correlation/regression data at the air station-level. In other words, the survey data would not even have to be reduced to factors, but instead, remain in its raw form. Instead of factors, the study could use individuals' survey item responses as the independent variable. As for the outcome variable, safety managers would have data associated with individuals' hazard reports. Using the user ID, this research could be repeated associating individual safety survey responses to the quantity of hazards reported by each individual. With this current research, the number of lines of data was 110. Meanwhile, survey responses totaled 10,622 for the last four years. Keeping the data at the individual level rather than the air station level would increase the data granularity by a factor of 96.5 (10,622 / 110).

This idea of associating an individual with a user ID to track their hazard reports adds complexity to assuring anonymity. Based on research about the interaction between just and reporting cultures, air station cultures would need to make its members truly feel safe to report hazards without concern of reprisal. As the literature suggests, this is a timely and exhaustive endeavor.

Conclusion

The U.S. Coast Guard safety survey does not predict the extent to which aviation hazards are reported, nor is the relationship correlated. The premise that prompted USCG aviation safety practitioners to probe into this topic is sound and the results of this research may differ with improved means of measuring the U.S. Coast Guard's aviation safety data.

In recent years, several academic articles documenting and accounting for barriers to reporting cultures have been published (Cooper et al., 2019; McMurtrie & Molesworth, 2018; Vrbnjak, Denieffe, O'Gorman, & Pajnkihar, 2016). Other works have also been published documenting the importance of assessing safety culture (Reason, 2008; Stolzer & Goglia, 2015; Wiegmann et al., 2004). There still exists a gap that directly ties the elements of safety culture evaluation with proactive means of assessing safety management systems at large, such as hazard reporting.

Possible implications for research and policies based on this study are for other studies to be performed using this methodology as a template in an effort to help safety managers know if their safety metrics are effective at measuring what is intended. A limitation for future studies is the researcher's access to aviation organizations that conduct safety surveys and document hazard reports (or are willing to do so). Overcoming this limitation, safety practitioners have the potential to gain insight into the state of their organization's safety culture, and ultimately, suppress mishaps.

APPENDICES

APPENDIX A
List of Survey Questions

Rank.

- ☐ E1 to E3
- ☐ E4 to E6
- ☐ E7 to W4
- ☐ O1 to O3
- ☐ O4 to O6
- ☐ Civilian
- ☐ Other

Current Job (choose one)

- ☐ Aviation - Rotary-wing Pilot, Aircrew, or AMS
- ☐ Aviation - Fixed-wing Pilot, Aircrew, or AMS
- ☐ Aviation - Support (non-aircrew)
- ☐ Ops Afloat - WMSL/WMEC/WHEC
- ☐ Ops Afloat - PB/FRC
- ☐ Ops Afloat - ATON/Icebreakers
- ☐ Ops Ashore - Boat Station
- ☐ Ops Ashore - Response
- ☐ Ops Ashore - Prevention
- ☐ Ops Ashore - ATON
- ☐ Ops Ashore - Logistics
- ☐ Ops Ashore - General/Other
- ☐ DSF - PSU
- ☐ DSF - MSRT
- ☐ DSF - TACLET
- ☐ DSF - MSST
- ☐ DSF - NSF
- ☐ DSF - Dive Locker

Which of the following assets/platforms are you assigned to perform your operational duties? (If none, you may skip this question.)

- ☐ H-60
- ☐ H-65
- ☐ C-130
- ☐ C-144
- ☐ C-27
- ☐ C-37
- ☐ Patrol Boat
- ☐ Buoy Tender/Construction Tender/Tugs
- ☐ WMEC/WMSL/WHEC/WPC
- ☐ Icebreaker
- ☐ MLB/UTB/RB-M
- ☐ ATON
- ☐ PSU/SPC-type
- ☐ Other boat

How long have you been assigned to your current unit?

- ☐ 0-6 months
- ☐ 7-24 months
- ☐ more than 2 years

Have you recently returned from a unit deployment? (choose one)

- ☐ Within last 30 days
- ☐ Within last 1-2 months
- ☐ Within last 3-6 months
- ☐ Within last 7-24 months
- ☐ I am currently deployed
- ☐ N/a; My current job doesn't require deployments

1. Standards (unit ORGMAN, COMDT policies, MPCs, etc.) are clearly defined for the job I do.

☐ Strongly agree - Strongly disagree

☐ Don’t know

☐ N/a

2. Unit members, from the top down, incorporate risk management (RM) principles/processes into decision-making for all activities.

3. My unit recognizes individual safety acts through awards and incentives.

4. Our unit trains its personnel to safely conduct their jobs.

5. Effective communication flow exists within my unit.

6. Effective communication flow exists with external units.

7. My unit adequately trains our personnel to perform their primary (specialty) jobs/duties.

8. The frequency and quality of unit drills is sufficient that I am confident I would know what to do in the event of an emergency (e.g., aircraft/vessel mishap, fire, adverse weather, etc.).

What type of drill(s) would benefit you the most?

____

9. I was encouraged to take this survey.

☐ Yes

☐ No

10. My unit has a reputation for high-quality performance.

11. I have the authority to halt unsafe activities until the hazards/risks are addressed.

12. I am able to perform my job without distractions.

13. Safety stand downs are effective in my unit.

14. Individuals are comfortable approaching supervisors about personal problems or illness.

15. Morale in my unit is high.

If you agree, what does your unit do well to promote morale? If you disagree, how would you improve morale?

____

16. Personnel/crews work effectively as a team.

17. On a scale of 1 to 10, rate the unit's overall safety posture (1-Disastrous - 10 Completely safe).

 1 – Disastrous

 10 – Completely safe

 N/a

18. The Safety Officer/Safety Manager position is a desirable position in my unit.

19. Safety-conscious decision-making is positively recognized by leadership, regardless of outcome.

20. Leaders/supervisors in my unit care about members' quality of life.

21. Leaders/supervisors in my unit encourage reporting safety violations, unsafe behaviors, near-miss events, or hazardous conditions without fear of reprisal.

