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Leadership influence on aviation safety culture inculcation as it relates to Certified Non-scheduled Air Taxi Operators

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LEADERSHIP INFLUENCE ON AVIATION SAFETY CULTURE INCULCATION AS IT RELATES TO CERTIFIED NON-SCHEDULED AIR TAXI OPERATORS

A dissertation proposal submitted in partial satisfaction

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by

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Sometimes you are lucky enough to have people recognize greater capabilities than you believe you possess. Drs. Kenneth King and Nancy O'Donnell were those people for me. As

Dean and Associate Dean respectively in the College of Education at Oklahoma State, both identified my leadership potential and pushed me to develop that skill as an undergraduate. They allowed me to take on roles that gave me great responsibility; a position I was not entirely sure I was ready. It did work out and their confidence provided a foundation for taking entrepreneurial risk later in life ultimately laying the groundwork for seeking a terminal degree.

All the members of my Pepperdine EDOL cohort deserve recognition as they helped me grow and constantly challenge my assumptions. Special recognition goes to Amber, Gabrielle, Grey, Sam, and Victoria all of whom contributed to edits, shared projects, special trips, and just being great friends. Their support has been invaluable and I am honored to call them fellow doctors.

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The final member of the committee deserves special acknowledgement. Without his repeated inquiries of when I would pursue this achievement, I doubt I would have taken the time to complete this task. Dr. Steven Marks served as my unofficial undergraduate academic advisor when he was under no obligation to do so. His lifelong commitment to education and specifically space education will forever be known due to his many awards and industry recognitions, but what I value more than all those accolades is his friendship. Dr. Marks has always been there and served as an educational mentor to me for over 25 years. The purpose of this section is to acknowledge those who contributed to this highest educational accomplishment. There is no other deserving more credit than Dr. Marks.

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ABSTRACT

A general aviation industry segment member known as a Certified Non-scheduled Air Taxi Operator (CNATO) conducts passenger flights on-demand for hire. While airline accidents have reached historic lows, CNATO accident rates remain above one per 100,000 hours (NTSB, 2015b). Unlike airlines, the Federal Aviation Administration has not made safety management system implementation mandatory within CNATOs. As a result, there has been no decrease in CNATO organizational accidents over a 6-year period since 2009. Study goals strove to find a predictable method of variable identification influencing at-risk CNATOs.

The study utilized a sequential transformative design comprising quantitative surveys and aviation accident databases to answer four research questions. Research questions used explanatory correlational methodology of independent and intervening variables examining descriptive, relational, and comparative results. Safety Culture Indicator Scale Measurement System (SCISMS) and Multifactor Leadership Questionnaire (MLQ) Form 5x served as survey instruments that gathered leadership and safety culture information. Accident data was obtained from government sources through the Aviation Safety Information Analysis and Sharing (ASAIS) database.

An inclusion criterion, stratified random cluster, and systematic random sampling narrowed the entire 2,046 CNATO population to a sample size of 25 participants from three FAA flight standards regional offices. Each participant had 3 weeks to complete an online survey containing 106 questions. Twenty participants completed the survey. Data analysis followed a discriminant function analysis to develop quantitative correlations between multiple variables. Characteristics of each participant yielded no conclusive data to suggest CNATOs share common safety culture dimension dominance. Study results concluded there was no relationship between leadership style, safety culture dominance, and accident rates. A comparison of CNATOs using safety management systems and accident rates also showed no relationship exists. The final research question sought to find a relationship between leadership style, safety dimension, and accident rate. None was found, however, a statistical trend emerged outside the research questions as a result of sequential research design. Data indicated a relationship among transformational leadership characteristic scale and SCISMS mean score. While the study yielded seminal individual results, research questions proved safety culture remains difficult to define and found relationships to identify at-risk organizations remains elusive.

Keywords: safety culture, high reliability organization, organizational accidents, aviation, leadership, safety climate

Chapter I: Introduction

According to the latest statistics, general aviation aircraft for hire classified as Certified Non-scheduled Air Taxi Operators (CNATO), flew over 1.8 million hours (Federal Aviation Administration [FAA], 2015). These commercial operators provide critical aviation charter services, from medical transport to traffic reports. Although these professional aircraft operators are certificated to serve the public, it was not until 2006 regulations that they became subject to mandated *safety management systems*. Safety programs implemented by United States airlines have demonstrated their effectiveness by eliminating any airline accidents: there have been no fatalities since 2009. However, aircraft operators within the non-scheduled FAA Part 135 regulations, referred to in this study as CNATOs, have seen accident rates increase 36% in 2011 over that of 2010 (Air Safety Institute, 2011). The data for 2012 through 2014 revealed almost no change in overall accident rates, however, the lethality of accidents increased from 14.8% to 15.9% (Air Safety Institute, 2012). Understanding how CNATOs and their leaders create a culture of safety could aid the public good in stemming the increasing trend of accidents in the industry segment.

Safety management systems (SMS) have evolved since their first development in military and airline uses. The purpose of an SMS is to reduce the risk for catastrophic failure by developing a set of tools for early detection of accidents and other potentially harmful processes at the organizational level (Desai, Roberts, & Ciavarelli, 2006). Used exclusively in *high reliability organizations* such as aircraft carrier operations and nuclear generation facilities, an SMS develops reliable processes to mitigate risk. Now prevalent in aviation, it was not until the late 1980s, after a series of maintenance and pilot errors that the scheduled airline industry segment adopted the SMS model. After years of demonstrated success in airline operations, the general aviation segment of the industry began to look at using a less rigorous version of the same methodology.

Dating back to 2001, the International Civil Aviation Organization (ICAO) had been working to establish the Standards and Recommended Practices (SARPs) for adoption by the worldwide aviation agency. The impetus for SARPs was in direct response to the desire by member countries to uniformly enact a comprehensive safety management system across all aircraft operations. In 2010, the Federal Aviation Administration released Advisory Circular 120-92A. This circular established a basic safety recommendation framework for aircraft operators, and suggested new operating standards of SMS. It is important to note that an Advisory Circular is an optional document that carries with it no penalties for non-compliance. The advisory circular served as a recommendation to CNATOs previously untouched by direct procedural regulation. Wide scale adoption by CNATOs has yet to occur; this creates an opportunity to research how the industry segment manages potential implementation of a voluntary SMS and the leader influence on cultural adoption.

Statement of the Problem

Aviation organizations rely heavily on a high level of operational safety in order to function properly (Kelly & Patankar, 2004; Roberts & Libuser, 1993; Schein, 1983). A lapse in safety can cause loss of life and organizational failures from which recovery is difficult. For this reason, it is imperative that CNATOs adopt a culture which promotes safety and entrenches safety practices with which all staff members comply. The classification of aviation as a high reliability organization has unique implications as to leadership approach and organizational culture development. The general aviation industry has a gap in knowledge in developing a safety culture to its stakeholders despite the importance of safety integration into all passenger carrying entities. With the advancement of high reliability organization methodologies and theory to prevent *organizational accidents*, the aviation industry has migrated toward the development of a SMS to improve safety. Adoption of a SMS framework has taken many forms, but no single methodology has emerged. Instead, CNATOs have chosen to implement a variety of different programs to serve their purposes. Several differing methods of culture development and SMS adoption has elevated leadership influence as a clearly defined variable.

When the rare organizational accident occurs, the people responsible for those actions often have no comprehension as to the cause (Reason, 1998). After all, organizational accidents are hard to predict and often occur in areas where production or protection fails to cover such events. Production is an overarching concept related to the production of services; in the case of aviation, the transportation of people (Reason, 1998). This activity is thick in processes and procedures that comprise the various steps performed in order to produce the service. Protection relates to the institutional methods taken to protect the service from human error (Reason, 1998). These can include simple checklists evaluating whether a trip should even be initiated to a complex task such as computer modeling to calculate the risk of the activity based on input parameters.

There was substantial scholarly debate as to whether aviation safety can be categorized as either prolonged state of existence known as culture, or climate, a temporary state subject to change (O'Connor, O'Dea, Kennedy, & Buttrey, 2011). Surprisingly, the literature was unclear as to whether the existence of strong organizational safety culture impacts accident rates. There were compelling examples of safety culture measurement within the military, but this has yet to be applied to general aviation (La Porte, Roberts, & Rochlin, 1988; Rochlin, La Porte, & Roberts, 1998). A previous culture survey was conducted within Part 121 airline operations in an attempt to measure safety culture effectiveness (Gibbons, von Thaden, & Wiegmann, 2006). Aviation has enjoyed a historic decline in the number of fatal accidents in scheduled airline operations in the past 20 years. This suggests that the decrease in fatal accidents is related to the inculcation of safety culture into the organizations responsible for carrying the paying passengers. Unfortunately, there was no analysis as to whether results would apply in other aviation industry segments or what, if any, impact it had on organizational accidents. Leadership influence and development of a strong safety culture largely influences whether CNATOs have integrated production and protection to prevent accidents from happening. Therefore, research was necessary to determine variables in CNATOs which may reduce organizational accident rates.

Purpose and Significance of the Study

The present study addressed the gap in knowledge as to whether inculcation of a safety culture in CNATOs has an effect on organizational accidents. The study (a) examined the way leadership introduces and reinforces safety culture within an organization, (b) how the safety culture is implemented by followers, (c) investigated the types of artifacts used by the aircraft operator to provide reinforcement of established safety processes, and (d) determined the extent to which safety culture has an effect on overall safety results.

Organizational safety in CNATOs has many intervening variables. Leaders influence the creation and establishment of companywide methodologies and mechanisms for cultural development (Bass & Avolio, 1993). These critical individuals serve as foundation blocks to create a safety culture. Oversight agencies like the Federal Aviation Administration and accrediting bodies only focus on basic compliance. Some organizations tie compliance to culture, but many do not. Forced compliance could create an external artificial force influencing culture. The study investigated the causal link between leadership sponsored safety initiatives, the development of a safety culture, and their effect on accident rates within a sampling of CNATOs.

While NTSB statistics demonstrate aviation as low risk in relation to other transportation methods, the high frequency of aviation operations allow more potential organizational accidents to occur. CNATO safety culture development lacks consistency and provides an opportunity to examine various factors that may influence a reduction in accident rates. Without a frequently modified, time-tested, common set of best practices based on current data, industry safety rates will likely remain unchanged. Third-party provided safety programs satisfy regulator demands, but no study determined whether these programs influence the organizational culture as opposed to internally developed safety programs. These are areas that were worthy of investigation and could result in public good by increasing operational, organizational, and cultural safety.

Compliance with safety requirements has an impact on all areas of aviation in the public perception of aviation as a safe mode of transportation. Due to intense media scrutiny for aviation accidents and incidents, it is of critical importance for professionals in the industry to promote safety culture and seek to achieve scheduled airline reliability. The study of newly enacted SMS requirements is of major importance to CNATOs and to overall aviation. Assumptions have been made that aviation, an industry already rich in processes, benefits further from SMS programs. The addition of regulations to create a safety culture could artificially influence the actual process of establishing a safety culture. Research had not been carried out to assess the variables influencing safety culture. Further study of the causal relationship between development of a safety culture and regulation can assist in creating effective regulatory policy.

Due to the absence of research on whether safety culture has an effect on overall safety results, the study aimed to measure safety culture practices among selected CNATOs and draw inferences from the findings. There is a lack of literature providing analysis of the relationship between SMS, safety culture and overall accident rates. The creation of safety culture in military aviation operations has been previously examined, but the mission and style of military operations are only minimally comparable to the typical CNATO (La Porte et al., 1988; Roberts, Rousseau, & La Porte, 1994; Roberts, Stout, Halpern, Haas, & Hall, 1994; Rochlin et al., 1998). A closer analysis of aviation safety culture and SMS effectiveness was conducted in Part 121 airline operations (Gibbons et al., 2006). The same rigor with which previous studies have evaluated safety variables has not been applied to research in CNATOs. This study seeks to bring clarity for a large segment of the industry who collectively fly 19 million flight hours a year.

A sequential transformative mixed method approach used established theoretical frameworks to measure the relationship between an existence of strong safety culture, the effect of leadership influence, and organizational accidents. Research questions were explored using quantitative methods. Accident databases provided data from NTSB, NASA, and FAA public records available on the internet. At the same time, the effect of leadership and SMS influence was explored using a survey with a representative group of CNATOs within a random stratified sample demographic and geography. The rationale for using quantitative data was to encourage impartiality in addressing the research problem by converging both broad numeric trends in accident data and detailed statistical views of operations within each CNATO.

The purpose of this study was to (a) determine the safety culture characteristics possessed a typical CNATO organization, (b) identify what relationship, if any, exists between organizational culture and performance outcomes, including accident rates, (c) identify what difference, if any, exists in accident rates of CNATOs that use safety management system programs and those that do not, and (d) identify what relationships, if any, exist between CNATO leadership style, the development of a safety culture and accident rates.

Recent Statistics

The following tables classified total hours flown by CNATOs in comparison to the other aircraft types in 2014 and accident rates for each phase of flight in 2012. While the total hours flown demonstrate only a fraction of the total across the entire industry, the professional nature of the flight implies a higher standard is required.

Table 1

Total Air Taxi Hours Flown by Aircraft Type in 2014

Aircraft Type	*On-Demand FAR Part 135 Use*			
	Total	Air Taxi	Air Tours	Air Med
Fixed Wing: Total				
Est. Total Hours	18,461,498	2,185,564	89,480	197,087
% Std. Error	1.2	4.6	19.5	12.6
Piston: Total				
Est. Total Hours	11,967,414	553,555	63,697	24,260
% Std. Error	1.6	10.0	30.0	32.5
Turboprop: Total				
Est. Total Hours	2,612,979	586,263	22,442	95,184
% Std. Error	1.2	3.6	13.5	6.9
Turbojet: Total				
Est. Total Hours	3,881,105	1,045,745	3,342	77,643
% Std. Error	1.0	2.5	34.8	8.3

Note. Data in this table are from *General Aviation and Part 135 Activity Surveys - CY 2014,* Table 3.2, by FAA, 2015. Copyright 2015. In the public domain.

Table 2

Non-Scheduled Air Taxi Accident Rates 2012

Types of Accidents	Accidents		Fatal Accidents		Lethality
Collision	3	7.3%	2	16.7%	66.7%
Descent/Approach	2	4.9%	2	16.7%	100.0%
Fuel Management	3	7.3%	1	8.3%	33.3%
Go-Around	2	4.9%	0		
Landing	6	14.6%	1	8.3%	16.7%
Maneuvering	1	2.4%	1	8.3%	100.0%
Mechanical	5	12.2%	1	8.3%	20.0%
Other	2	4.9%	1	8.3%	50.0%
Other (Power Loss)	1	2.4%	0		
Takeoff	7	17.1%	1	8.3%	14.3%
Taxi	4	9.8%	0		
Weather	5	12.2%	2	16.7%	40.0%

Note: Adapted from the *24th Joseph Nall Report: General Aviation Accidents in 2012*, by Air Safety Institute, 2012. Copyright 2012 by Air Safety Institute. Adapted with permission.

Research Questions

This proposal created quantitative data points in order to address four key research questions. The study answered the following questions:

1. What safety culture characteristics does a typical CNATO organization possess?
2. To what extent, if at all, does organizational culture have a relationship with performance outcomes, including accident rates?
3. To what extent, if at all, is there a difference in accident rates of CNATOs that use commercially available safety management system programs and those that do not?
4. To what extent, if at all, does CNATO leadership style have a relationship with the development of a safety culture and accident rates?

Conceptual Framework and Hypothesis

Established conceptual frameworks assisted in describing core constructs between CNATO intervening variables and accident rates. Due to the highly complex nature of the topic, these frameworks helped clarify the basic concepts to answer research question. Organizational accident, high reliability organization, and safety culture theory all play critical roles in the study.

The theoretical framework of organizational accident theory assisted in the ability to define what is outside of normal operations. Reaching prominence in the wake of organizational failures, the field is highly mature and provided characteristics of lapses in culture that create accidents. An organizational accident is the result of technological processes that have radically altered the relationship between machines and their human elements (Reason, 1997). The relationship between man and aircraft describes such a situation. Organizational accident theory examines the casual sequence, organizational factors, workplace conditions, and unsafe acts as root causes of individual accidents. Scientific inquiry was then employed to examine upstream organizational factors contributing to the accident to investigate variable interactions addressed in the research questions.

Second, the concept of high reliability organization (HRO) theory was used to create a link between industries demanding greater operational standards. Measurements in the HRO fields have established the ability to qualitatively and quantitatively capture the degree to which an organization has achieved culture change. In framing the research in this method, a comparison was drawn across industries.

A theoretical framework used by the study was the influence of leadership on the creation of a strong safety culture. One of the most relevant and well-researched area relates to highly uncertain and changing organizations to assess leaders' resiliency. The literature created a structural and static construct of meanings which a group collectively addressed hazards in a systematic way (Zohar, 2010; Zohar & Luria, 2005). Empowering participants in high-risk activities create positive cognitive mindsets, thus preventing hazards (Pidgeon, 1991). When assessing the true ability of a participant organization to reach safety culture, a construct rich in meaning to the aviation industry is used. Patankar and Sabin (2010) developed a theoretical framework to help understand the elements of safety culture and their interactions with organizations.

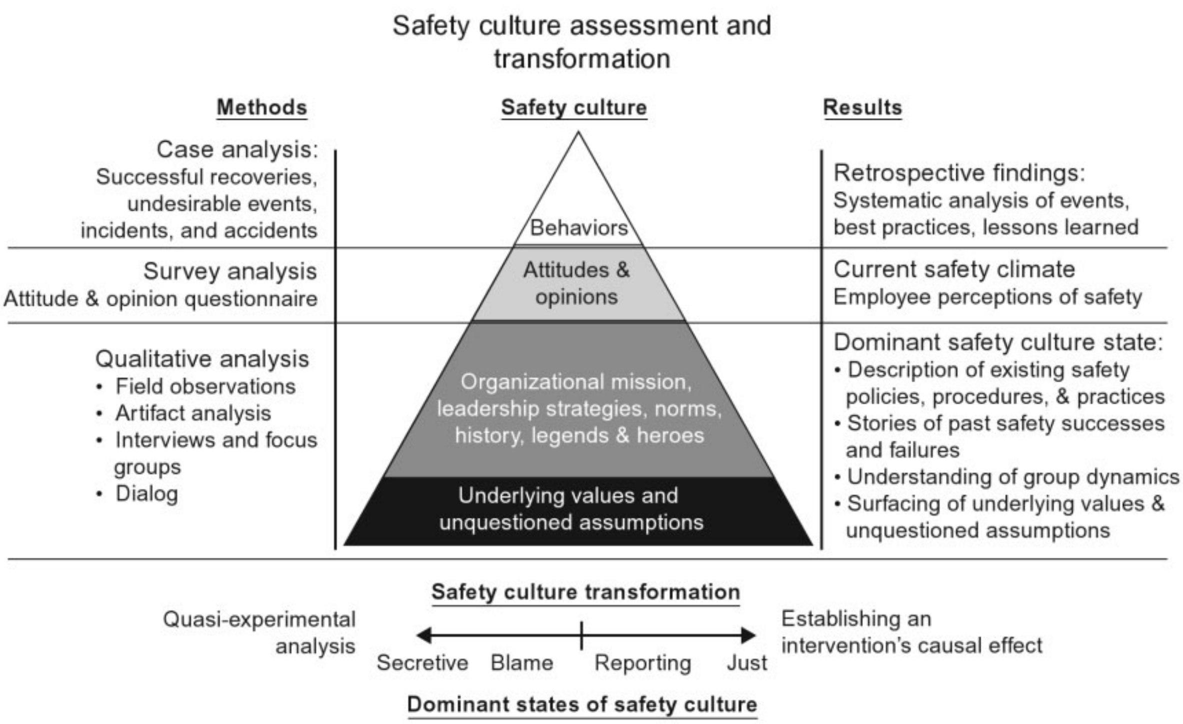


Figure 1. Safety culture pyramid. Describes progression of safety culture methods, results of assessment, and transformation. From *Human Factors in Aviation* (2nd ed., pp. 95-122), by M. S. Patankar and E. J. Sabin, 2010, Burlingame, MA: Ashgate. Copyright 2010 by Ashgate Publishing. Reprinted with permission.

Figure 1 shows various levels of organizational safety culture development from cursory behaviors to underlying values and unquestioned assumptions. Leadership in combination with the use of this widely accepted process methodology around aviation safety culture and related fields ranging from healthcare to military applications will allow for the study to establish a strong theoretical foundation (Beebe, 2013; Kelly, Meyer, & Patankar, 2012).

Organizational culture is a nebulous term with various meanings. This seemingly simple concept has sparked great debate whether an activity or behavior is sustainable enough to become a culture, or whether it remains a climate. The general definition of *culture* is a system of shared meaning held by members that distinguish one organization from another organization (Schein, 1983). In contrast, Zohar (1980) defines *climate* as a summary of perceptions that employees share about their work environment. The general consensus is climate comprises an element within organizational culture that focuses on the more short term impact of storytelling (Schein, 1996). More specifically, climate can be characterized as a "mood state" at a particular moment in time (Cox & Flin, 1998, p. 192). Culture is more inherently a sustained state of being that resists frequent changes and distractions within the organization.

It is important to note that the inculcation of a successful safety culture in a CNATO is dependent upon the existence of strong leadership and foundation of rich processes. The resulting safety culture creates an environment free from organizational accidents. Interdependency of these theoretical frameworks necessitate a reference to each idea independently.

Figure 2 graphically represents the foundational building blocks of frameworks used in the study. The process and leadership influence together form either a weak or strong HRO safety culture. From data collected, the study will answer whether organizational accidents occur if one or many of the foundational blocks exist.

Figure 2. Dissertation conceptual framework. Represents building block knowledge constructs. Leadership influence and processes forms foundation of understanding HRO safety culture, which then creates reader context for organizational accidents.

Directional hypothesis. The quantitative data presented in military safety literature and the experience of the researcher lead to a hypothesis regarding the relationship between variables. In a directional hypothesis "the investigator makes a prediction about the expected outcome, basing this prediction on prior literature and studies on the topic that suggest a potential outcome" (Creswell, 2009, p. 145). A common business process analysis tool used in the private sector is the Gartner Group Magic Quadrant.

Figure 3 represents a graphical visualization of theoretical frameworks and their relationship to the study hypothesis. The chart represents relationships in a 2x2 chart with the least advantageous process or product being in the bottom right quadrant. In listing the two prevailing variables on the axis, a curvilinear representation develops based on hypothesized data results. The curvilinear relationship with various safety phenomenon and behavioral outcomes has been statistically proven by Zohar and Luria (2005) and Perrow (1984). Therefore, it is reasonable to assume leadership and organizational accidents would yield no different results due to an absence of contradictory anecdotal data. For the directional hypothesis posed here, the greater the influence of safety culture and leadership influence, the less organizations are prone to accidents. This hypothesis remains true as culture reaches equilibrium with leadership influence at which point micromanagement negatively affects organizational accident reduction rates. A set of quasi-experimental procedures embedded within the selected instrumentation yielded specific statements for hypothesis testing to either validate or invalidate this hypothesis.

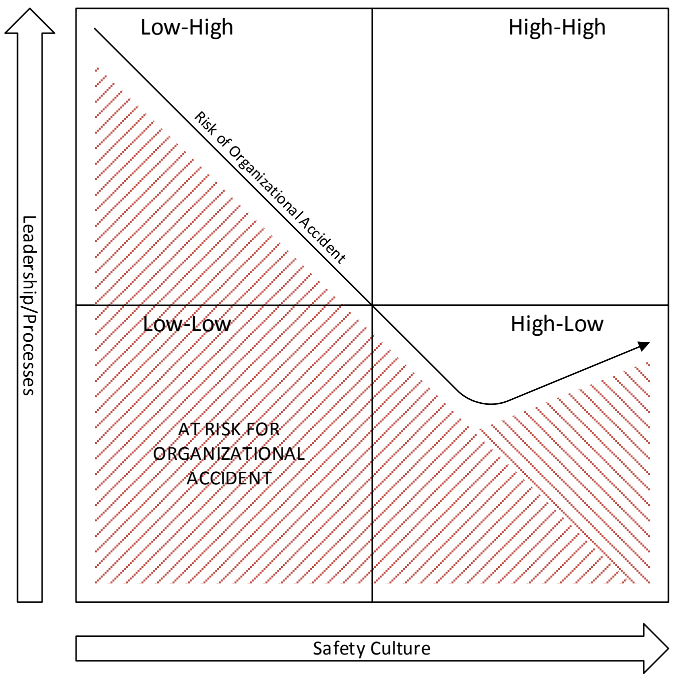


Figure 3. Aviation safety magic quadrant.

The following quantitative statement describes the relational phenomenon hypothesis between study variables:

H_1: Organizational accidents moderate the curvilinear relationship between safety culture and leadership influence in such a way that an intermediate level of detail of leadership influence is associated with higher safety culture when the priority of safety is high rather than low.

Limitations of the Study

As with any academic research study, there were limitations as to the reach and abilities of the researcher to conduct a comprehensive examination of the topic. The study sought to generalize findings to those CNATOs in the most concentrated FAA regions to represent the entire population. Further, there are a large number of variables across the entire population that may have a factor on the effectiveness of safety culture and leadership impacts on accident rates. The limited number of variables selected for consideration in the research design are stated within Chapter III.

The method in which federal government statisticians stratify accident data is difficult to isolate CNATO generalities within the random sample size. This will require the researcher to make assumptions as to the type of aircraft operated by the CNATO and correspond accident data to those types of operations.

The participants' willingness to answer survey instrumentation honestly and openly is outside the control of researchers. Every effort was made to ensure validation of outlier data is verified while maintaining the study integrity. Should participants not divulge information, study results will be limited.

Leadership styles, organizational safety culture are highly subjective. Even with a reliable and valid instrument, there were influences and variables not considered which may be materially relevant to each study participant.

Definition of Terms

The purpose of this section is to assist in establishing a common understanding of how terms are used within the study. Precise terminology using authoritative definitions provides scientifically grounded research (Creswell, 2009). Terms used throughout the study were presented in alphabetical order below:

Abductive reasoning: The collection and analysis of research data using multiple stages to gain clarity and meaning to an observation. This is achieved by combining the reliability of empirical data with validity of lived experience. Abductive reasoning is "understood as a process that values both deductive and inductive approaches but relies principally on the expertise, experience, and intuition of researchers" (Wheeldon & Åhlberg, 2012, p. 7).

Aircraft accident:

> an occurrence associated with the operation of an aircraft that takes place between the time any person boards the aircraft with the intention of flight and all such persons have disembarked, and in which any person suffers death or serious injury, or in which the aircraft receives substantial damage. (14 CFR Title 49 §830.2)

AOPA: Aircraft Owners and Pilots Association

Annex 1 through 19: Amendments and additions to the *Chicago Convention*

ASF: Air Safety Foundation

ATP: Airline Transport Pilot

CASA: Civil Aviation Safety Authority

Chicago Convention: *ICAO* Chicago Convention of December 07, 1944

CNATO: Certificated Non-scheduled Air Taxi Operator classified under Part 135 of the Federal Aviation Administration regulations.

FAA: Federal Aviation Administration

High Reliability Organization (HRO): a subset of high-risk organizations designed and managed to avoid such accidents characterized by the response of the organization's constituencies when it fails, the tendency to operate at or near the edge of human capacity, and diverse constituencies (Roberts & Rousseau, 1989).

IBAC: International Business Aircraft Council

ICAO: International Civil Aeronautics Organisation

Incident: "an occurrence other than an accident, associated with the operation of an aircraft, which affects or could affect the safety of operations" 49 CFR §830.2

ISBAO: International Standard for Business Aircraft Operations

NASA: National Aeronautical and Space Administration

NBAA: National Business Aircraft Association

Normal accidents: unpreventable and unpredictable accidents involving complex systematic or equipment failures, signals only visible in retrospect, and/or operator error which is not fully correctable until after the accident has occurred (Perrow, 1984).

Operating certificate: a regulatory designation issued by a local FAA Flight Standards District Office to each CNATO authorizing and defining operating parameters of aircraft.

Organizational Accident: a comparatively rare but often catastrophic event that occurs within complex modern technology, such as nuclear power plants, commercial aviation, the petrochemical industry, chemical process plants, marine and rail transport, and the off-shore oil industry (Reason, 1997).

Post hoc ergo propter hoc: Philosophical fallacy theory from latin phrase meaning "after this, because of this". From the 1662 textbook of logic, La logique, ou l'art de penser was written anonymously by published by Antoine Arnauld and Pierre Nicole outlining the post hoc theory.

Safety climate: perceptions held by participants regarding molar perceptions they share of their organizational environment at a particular moment in time (Zohar, 1980). A cultural artifact resulting from espoused values and shared tacit assumptions (Schein, 2000).

Safety culture: a prolonged state of organizational understanding, shared by the participants, of safety and its antecedents. "The set of beliefs, norms, attitudes, roles, and social and technical practices that are concerned with minimising the exposure of employees, managers, customers and members of the public to conditions considered dangerous or injurious" (Guldenmund, 2000, p. 228)

Safety Management Systems (SMS): "the formal, top-down business-like approach to managing safety risk. It includes systematic procedures, practices, and policies for the management of safety (including safety risk management, safety policy, safety assurance, and safety promotion)" (Federal Aviation Administration, 2007, p. 1).

Sociotechnical systems: the tight integration and interdependency of systems with human interaction.

Standards and Recommended Practices (SARPs): a proactive safety strategy based on the implementation of a State Safety Programme (SSP) that systematically addresses safety risks, in agreement with the implementation of safety management systems (Parker, Lawrie, & Hudson, 2006).

Summary

NTSB statistical data has shown the rate of organizational accidents in CNATOs exceeds scheduled airline occurrences and has repeatedly placed it on their 2015 "Most Wanted List" (NTSB, n.d., 2015b). A lack of academic research specific to CNATOs regarding identification of variables leading to organizational accidents has exposed the flying public to risk. By applying established theoretical frameworks in organizational accidents, HRO, and safety culture, to a set of variables such as leadership influence and operational process compliance, a better picture emerges about the effects of factors involved in organizational accidents. These discoveries could help shape CNATO public policy and aid the public good in creating a safer flying experience.

Using established theoretical frameworks in the field of organizational safety culture, HRO, and aviation, a context was created to better understand study objectives. Little academic argument exists as to whether leadership influences safety culture because inclusion of SMS and organizational culture development is dependent upon leader initiation. Examples of these variables reducing accident rates has been found in military applications, but has never been applied to CNATOs.

The study seeks to answer four research questions:

1. What safety culture characteristics does a typical CNATO organization possess?
2. To what extent, if at all, does organizational culture have a relationship with performance outcomes, including accident rates?
3. To what extent, if at all, is there a difference in accident rates of CNATOs that use commercially available safety management system programs and those that do not?
4. To what extent, if at all, does CNATO leadership style have a relationship with the development of a safety culture and accident rates?

To address the research questions, a sequential transformative mixed method approach determined whether a multivariate relationship exists among safety culture inculcation, leadership influence, and organizational accidents. Finding an association and/or a relationship determines the degree to which CNATOs could create a common set of aviation safety best practices.

Chapter II: Literature Review

Introduction

The purpose of this multi-disciplinary literature review was to properly provide a frame of reference for this study in the context of existing research addressing the topic of leadership and organizational culture development as it relates to aviation safety and to confirm the study's unique contribution to the field. The literature search utilized two university institutional libraries, Pepperdine University and Oklahoma State University, for cross-reference and access to additional resources. Research was conducted via electronic database search of WorldCat and Summons search engines to identify peer-reviewed academic journal resources primarily consisting of EBSCOhost academic search complete, ABI/Inform Global, Emerald management extra, Wiley online library, Sage journals online, JSTOR, and Scopus. In addition, ProQuest Dissertation and Thesis searches identified emerging research in the field of aviation safety and organizational dynamics.

A search included word combinations of key terms to identify relevant empirical studies. Combinations included aviation leadership, high-trust, organizational culture, safety culture, safety climate, high reliability organizations, organizational accidents, and aviation accident data. Research regarding leadership and organizational culture yield largely qualitative studies. Each study selected had to be an empirical investigation and meet one of three inclusion criterion. First was relevancy in the following areas of core leadership principles, organizational culture, and operational aviation characteristics at the individual level of analysis. Second, studies had to base their findings on sound academic qualitative or quantitative investigative theory, and third, they must have been peer reviewed.

The body of literature strongly indicated a lack of research has occurred pertaining to identification of leadership traits and organizational culture development within aviation. For this reason, Chapter II presents multi-discipline theory, constructs, and research that underlie the factors of creating an inculcation of a safety climate within certificated non-scheduled air taxi operators from the perspective of four domains: (a) the study of organizations' (and thereby organizational leaders') approach to leadership and its response to the development of a safety culture, (b) performance within an operating environment of high reliability organizations and their interrelationship with organizational culture, (c) the selection of core elements which contributed to the creation of an approved safety management system, and (d) the influence of safety culture on aircraft operator accident rates.

Leadership Characteristics in Aviation

"The organization's culture develops in large part from its leadership while the culture of an organization can also affect the development of its leadership" (Bass & Avolio, 1993, p. 112). The study of leadership is a broad and vast topic to explore. A simple search in WorldCat using the word leadership yields over 839,000 entries. Literature abounds in relation to the types, methods, and characteristics of leadership. Despite the vastness of research, only a small, disconnected amount of literature supports the application of any prevalent traits or characteristics to aviation leaders. While the literature has conducted individual research of leaders in airlines, aerospace, and other related occupations within aviation, there has been no consensus as to one superior leadership model (Kutz, 1998). There is also an extensive presence of literature to support the connection to leadership influence on the development of a strong organizational culture (Beebe, 2013; Berkowitz & Wren, 2013; Chang & Lee, 2007; Meier, 2014; Tsai, 2011). Due to the absence of substantive literature directly related to leadership traits specifically in aviation, three distinct leadership models will be discussed for potential inclusion as a direct application to the operation of a certificated non-scheduled air taxi operator.

Situational approach. The aviation industry has a high degree of variability and regulatory restrictions. Leaders must constantly adapt to a changing environment in which they operate. As a result, a situational approach to leadership emerges as one industry prevalent construct. Situational leadership was established by Hersey and Blanchard (1969) as a response to Reddin's (1967) 3-D management style theory and the Managerial Grid of Blake and Mouton (1964). Both these new models were based on the groundbreaking work of Stodgill (1948) and his attempts to define and focus research on the identification of leadership traits (Northouse, 2012). The rigidity and absoluteness of prior leadership grids did not appeal to Hersey and Blanchard. Researchers set out to address the gap in research and believed there was an opportunity to create a more relevant and workable model to account for variable situations (Hambleton & Gumpert, 1982). After several iterations of the situational leadership model, they introduced the concept of tri-dimensional leadership.

A Tri-Dimensional Leadership Effectiveness model posits a leader response does not exhibit a single characteristic or style, but rather is completely situational and varies based on the leader, follower, and situation (Hersey, Blanchard, & Johnson, 1996; Northouse, 2012). While not directly including aviation organizations in the list of applicable industries, they state:

> Crisis-oriented organizations such as the military or fire department, there is considerable evidence that the most appropriate style would be high task and low relationship, since under combat, fire, or emergency conditions success often depends on immediate response to orders. (Hersey et al., 1996, p. 243)

Application of the tri-dimensional leadership model is appropriate due to the high command and control environment required within aviation. While the ability to adapt to the situation is critical, the ability to continue to relate on a personal level still proves critical to success. The situational leadership style builds a culture where adaptation to the environment allows for action and recognition of follower needs. While the leader may not be the most charismatic, followers recognize the rational response to the situation and agree to follow the leader. This resulting action builds trust between leader-follower. Studies found "the quality of leader-member interaction influences the leader's concern for members' welfare, which in turn influences safety-climate perceptions in the group and hence the safety behavior of the group" (Zohar, 2002b, p. 76). The situational leadership model demonstrates through evidence that closer, higher-quality relationships increase leader concerns for follower welfare. This concept provides the base for the successful creation of culture and high-trust in organizations.

Another reoccurring theme in the literature tying aviation to situational leaders was the concept of sense-making. Human nature dictates that individuals interpret activities through their own lens. Interviews of post-accident aviation accidents typically yield differing accounts of the same set of outcomes. Sense-making in situational leadership shifts the evaluation of an experience from past tense to instantaneous streams of information evaluated in real-time (Roberts & Bea, 2001b). This concept is repeated throughout the literature and was often described as being from a positivist point of view. Further examples of situational leadership in aviation existed within studies of air traffic control organizations. Two air traffic facilities were studied to measure how leader adaptability was handled using various situations, conditions, tasks and structure (Arvidsson, Johansson, Ek, & Akselsson, 2007). These two examples provide an example of the strong foundation of situational leadership in aviation.