22. Leaders/supervisors set a good example for following rules and adhering to standards.

23. Leaders/Supervisors in my unit discourage cutting corners to get the job done.

24. Leaders/Supervisors in my unit react well to unexpected changes.

25. Leaders trust subordinates to manage routine operations.

26. Leaders/supervisors are actively engaged in the promotion and management of the safety program.

27. I have easy access to all of the Personal Protective Equipment (PPE) required for the tools and chemicals with which I work (to include eye, ear, hand and foot protection as well as a current MSDS for chemicals).*

If not, what PPE are you lacking?

____

28. My unit's work performance when deployed is of the same quality as our work performance when at home base.

29. Additional duties do not adversely affect safety in my unit.

If additional duties do affect safety, please explain.

____

30. I am provided adequate resources (e.g., time, staffing, budget and equipment) to accomplish my job.

31. My unit has sufficient experienced personnel to operate safely.

32. Over the past year, I believe the mishap potential at this unit has:

- Increased
- Stayed the same
- Decreased
- Don’t know; new to unit

If you selected "increased", why did mishap potential increase?

If you selected "decreased", why did mishap potential decrease?

33. What safety-related area does your unit excel at?

Off-duty Safety Programs

34. Which of the following activities do you engage in while driving?

- Phone calls, no hands free
- Phone calls- with hands free
- Texting
- Emailing
- Eating
- Other PDA use
- None of the above

35. Our leaders do a good job communicating policies regarding motorcycle safety.

36. Our leaders do a good job communicating policies regarding private motor vehicle (PMV/POV) safety.

37. My supervisor assists me in identifying and reducing risks associated with PMV/POV travel.

38. Our leaders do a good job communicating policies regarding drinking and driving.

39. I *do not* drive fatigued.

40. My unit ensures that personnel are made aware of local area hazards for off-duty activities.

41. My unit's off-duty and recreational activity program led by the unit safety coordinator (or ground safety officer) is working well to reduce injuries.

42. The most significant action(s) my Commanding Officer, OIC, or Team Leader can take to improve safety is/are:

43. If you were the Commanding Officer/OIC, what safety issues would you make it a priority to address? (Choose up to three).

 Crew training Maintenance tempo Operations tempo Personnel shortages

 Standardization Risk management Crew fatigue Caring for crews

 Non-punitive reporting culture Hazmat and/or chemical hazards

 Mishap preparedness Safety communications

 Crew experience level Other

(Operations-only questions)

1. Stan/evals* are conducted as intended, to honestly assess crew qualifications, standardization and proficiency. (*Terminology varies by community: includes SEOPS/TSTA, RFO, STAN checkrides, workups, DORA, etc.)

2. Personnel must possess the appropriate experience and skills to earn designations/qualifications in my unit.

3. The awareness of unit crews regarding familiarity with local area operational hazards (e.g., navigational hazards, terrain, towers, traffic patterns, fuel availability) is adequate to support safe and standard operations.

4. Crew rest policies are enforced at my unit.

- Strongly agree
- Strongly disagree
- I'm not familiar with our crew rest policies

5. Crew Endurance Management is a factor in our day-to-day operations and the principles are followed.

- Strongly agree
- Strongly disagree
- I'm not familiar with crew endurance management.

6. Violations of required operating procedures or other local/unit regulations are rare in my unit.

7. The stan/evaluation personnel at my unit (to include SEOPS, TSTA and RFO) are well-respected.

8. Mission-related training conducted in a classroom setting is rarely postponed or cancelled.

9. Our unit's operational demands allow members to obtain sufficient rest to perform their jobs.

10. Our unit members' life style, behavior, and judgment allow them to obtain sufficient rest to perform their jobs.

11. I have adequate time to prepare for and brief my missions.

12. Crews at my unit are able to maintain operational proficiency.

13. I am satisfied with the quality and fit of the personal protective equipment I wear while conducting missions (e.g., helmets, survival vests, etc.).

14. My asset/platform(s) is/are capable of safely accomplishing the missions assigned to it/them.

How can your unit increase proficiency and/or currency?

In what area(s) does the unit lack proficiency and why?

15. In your opinion, what will be some of the causal factors leading to the unit's next serious on-duty mishap (Class A or B mishap)? (choose up to three)

☐ Crew inattention/complacency ☐ Poor weather (including low visibility conditions)

☐ Mechanical failure ☐ Fatigue ☐ Congested operating areas (e.g., collision hazards)

☐ Inadequate/insufficient training ☐ Maintenance error ☐ Rushing

☐ Towing or ground equipment operations ☐ Refueling / servicing / HAZMAT

☐ Poorly-designed (or lack of) procedures ☐ A hazard we aren't aware of yet

☐ Automation mismanagement ☐ Poor awareness of local hazards in operational environment

☐ Inexperience ☐ Physiological (nausea, disorientation, hypoxia) ☐ Other

16. (Aviation-only) The Crew Resource Management (CRM) program is helping to improve mission performance, crew coordination, and safety.

17. (Afloat/Ashore-only) The Team Coordination Training (TCT) program is helping to improve mission performance, crew coordination, and safety.

(Maintenance/repair personnel only)

1. Maintenance activities are accurately documented at my unit.

2. My unit effectively communicates pertinent maintenance information during shift changes, duty section changes, and watch reliefs (as applicable).

3. Tool control is closely monitored.

4. Maintainers in my unit must possess the appropriate experience and skills to earn qualifications.

5. Anyone intentionally violating maintenance procedures (MPC or other written technical guidance) is swiftly corrected.

   Comments on MPC/technical procedures violations:

6. Maintainers in my unit are given adequate training opportunities (C-schools) to develop their skills.

7. Maintainers work effectively as a team.

8. Quality Assurance (QA) is well-respected at my unit.

9. Leaders/supervisors in my unit emphasize safe maintenance in achieving operational readiness/availability goals.

10. Parts are sufficiently available to meet maintenance demands.

Comments on parts availability:

11. Required tools and equipment are serviceable and used at my unit.

Comments on tool quality.

12. Required publications are current and used in my unit.

13. My maintenance crew/team/shift is sufficiently staffed for its workload.

Comments on staffing.