Situational approach has its downside. When Hersey and Blanchard (1996) revised their life-cycle behavioral theory 25 years later, they acknowledge numerous gaps in applying only two dimensions to expand upon the previous work presented by Blake and Mouton. While situational leadership theory and tri-dimensional models were updated from their original, the application remains incomplete due to descriptions for only four out of a possible nine dimensions (Graeff, 1997). Ambiguity caused by the lack of further description allows the literature to indicate ambiguity and incompleteness as key descriptors for the situational leadership theory. However, the nature of the dynamic environment in which aviation operates and the level of industry maturity demands inclusion of this still popular leadership type.

Path-goal theory. The leader member exchange (LMX) construct was first proposed by Graen and colleagues as a method to describe and explain the unique relationship between leader and follower (Graen, Dansereau, & Minami, 1972; Graen, Orris, & Johnson, 1973). LMX relies upon a strong relationship between members within the organization. In creating these complex ecosystems, groups self-organize based on common goals. The byproduct of this type of self-organization is the isolation of out-groups that do not actively follow or fall in line with the leader at the top of a LMX organization. LMX leaders reward members of these in-groups with honesty, open exchange of information, and support. This concept has been identified in literature as social exchange based contracts.

Further literature reveals a more recent trend toward a horizontal version of LMX called team member exchange (TMX). Similar in its relationship between the members, TMX uses social exchanges inside work groups rather than between a dyadic leader-follower arrangement to identify the quality within teams (Banks et al., 2014; Seers, 1989; Seers, Petty, & Cashman, 1995). This latest theory reflects a more modern view of workplace dynamics where teams have emerged as centers of organizational power. The evolution of LMX to TMX provides an opportunity to evaluate the potential relationships of aviation to both constructs while statistically treating them in the same manner. Meta-analysis research proves the two have strong comparisons and can be related by applying proper assumptions (Banks et al., 2014). Both LMX and TMX have strong applications and a history of ties to aviation leadership.

Researchers have identified clear examples of LMX within aviation organizations. The strongest historical example were the leaders of Eastern Airlines. The first leader of the organization was World War I flying ace, Eddie Rickenbacker. Rickenbacker was frequently referred to as having a militaristic style of leadership and often referred to his employees as privates (Lewis, 2005). His blind allegiance to the International Association of Machinists union resulted in a series of critical mistakes that shuttered the airline for nearly a month. Despite being the father figure to many within the organization, his leadership style was often a source of contention. Rickenbacker was known to be hard-lined and arrogant, but this behavior was rooted in his inferiority of only having a seventh grade education (Berstein, 1991; Lewis, 2005). Despite strong command and control characteristics, accidents were frequent during his 28 year reign as leader of the airline. Eastern Airlines flourished under his leadership in the early days of aviation where reliability and accidents were common. The next leader of Eastern Airlines reflected the strong ties to military aviation. Frank Borman was a graduate of the United States Military Academy, fighter pilot, and a member of the second class of NASA astronauts. In one of his first actions as the leader of Eastern Air Lines, Borman sent a clear message to the employees and fired or demoted 24 vice presidents in a clear attempt to strip autonomy from the lower levels of management (Conger, 2000). While a main objective of profitability was a clear mission, Borman often delivered the news to employees in a callous, pessimistic, and rough manner. He frequently relegated employees to menial assignments when they lost favor with Borman.

Transactional-transformational leadership. Extensive studies linking transactional and transformational leadership styles have been performed. For the purposes of this study, meta-analysis of the literature supports the characteristics of both styles are similar enough to discuss in one context (McCleskey, 2014). A summary of literature perspectives on both styles will provide a foundation and demonstrate a pattern of evolutionary validation the two are inextricably related.

In a transactional leadership arrangement, the leader and follower enter into a social contract to accomplish specific goals and outcomes. Relationships are formed to maximize both individual and organizational advancements through exchanges with gratification components for each participant (Burns, 1978). In this theory, gratification is provided through contingent awards such as praise and tangible reward like a promotion, salary increase or bonus. This symbiotic relationship created by contingent reward has been proven to increase organizational effectiveness in situations free from complex external factors (Bass, 1985; Bass, Avolio, Jung, & Berson, 2003; Bass & Bass, 2009; Gregory, Harris, Armenakis, & Shook, 2009). After extensive study, transactional leadership proved ineffective in developing long term relationships with followers and therefore was seen as a short-term solution.

Bass' (1985) transformational leadership theory (TFL) has generated considerable empirical research interest over the past decades. The creation of transformational leadership stemmed from a perceived shortcoming of fundamental transactional leadership interaction in relation to basic worker needs. Meaningful transformation includes leader interactions that include: presenting outcomes in a way where values are enhanced, putting team above individual needs, and recognizing others need for recognition (Bass, 1985). As opposed to the purely transactional nature of previous follower interaction, transformational emphasizes the inclusion of charisma by providing followers with inspirational motivation and idealized influence (Bass & Riggio, 2006). Some of the characteristics of transformational leaders include articulating a captivating vision for the future, acting as charismatic role models, fostering the acceptance of common goals, setting high performance expectations, and providing individualized support and intellectual stimulation for followers (Bass, 1985; Bass & Avolio, 1993; Menges, Walter, Vogel, & Bruch, 2011).

Numerous studies of relationships between transformational leadership and performance have been conducted in settings considered stable or free from external influences. These studies are not applicable to the highly regulated, externally rich, and changing aviation setting. A lack of study around dynamic work environments led Bass et al. (2003) to further examine the relationship between leadership and performance in operating environments under high levels of stress and uncertainty. Researchers built upon the operationalized notion of relative validity and studied other instances of transformational leadership within highly dynamic workplaces. A meta-analysis reported 87 studies with positive relationships among transformational leadership and pre-determined organizational outcomes (Judge & Piccolo, 2004). In a sample of 72 light infantry rifle platoons, the researchers examined how transformational leadership, transactional leadership, unit potency (unit confidence to perform tasks), and unit cohesion (teamwork) predicted performance on a training platoon mission. The results indicated a predictable transformational and transactional relationship with an indicated medium correlation of $r = 0.44$, $p < .05$ (Judge & Piccolo, 2004). Scoring a medium correlation, the stress environments must be evaluated individually and not generalized.

Building on the groundbreaking behaviorists such as Skinner, Watson, and Pavlov, Isreali industrial engineering and management professor Dov Zohar sought to apply meaning in the highly complex industrial systems to achieve a higher level of safety. In addition to creating the term *safety climate*, he studied the supervisory practices in transformational leaders as they related to creating safe work environments (Zohar, 1980). The quantitative study of 427 workers repairing industrial equipment in a hazardous workplace revealed a transformational leadership based intervention model resulted in a significant decrease in microaccident rates (Zohar, 2000, 2002a). This and other research demonstrates the importance transactional and transformational leadership in developing a strong leader-follower relationship built on trust.

Despite the seemingly positive aspects of transactional leadership, the literature cited many critics of the leadership style. Perhaps the most surprising was Bass himself. The model showed deficiencies regarding internal consistency, conceptual contradictions, and ambiguities (Bass & Bass, 2009). Transformational leadership relies greatly on the characteristics of the leader, but academic debate continues about reliability and validity of how follower outcomes are measured within the leader context. Yukl (2008) suggested the impact on work groups, teams and organizations was unclear due to a lack of weight placed on the measurement of variables in previous studies. The debate will continue on the merits and detractions of transformational-transactional leadership, but its presence in aviation organizations is strong and will provide a framework to help describe this study.

Leadership and safety behaviors have been studied in literature often enough to have warranted a meta-analysis. Clarke (2013) examined articles containing any combination of five safety dimensions and the term leadership. Over 800 papers were identified in the search. From that sample, 32 studies identified as having measured leadership using safety variables. Findings indicated safety compliance was strongest in transactional leadership (p = .41) while safety participation (p = .44) was stronger in transformational leadership (Clarke, 2013). Figure 4 graphically represents the leadership style relationships to safety variables measured.

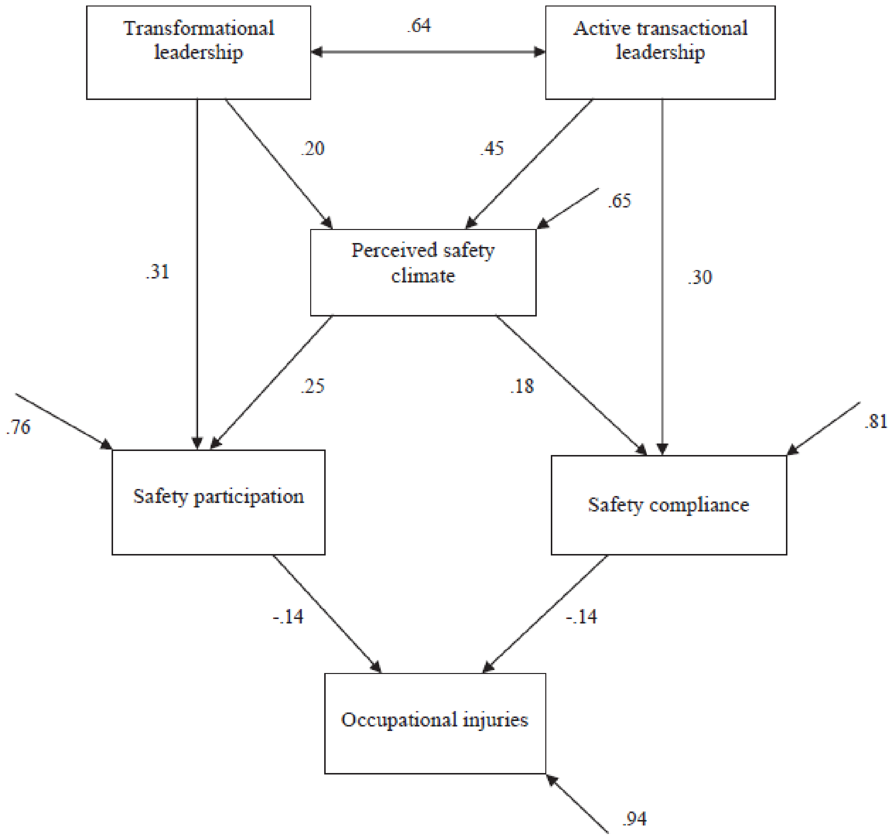


Figure 4. Final model of relationships between leadership, perceived safety climate, safety. From "Safety Leadership: A Meta-analytic Review of Transformational and Transactional Leadership Styles as Antecedents of Safety Behaviours," S. Clarke, 2013, *Journal of Occupational & Organizational Psychology*, *86*(1), p. 34. Copyright 2013 by Wiley-Blackwell. Reprinted with permission.

The meta-analysis discussion provides great insight into the importance of leader adaptation to variables in stating the following:

> The findings indicate that there is empirical evidence to support a role of active transactional leadership that is distinct from transformational leadership, suggesting that the overall concept of safety leadership needs to be extended beyond the idea of transformational leadership to include other types of leader behavior. (Clarke, 2013, p. 33)

Beyond those findings, the author recognizes several limitations in the body of literature. There has been little research done in the area of active transactional leadership in the context of safety.

Additional limitations exist in the causal link interpretation of the cross-sectional data methodology. As discussed later, this meta-analysis also operationalized safety climate as an individual level variable but states there is strong evidence to support treating climate as a group-level effect. Aviation requires safety climate and culture to be considered group level in order to consider the dyadic unit created as a result of the close work environment and interactions.

Importance of High-Trust Organizations

"Trust between individuals and groups is a highly important ingredient in the long-term stability of the organization and the well-being of its members" (Cook & Wall, 1980, p. 39). Research consistently showed the relationship between leaders and followers require high-trust in a workplace susceptible to organizational accidents regardless of individual leadership traits (Cox, Jones, & Collinson, 2006; Dirks & Ferrin, 2001; Freiwald, 2013; Schein, 2010). In conducting extensive quantitative study, a team of researchers learned five drivers were strong and stable predictors of organizational trust across cultures, languages, industries, and types of organizations: competence, openness and honesty, concern for employees and stakeholders, reliability, and identification (Shockley-Zalabak & Morreale, 2011; Shockley-Zalabak, Morreale, & Hackman, 2010). These characteristics are consistent with early research performed in military operations where trust is critical to developing a safety culture and following organizational accidents at NASA (Ciavarelli, 2006; Roberts, Stout, et al., 1994; Wong, Desai, Madsen, Roberts, & Ciavarelli, 2005).

Understanding trust building and the creation of an established theoretical framework for leader-follower performance outcomes led to the application of the model to civilian aviation related fields. Commitment to the job, an antecedent of employee satisfaction, was quantitatively measured inside the FAA air traffic control system to draw inferences on trust

(Cho & Park, 2011). Based on the previously reviewed management theories, the relationship between the leader and follower of great importance. LMX considers trust as a key predictor in the ability of an organization to act effectively (Dansereau, Graen, & Haga, 1975). Transactional and transformational describes trust as fundamental to ensure exchange of contingent reward. Situational leadership demonstrates a leader adapting and formulating a rational response as the foundation of trust. Without trust, each style of leadership weakens. A comprehensive study revealed, from a sample size of 19,849 respondents and $p < .001$, that trust in management has the strongest tie to performance outcomes (Cho & Park, 2011). Other relative effects of trust revealed in the study is included in Figure 5 and serves as a framework for future studies using structure equation modeling.

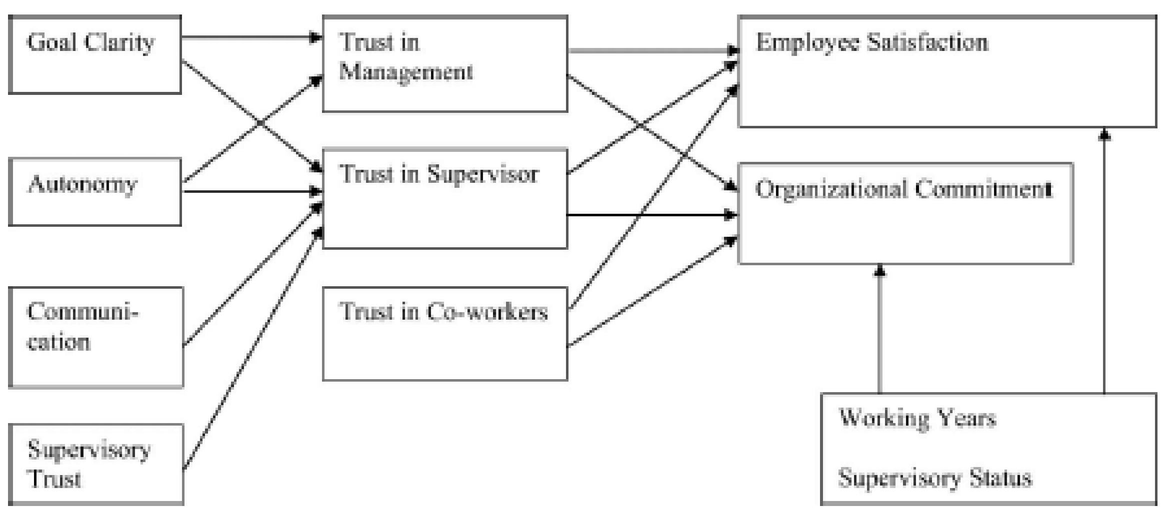


Figure 5. Antecedents of high-trust organizations. From "Exploring the Relationships Among Trust, Employee Satisfaction, and Organizational Commitment," Y. J. Cho, & H. Park, 2011, *Public Management Review*, *Vol. 13*, p. 556. Copyright 2011 by Taylor & Francis. Reprinted with permission.

The literature overwhelmingly supports a conclusion that trust in the organizational leader is the foundation for the development of a strong safety culture (Cox & Flin, 1998; Cox et al., 2006; Mercurio & Roughton, 2002; Schobel, 2009). Beyond trust established by the leader, there are behaviors required within the organization. Trust created between human interactions becomes a factor in the development of high-trust organizations, particularly through cooperation and communication. This high level of integration of human interaction and trust has been supported in the literature through a comprehensive meta-analysis (Colquitt, Scott, & LePine, 2007; Dirks & Ferrin, 2001). Another critical variable in understanding how high-trust organizations form and operate is the complex interaction between humans and machines. As technology advanced, the relationship humans developed with machines changed. Complex processes and systemization of critical tasks have created two methods of dealing with uncertainty: minimization and coping (Grote, 2007). Each have become a factor in every operational discussion. Creation of trust and safety performance within an organization is largely determined only when placed in context where trust is conferred (Schobel, 2009). As with aviation, other industries reliant upon technological interaction have similar challenges. Historic research emerged further describing these complex interactions within industries where the organizational systems and processes failed.

Organizational Accidents

Following the Three Mile Island nuclear reactor accident, researchers began to attempt understanding the relationship between complex organizational systems and accidents. The first study to explore the interrelationship of increasingly complicated technology and the causes of accidents developed into the theory of *normal accidents* (Perrow, 1984). Normal Accidents Theory proposes tightly-coupled technological systems and unexpected failures are inevitable and cannot be eliminated through redundancy. The adaptation of social science and inquiry into human factors, which cause accidents, quickly evolved with the space shuttle Challenger disaster and Chernobyl nuclear disaster in January and April 1986 respectively. Seminal work was undertaken in a series of governmental inquiries conducted by NASA into the shuttle disaster tying the accident to organizational level failures (President's Commission on the Space Shuttle Challenger Accident, 1986; Wong et al., 2005).

An *organizational accident* is defined as a comparatively rare but often catastrophic event that occurs within complex modern technology, such as nuclear power plants, commercial aviation, the petrochemical industry, chemical process plants, marine and rail transport, and the off-shore oil industry (Reason, 1997, 2000). Much like normal accidents described by Perrow (1984), organizational accidents are a product of changing systematic relationships between human interaction and technological innovations. However, the introduction of latent and active factors further clarify the organizational accident. Latent conditions are inherent to all organizations and can remain dormant for years prior to combining with active failures or external hazards to cause an accident. Organizational accidents arise not only as a consequence of organizational decisions, but also as a result of external decision paths, many of which are outside the control of the organization. Using the space shuttle Challenger disaster, the active condition was the decision by mission leadership to ignore the manufacturers' engineer, Roger Boijoly, expressing concern about the O-ring 6 months prior to the launch (McDonald & Hansen, 2009). The weather served as the latent condition by dropping unseasonably low the day of launch. Without both active and latent conditions precedent, the organizational accident would not have occurred. Additional research was subsequently performed in order to explain this complex phenomenon further and create the comprehensive organizational accident definition.