14. (Aviation-only) My unit's Maintenance Resource Management (MRM) program is helping to improve maintenance performance, coordination, and safety.

(Pilots and coxswains only)

1. Crews are provided clear processes to address asset/gear discrepancies with maintenance/engineering authorities before and after missions.

2. My Command (or team leader) effectively applies risk management (RM) principles and makes prudent risk vs. gain decisions.

3. The Sector/District/Area (or other TACON) providing my mission tasking effectively applies RM principles and makes prudent risk vs. gain decisions.

4. My unit closely monitors currency standards.

5. My unit adequately reviews and updates standards and operating procedures.

6. I know and understand the operational expectations set forth by unit leaders (CO, OIC, OPS, Team Leaders, etc.).

7. My unit provides me with sufficient training hours per month to operate safely.

8. My unit has sufficient manning/assets to perform its current tasks.

9. The unit Safety Officer(s) are effective at promoting safety at my unit.

10. My unit closely monitors proficiency in flight and mission planning.

Appendix B

UND IRB Approval Letter

UND UNIVERSITY OF NORTH DAKOTA

DIVISION OF RESEARCH & ECONOMIC DEVELOPMENT

UND.edu

Institutional Review Board
Twamley Hall, Room 106
264 Centennial Dr Stop 7134
Grand Forks, ND 58202-7134
Phone: 701.777.4279
Fax: 701.777.6708
UND.irb@research.UND.edu

November 9, 2018

Principal Investigator(s):	James Cooley
Project Title:	USCG Aviation Safety: Relationship Between the Safety Survey and the Extent of Hazard Reporting
IRB Project Number:	IRB-201811-097
Project Review Level:	Exempt 4
Date of IRB Approval:	11/08/2018
Expiration Date of This Approval:	11/07/2021

The application form and all included documentation for the above-referenced project have been reviewed and approved via the procedures of the University of North Dakota Institutional Review Board.

If you need to make changes to your research, you must submit a Protocol Change Request Form to the IRB for approval. No changes to approved research may take place without prior IRB approval.

This project has been approved for 3 years, as permitted by UND IRB policies for exempt research. You have approval for this project through the above-listed expiration date. When this research is completed, please submit a Termination Form to the IRB.

The forms to assist you in filing your project termination, adverse event/unanticipated problem, protocol change, etc. may be accessed on the IRB website: http://und.edu/research/resources/human-subjects/

Sincerely,

Michelle L. Bowles

Michelle L. Bowles, M.P.A., CIP
IRB Manager

MLB/sb

Cc: Mark Dusenbury, Ph.D.

USCG IRB Approval Letter

U.S. Department of Homeland Security
United States Coast Guard

COMMANDANT
UNITED STATES COAST GUARD

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6500
28 NOV 2018

MEMORANDUM

COMPERATORE.CARLOS.A.1272010524 Digitally signed by COMPERATORE.CARLOS.A.1272010524 Date: 2018.11.28 09:49:33 -05'00'

From: C. A. Comperatore, Ph.D.
Chair, CG Institutional Review Board

Reply to P. K. Ng
Attn of: 202-475-5204

To: J.R. Cooley, LCDR

Subj: USCG AVIATION SAFETY: RELATIONSHIP BETWEEN THE SAFETY SURVEY AND THE EXTENT OF HAZARD REPORTING

Ref: (a) Coast Guard Human Research Protection Program, COMDTINST M6500.1 (Series)
(b) 45 CFR 46 - Protection of Human Subjects

1. The Coast Guard Institutional Review Board (CGIRB) reviewed the subject survey, received on 16 November 2018, pursuant to references (a) and (b). This research project examines statistical relationships among questions from the U. S. Coast Guard Operational Safety Climate Questionnaire and hazard reporting in the aviation community.

2. The CG IRB recognizes the University of North Dakota Institutional Review Board as the prime oversight entity for this study.

3. You may commence data collection at your convenience. However, the CG IRB requires that you submit an annual status update to the CG IRB until completion of the study.

4. Please submit any modifications to the current version of the study proposal to the CG IRB for review and approval before implementation.

5. Please be advised that all surveys or questionnaires must comply with the Privacy Act of 1974, 5 U.S.C. 552a, requiring agencies to provide a Privacy Act Statement (PAS). Should you employ any questionnaires or surveys in your study, please contact CG-611 for review and approval of your survey's PAS.

6. Should you have any questions or concerns, do not hesitate to contact Ms. Ng via email at pik.k.ng@uscg.mil.

#

Appendix C

Factor and Reliability Analysis– All Survey Items Except Q6 and Q7

The following is a list of the clustered items for the seven factors encapsulated in the first iteration of Principle Axis Factoring.

Factor 1: Skills/standardization evaluations

Factor 2: Resources

Factor 3: Crew rest/workday

Factor 4: Standards monitoring

Factor 5: Leadership and safety

Factor 6: Unit safety adoption

Factor 7: Safety Officer and promotion

Table C1. Factor and Reliability Analysis– All Survey Items Except Q6 and Q7

Table C1. Survey Item	Factor 1	2	3	4	5	6	7
1. Stan/evals* are conducted as intended, to honestly assess crew qualifications, standardization and proficiency. (*Terminology varies by community.)	0.539						

Table C1.

Survey Item	Factor 1	2	3	4	5	6	7
3. The awareness of unit crews regarding familiarity with local area operational hazards (e.g., navigational hazards, terrain, towers, traffic patterns, fuel availability) is adequate to support safe and standard operations.	0.501						
2. Personnel must possess the appropriate experience and skills to earn designations/qualifications in my unit.	0.495						
14. My asset is capable of safely accomplishing the missions assigned to it.	0.478						
13. I am satisfied with the quality and fit of the personal protective equipment I wear while conducting missions (e.g., helmets, survival vests, etc.).	0.428						
7. The stan/evaluation personnel at my unit (to include SEOPS, TSTA and RFO) are well-respected.	0.426						
16. The Crew Resource Management (CRM) program is helping to improve mission performance, crew coordination, and safety.	0.329						
30. I am provided adequate resources (e.g., time, staffing, budget and equipment) to accomplish my job.		0.505					
8. My unit has sufficient manning/assets to perform its current tasks.		0.501					

Table C1.