The field of study continued to develop and in addition to a formal definition for organizational accident, James Reason postulated a model called Swiss Cheese Model (SCM) that identifies four failure domains: organizational influences, supervision, preconditions, and specific acts (Reason, 1997; Underwood & Waterson, 2014). In ordinary circumstances, the risk mitigation process, enhanced by the domain layers, coordinate to create a solid mass. However, when either active or latent errors are exposed within each domain at the precise time of an incident, the failure is allowed to pass through each layer like Swiss cheese. Organizational accidents using the SCM have been directly related to the aviation industry by using the FAA air traffic control system (Underwood & Waterson, 2014).

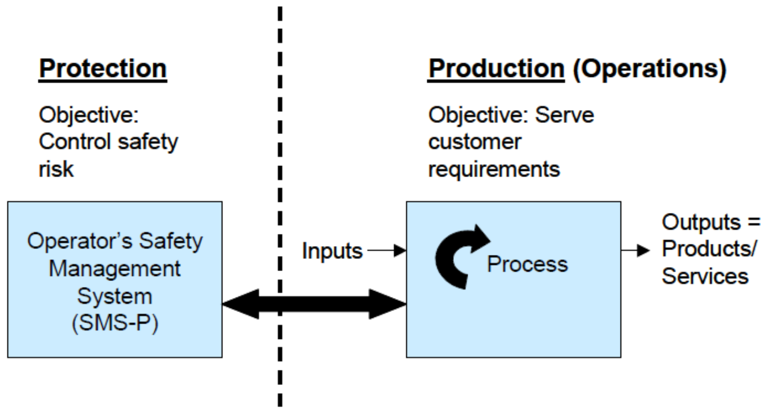


Figure 6. Accident system relationships. From *FAA Advisory Circular 120-92*, (p. 5), by the Federal Aviation Administration. Copyright 2006. In the public domain.

Reason (1998) also states that when the rare organizational accident occurs, the people responsible for those actions often have no comprehension as to the cause. The FAA quickly adopted Reason's work to aviation and used the SCM to complex techno human aviation interactions. Understanding the root cause and preventing organizational accidents rely upon two concepts: production and protection. Production is an overarching concept related to the production of services; in the case of aviation, the transportation of people (Reason, 1998).

Figure 6 graphically represents the concept of protection and production to aviation as described in FAA (2006) *Advisory Circular 120-92*. Production in aviation primarily involves a customer requirement of safe passage. Internally, the processes involved in operating the aircraft in a safe manner relies upon inputs from machine, man, and nature. Protection relates to the institutional methods taken to protect the service from human error (Reason, 1998). These systems can range from simple checklists to a complex computer model mitigating the risk of the activity based on input parameters. Complete systems that address both protection and production include an SMS.

Researchers discovered human factor involvement accelerates the ability for the error to occur in most cases (Lindvall, 2011; Taylor, van Wijk, May, & Carhart, 2014; Wiegmann & Shappell, 2003). Human interaction was previously mentioned as a key component in the successful development of high-trust organizations. That interaction serves a critical role in organizational accidents as well. Human factors in aviation is widely accepted by the safety community and National Transportation Safety Board as the leading cause of most aircraft accidents (Air Safety Institute, 2011). A field of study emerging within aviation to study human-system interaction is human factors analysis.

High Reliability Organization (HRO)

High reliability organization (HRO) theory relates to enterprises that operate within low error tolerances, are committed to a continual reduction in the causes of error, and contend with complex technical systems as a normal course of operations (Rochlin, 1993; Schulman, 1993; Turner & Pidgeon, 1997). Early adaptations applied HRO theory to industries where organizational accidents violated the public trust. While all industries may have elements of high risk operations, there are only a few that have the potential to harm large numbers of people in a single organizational accident. From a scientific approach, an example of a null hypothesis to describe a HRO could be defined as: “organizations do not vary in internal processes as a function of the degree to which their production technologies are perceived as hazardous or the consequences of individual failures vary in severity" (Roberts, 1990b, p. 160).

There are eight distinct characteristics to help identify a HRO. They are hyper complexity, operational urgency, extreme hierarchical differentiation, complex communication networks, high degree of accountability, high frequency of immediate feedback about decisions, compressed time factors, and more than one critical outcome must happen simultaneously (Roberts & Rousseau, 1989). These characteristics combine to form a highly complex interrelationship as described by Perrow, Reason and Roberts. Researchers believed there was more to understanding HRO behavior and proposed in conjunction with the University of California at Berkley the creation of a working group called the "HRO project". "The HRO project then sought to explicate phenomena which are surprising and unexpected - as well as skeptically received as incredible within the scope of current social science understanding of complex organization" (La Porte, 1996, p. 61). Figure 7 represents the culmination of the working group to describe the phenomenon in the context of other familiar functional relationships.

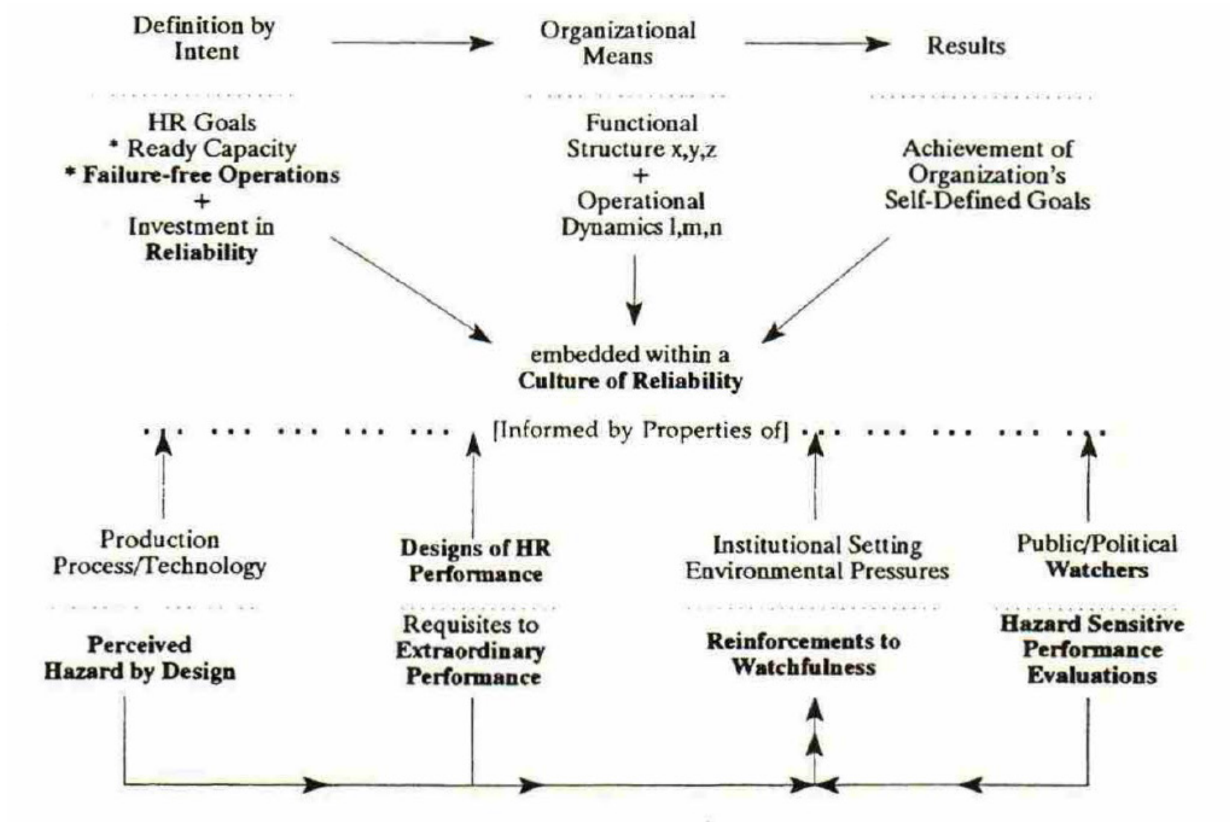


Figure 7. Conceptual logic undergirding HRO studies. From "High Reliability Organizations: Unlikely, Demanding and at Risk", (p. 62), T. R. La Porte, 1996, *Journal of Contingencies & Crisis Management, 4*(2). Copyright 1996 by Wiley-Blackwell. Reprinted with permission.

HROs are not necessarily high-risk organizations by nature, but rather take extraordinary measures to achieve error-free performance (Weick, Sutcliffe, & Obstfeld, 2008). Reliability is an extremely hard standard to reach. Regardless of previous success, HROs operate in an environment which demand continuous predictability. Unfortunately, organizational accidents cannot be offset with previously successful performance; they do not have the ability to be credited to the next event (Schulman, 1993). An examination of literature on the lessons learned from HRO research provide a relevant framework in which to understand organizations operating within an industry that demands error-free performance.

Evolution of HRO theory. As described earlier in the context of organizational accidents, Perrow's (1984) High Reliability Theory, provides a foundation to describe activities within the HRO. The theory remains actively debated in HRO literature as to whether exogenous influences can be effectively integrated or whether the highest degree of reliability exists in a closed system free from trial and error (Roberts & Rousseau, 1989; Weick, 1987; Weick et al., 2008). In contrast, many HROs believe trial and error leads to a better understanding of how systems fail and the human interaction necessary to disrupt organizational accidents (La Porte & Consolini, 2008; Rochlin et al., 1998; Schulman, 1993). Those advocating trial and error believe experimentation increases system understanding which in turn increases the human ability to intervene appropriately. In articulating the position that trial and error is the only way to achieve true understanding, Rochlin (1999) made the following argument:

> The maintenance of safe operation so defined is an interactive, dynamic, and communicative act, hence it is particularly vulnerable to disruption or distortion by well-meant but imperfectly informed interactions aimed at eliminating or reducing 'human error' that do not take into account the importance of the processes by which the construction of safe operation is created and maintained. (p. 1549)

The debate in literature will continue as to whether it is truly feasible to achieve error-free performance in a HRO through predefined processes and systems versus trial and error. The application of this argument to aviation has been clearly resolved through extensive experimentation in activities ranging from airborne flight testing to the constant adjustment of checklists by manufacturers. Regardless what position the literature argues, there is compelling evidence to support aviation has a rich history in applying the concepts of HRO to a wide range of activities.

HRO in military operations. In a quest to understand organizational accidents on a massive scale, a more focused field of research applying HRO theory to military flight applications emerged. The first comprehensive studies into operating within a HRO involved

Naval aircraft carrier operations (La Porte, 1996; La Porte et al., 1988; Roberts, 1990a; Roberts, Stout, et al., 1994; Rochlin et al., 1998; Weick & Roberts, 1993). Due to the high number of fatalities of carrier-based aircraft, the Navy undertook a project to determine root causes and create a high performing safety environment. Researchers described the high-risk environment of carriers could have applications in any area containing complex processes and human-systems interaction. Mishaps peaked in 1953 with 57 accidents, but through the continued diligence and increased process analysis, the mishaps steadily decreased to 15 by 1965 (Roberts, 1990a). The incredible success reported in the study represents high validity since the accident rates continuously improved through 2013 when the accident rate fell to 0.48 per 100,000 hours (Naval Safety Center, 2014). Many of the lessons from this literature informed future research in other industries.

HRO within NASA. HRO theories and concepts quickly became adopted and ingrained into NASA due to a series of unfortunate accidents (Bigley & Roberts, 2001; Casler, 2013; La Porte, 1996). Beginning with STS-51, space shuttle Challenger, NASA and researchers began to study the institutional level failures that occurred. In using STS-51 as a representative model, Reason (1997) was able to accurately describe organizational accidents. Unfortunately, it was not until the second accident of STS-107 and the loss of vehicle and crew of Columbia in 2003 that NASA acted in response to extremely critical identification of organizational failures (Boin & Schulman, 2008; Mahler & Casamayou, 2009). HRO research took the fundamental concepts of organizational accidents and evaluated the situation for its relationship with characteristics of other activities requiring failure-free operations. NASA operates in an environment where risk is inevitable. The complexity involved with basic components of space travel such as the vehicle, tightly coupled systems, and high reliance on technology clearly support NASA as an HRO

(Casler, 2013; Mahler & Casamayou, 2009). Add the large number of decision makers and operational urgency to the process and it matches all the previous criteria previously stated. There was also a tight correlation between leadership, culture, and safety at NASA (Norelli, 2015). Later research describes the method in which NASA has rejected integration of HRO concepts into organizational culture development. In operationalizing 10 components of HRO, NASA was found to fit only four (Casler, 2013). The failure to recognize a need to integrate HRO thinking is troubling after two very high profile organizational accidents that led to the eventual de-funding of multiple re-entry space flight. Failures at NASA may have facilitated other governmental organizations to fully embrace HRO concepts.

HRO in the FAA Air Traffic Control system. The Federal Aviation Administration (FAA) has utilized the HRO theoretical model in air traffic control operations. At the time of adoption by the FAA in 1982, several high profile mid-air collisions had occurred, a controller strike had just occurred, and the agency was in the process of a technology update (Schulman, 1993). Management was seeking a solution to redesign the organizational culture to achieve greater reliability and keep pace with aviation technological advancements. In order to ensure success, the FAA understood full implementation would mean not only an organizational change, but a policy change (O'Neil & Krane, 2012). Air traffic controllers have highly complex reciprocal interdependencies between pilots, systems, and even other controllers (Busby & Iszatt-White, 2014; Nævestad, 2009; Roberts & Bea, 2001a). This tightly coupled interdependence creates a dynamic workplace ripe with potential for organizational accidents (La Porte & Consolini, 2008; O'Neil, 2011). Using the mitigation tactics of HRO allowed the FAA to understand the organizational subtleties that cause accidents and eliminate them. By 2000, the accident rate was 0.0004, and by 2002 the FAA Air Traffic Control system had achieved a zero fatal accident rate (O’Neil & Krane, 2012). HROs are inherently concerned with reliability over performance, therefore the FAA example proved no different to NASA, nuclear power plant, and aircraft carrier aviation operations in demanding adherence to both at the same time.

HRO adoption in commercial aviation. After the clear success of HRO theory within military operations and the FAA, the concept gained favor in commercial aviation. Prevalence of hiring participants from these two early adopters allowed airlines to re-evaluate their operations from a new perspective, but the adoption was slow in coming. The identification of commercial aviation as a HRO has also been studied and well-grounded in literature. The empirical results from the literature demonstrate the ability of HROs to reduce the number of errors (O’Neil & Kriz, 2013; Roberts & Bea, 2001a). In a 68-year study of commercial airline operations and accident rates, the advent of HRO theory proved statistically significant. “Our analysis of the American aviation policy-agency regulatory framework revealed a statistically significant relationship between the emergence of specific high-reliability policy and the regulatory agency characteristics that produced a reduction of commercial airline Part 121 accidents” (O’Neil & Kriz, 2013, p. 609).

Commercial aviation has a long history of hierarchical deities in the cockpit known as pilots (Rochlin, 1999). The mere nature of the official designation of ‘pilot-in-command’ provided little ambiguity as to who was ultimately responsible for the operation of the aircraft. However, the human relationship evolved into a more complex system as the level of cooperation necessary to operate the aircraft increased (Wiegmann & Shappell, 2003). In addition, increasing technology in flight systems removed the predictability and simplicity of the aircraft (Rochlin, 1999). Previous training focused on piloting skills and less on the aircraft systems. Now highly complex engine power plants and advanced navigation avionics proved an inability of humans to effectively understand the infinite variability.

A clear criticism of the literature is that no one appears to dispute the presence of each HRO characteristic within aviation, but no empirical research conducted support such claims. It appears the reliable and valid measurement tools used in military outcome analysis or various other fields has not resulted in meaningful study of HRO practices in commercial aviation.

HRO in healthcare. Since the establishment of HRO organizational theory, numerous industries have joined the quest to achieve error-free operations. Healthcare has been the most recent entrant into HRO due to the parallels in imagery between aviation operations and medicine to the consumer. Examples in clinical operations have been well researched and have shown successful outcomes (Gaba, Singer, Sinaiko, Bowen, & Ciavarelli, 2003; Singer, Rosen, Zhao, Ciavarelli, & Gaba, 2010). One study went so far as to compare safety related attitudes and experiences of 2,989 California hospital employees in 15 locations to 6,901 members of naval aviation units. The conclusion was the hospitals lacked a strong HRO characteristics in comparison to the Naval Aviators (Gaba et al., 2003). This result was not unexpected since the hospitals did not claim to have fully implemented HRO and the Navy has been a self-proclaimed HRO for over 20 years. Researchers were not satisfied with the results from the first survey and many of the same investigators participated in a more wide-scale evaluation using the same question set. In the second study, 13,841 hospital workers and 14,854 naval aviators were administered the same survey with significantly different results. One hospital performed at the same level of the Navy and at least one hospital outperformed the Navy in all but 3 of the 16 benchmarks (Singer et al., 2010). The study results prove the ability of HRO theory application in environments placing value on creating near error-free organizations.

Table 3 represents other industries experimenting with HRO application along with those previously mentioned as having pioneered the effort (Binci, Cerruti, & Donnarumma, 2012).

Table 3

Examples of HRO Typologies

HRO's typologies	HRO's priorities	Examples of organizations targeting high reliability
Fire emergency services	To prevent, prepare for, respond to and recover from a diverse range of fire emergencies	US wildland and urban fire fighting
Healthcare	To ensure effective performance and safety with results close to zero error despite operating in unpredictable environments and organization being inherently risky	Loma Linda Hospital Kaiser Permanente
Power grid	To maintain reliability of power grids and guarantee electric service continuity avoiding service interruptions and blackouts	Norwegian electricity network operators California Independent System Operator (CAISO)
Air Traffic Control	To effectively manage the air traffic flow with safety of flight operations and avoid possible disasters	Federal Aviation Administration's Air Traffic Control Centers
Civil Aviation	To ensure the safety and reliability of air transport	SAS Airlines United Airlines
Space Flight	To reach new and unknown places for the benefit of humanity in conditions of safety and reliability	Columbia Accident Investigation Board (CAIB)
Railway sector	To provide a safe, fast and reliable transport service	UK train operators
Petroleum and chemical industries	Research, production, transportation and marketing of oil and natural gas by avoiding natural disasters and minimising organisational risk	Chevron
Nuclear power	To provide low-cost electricity in a safe, clean and reliable way	Diablo Canyon Power Plant

Note. From "Resistance in HROs, Setback or Resource?" D. Binci, C. Cerruti, and S.A Donnarumma, 2012, *Journal of Organizational Change Management, 25*(6), p. 868. Copyright 2012 by Emerald Group Publishing. Reprinted with permission.

HRO as a construct. Various stated examples of successful implementation of HRO have proven the applicability of the theory. The continued debate highlighted by the literature is the lack of conceptualization of key reliability characteristics such as culture, technology, structure, and collective mind (Nævestad, 2008; Offstein, Kniphuisen, Bichy, & Childers, 2013; Roberts & Bea, 2001a, 2001b, Rochlin, 1996, 1999). Scholars refer to these core characteristics as *sociotechnical systems*. Sociotechnical systems approach relies upon jointly optimized technical and social subsystems. This tightly coupled system allows the primary task to be accomplished with the highest degree of efficiency (Nævestad, 2009). There is little argument that HROs, and by default sociotechnical systems, rely upon a high degree of shared beliefs and expectations. With the tightly coupled human systems, the hypersensitivity to prevent failure results in unwarranted simplification and creation of rigid processes that jeopardize HRO effectiveness (Roberts & Bea, 2001a; Weick et al., 2008).

Any time a pilot or other participant in HRO relies upon rote memory to perform tasks, the system has failed. Studies prove the danger of collective mindfulness is rooted in the fact that HROs have so few accidents it results in unrealistic ideas and over-confidence (Offstein et al., 2013; Rochlin, 1999). In a series of maritime examples, one study used the Titanic as an example of this contradiction to HRO philosophy. Everyone from the captain to the dishwasher was told the Titanic was unsinkable and therefore created a false sense of fantasy based on unrealistic ideas. The crew had little training in the massive ship and based decisions based on efficiency rather than reliability (Roberts & Bea, 2001b). "In the more effective HROs, complacency is interpreted as a failure of striving, inattention is interpreted as a failure of vigilance, and habituation is interpreted as a failure of continuous adjustment" (Weick et al., 2008, p. 41).

HRO conclusion. Each example included in various settings underscore a broader point of how a HRO theory integrates with organizational culture. The goal for every HRO is to achieve organizational reliability. Weick (1987) states that the Challenger accident, Three Mile Island, and Bhopal were all organizational issues related to reliability and not efficiency. The unintentional result is efficiency inherently creates an organizational culture of unreliability. As system complexity is introduced into an organization, the human must match that complexity and account for a variety of possible variables to achieve predictability (Bigley & Roberts, 2001; Schulman, 1993). This predictability, whether in human behavior, systems, or processes serves as a critical component to create organizational reliability, a key component to a successful HRO. Therefore, we must examine the concepts of organizational culture and how the environment to sustain a HRO can be created. While integration of culture to organizational accident is not mentioned in Perrow (1984), the literature suggests a strong connection within HRO. This would account for an updating of the basic theory to cover additional variables uncovered during subsequent studies. Criticism has been voiced as to the unintended diversion resulting in a rush to solve the argument whether HRO and NAT are related (Roberts, 2009). It is clear from meta-analysis the two have similar overlapping characteristics, but are in fact two distinct theories. Taking into consideration the body of literature on HRO theory, perhaps one quote can accurately summarize the entire field of study:

> While the conceptual problems of interdependence and complexity have been part of the social science agenda for at least twenty years, this work is still in a very early stage of development when set against the organizational phenomena being observed. (La Porte & Consolini, 2008, p. 74)

Organizational Culture and Climate

There is substantial scholarly debate as to whether aviation safety can be categorized as either prolonged state of existence known as culture, or climate, a temporary state subject to change (O'Connor et al., 2011). Surprisingly, the literature is unclear as to whether the existence of strong organizational safety culture impacts accident rates. There are strong examples in measurement of safety culture in the military, but this has yet to be applied to general aviation.

Organizational culture. Organizational culture is a broad term established to explain the interrelationship between leaders, followers, and the organization. To state organizational culture is a frequently studied topic would be an understatement; in a WorldCat search using organizational culture as a term, over 24,000 peer-reviewed articles appear. Researchers have been actively searching for a clear definition of culture and attempting to understand the impact to organizations from a sociological, psychological, and anthropological perspective. Culture has been discussed in the context of organizational development for many years, but the academic literature did not apply scientific rigor to the topic until its peak in 2011 with 1,882 peer-reviewed articles. The relative infancy of organizational culture research as a phenomenon has allowed researchers to explore a great deal of related topics.

The creation of a high functioning, nearly error-free organization relies upon elements of centralized processes, but also development of a successful culture. Interpretation, improvisation, and unique action are all necessary for highly dynamic operating environments and without organizational culture, there would be no inability to adapt (Weick, 1987). Due to the high number of articles on the topic, studies have formulated unique definitions of organizational culture over the years. Researchers continue to frame the conversation in a way that is beneficial for them. One recent study cited 164 different definitions for organizational culture (Fisher & Alford, 2000). Despite the ongoing debate, the literature has accepted a definition of organizational culture proposed by Schein (1990):

> (a) a pattern of basic assumptions, (b) invented, discovered, or developed by a given group, (c) as it learns to cope with its problems of external adaptation and internal

> integration, (d) that has worked well enough to be considered valid and, therefore (e) is to be taught to new members as the (f) correct way to perceive, think, and feel in relation to those problems. (p. 111)

Schein (1990) explains further that Lewinian field theory cannot explain the complex relationship of organizational subgroups and units. Therefore, a return to a natural state of equilibrium is impossible due to the amount of dynamic social systems, or culture, within an organization.

Early research into organizational culture focused on identifying how it was created, communicated, and rooted using a single workplace. Due to the measurement of culture being very subjective and from a sociological viewpoint, studies relied heavily on qualitative analysis (Büschgens, Bausch, & Balkin, 2013; Denison, 1996; Marchand, Haines, & Dextras-Gauthier, 2013; Schein, 2010). This myopic research agenda created a large volume of studies on the theoretical limits and conceptual development of organizational culture, but very little on measurable outcomes. It was not until recently that literature began to research differences in culture and how they affect the organization.

Since organizational culture is a variable in the behavioral outcomes of followers, the effect of a strong culture could stifle innovation. In a meta-analytic review of 43 studies examining 6,341 organizations, the effect of a strong culture impacting both radical and incremental innovation was found to not be statistically significant in hindering the innovation process (Büschgens et al., 2013). This finding lends validity to HRO theory of enhanced performance when a strong organizational culture is present. The lack of impact in innovation allows the follower the freedom to interpret and adapt to changing environments to avoid catastrophic failures (Bigley & Roberts, 2001). Effectiveness is also a key driver to successful organizational culture and is easily measured using quantitative measures. The issue of how to measure effectiveness has become a central question in the research. Various opinions have emerged as to what constitutes effectiveness since the multidimensional nature of operational criteria differs between organizations and individual decision makers (Denison & Mishra, 1995). It is therefore nearly impossible to measure effectiveness in a context that is meaningful to the body of literature. One meta-analytic review looked at 84 studies to measure overall effectiveness using dimensions specified by the Competing Values Framework. Each dimension utilizes a recognized element of organizational culture to effectively categorize the characteristics but lacked any tangible measure. The study found that positive correlations in 23 out of 25 possible effectiveness measures (Hartnell, Ou, & Kinicki, 2011). Despite the shortcomings of measuring effectiveness, these two meta-analysis examples prove the presence of a strong organizational culture leads to higher effectiveness and innovation than those without.

In the end, organizational culture must be evaluated in its most basic form. The literature must temporarily set aside the philosophical argument of whether it is sociological, psychological, normative, pragmatic, or anthropological (Brinkmann, 2007; Edwards, Davey, & Armstrong, 2013). For this and other studies, organizational culture has been viewed in the context of a variable acting as a subsystem within human, process, and organization interaction driving the outcomes like an invisible hand. The magnitude of complexity and interdependency of organizational culture has proven too much for the literature to draw meaningful conclusions and assumptions. A few aviation related studies lacked empirical meaning, or used conjecture for effect to describe another industry.

Organizational climate. Organizational climate can be regarded as the surface features of the culture attributed to leader-follower attitudes and perceptions at a given point in time. It is a snapshot of the state of an organization providing an indicator of the underlying culture of a work group, plant, or organization (Flin, Mearns, O'Connor, & Bryden, 2000). A major distinguishing factor highlighted in literature relates to climate is a lack of organizational memory and therefore can be easily changed or manipulated by leaders. "Climate refers to a situation and its link to thoughts, feelings, and behaviors of organizational members. This it is temporal, and subjective" (Denison, 1996, p. 644).

In order to highlight and summarize the various theories of thought of climate versus culture, Table 4 provides additional insight as to how the literature treats the two distinct theories. Many researchers distinguish the differences using the temporal orientation and level of analysis characteristics. Organizational climate only touches on the surface-level manifestations of a particular phenomenon, where culture attempts to seek understanding of the underlying values driving the behavior. Schein (1990), the recognized founder of organizational culture, articulates his struggles with the very question of how to distinguish the two. He resolves this conflict by making a general statement that climate can be considered a cultural artifact comprising several concepts (climates) in order to adequately describe the situation (Schein, 2000).

Table 4

Contrasting Organizational Culture and Climate Research Perspectives

Differences	Culture Literature	Climate Literature
Epistemology	Contextualized and idiographic	Comparative & nomothetic
Point of View	Emic (native point of view)	Etic (researcher's viewpoint)
Methodology	Qualitative field observation	Quantitative survey data

(continued)

Differences	Culture Literature	Climate Literature
Level of Analysis	Underlying values and assumptions	Surface-level manifestations
Temporal Orientation	Historical evolution	Ahistorical snapshot
Theoretical Foundations	Social construction; critical theory	Lewinian field theory
Discipline	Sociology & anthropology	Psychology

Note. From “What is the Difference Between Organizational Culture and Organizational Climate? A native’s point of view on a decade of paradigm wars,” D.R. Denison, 1996, *Academy of Management Review, 21*(3), p. 625. Copyright 1996 by Academy of Management Review. Adapted with permission.

High reliability organizations like aviation are not resilient when only operating as an organizational climate. Evidence from the HRO literature overwhelmingly supports culture is superior to climate (Klein, Bigley, & Roberts, 1995; Nævestad, 2009; Roberts, Rousseau, et al., 1994; Rochlin, 1999). Much of the early literature on organizational climate infers culture is similar without distinction. The purpose of describing distinct differences in literature is to prevent interchangeable use of organizational climate and culture. It is especially important while introducing the concept of safety culture.

Safety Culture

Based on the pioneering work of Perrow (1984), Pidgeon (1991), Reason (1998), and Schein (1990), the field of organizational culture found clarification and purpose in creating the subset known as safety culture. “The safety culture of an organization is the product of individual and group values, attitudes, perceptions, competencies, and patterns of behavior that determine the commitment to, and the style and proficiency of, an organization’s health and safety management” (Cox & Flin, 1998, p. 191). Placing culture in an organizational context allows for qualitatively thick description. The need to avoid catastrophic failures gave rise to a theory where robust human relationships between systems and technology could limit organizational accidents. The International Nuclear Safety Advisory Group (INSAG) first described safety culture to reflect on the operational and human failures at Chernobyl. The report stated, "Safety culture is that assembly of characteristics and attitudes in organizations and individuals that establish an overriding priority" (INSAG, 1991, p. 1). As with any emerging theory of thought, there is significant dispute in literature as to how to define safety culture. Guldenmund (2010) summarizes the literature well and captured the diversity of thought as represented in Table 5. The inconsistency in the definitions used by the studies reflects a continued debate. Due to the complex nature of safety culture and the sociological interactions, two schools of thought emerged to provide constructs and potentially solve the uncertainty: functionalist and interpretive approaches.

Table 5

Definitions of Safety Culture

Author(s)	Definition of Organizational Safety Culture	Part*
Deal & Kennedy, (1982) but used by numerous other authors also in the field of safety Cox	The way we do things around here	M
Cox & Cox (1991)	Safety cultures reflect the attitudes, beliefs, perceptions, and values that employees share in relation to safety	C
INSAG (1991)	Safety culture is that assembly of characteristics and attitudes in organizations and individuals that establishes that, as an overriding priority, nuclear plant safety issues receive the attention warranted by their significance	C
Pidgeon (1991)	The set of beliefs, norms, attitudes, roles, and social and technical practices that are concerned with minimizing the exposure of employees, managers, customers, and members of the public to conditions considered dangerous or injurious	W
ACSNI (1993)	The safety culture of an organization is the product of individual and group values, attitudes, perceptions, competencies, and patterns of behavior that determine the commitment to, and the style and proficiency of, an organization's health and safety management Organizations with a positive safety culture are characterized by communications founded on mutual trust, by shared perceptions of the importance of safety, and by confidence in the efficacy of preventive measures	W
Ostrom,Wilhelmsen, & Kaplan (1993)	The concept that the organization's beliefs and attitudes, manifested in actions, policies, and procedures, affects its safety performance	W

(continued)

Author(s)	*Definition of Organizational Safety Culture*	Part*
Geller, E.S. (1994)	In a total safety culture (TSC), everyone feels responsible for safety and pursues it on a daily basis	M
Berends (1996)	The collective mental programming toward safety of a group of organization members	C
Guldenmund (2000)	Those aspects of the organizational culture that will impact on attitudes and behavior related to increasing or decreasing risk	C
Hale (2000)	The attitudes, beliefs, and perceptions shared by natural groups as defining norms and values, which determine how they act and react in relation to risks and risk control systems	C
Richter & Koch (2004)	The shared and learned meanings, experiences, and interpretations of work and safety—expressed partially symbolically—which guide peoples' actions toward risks, accidents, and prevention	C
Westrum (2004)	The organization's pattern of response to the problems and opportunities it encounters	M

Note. * The part of culture the definition primarily focuses on; C = core, M = manifestations, W = whole. From "(Mis)understanding safety culture and its relationship to safety management," F.W. Guldenmund, 2010, *Risk Analysis, 30*(10), p. 1467. Copyright 2010 Society for Risk Analysis. Reprinted with permission.

Functionalist approach. Scholars have identified the functionalist approach to safety culture as shared patterns of behavior (Denison & Mishra, 1995; Nævestad, 2009). These shared patters are collected qualitatively through surveys of a variety of stakeholders within the organization. In many cases, researchers interpret the data subjectively and construct scales in order to articulate the study findings. A functionalist approach sacrifices reliability in favor of observational richness and context (Nævestad, 2009). For researchers skilled in the industry or familiar with the human factors being studied, identification of shared patters and a functionalist approach may be preferred. Safety culture research has traditionally been conducted through a social and organizational philosophy lens (Guldenmund, 2000).

Interpretive approach. Interpretive approach to culture assigns order and meaning to organizational phenomena. Scholars draw upon anthropology theorists to understand culture as shared systems of meaning where humans interpret their experience through a theoretical lens and guide their action based upon those interactions (Nævestad, 2009). They understand culture as shared patterns of meaning that members of organizations draw on as they interpret their beliefs, behavior and collective identity (Alvesson, 2012; Glendon & Stanton, 2000).

Interpretive analysis of safety phenomenon excel at revealing how meaning is applied to patterns, motivations, and preventative measures.

Safety culture as a construct. Safety culture has been described in management literature as a systemic, structural, and static construct (Pidgeon, 1991). The basic premise of safety culture creation is the ability of the organization to align policy and action. Safety culture relies upon the development of high-trust and leader-follower relationships to be effective. Organizational culture exists as a part of the entity, therefore an organizations *is* rather than *was* and created as a result of historical actions that formed the culture (Guldenmund, 2010; Patankar, Bigda-Peyton, Brown, & Kelly, 2005). The social contract established to provide reward, whether in transactional, path-goal, or situational leadership, relies on the enacted policies being supported for safety culture to be effective (Zohar, 2008). It was not until Reason (1997) specifically created a series of criterion that safety culture gained wide scale acceptance. He proposed the following characteristics:

- has a safety information system that collects, analyses and disseminates information from incidents and near misses, as well as from regular proactive checks on the system;
- has a reporting culture where people are prepared to report their errors, mistakes and violations;
- has a culture of trust where people are encouraged and even rewarded to provide essential safety-related information, but also in which it is clear where the line between acceptable and unacceptable behavior is drawn;
- is flexible, in terms of the ability to reconfigure the organizational structure in the face of a dynamic and demanding task environment;

- has the willingness and competence to draw the right conclusions from its safety system, and is willing to implement reform when it is required. (Parker et al., 2006, p. 552)

This construct had been accepted until reflective analysis was performed of existing literature and a new shortened safety culture construct was created. Four elements were identified in the new model: management concern, personal responsibility, peer support for safety, and safety management systems (Flin et al., 2000; Frazier, Ludwig, Whitaker, & Roberts, 2013; Guldenmund, 2000). For the purposes of this study, the new safety culture construct was used to provide meaning and frame actions within culture data collected.

In a comprehensive review of safety culture 30 years after first proposing such a concept, Zohar (2010) performed a meta-analysis of academic progress on his topic. The results were mixed. On one hand, the meta-analysis validated results of previous studies by Zohar (2000) and confirmed variation for within-group and between-group safety culture. This demonstrated culture was individualistic in nature. Safety culture has been lacking research to address the organizational hierarchy arising from inconsistent policy implementation (Zohar, 2002a; Zohar & Luria, 2005). The meta-analysis proved qualitatively that no progress had been made in solving this issue.

It is relevant to note that while safety culture in aviation is assumed as a perceived necessity and conceded fact, there has been astonishingly little literature written addressing the topic (Guldenmund, 2007; Parker et al., 2006; Reiman & Rollenhagen, 2013; Zhang, Wiegmann, von Thaden, Sharma, & Mitchell, 2002; Zohar, 2010). Additional empirical research is needed in this field to help overcome conflicting theoretical frameworks and complex theories that dominate the literature in this topic area. Safety culture will continue to be recognized in literature as a multi-dimensional concept (Cox & Flin, 1998; Dov, 2008; Fernández-Muñiz, Montes-Peón, & Vázquez-Ordás, 2007; Lawrie, Parker, & Hudson, 2006; Pousette, Larsson, & Törner, 2008).

Development of Safety Programs

Researchers have long associated safe operating environments with development of safety programs (Hale, Heming, Carthey, & Kirwan, 1997; Pidgeon, 1991; Weick et al., 2008). After processing the groundbreaking work of organizational safety theorists, researchers turned their focus creating processes to make organizations safety reliable and sustainable. Human error has long been associated with the worst organizational accidents in history and accounts for 80% of all aviation accidents in history (Gibbons et al., 2006; Reason, 1997). A reduction of human error through methodical approaches to complex processes creates the opportunity for safety culture inculcation. The resulting safety programs originated in energy sector industries which required tight coupling of technology and human interaction (Rochlin, 1996; Wold & Laumann, 2015). Generally, safety programs are merely tools for organizations to interact with their influencers through advanced communication (Vinodkumar & Bhasi, 2011). Safety programs quickly gained wide-scale acceptance to address all kinds of organizational accidents and was embraced as early as 1995 by the International Standards Organization and American National Standards Institute (Vinodkumar & Bhasi, 2011). To further cement the theoretical framework of specialized safety programs to highly complex processes, safety management systems (SMS) incorporate key organizational functions.