Survey Item	Factor 1	2	3	4	5	6	7
29. Additional duties do not adversely affect safety in my unit.		0.474					
12. I am able to perform my job without distractions.		0.425					
31. My unit has sufficient experienced personnel to operate safely.		0.363					
12. Crews at my unit are able to maintain operational proficiency.		0.354					
9. Our unit's operational demands allow members to obtain sufficient rest to perform their jobs.			0.781				
4. Crew rest policies are enforced at my unit.			0.740				
5. Crew Endurance Management is a factor in our day-to-day operations and the principles are followed.			0.740				
10. Our unit members' life style, behavior, and judgment allow them to obtain sufficient rest to perform their jobs.			0.535				
6. Violations of required operating procedures or other applicable local/unit regulations are rare in my unit.			0.452				
11. I have adequate time to prepare for and brief my missions.			0.358				
10. My unit closely monitors proficiency in flight and mission planning.				0.690			
4. My unit closely monitors currency standards.				0.617			

Table C1.

Survey Item	1	2	3	4	5	6	7
5. My unit adequately reviews and updates standards and operating procedures.				0.460			
22. Leaders/supervisors set a good example for following rules and adhering to standards.					-0.799		
20. Leaders/supervisors in my unit care about members' quality of life.					-0.764		
24. Leaders/Supervisors in my unit react well to unexpected changes.					-0.762		
25. Leaders trust subordinates to manage routine operations.					-0.707		
23. Leaders/Supervisors in my unit discourage cutting corners to get the job done.					-0.648		
21. Leaders/supervisors in my unit encourage reporting safety violations, unsafe behaviors, near-miss events, or hazardous conditions without fear of reprisal.					-0.643		
26. Leaders/supervisors are actively engaged in the promotion and management of the safety program.					-0.569		
14. Individuals are comfortable approaching supervisors about personal problems or illness.					-0.500		
19. Safety-conscious decision-making is positively recognized by leadership, regardless of outcome.					-0.381		

Table C1.

Survey Item	Factor 1	2	3	4	5	6	7
2. My Command effectively applies risk management (RM) principles and makes prudent risk vs. gain decisions.					-0.355		
11. I have the authority to halt unsafe activities until the hazards/risks are addressed.					-0.315		
4. Our unit trains its personnel to safely conduct their jobs.						-0.591	
2. Unit members, from the top down, incorporate risk management (RM) principles/processes into decision-making for all activities.						-0.528	
7. My unit adequately trains our personnel to perform their primary (specialty) jobs/duties.						-0.526	
1. Standards (unit ORGMAN, COMDT policies, MPCs, etc.) are clearly defined for the job I do.						-0.508	
5. Effective communication flow exists within my unit.						-0.488	
6. Effective communication flow exists with external units.						-0.411	
8. The frequency and quality of unit drills is sufficient that I am confident I would know what to do in the event of an emergency (e.g., aircraft/vessel mishap, fire, adverse weather, etc.).						-0.404	

Table C1.

Survey Item	Factor 1	2	3	4	5	6	7
3. My unit recognizes individual safety acts through awards and incentives.						-0.370	0.341
10. My unit has a reputation for high-quality performance.						-0.369	
18. The Safety Officer/Safety Manager position is a desirable position in my unit.							0.508
9. The unit Safety Officer(s) is/are effective at promoting safety at my unit.				0.389			0.440
13. Safety stand downs are effective in my unit.							0.342
Eigenvalues	**21.54**	**2.13**	**1.79**	**1.35**	**1.21**	**1.08**	**1.01**
Percent of Variance	**42.23**	**4.18**	**3.50**	**2.65**	**2.37**	**2.11**	**1.97**
α	**.86**	**.80**	**.89**	**.80**	**.92**	**.89**	**.66**
Extraction Method: Principal Axis Factoring. Rotation Method: Oblimin with Kaiser Normalization.							

Factor 1: Skills/standardization evaluations

Factor 2: Resources

Factor 3: Crew rest/workday

Factor 4: Standards monitoring

Factor 5: Leadership and safety

Factor 6: Unit safety adoption

Factor 7: Safety Officer and promotion

Appendix D

Factor and Reliability Analysis – Final PAF Survey Item Extraction Adherence

The following is a list of the clustered items for the three factors encapsulated in the fourth iteration of Principle Axis Factoring.

Factor 1 represented several topics including training quality, FSO perception, Crew Resource Management, standardization, and protective equipment.

Factor 2 represented resources, namely time and experience.

Factor 3 represented asset reliability and satisfaction with protective equipment

Table D1.

Survey Item	Factor 1	2	3
9. The unit Safety Officer(s) is/are effective at promoting safety at my unit.	0.719		
3. My unit recognizes individual safety acts through awards and incentives.	0.653		
19. Safety-conscious decision-making is positively recognized by leadership, regardless of outcome.	0.631		
1. Crews are provided clear processes to address asset/gear discrepancies with maintenance/engineering authorities before and after missions.	0.603		
13. Safety stand downs are effective in my unit.	0.565		
5. My unit adequately reviews and updates standards and operating procedures.	0.551		
16. The Crew Resource Management (CRM) program is helping to improve mission performance, crew coordination, and safety.	0.512		
1. Standards (unit ORGMAN, COMDT policies, MPCs, etc.) are clearly defined for the job I do.	0.470		

Table D1.

Survey Item	Factor 1	2	3
8. The frequency and quality of unit drills is sufficient that I am confident I would know what to do in the event of an emergency (e.g., aircraft/vessel mishap, fire, adverse weather, etc.).	0.426		
28. My unit's work performance when deployed is of the same quality as our work performance when at home base.	0.406		
27. I have easy access to all of the Personal Protective Equipment (PPE) required for the tools and chemicals with which I work (to include eye, ear, hand and foot protection as well as a current MSDS for chemicals).*	0.357		
30. I am provided adequate resources (e.g., time, staffing, budget and equipment) to accomplish my job.		0.722	
12. I am able to perform my job without distractions.		0.662	
29. Additional duties do not adversely affect safety in my unit.		0.631	
31. My unit has sufficient experienced personnel to operate safely.		0.537	
8. Mission-related training conducted in a classroom setting is rarely postponed or cancelled.		0.370	
14. My asset is capable of safely accomplishing the missions assigned to it.			0.530
13. I am satisfied with the quality and fit of the personal protective equipment I wear while conducting missions (e.g., helmets, survival vests, etc.).			0.479
11. I have adequate time to prepare for and brief my missions.		0.355	0.385
12. Crews at my unit are able to maintain operational proficiency.		0.328	0.330
Eigenvalue	**7.90**	**1.31**	**1.06**
Percent of Variance	**39.49**	**6.54**	**5.28**
α	**.87**	**.79**	**.59**

Extraction Method: Principal Axis Factoring.
Rotation Method: Oblimin with Kaiser Normalization

Appendix E

First PAF Iteration – Close Factor Loading

Table E1. First PAF Iteration.
Descriptive Statistics

	Mean	Std. Deviation	Analysis N	Missing N
1. Standards (unit ORGMAN, COMDT policies, MPCs, etc.) are clearly defined for the job I do.	1.8607	0.77004	10622	99
2. Unit members, from the top down, incorporate risk management (RM) principles/processes into decision-making for all activities.	1.8083	0.73444	10531	190
3. My unit recognizes individual safety acts through awards and incentives.	2.0882	0.92949	10385	336
4. Our unit trains its personnel to safely conduct their jobs.	1.8407	0.71320	10575	146
5. Effective communication flow exists within my unit.	2.3004	1.00099	10496	225
6. Effective communication flow exists with external units.	2.3816	0.89955	9600	1121
7. My unit adequately trains our personnel to perform their primary (specialty) jobs/duties.	1.9797	0.80184	10552	169

Table E1. First PAF Iteration.
Descriptive Statistics

	Mean	Std. Deviation	Analysis N	Missing N
8. The frequency and quality of unit drills is sufficient that I am confident I would know what to do in the event of an emergency (e.g., aircraft/vessel mishap, fire, adverse weather, etc.).	2.1636	0.86291	10456	265
10. My unit has a reputation for high-quality performance.	1.6678	0.71274	10472	249
11. I have the authority to halt unsafe activities until the hazards/risks are addressed.	1.5918	0.70268	10589	132
12. I am able to perform my job without distractions.	2.4378	1.05076	10617	104
13. Safety stand downs are effective in my unit.	2.1047	0.84821	9890	831
14. Individuals are comfortable approaching supervisors about personal problems or illness.	1.8576	0.78534	10506	215
18. The Safety Officer/Safety Manager position is a desirable position in my unit.	2.4805	0.82473	9473	1248
19. Safety-conscious decision-making is positively recognized by leadership, regardless of outcome.	2.0062	0.77918	10341	380
20. Leaders/supervisors in my unit care about members' quality of life.	1.8764	0.83934	10532	189

Table E1. First PAF Iteration.

Descriptive Statistics

	Mean	Std. Deviation	Analysis N	Missing N
21. Leaders/supervisors in my unit encourage reporting safety violations, unsafe behaviors, near-miss events, or hazardous conditions without fear of reprisal.	1.7902	0.72453	10504	217
22. Leaders/supervisors set a good example for following rules and adhering to standards.	1.9147	0.77605	10519	202
23. Leaders/Supervisors in my unit discourage cutting corners to get the job done.	1.8494	0.80645	10495	226
24. Leaders/Supervisors in my unit react well to unexpected changes.	2.0634	0.84482	10470	251
25. Leaders trust subordinates to manage routine operations.	2.0585	0.88583	10549	172
26. Leaders/supervisors are actively engaged in the promotion and management of the safety program.	1.9794	0.70199	10319	402
27. I have easy access to all of the Personal Protective Equipment (PPE) required for the tools and chemicals with which I work (to include eye, ear, hand and foot protection as well as a current MSDS for chemicals).*	1.8524	0.77387	10287	434
16. Personnel/crews work effectively as a team.	1.8138	0.64390	10569	152

Table E1. First PAF Iteration.
Descriptive Statistics

	Mean	Std. Deviation	Analysis N	Missing N
28. My unit's work performance when deployed is of the same quality as our work performance when at home base.	1.9318	0.73220	7703	3018
29. Additional duties do not adversely affect safety in my unit.	2.4127	0.93705	10085	636
30. I am provided adequate resources (e.g., time, staffing, budget and equipment) to accomplish my job.	2.5709	1.09495	10570	151
31. My unit has sufficient experienced personnel to operate safely.	2.2473	0.94334	10505	216
1. Stan/evals* are conducted as intended, to honestly assess crew qualifications, standardization and proficiency. (*Terminology varies by community.)	1.7590	0.67173	6606	4115
2. Personnel must possess the appropriate experience and skills to earn designations/qualifications in my unit.	1.7623	0.69107	6777	3944
3. The awareness of unit crews regarding familiarity with local area operational hazards (e.g., navigational hazards, terrain, towers, traffic patterns, fuel availability) is adequate to support safe and standard operations.	1.7778	0.61886	6720	4001

Table E1. First PAF Iteration.
Descriptive Statistics

	Mean	Std. Deviation	Analysis N	Missing N
4. Crew rest policies are enforced at my unit.	1.9092	0.81161	6763	3958
5. Crew Endurance Management is a factor in our day-to-day operations and the principles are followed.	2.0101	0.80228	6317	4404
6. Violations of required operating procedures or other applicable local/unit regulations are rare in my unit.	1.9202	0.69775	6426	4295
7. The stan/evaluation personnel at my unit (to include SEOPS, TSTA and RFO) are well-respected.	1.8037	0.67397	6519	4202
8. Mission-related training conducted in a classroom setting is rarely postponed or cancelled.	2.3317	0.93837	6288	4433
9. Our unit's operational demands allow members to obtain sufficient rest to perform their jobs.	2.2097	0.84344	6738	3983
10. Our unit members' life style, behavior, and judgment allow them to obtain sufficient rest to perform their jobs.	2.0257	0.67553	6502	4219
11. I have adequate time to prepare for and brief my missions.	1.9978	0.69877	6700	4021
12. Crews at my unit are able to maintain operational proficiency.	2.1274	0.81904	6734	3987