Safety Management Systems. An SMS can be described as an attempt to systematize safety culture with repeatable methodologies. Through a culmination of extensive research, SMS was designed to meet organizational effectiveness measures to include “internal control systems, safety experts, safety committees and quality circles, supervision and behavior modification, audits, decision making, and safety culture” (Hale et al., 1997, p. 123). These multidimensional elements merge to define the purpose of developing successful SMS programs aimed at preventing accidents. Several researchers provide an alternative purpose of SMS, which is to help the organization meet the regulatory requirements (Cox & Flin, 1998; Hale et al., 1997; Neal & Griffin, 2006). Regardless of conflicting dimensions postulated by researchers, the concept of SMS originated from a theory of coordinating mechanisms. Mintzberg (1980) stated that coordination to accomplish a common mission were guided by five tasks: standardization of work processes, outputs, skills, direct supervision, and mutual adjustment. An effort to continue Mintzberg’s work and place definitive safety science research parameters resulted in the Delft framework.

> The purpose of this is to show what organizational and management factors can be introduced or improved in order to improve the performance of the SMS. The framework therefore aims to provide the basis for assessing and improving an existing SMS and for designing a new one from scratch. (Hale & de Kroes, 1997, p. 125)

While Delft failed to gain momentum, modern SMS program development continues to follow these basic frameworks.

There is also a general agreement in meta-analytic research that SMS is a means to change safety management from being reactive to being proactive (Liou, Yen, & Tzeng, 2008). Anticipating hazardous situations before they occur was more important and not just acting after an accident has occurred, or phrased differently; to protect against human error (Antonsen, 2009; Dekker, 2003; Dien, 1998). Inclusion and involvement by decision-making participants actively engaging in HRO activity improves communication flow throughout the organization. With improvement in communication and involvement, SMS programs are statistically more effective (Block, Sabin, & Patankar, 2007; Fernández-Muñiz et al., 2007; Vinodkumar & Bhasi, 2011;

Zohar & Luria, 2005). Meta-analysis overwhelmingly supports the importance of safety culture development and its interrelationship with SMS program usage across all industries (Vinodkumar & Bhasi, 2011). Successful use of SMS specifically in accident prevention within HRO operations resulted in aviation industry leaders considering the adoption of SMS.

Adaptation to of safety programs to scheduled air carriers. Military aviation developed a strong safety culture by using SMS as previously discussed in the context of HRO theory. Civil aviation took notice on the heels of numerous high profile scheduled air carrier accidents. Air carriers operate under Part 121 of the federal regulations, more colloquially referred to as the airlines. The issue was not only airline accidents, but an organizational failure to proactively prevent incidents of all types. While it was in the best interest of airlines to become reflective in their organizational practices, it was a 1991 push from NTSB Safety Board member Dr. John Lauber who was credited for beginning the safety climate conversation to airlines (Kelly, 2013). As Logan (2008) states, "Before 1995, safety in the airline industry was reactive. An accident or accidents would occur, and, eventually, a mitigation strategy would be developed, implemented, and, in most cases, mandated, resulting in an incremental overall improvement in safety" (p. S178). Both airlines and federal regulators understood a change had to occur. The stakeholders created the cooperative Air Transportation Oversight System (ATOS) program to gather useful prevention and safety data from airlines (McFadden & Towell, 1999). Airlines voluntarily adopted variations of basic SMS concepts into customized safety programs. The success of a cooperative and voluntary airline SMS program cannot be denied. There have been two United States certificated airline accidents out of over 160 million flight hours since formal SMS adoption in 2006 and no accidents at all since 2009 (National Transportation Safety Board, n.d.).

Researchers have also tied the effectiveness of airline SMS program to safety culture. Lin (2012) conducted a quantitative factor analysis of Taiwanese airline pilots and found safety culture and performance of a SMS were positively significant by answering the question “The safety culture positively affects the performance of SMS” (p. 168). Similar results in Fernandez-Muniz et al. (2007), McNeely (2012), Byrnes (2015) found SMS serving as a key dependent and independent variable for behaviors leading to sustainable safety culture. The intensive airline SMS design and its associated complexities were visually demonstrated as an impact relations map in Figure 8. Commonly referred to as the safety triangle, the graphic demonstrates interrelationships identified by researchers using mathematical evaluation of system design and accident data (Liou et al., 2008). Unfortunately, the extent and complexity of SMS programs established for airlines have minimal application to the limited CNATO industry segment human and physical resources available.

Figure 8. Airline SMS impact relations map. Shows dependencies of an effective SMS program. From "Building an Effective Safety Management System for Airlines," J. J. H. Liou, L. Yen, and G.H. Tzeng, 2008, *Journal of Air Transport Management*, *14(1)*, p. 24. Copyright 2007 by Elsevier Ltd. Reprinted with permission.

Adoption of safety programs to general aviation. While logic would suggest the reduction in airline accidents would suggest wide-scale implementation to all sectors of aviation, including CNATOs, there is a lack of literature to support any effort undertaken. Some suggest business aviation is embarking on an effort to implement voluntary SMS programs (National Business Aircraft Association, n.d.). The FAA continues to encourage all operators to use SMS and other safety culture tools, but has stopped short of mandating it through regulation. International guidance has been more far-reaching and comprehensive.

Dating back to 2001, the ICAO had been working to establish the Standards and Recommended Practices (SARPs) for adoption by the organization. The impetus for SARPs was in direct response to the desire by member countries to enact a comprehensive safety management system across all aircraft operations. United States based CNATOs were repeatedly asking FAA officials how to effectively conduct operations internationally in ICAO countries. In response to mounting pressure, the FAA issued *Advisory Circular 120-92A*, mirroring the more stringent requirements created by ICAO and changed the advisory circular previously created for airlines from "Introduction to Safety Management Systems for Air Operations" (FAA, 2006) to "Safety Management Systems for Aviation Service Providers" (FAA, 2010). The revised document outlined the components of a SMS, but lacked specific guidance on SMS development. CNATOs were left to use customized SMS solutions or commercially available solutions from a highly fragmented market (Cacciabue, Cassani, Licata, Oddone, & Ottomaniello, 2014). Effectiveness of the limitless amount of SMS programs in CNATOs has not been examined in literature.

Accident rates in aircraft operators. Research suggests that airline accident rates on their own are not a predictor of future accidents (Liou et al., 2008). Latent factors have been given minimal consideration to help define casual relationships of accidents. Human behavior is inherently unpredictable and therefore accident data can only represent trends that may influence failures. Complex system factors such as those found in aviation are inextricably entwined. Existing literature support the linkage of HRO, safety culture, and leadership to accident rates in commercial operators (O'Neil & Kriz, 2013; Wiegmann & Shappell, 2003). Placing strict context on how accident data is analyzed can eliminate improper assumption as to whether factors are directly or indirectly mutually related.

Sources for gathering accident data for the study has been traditionally limited to publicly available sources such as the NTSB, FAA, and industry groups. However, the literature has often suggested adaptation of military rates to other aviation industries (Desai et al., 2006). While correlations of civilian to military flight operations could be drawn in limited circumstances, CNATOs do not act in a similar manner to military operators, nor are there many commonalities in organizational structure. Researchers agree that factors pertaining to other HRO industry segments are not easily translated to CNATO operations (Cooke & Szumal, 2000; Glendon & Stanton, 2000; Scott, Mannion, Davies, & Marshall, 2003).

Summary

The study seeks to find similarities and relationships between highly established CNATO operational dimensions and variables. Existing literature, or in some cases a lack of academic and industry literature, has provided insight into leadership characteristics, high-trust organizations, organizational accidents, HROs, organizational culture and climate, safety culture, SMS, and instrumentation. A synthesis of theoretical frameworks emerge from further examination of each topic comprising study programmatic themes.

What has emerged from the literature review were three overarching themes to guide the study. First, an almost absolute of certainty exists in literature that leadership affects follower compliance with safety culture and organizational accident prevention. Additionally, the literature was close to certain of strong organizational culture creating a foundation for safety culture effectiveness and reduction of organizational accidents. Finally, artifact creation and implementation through SMS development and implementation effects organizational accidents to a fair degree of certainty.

The varying degree of certainty with which the literature addresses each of these intervening and independent variables provides a springboard to investigate the research questions, primarily: To what degree does each variable have on its own to affect organizational accident avoidance?

Wide scale adoption of core theoretical concepts used in literature regarding aviation safety culture, organizational accidents, and HRO served as an exciting discovery. Groundbreaking social science work exemplified by Wiegmann, Reason, and Roberts respectively in their fields provided invaluable insight. Theoretical frameworks described in the literature review allow further research an opportunity to investigate highly specific relationships between variables such as the one explored in this study. However, a lack of healthy academic debate regarding specific aviation industry drivers within those frameworks served as a potential limitation. Literature topics within the study used comparative rather than contrasting analytic methods due to the homogeneity of thought. Identification of this limitation and concluding more review that is academic only reinforces the importance and significance of the study.

Chapter III: Methods and Procedures

Restatement of Research Problem

The Chapter II literature review demonstrated CNATOs operate in a high-reliability organizational environment where safety culture and programs are necessary to prevent organizational accidents. HRO analysis of United States Naval carrier operations and adaptation of SMS programs in airlines have dramatically reduced accidents in those two applications. Unfortunately, there has been little scientific or academic focus in determining safety culture factors in CNATOs. In an effort to seek further understanding, this study employed an ethnographic method to explore insights and experiences of participants. Through ethnography, data collected provides insight into values held and allows general patterns to emerge. Probing participant experiences in operating a CNATO placed in context with variables leads understanding the research questions. The purpose of this study is to (a) examine the way leadership introduces and reinforces safety culture within an organization, (b) how the safety culture is implemented by followers, (c) investigate the types of artifacts used by the aircraft operator to provide reinforcement of established safety processes, and (d) determine the extent to which safety culture has an effect on organizational accidents.

Accident rates in CNATOs have continued at levels high in contrast to scheduled airline operators - 0.157 per 100,000 flight hours for scheduled airlines and 1.02 per 100,000 for CNATOs (NTSB, 2015a). The CNATO accident rate is more than six times that of the scheduled carriers. Identification of relevant factors may assist in reducing CNATO accidents to a rate closer to that of airlines. As these statistics suggest, CNATO safety culture may lack consistency and provide an opportunity to examine various factors that influence a reduction in accident rates. Examining factors such as leadership style, development of a strong safety culture, SMS implementation, organizational culture, and regulatory influence enhance CNATO operational safety and mitigation of organizational accidents. Integrating both qualitative and quantitative methods in an examination of CNATO activities more accurately identify relationships between variables than a single investigative method. This chapter articulates the selected research methodology, including the process for selecting data sources, instrumentation, quantitative and qualitative data collection procedures, and human subject consideration.

Restatement of Research Questions

As mentioned in Chapter I, the study employed quantitative methods to address the following questions:

1. What safety culture characteristics does a typical CNATO organization possess? (descriptive)
2. To what extent, if at all, does organizational culture have a relationship with performance outcomes, including accident rates? (relational)
3. To what extent, if at all, is there a difference in accident rates of CNATOs that use safety management system programs and those that do not? (comparative)
4. To what extent, if at all, does CNATO leadership style have a relationship with the development of a safety culture and accident rates? (relational)

Research Design and Rationale

This quantitative study's ultimate purpose was to inform policy as to how CNATOs develop strategies used to operationalize framework components and maximize the efficacy of safety culture. A combination regression and multivariate analysis study required development of a more comprehensive understanding toward both depth and breadth in CNATO operations. In addition, adaptation of a qualitative leadership instrument using quantitative data results indicated the degree to which responses allowed identification of comparison and contrasts between respondents. Johnson and Onwuegbuzie (2004) advocated a combination of "quantitative and qualitative research techniques, methods, approaches, concepts or language into a single study" (p. 15). Another practical application for study approach was the use of *abductive reasoning*. Abductive reasoning utilizes the experience, expertise, and intuition of researchers and applies both deductive and inductive skills to answer the research questions (Wheeldon & Åhlberg, 2012). This study will benefit from a comprehensive examination of quantitative data through a sequential transformative method of research approach.

Sequential transformative design. A sequential transformative design employed "a two-phase project with a theoretical lens overlaying the sequential procedures" (Creswell, 2009, p. 219) . Sequential mixed method data collection involved collecting data in iterative phases. Iterative data collected in one phase contributes to data collected in subsequent phases, effectively creating a sequential model. The 'sequential' portion of the research design entailed a quantitative organizational climate and safety survey to clarify numerical trends and obtain relevant artifacts. The next phase used qualitative leadership measures to understand how leadership influences organizational climate and safety. The 'transformative' portion involves reviewing the results from a CNATO leadership lens, which will produce meaningful correlation to organizational accident rates. Creswell (2009) asserted that the sequential transformative strategy allows the researcher to provide context for diverse perspectives and better advocate participants' worldview.

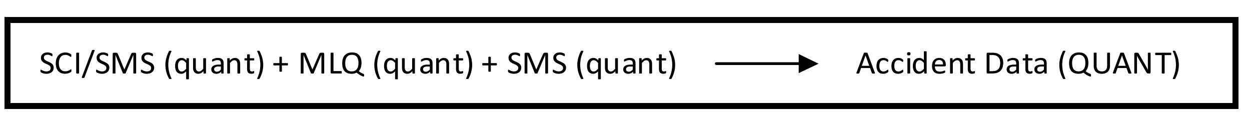


Figure 9. Study sequential transformative design model.

The four research questions encouraged methodological triangulation; no single method adequately addresses the four questions. Multiple perspectives gained by using sequential triangulation aid in guiding subsequent phases due to "the results of one method are essential for planning the next method" (Morse, 1991, p. 120; Richards & Morse, 2013). Triangulation validates results using a mixed method context to determine variable impact on accident rates. This design creates dominant versus equal paradigm emphasis. One single method did not prevail as an important dimension and determine weight and sequence. Design of this study included both concurrent and sequential time order decision design, as well as equal and dominant status paradigms. Figure 9 graphically represents the order and importance of the study instruments that guided research design. The sequence of research represented within Figure 9 shows activities performed first beginning on the left and time ordered left to right. Each concurrent data set revealed a more detailed understanding of the research question and provided context for the sequential collection stage represented right of the arrow. Due to the mix of quantitative and qualitative methods, capitalization represents a higher weighting of each instrument in their importance answering the research questions. Special attention to legitimation of data collected frames research actions. The legitimation step involved assessing the trustworthiness of both the qualitative and quantitative data and subsequent interpretations (Johnson & Onwuegbuzie, 2004).

Selecting a sequential transformative strategy allowed the researcher to provide context to answers provided by CNATOs prior to drawing conclusions on variable relationships to the accident data. Performing qualitative and quantitative investigation in phases enabled the research to dictate the necessary categorization to achieve effective data analysis.

Research Methods

CNATOs are dynamic social organisms developing over time influenced by internal and external forces. Examination of the research questions identified a set of dependent, intervening, and independent variables for further study. Taking a social constructivist view of CNATO culture development framed the research. In general, social constructivists seek understanding of environments in which participants experience culture development. They "rely as much as possible on the participants' views of the situation being studied" (Creswell, 2009, p. 8). While the constructivist view shaped the method, a factorial design using interaction effects also influenced the approach. Identification of an interaction effects design and assists in later data analysis by accounting for spurious or negative interaction. Experimental mixed method research of CNATOs using qualitative and quantitative instruments to gather variable information allowed comprehensive research question coverage.

Qualitative method. A qualitative, ethnographic component benefited the study; it enabled the collection of background information on participants to construct an overall setting. The ability to show patterns and processes demonstrated through values, beliefs, and practices of CNATOs fit an ethnography typology (Richards & Morse, 2013). Measuring CNATO interaction and experiences with predetermined variables using specific qualitative instruments provided the data necessary to develop these patterns. Comprehensive variable experience inquiry also provides comparative context within the industry and peers. Qualitative inquiry regarding leadership architype measures gave key data information on dependent variable relationships. Employing the interpretive explanation typology of qualitative findings allowed full exploration of emerging participant patterns.

> In contrast to findings that survey topics and themes without linking them, or that conceptually or thematically describe elements of experience without explaining them,

> interpretive explanations offer a coherent model of some phenomenon, or a single thesis or line of argument that addresses causality or essence. (Sandelowski & Barroso, 2003, p. 914)

Techniques within the research questions use require experimental ethnographic design techniques. Qualitative method will allow identification of variations between responses and an opportunity to differentiate CNATO safety compliance approaches. Third, leaders in charge of implementing the safety programs have varying degrees of experience. The behaviors of the leader is of particular importance to understand the context in which CNATO implemented SMS and safety culture inculcation. Finally, leader aptitude will potentially have an impact on whether a safety system is effective or not. Each of these phenomena will be further operationalized using ethnographic methods.

Data gathered used the industry standard MLQ-5x Short Form survey instrument measuring 9 factors designed by Avolio and Bass (1995). Collection of data occurred over a 3-week period via online survey tool Qualtrics. As described in previous summaries, a first level analytical style places the user inside the context of an aviation safety program. Next, thick description using a comparison of the various safety programs and their differences provided further context. It was presumed each CNATO used their own technique of implementation and effectiveness inside individualized leader and follower groups.

Quantitative method. Aviation is a science, and as such, the study benefited from the use of statistical quantitative data to answer the research questions. An explanatory correlational quantitative research methodology found simple associations and investigated the extent to which variables have an observable relationship defined by magnitude and/or an incremental change. This type of design recognized trends and patterns in data, but it did not seek to prove causes for observed patterns or predict outcomes. Correlational method examined pre-existing interaction and relationships between variables with no attempt to manipulate independent variables. Explanatory correlational methodology was ideally suited to the study because of a need to explain complex relationships of multiple variables. It is important to note that correlational methods cannot determine causality, only a relationship and/or association with variables (Chen & Popovich, 2002). Quantitative data collected in two phases was consistent with a sequential transformative mixed method approach. Two quantitative instruments combined to determine whether independent and intervening variables had an effect on CNATO accident rates.