Table E1. First PAF Iteration.
Descriptive Statistics

	Mean	Std. Deviation	Analysis N	Missing N
13. I am satisfied with the quality and fit of the personal protective equipment I wear while conducting missions (e.g., helmets, survival vests, etc.).	1.9600	0.80479	6733	3988
14. My asset is capable of safely accomplishing the missions assigned to it.	1.9071	0.74653	6774	3947
16. The Crew Resource Management (CRM) program is helping to improve mission performance, crew coordination, and safety.	1.8673	0.66990	5072	5649
1. Crews are provided clear processes to address asset/gear discrepancies with maintenance/engineering authorities before and after missions.	1.6081	0.61028	2493	8228
2. My Command effectively applies risk management (RM) principles and makes prudent risk vs. gain decisions.	1.5799	0.62900	2502	8219
3. The Sector/District/Area (or other TACON) providing my mission tasking effectively applies RM principles and makes prudent risk vs. gain decisions.	2.5275	1.03767	2307	8414
4. My unit closely monitors currency standards.	1.6492	0.64553	2500	8221

Table E1. First PAF Iteration.
Descriptive Statistics

	Mean	Std. Deviation	Analysis N	Missing N
5. My unit adequately reviews and updates standards and operating procedures.	1.7934	0.73776	2478	8243
6. I know and understand the operational expectations set forth by unit leaders (CO, OPS, etc.).	1.6849	0.68919	2510	8211
7. My unit provides me with sufficient training hours per month to operate safely.	2.0647	0.90496	2472	8249
8. My unit has sufficient manning/assets to perform its current tasks.	2.5868	1.12808	2500	8221
9. The unit Safety Officer(s) is/are effective at promoting safety at my unit.	1.7094	0.64132	2498	8223
10. My unit closely monitors proficiency in flight and mission planning.	1.8163	0.73220	2477	8244

Appendix F

Fourth PAF Iteration – Satisfactory to Proceed to Reliability

Table F1. Fourth PAF Iteration
Descriptive Statistics

	Mean	Std. Deviation	Analysis N	Missing N
1. Standards (unit ORGMAN, COMDT policies, MPCs, etc.) are clearly defined for the job I do.	1.8607	0.77004	10622	90
3. My unit recognizes individual safety acts through awards and incentives.	2.0882	0.92949	10385	327
8. The frequency and quality of unit drills is sufficient that I am confident I would know what to do in the event of an emergency (e.g., aircraft/vessel mishap, fire, adverse weather, etc.).	2.1636	0.86291	10456	256
12. I am able to perform my job without distractions.	2.4378	1.05076	10617	95
13. Safety stand downs are effective in my unit.	2.1047	0.84821	9890	822
19. Safety-conscious decision-making is positively recognized by leadership, regardless of outcome.	2.0062	0.77918	10341	371

Table F1. Fourth PAF Iteration
Descriptive Statistics

	Mean	Std. Deviation	Analysis N	Missing N
27. I have easy access to all of the Personal Protective Equipment (PPE) required for the tools and chemicals with which I work (to include eye, ear, hand and foot protection as well as a current MSDS for chemicals).*	1.8524	0.77387	10287	425
28. My unit's work performance when deployed is of the same quality as our work performance when at home base.	1.9318	0.73220	7703	3009
29. Additional duties do not adversely affect safety in my unit.	2.4127	0.93705	10085	627
30. I am provided adequate resources (e.g., time, staffing, budget and equipment) to accomplish my job.	2.5709	1.09495	10570	142
31. My unit has sufficient experienced personnel to operate safely.	2.2473	0.94334	10505	207
8. Mission-related training conducted in a classroom setting is rarely postponed or cancelled.	2.3317	0.93837	6288	4424
11. I have adequate time to prepare for and brief my missions.	1.9978	0.69877	6700	4012
12. Crews at my unit are able to maintain operational proficiency.	2.1274	0.81904	6734	3978

Table F1. Fourth PAF Iteration
Descriptive Statistics

	Mean	Std. Deviation	Analysis N	Missing N
13. I am satisfied with the quality and fit of the personal protective equipment I wear while conducting missions (e.g., helmets, survival vests, etc.).	1.9600	0.80479	6733	3979
14. My asset is capable of safely accomplishing the missions assigned to it.	1.9071	0.74653	6774	3938
16. The Crew Resource Management (CRM) program is helping to improve mission performance, crew coordination, and safety.	1.8673	0.66990	5072	5640
1. Crews are provided clear processes to address asset/gear discrepancies with maintenance/engineering authorities before and after missions.	1.6081	0.61028	2493	8219
5. My unit adequately reviews and updates standards and operating procedures.	1.7934	0.73776	2478	8234
9. The unit Safety Officer(s) is/are effective at promoting safety at my unit.	1.7094	0.64132	2498	8214

Appendix G

Table G1. List of Survey Items Used for Analysis with USCG-Defined Item Coding

Q11R	1. Standards (unit ORGMAN, COMDT policies, MPCs, etc.) are clearly defined for the job I do.
Q12R	2. Unit members, from the top down, incorporate risk management (RM) principles/processes into decision-making for all activities.
Q13R	3. My unit recognizes individual safety acts through awards and incentives.
Q14R	4. Our unit trains its personnel to safely conduct their jobs.
Q15R	5. Effective communication flow exists within my unit.
Q16R	6. Effective communication flow exists with external units.
Q17R	7. My unit adequately trains our personnel to perform their primary (specialty) jobs/duties.
Q18R	8. The frequency and quality of unit drills is sufficient that I am confident I would know what to do in the event of an emergency (e.g., aircraft/vessel mishap, fire, adverse weather, etc.).
Q21R	10. My unit has a reputation for high-quality performance.
Q22R	11. I have the authority to halt unsafe activities until the hazards/risks are addressed.
Q23R	12. I am able to perform my job without distractions.
Q24R	13. Safety stand downs are effective in my unit.
Q25R	14. Individuals are comfortable approaching supervisors about personal problems or illness.
Q30R	18. The Safety Officer/Safety Manager position is a desirable position in my unit.
Q31R	19. Safety-conscious decision-making is positively recognized by leadership, regardless of outcome.
Q33R	20. Leaders/supervisors in my unit care about members' quality of life.
Q34R	21. Leaders/supervisors in my unit encourage reporting safety violations, unsafe behaviors, near-miss events, or hazardous conditions without fear of reprisal.
Q35R	22. Leaders/supervisors set a good example for following rules and adhering to standards.
Q36R	23. Leaders/Supervisors in my unit discourage cutting corners to get the job done.
Q37R	24. Leaders/Supervisors in my unit react well to unexpected changes.
Q38R	25. Leaders trust subordinates to manage routine operations.
Q39R	26. Leaders/supervisors are actively engaged in the promotion and management of the safety program.

Table G1. List of Survey Items Used for Analysis with USCG-Defined Item Coding

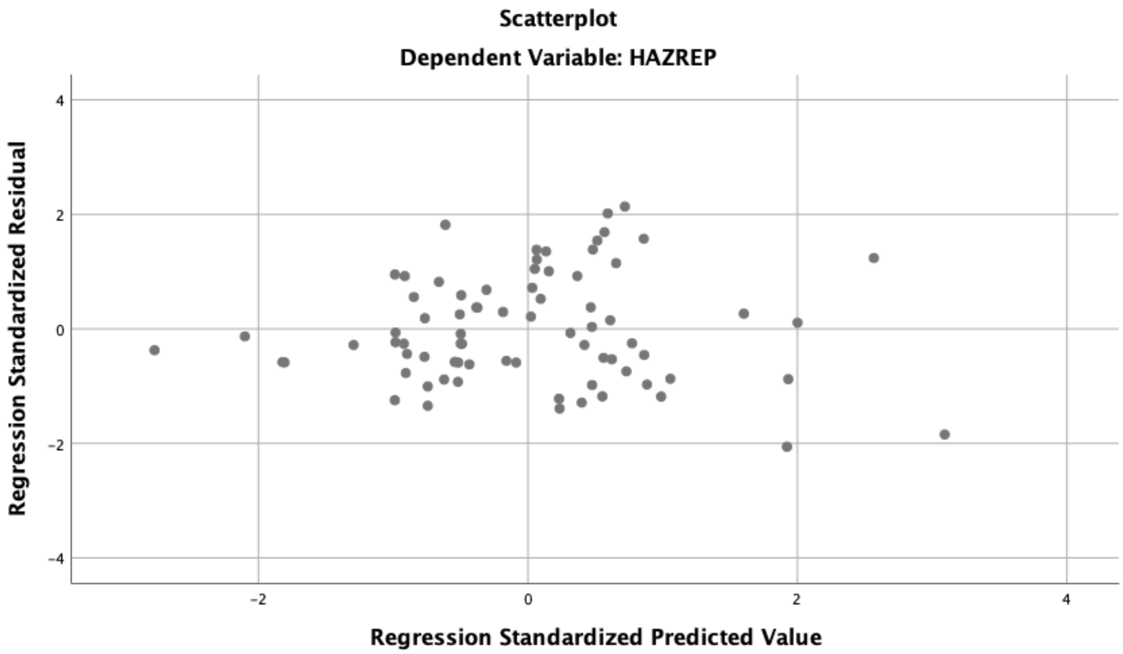
Q40R	27. I have easy access to all of the Personal Protective Equipment (PPE) required for the tools and chemicals with which I work (to include eye, ear, hand and foot protection as well as a current MSDS for chemicals).*
Q28R	16. Personnel/crews work effectively as a team.
Q42R	28. My unit's work performance when deployed is of the same quality as our work performance when at home base.
Q43R	29. Additional duties do not adversely affect safety in my unit.
Q45R	30. I am provided adequate resources (e.g., time, staffing, budget and equipment) to accomplish my job.
Q46R	31. My unit has sufficient experienced personnel to operate safely.
Q65R	1. Stan/evals* are conducted as intended, to honestly assess crew qualifications, standardization and proficiency. (*Terminology varies by community.)
Q66R	2. Personnel must possess the appropriate experience and skills to earn designations/qualifications in my unit.
Q67R	3. The awareness of unit crews regarding familiarity with local area operational hazards (e.g., navigational hazards, terrain, towers, traffic patterns, fuel availability) is adequate to support safe and standard operations.
Q68R	4. Crew rest policies are enforced at my unit.
Q69R	5. Crew Endurance Management is a factor in our day-to-day operations and the principles are followed.
Q70R	6. Violations of required operating procedures or other applicable local/unit regulations are rare in my unit.
Q71R	7. The stan/evaluation personnel at my unit (to include SEOPS, TSTA and RFO) are well-respected.
Q72R	8. Mission-related training conducted in a classroom setting is rarely postponed or cancelled.
Q73R	9. Our unit's operational demands allow members to obtain sufficient rest to perform their jobs.
Q74R	10. Our unit members' life style, behavior, and judgment allow them to obtain sufficient rest to perform their jobs.
Q75R	11. I have adequate time to prepare for and brief my missions.
Q76R	12. Crews at my unit are able to maintain operational proficiency.
Q78R	13. I am satisfied with the quality and fit of the personal protective equipment I wear while conducting missions (e.g., helmets, survival vests, etc.).
Q79R	14. My asset is capable of safely accomplishing the missions assigned to it.
Q81R	16. The Crew Resource Management (CRM) program is helping to improve mission performance, crew coordination, and safety.
Q111R	1. Crews are provided clear processes to address asset/gear discrepancies with maintenance/engineering authorities before and after missions.