Measurement of organizational safety culture was operationalized and collected in phase one using existing instruments which included the SCSMI, a 5-factor, 55-item quantitative survey, and MLQ Form 5X-Short, a 45-item scaled survey. Numeric data from the Pepperdine Qualtrics hosted survey yielded observational data. Data gathered during the survey informed researchers as to basic demographics and the extent to which culture existed within the sample size. This research design ensured relevant data for safety culture triangulation between quantitative and qualitative results. Collection of survey data occur over a 3-week period and managed by the web-based software Qualtrics. Results were exported to Microsoft Excel which provided greater ease in data analysis.

Accident data from the FAA, NTSB, and NASA residing on publicly available government websites comprised phase two. To assist in organizing large amounts of data from these sources, each database import into Microsoft SQL used common Primary Keys for ease of merging data into one output. Frequent federal agency crosschecking of information residing within these databases ensure reliability. Maintainers of these resources are full-time employees of the United States government and are dedicated to integrity of the data. Data analysis of all qualitative data and quantitative surveys preceded accident data collection in order to account for any organizational accidents occurring after phase one data collection.

Population, Sample Size, and Response Rate

The study's unit of analysis can be defined as a CNATO based in the United States who may or may not have experienced an organizational accident. The study's population represented all FAA certified CNATOs. Measurement of leadership characteristics and culture opinion served as an aggregate descriptor to measure culture development. Since the analysis unit is at an organizational level, aggregated data from individuals served to define representative patterns. The following section describes the process undertaken to define population, sample size, and targeted response rate.

Population. According to the publicly available FAA Air Operators database, the total population comprising all CNATOs in the United States was 2,046 (Federal Aviation Administration, n.d.). Table 6 provides a breakdown of total CNATO population by Flight Standards Regional Office (FSRO). CNATOs must comply with an extensive compliance proposal and on-site examination prior to certification. Regulations clearly establish required elements under 14 C.F.R. §119, Certification: Air Carriers and Commercial Operators, but specific guidelines delegated to the FAA Administrator. A more comprehensive application process described in *Advisory Circular 120-49* set specific tasks to become a CNATO. Such things as pre-application, initial meeting, invitation for application, formal application, document compliance, demonstration and inspection, and certification make the process daunting for any potential applicant (Federal Aviation Administration, 1988). Demographic information for each CNATO authorized by the FAA resided within a database on a publicly available website.

Table 6

Total Population by FAA Flight Standards Regional Office

FAA Flight Standards Region (States covered by Region)	CNATO Population
Eastern (CT, DE, DC, ME, MD, MA, NH, NJ, NY, NC, PA, RI, VT, VA, WV)	311
Western Pacific (AZ, CA, HI, NV)	300
Southern (AL, FL, GA, SC, PR)	292
Alaska (AK)	291
Great Lakes (IL, IN, MI, MN, ND, OH, SD, WI)	253
Northwest Mountain (CO, ID, MT, OR, UT, WA, WY)	241
Southwest (AR, LA, MS, NM, OK, TX)	221
Central (IA, KS, KY, MO, NE, TN)	137
Total (N=)	2046

Note: Data taken from "ACTIVEAIROPERATOR" data table contained within *Aviation Data and Statistics: Air Operators for Compensation or Hire*, FAA, n.d. Database publicly available.

Criteria for inclusion. In order to focus the sampling frame of this relatively large population, a purposive non-probabilistic method narrowed the study population by limiting inclusion criteria to the following:

1. Participants represent CNATOs based within in the United States.
2. Participant organizations certified as a CNATO and currently listed in good standing within the FAA Air Operator Certificate Information database.
3. Participant organizations operating two or more turbine powered, fixed-wing and non-seaplane aircraft within the *operating certificate*.
4. Participants have one of three title positions identified in 14 CFR 119.69(a) or the primary executive leader and only serve in one of the preceding roles.
5. Participants are over the age of 18.

Application of inclusion criteria narrowed the total population to 605 eligible participants.

Sample size. Study sample size methodology employed a multi-stage sampling method utilizing stratified random cluster and systematic random sampling. Stratified sampling divided a population into sub-populations called strata and in each of these sub-populations, a simple random sample is taken (Cochran, 2007). CNATOs earn initial certification by demonstrating compliance standards with FAA regulations. Once awarded, each CNATO reports to a FAA Flight Standards Regional Office (FSRO) for ongoing compliance monitoring. The purposeful sample size of participants from three FSROs provided first stage strata data. Sampling three FSROs provided study efficiency by geographically focusing data collection efforts. Eight strata included Alaska, Western Pacific, Northwest Mountain, Southwest, Great Lakes, Central, Southern, and Eastern.

All eight FSROs were entered in an Excel spreadsheet and sorted by inclusion population in decreasing value from highest to lowest to determine strata inclusion. Six fields of random generator formulas created a list of numbers from one to eight. The first three fields generated non-reoccurring numbers equating to the line number of a FSRO. Randomly selected regional offices include: Eastern, Southwest, and Western Pacific. Based on the inclusion criterion stated previously and the initial cluster sampling method, potential participants narrowed from 2,046 total CNATOs to a sampling frame of 289 participant organizations. The 289 CNATOs shared many similar characteristics such as size of operation, revenue, and fleet size.

Finally, to ensure probabilistic integrity, the study continued with the stratified random sampling method. Proportionate random sampling required taking the sum of each strata and dividing it by the sample size. The resulting formula $f = (N_1 + N_3 + N_5) / n$ yielded a sampling integer of $11.56 = (109 + 99 + 81) / 25$. Sampling integer determines random participant selection intervals from the list. Table 7 displays the data value progression from strata population to sample size for each FSRO. By dividing the sampling frame by the sampling integer, the sample size was calculated for each FSRO and indicated in Table 7 as *n* Strata or sample size.

Table 7

CNATO Stratified Random Sampling Methodology

Strata (FSRO)	*N*	Sampling Frame	Sampling Integer ($N / n = f$)	*n* Strata
N_1 (Eastern)	311	109	11.56	9.43
N_3 (Western Pacific)	300	99	11.56	8.56
N_5 (Southwest)	221	81	11.56	7.00
Total	832	289		25

A Priori power analysis. The goal of any study is to reach a high probability and confidence level demonstrating any data collected accurately represents the entire population. Avoidance of Type I (α) errors, false positive, and Type II (β) errors, accepting a null that is actually positive, depend upon factors such as level of significance, power level, and effect size. Determining the CNATO sample size necessary to reach statistical significance involved a multistep process and was cross-checked using two methods; kMeans and Poisson Regression.

A kMeans calculator available within SAS JMP Pro 12.2 (JMP) performed a standard deviation calculation. After entering the total population stratified by FSRO, a bivariate fit model determined a total population standard deviation of 58.31 and $\mu = 256.88$. Using the JMP sample size calculator with the following parameters, $\alpha = 0.05$, std(X) = 58.31, and Power = 0.80, it was determined $n = 25$. Therefore, the CNATO sample size was 25 for the purposes of this study. Based on these calculations, a sample size of 25 was statistically significant to represent the total population.

The second validation of sample size calculation involved employing a Poisson regression or z-Test. Additional sample size values used G*Power, another popular statistical calculator program. Inputting existing parameters used during previous testing, $\alpha = 0.05$, Power = 0.80, and one-tail modeling, G*Power calculated the sample size of 25 with a critical z of 1.644 and actual Power = 0.812. Complete parameters and results from testing are included in Figure 10. Using a z-Test reinforced kMeans results with the sample size as statistically significant.

z tests – Poisson regression		
Options:	Large sample z–Test, Demidenko (2007) with var corr	
Analysis:	A priori: Compute required sample size	
Input:	Tail(s)	= One
	Exp(β1)	= 1.75
	α err prob	= 0.05
	Power (1–β err prob)	= 0.8
	Base rate exp(β0)	= 0.7
	Mean exposure	= 1
	R^2 other X	= 0
	X distribution	= Normal
	X parm μ	= 0
	X parm σ	= 1
Output:	Critical z	= 1.6448536
	Total sample size	= 25
	Actual power	= 0.8124172

Figure 10. G*Power test results for sample size.

Participant selection. While the analytical unit is CNATOs, the hierarchal model relies upon individuals to measure organizational characteristics. Federal regulations require CNATOs to maintain three positions of operational importance as part of the application process. Specifically:

> (a) Each certificate holder must have sufficient qualified management and technical personnel to ensure the safety of its operations. Except for a certificate holder using only one pilot in its operations, the certificate holder must have qualified personnel serving in the following or equivalent positions: (1) Director of Operations (2) Chief Pilot (3) Director of Maintenance. (14 C.F.R. §119.69)

Qualifications for each position are further defined in the regulations under §119.71. Due to operational complexity of some larger CNATOs, many have elected to hire a Chief Executive Officer. A key position not identified in the regulations, but serves an important role in developing safety culture and internal policy affecting accident rates is the non-flying manager. These four influential positions in the organization comprise the CNATO. The study population was comprised of organizations and persons described herein to provide further context to the analysis unit.

The study recruitment of any CNATO key personnel previously described yielded meaningful data. Each have direct responsibility for safe operation of the aircraft and organizational accident avoidance. Solicitation for data collection included all key personnel holding one of the following titles within the CNATO: Chief Executive Officer, Director of Operations, Chief Pilot, or Director of Maintenance. Delegation of responding may have fallen to a designated safety officer that does not hold one of these titles. This delegation does not rise to the level of snowball sampling due to positional nuances unique to aviation. Specialization often occurs and operational functionality remained the primary intent. SCISMS instrumentation accounted for positional title variations and properly captured substitutions in the demographic questioning.

Human Subjects Consideration

The United States Department of Health and Human Services established compliance criteria in the protection of Human Research Subjects and maintains jurisdiction of all research based regulations. Title 45 of the Code of Federal Regulations, 45 C.F.R. §46.101, provides compliance guidelines on research study submission to the Institutional Review Board (IRB) of the Pepperdine University Graduate School of Education and Psychology. Research conducted and designed within this study met the standard for exemption under Category II of the federal guidelines. In accordance to U.S. Department of Health and Human Resources (2009) exempt guidelines set forth, the following applies to this study:

> (b) Unless otherwise required by department or agency heads, research activities in which the only involvement of human subjects will be in one or more of the following categories are exempt from this policy:
> (2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside of the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, or reputation. (p. 28012)

The study utilized survey procedures described herein to obtain voluntary information from participants regarding operational and organizational aspects of the CNATO. Study adherence to Federal guideline (b)(2)(i) dictated all participants remain confidential and pseudonyms immediately documented for all data collection. Although CNATOs operate in a highly regulated environment, inclusion in this study did not expose participants to undue risk. Due to the standardized survey instrument construction, participants' responses did not expose them to criteria outlined in (b)(2)(ii). Survey results were collected using the online tool Qualtrics and stored online via a password protected account only available to the researcher and research supervisor. Within each online survey were comprehensive instructions as to the nature and completion expectations of the participant. Application to the Pepperdine IRB took place after dissertation proposal acceptance and a Notice of Approval has been included in Appendix E as evidence of compliance.

While ethical issues have the potential to compromise any research project, the study provided no personal monetary gain to the researcher; therefore, the likelihood of ethical issues was minimal. All research submitted to participants accurately reflected any study sponsorship, clearly stated the purpose of the study, provided a chance to answer confidentially, and requested consent. The nature of this topic involved testing human subjects in an interaction method but did not incorporate intervention or private information data gathering. In accordance to the ethical standards, an age verification and method of informed consent statement preceded any online survey conducted within this research to ensure compliance with the regulation. Participant permission obtained ensures study parameter and guideline acknowledgement. No participants received compensation for their responses. Any proprietary, copyrighted, trademarked, or confidential company information shared during the study remains the sole property of the provider. A copy of the informed consent declaration and outline of risk is included in Appendix D.

Certification from the Collaborative Institutional Training Initiative (CITI) ensured responsible conduct of research prior to data collection. The training raised awareness to avoid any ethical conflicts presented during research. Certification covered conflicts of interest, physical science responsible conduct of research, information privacy security, and two modules of social, behavioral, and educational researchers (SBE). Thousands of academic institutions recognize CITI as the leading provider of online training for human subject research.

Instrumentation

Recent literature suggests a triangulated use of ethnography, case study, and empirical methodology has gained favor among researchers to measure safety culture (Glendon & Stanton, 2000; Guldenmund, 2007). "There appears to be agreement among researchers that both qualitative and quantitative methods have unique potential for assessment and theory testing and that there is a benefit to combining methods to gain a comprehensive understanding of safety culture" (Wiegmann, Zhang, von Thaden, Sharma, & Gibbons, 2004, p. 129). For this reason, the literature led to an instrument that captures safety culture values quantitatively but allows for qualitative clarification.

Multifactor Leadership Questionnaire, Form 5X-Short (MLQ). A meta-analysis conducted by Hartnell, Ou, and Kinicki (2011) made reference to over 4,600 articles on the topic of organizational culture since 1980. Researchers have since developed a wide range of tools to measure and assess organizational culture effectiveness. The goal of such surveys is to assess leadership elements in a context when culture is developed as an organization learns to cope with the dual problems of external adaptation and internal integration (Schein, 1990). One of the most comprehensive and utilized leadership psychometric tools is the MLQ (Northouse, 2012). According to WorldCat, MLQ appeared in peer-reviewed academic works 6,690 times.

MLQ has been in use for over 20 years and demonstrated both validity and reliability. The survey comprised 45 items, including 36 items that represent seven leadership behavior factors that measure three distinct leadership archetypes using a 5-point Likert scale. Given that promotion and prevention focused affect differ in their motivational consequences, prior meta-analytic work supports the differences in predictive validity for promotion and prevention focused affect (Baas, De Dreu, & Nijstad, 2008). Scholarly analysis suggests the MLQ demonstrates invariant homogeneous characteristics in various testing conditions. Results testing all nine factors using covariant analysis proved significant where goodness of fit was 0.93, $n = 6{,}195$ and $p < .001$ (Antonakis, 2001; Antonakis, Avolio, & Sivasubramaniam, 2003). The MLQ enabled an examination of the regulatory influence of leader trait affect as a moderator of the relationship between leader trait affect and leadership. Overall instrument validity was confirmed by meta-analysis using confirmatory structural equation of the nine single-order factors (Antonakis, 2001).

Using the MLQ allows categorization of CNATO leaders into seven behavioral areas: idealized influence, inspirational motivation, intellectual stimulation, individualized consideration, contingent reward, management-by-exception, and laissez-faire. From those behavior traits, three leadership styles (transformational, transactional, and laissez-faire) will be identified and allow for trends between the variables to emerge. Electronic copyright permission to administer the MLQ obtained from Mind Garden allowed up to 300 participants and proof of compliance was included in Appendix F. MLQ Form 5X-Short instrumentation delivery used the Pepperdine Qualtrics online survey platform.

Leadership instrument constructs. Leadership style in the development of safety culture is well represented in the literature (Bass et al., 2003; Schein, 2010; Tsai, 2011; Yukl, 2008). Bass and Avolio's (2003) multifactor leadership questionnaire (MLQ) version 5X-Short served as an instrument used by studies across numerous organizations, including military, business, industrial, education, government, and nonprofit organizations. Researchers agree a reliable survey instrument to operationalize leadership factors, comprising the full-range leadership theory (FRLT), have been demonstrated within the MLQ 5X as evidenced by WorldCat cited inclusion in over 4,300 peer-reviewed articles. The MLQ 5X serves as a construct to explain FRLT, whereby leaders are described on a scale from highly avoidant to highly inspirational (Antonakis et al., 2003). The constructs comprising the FRLT describe three typologies of leadership behavior: transformational, transactional, and non-transactional leadership and represented by nine factors. Literature also refers to non-transactional typology as laissez-faire or passive leadership (Bass & Riggio, 2006). Table 8 describes factors associated with each leadership type and a short description of their meaning. Research meta-analysis posits effective leadership was represented when transformational and transactional are used in response to organizational challenges (Judge & Piccolo, 2004).

Table 8

MLQ Leadership Typology and Constructs

LEADERSHIP	FACTORS	MEANINGS
TRANSFORMATIONAL	Idealized Influence (Attribute)	To influence the associates as role model in moral and value.
	Idealized Influence (Behavior)	To inspire associates to achieve the goals by extra effort.
	Inspirational Motivation	To communicate their vision and mission, identify the right and important things and find the ways to achieve the goals.
	Intellectual Stimulation	To simulate associates to question old problems, challenge others, think problems in new ways and make innovations by their own.
	Individualized Consideration	To meet associates' individual needs and develop them to their full potential uniquely.
TRANSACTIONAL	Contingent Reward Leadership	To set obligations, objectives, and tasks for associates, and reward associates when contractual obligations are fulfilled.
	Management-by-Exception Active and Management-by-Exception Passive	To check the standards of work to be met actively or passively.
LAISSEZ-FAIRE	Passive Avoidant	To avoid making decisions, does not take responsibility, and does not use authority.

Note. From *Mind Garden MLQ Author's Guide*, by B. Avolio and B. Bass, 1995, Menlo Park, CA: Mind Garden, Inc. Copyright 1995 Mind Garden, Inc. Adapted with permission.

SCISMS questionnaire. The Safety Culture Indicator Scale Measurement System (SCISMS) was the product of a second generation CASS survey tool administered to scheduled airline participants. Using a survey instrument with high reliability and validity, the 4-factor

SCISMS has passed extensive and academically rigorous scrutiny (Gibbons et al., 2006). SCISMS has demonstrated both reliability through internal consistency and construct validity. Review of the instrument has demonstrated overall fitness with results of a RMSEA = 0.04 where χ^2 (27, N = 427) = 452.29 and p < .001 (Gibbons et al., 2006). The study has obtained permission from a private company to administer the SCISMS to aviation organizations identified in the sample size discussion.

This instrument utilizes a 7-point Likert scale to measure organizational commitment, formal safety indicators, operations interactions, and informal safety indicators. The Commercial Aviation Safety Survey (CASS), a previous application of the SCISMS survey, measured safety culture within Part 121 airline operators. Recognizing CNATOs operate differently, the original CASS survey included CNATO participants to ensure validity. Inclusion of CNATO participants recognize SMS nomenclature, safety techniques, and collection methodology, and therefore the SCISMS application is logical. Use of this survey will also allow researchers to draw meaningful comparisons between CNATO and airline results. Instrumentation delivery uses the Pepperdine Qualtrics online survey platform. Due to limited distribution, a sample SCISMS survey questionnaire is included as APPENDIX A SCISMS SAMPLE QUESTIONNAIRE.