Table G1. List of Survey Items Used for Analysis with USCG-Defined Item Coding

Q112R	2. My Command effectively applies risk management (RM) principles and makes prudent risk vs. gain decisions.
Q113R	3. The Sector/District/Area (or other TACON) providing my mission tasking effectively applies RM principles and makes prudent risk vs. gain decisions.
Q114R	4. My unit closely monitors currency standards.
Q115R	5. My unit adequately reviews and updates standards and operating procedures.
Q116R	6. I know and understand the operational expectations set forth by unit leaders (CO, OPS, etc.).
Q117R	7. My unit provides me with sufficient training hours per month to operate safely.
Q118R	8. My unit has sufficient manning/assets to perform its current tasks.
Q119R	9. The unit Safety Officer(s) is/are effective at promoting safety at my unit.
Q129R	10. My unit closely monitors proficiency in flight and mission planning.

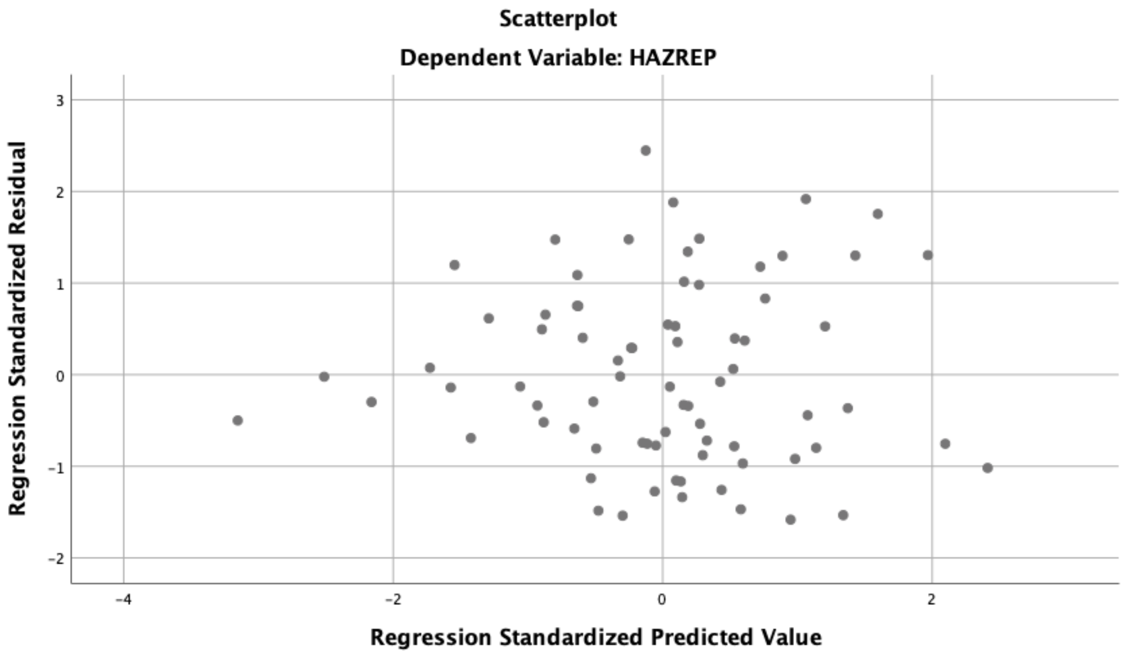
APPENDIX H

First PAF Factors 1 – 7 Zpred Scatterplot



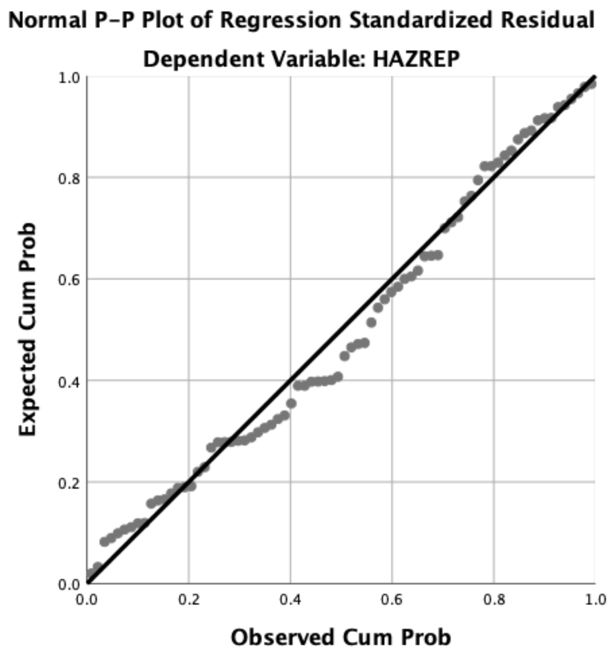
APPENDIX I

Final PAF Factors 1 – 3 Zpred Scatterplot



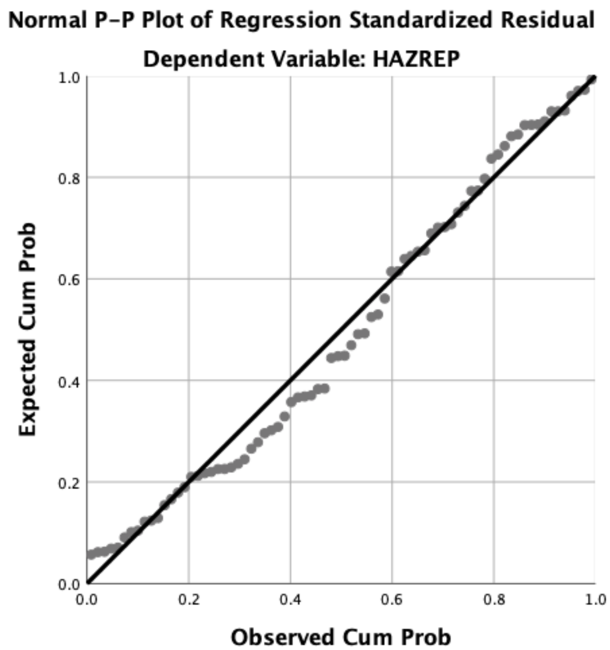
APPENDIX J

P-P Plot for First PAF



APPENDIX K

P-P Plot for Final PAF



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