Safety culture instrumentation constructs. As stated previously, academic debate continues in meta-analytic data analysis as to whether safety can be categorized as either a prolonged state of existence known as culture, or as climate, a temporary state subject to change (Clarke, 2013; O'Connor et al., 2011; Patankar et al., 2005; Zohar, 2010). Whether culture is a result of group values (Cox & Flin, 1998), workforce attitudes (Flin et al., 2000), or procedures (Guldenmund, 2000), researchers agree that any instrument capturing safety characteristics prove difficult to conclusively assess culture. Frazier et al. (2013) conducted the Safety Culture Survey (SCS), a confirmatory factor analysis of core safety culture utilizing a 92-item survey of 25,574 respondents, and found 12 first order factors. The SCS was administered to five different industries and multiple countries. As shown in Figure 11, the study concluded safety culture is a multidimensional variable with 12 factors influencing safety culture with a CFI = 0.95 and a RMSEA = 0.08 (Frazier et al., 2013). Despite a large number of factors identified, SCS nonetheless served as a step forward in identification of relevant safety culture dimensions by describing inclusionary categories in the following areas: management, SMS, personal responsibility, and peer support (Frazier et al., 2013). These findings were consistent with additional studies which added factors such as organizational culture (Edwards et al., 2013), training (Glendon & Stanton, 2000), and organizational lifecycle stage (Guldenmund, 2010) to the four categories. This body of academic work validated the foundation of a measurement instrument for aviation safety culture known as CASS.

CASS represented the first application measuring aviation safety-specific activities. In addition, CASS converted an unmeasurable activity into a quantitative tool. Factor analysis contributed to narrowing previously unwieldy list of 12 contributing factors of previous studies into the 5-factor model on measuring organizational commitment, management involvement, pilot empowerment, reporting systems, and accountability systems (Gibbons et al., 2006). The groundbreaking work synthesized the previous literature in an attempt to standardize an instrument for HROs attributing for a safety culture variable. Formal feedback to the 81-question Likert scale CASS used 108 participants in operations and administrative roles at Part

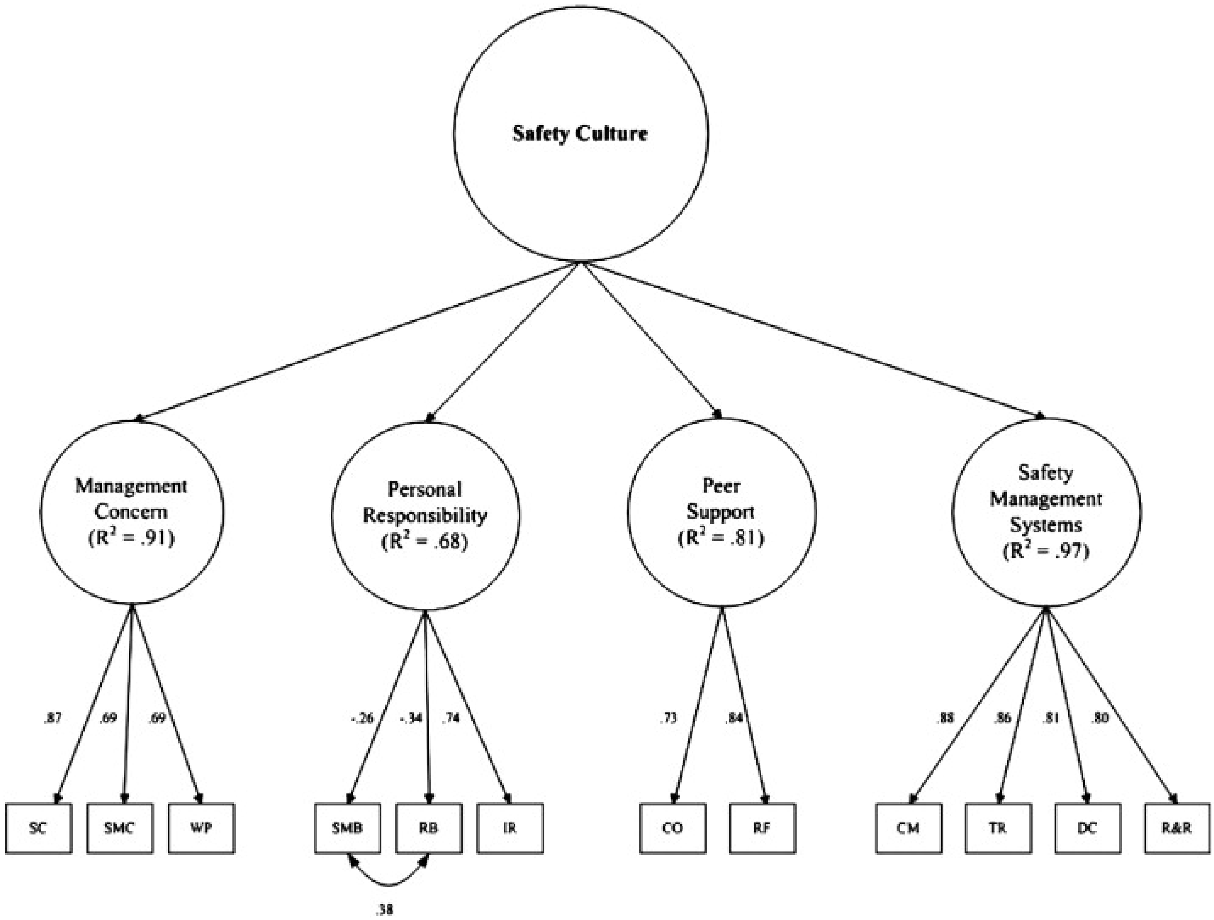


Figure 11. Meaningful variants of safety culture. SC = Supervisor Concern, SMC = Senior Management Concern, WP = Work Pressure, SMB = Supervisor/Management Blame, RB = Risky Behavior, IR = Incident Reporting, CO = Caution Others, RF = Respectful Feedback, CM = Communication, TR = Training, DC = Discipline, R&R = Rewards and Recognition. From "A Hierarchical Factor Analysis of a Safety Culture Survey," C.B. Frazier, T.D. Ludwig, B. Whitaker, and D.S. Roberts, 2013, *Journal of Safety Research, 45*, p. 24. Copyright 2013 by National Safety Council and Elsevier Ltd. Reprinted with permission.

121 air carriers. Questions also included a field for additional comments to allow participants an opportunity to clarify or notate further information. Response rate was 40% with n = 43 surveys returned, and concluded "none of the fit indexes for the five-factor model met conventional criteria for acceptable fit" (Gibbons et al., 2006, p. 224). The small sample size limited the effectiveness of any confirmatory factor analysis and rendered the results inconclusive. Researchers continued to refine the instrument to gain statistical validity. In a subsequent

revised CASS study, 503 completed surveys were returned from Part 121 air carriers and a confirmatory factor analysis confirmed conceptual revisions yielded high category correlations (Gibbons et al., 2006). Changes made to the original CASS model resulted in a new 55-item survey with higher reliability and validity known as Safety Culture Indicator Scale Measurement System (SCISMS).

The study will employ the SCISMS construct which represents a four-factor model reflecting organizational commitment, formal safety indicators, operations interactions, and informal safety indicators which are correlated with the personal safety attributes/behaviors of the individual (von Thaden & Gibbons, 2008). No one factor serves as primary, but rather each are interrelated similar to Reason's (1997) Swiss Cheese Model. SCISMS modifications also included confirmation of Zohar (2002a) the role of leadership in safety climate promotion. Tying key indicator importance to previous safety culture standards provided a context to complex interrelationship dynamics within the field of study. Figure 12 graphically represents transitional thinking from Gibbons et al. (2006) on changing the 5-factor CASS to 4-factor SCISMS. SCISMS continues to utilize a 7-point Likert scale with only three anchors identified for participants: 7 for *strongly disagree*, 4 as *neither agree or disagree*, and 1 for *strongly agree*. An EBSCOhost search shows 11 occurrences of SCISMS in peer-reviewed academic journals and five dissertations since released in 2008. Authors claim additional usage, but the private company who acquired the rights to the SCI/SMS tool has not disclosed additional data points.

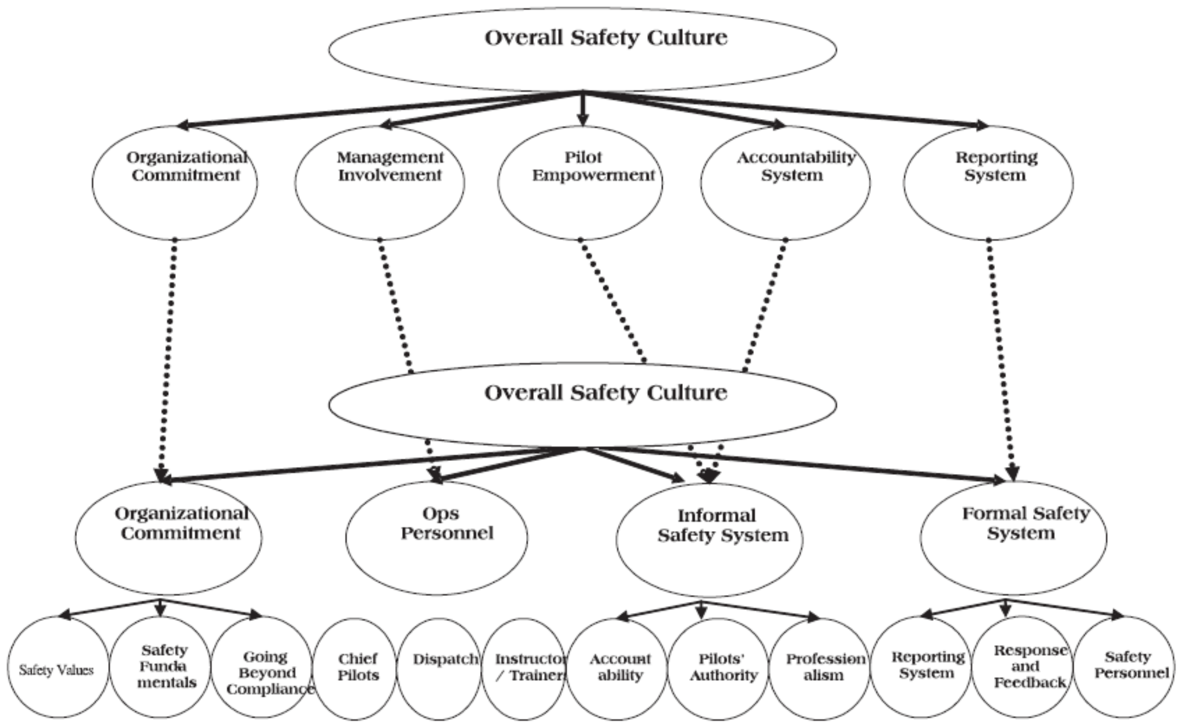


Figure 12. CASS to SCISMS comparison. Comparative diagram of CASS to SCISMS and a factor mapping using interrupted lines connecting core dimensions. From "Development and Initial Validation of a Survey for Assessing Safety Culture Within Commercial Flight Operations," A. M.Gibbons, T.L. von Thaden, and D.A. Wiegmann, 2006, *The International Journal of Aviation Psychology, 16*(2), p. 230. Copyright 2006 by Lawrence Erlbaum Associates. Reprinted with permission.

Aviation Safety Information Analysis and Sharing (ASIAS). Safety data related to the operation of aircraft in the United States is available through the Federal Aviation Administration information program called ASIAS. Within the ASIAS program, two key data sources were used for the study. The FAA Accident/Incident Data System (AIDS) contains data records for all aircraft *incidents* and *accidents* since 1978 searchable by a variety of search criterion (FAA, n.d.).

A second component of ASIAS is the National Aeronautics and Space Administration Aviation Safety Reporting System (ASRS). The ASRS provides a catalog of voluntary safety reports filed by participants in the National Airspace System. Voluntary reports increase the safety and reliability of aviation processes, are widely referred to as a source of research, and act as a precursor to change. Participants in the ASRS are free to report unsafe situations without fear of recourse from other government mechanisms commonly referred to as “whistleblower” programs. The data was verified and a part of the national archival records maintained by the federal government. Data collected through these instruments will provide unbiased information to calculate Certificated Non-Scheduled Air Carrier operator safety records.

Variables. Table 9 describes the method in which variables will be operationalized using data sources and instruments to report data. Each independent and intervening variable relates to the multitude of paths in which participants achieve organizational accident avoidance or dependent variable (anticipatory). To assist in identifying variables and their interrelationships, Figure 13 graphically represents the independent, intervening, and dependent variables. Data collection various relationships between variables will be a critical factor in analysis. The following section describes each variable and their relationship with research question.

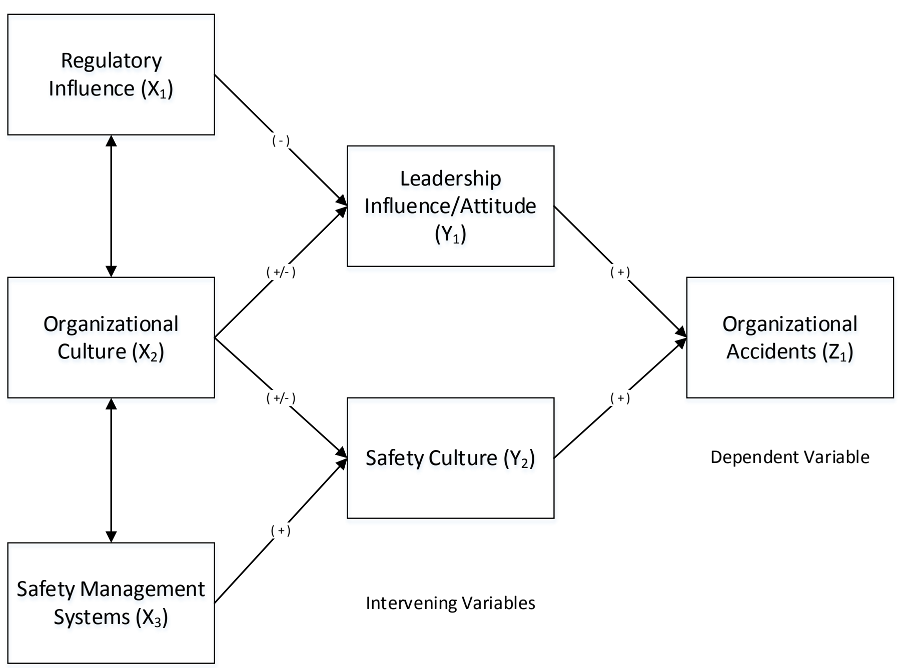


Figure 13. Variable path analysis casual model. Demonstrating interaction (and effect, either +/-) of independent, intervening, and dependent study variables.

Independent variable. The study included three independent variables: regulatory influence, organizational culture, and SMS. An independent variable "identifies forces or conditions that act on something else" (Neuman, 2014, p. 161). These attributes act independently to the other variables. RQ2, RQ3 integrated the independent variables and their effect on dependent variables. Regulatory influence serves as a constant presence in CNATO operations. No less than three Federal agencies have direct operational oversight and this constant oversight provides a foundation upon which CNATOs function. Regulation also forms organizational culture. Cultural development of CNATOs influence the way safety and leadership form. Finally, implementation of a SMS program determines whether safety cultures develop organically or aided by institutionally developed systems. Each of these independent variables share a precursor time value relationship with the intervening and dependent variables. The SCISMS instrument captures regulatory influence and presence of a SMS. MLQ Form 5X-Short assesses basic organizational culture measures allowing participant level comparison. Independent variables identified here help to explain the behavior that lead to CNATO organizational accidents.

Intervening variable. Literature review demonstrated numerous factors comprise safety outcomes (Reason, 1997; Roberts, 1990a; Schein, 1990). The two intervening variables selected represent an important bridge between independent and dependent variables: leadership style and safety culture. Intervening variables, or sometimes referred to as mediating variables, "stand between the independent and dependent variable, and they mediate the effects of the independent variable on the dependent variable" (Creswell, 2009, p. 50). Foundational research demonstrates leadership style and safety culture mediate the independent variables in other industries, but no measurement to CNATOs exist. Therefore, RQ1 and RQ4 sought to answer how intervening variables effect outcomes. SCISMS captures four dimensions of safety culture: Organizational Commitment to Safety (OC), Operations Interactions (OI), Formal Safety Indicators (FS), and Informal Safety (IS) Indicators. Using SCSMS provides safety culture insight and develops a foundation to begin grouping participants in the sequential transformative process. The MLQ Form 5X-Short serves as the industry leading leadership style measurement tool. The study sought understanding of independent variable and organizational accidents relationships accounting for leadership style. MLQ provided seven behavioral areas in which to relate safety outcomes.

Dependent variable. Organizational accidents in aviation occur in varying degrees. The ASAIS data set captured two types of events; incidents, described as damage to property or aircraft, and accidents, characterized by loss of life. These two organizational accident categories require different responses and thus are a determining factor in how leaders and the organization respond. Capturing the type of organizational accident data and comparing CNATO independent and intervening variables provided additional insight on safety outcomes. The study purpose to examine factors influencing organizational accidents relied upon the other variable types to explain influences on the dependent variable. For this reason, RQ2, RQ3, and RQ4 all used dependent variable data examining relational and comparative aspects of CNATOs.

Table 9

Instrumentation of Variables

Hypothesis	Variable name	Variable type	Measure name	Type of measurement
RQ1: Safety culture characteristics of CNATO (descriptive)	1. Safety Culture	1. Intervening	1. SCISMS	1.Safety culture dimension; (FS, IS, OI, OC)

(continued)

Hypothesis	Variable name	Variable type	Measure name	Type of measurement
RQ2: Organizational culture impact on performance (relational)	2a. Leadership type 2b. Organizational accidents	2a. Independent 2b. Dependent	2a. MLQ-5X 2b. ASIAS; 2 measures	2a. Leadership type; 9-factors 2b. Accident/incident
RQ3: Accident rates of CNATOs usage of SMS (comparative)	3a. Regulatory influence 3b. SMS use 3c. Organizational accidents	3a. Independent 3b. Independent 3c. Dependent	3a. SCISMS 3b. SCISMS 3c. ASIAS; 2 measures	3a. Formal safety indicators; 2-factors (OC, FS) 3b. Formal safety indicators; SMS use 3c. Accident/incident
RQ4: Leadership style relationship to culture and accidents (relational)	4a. Leadership type 4b. Safety culture 4c. Organizational accidents	4a. Intervening 4b. Intervening 4c. Dependent	4a. MLQ-5X 4b. SCISMS 4c. ASIAS	4a. Leadership type; 9-factors 4b. Dimension safety indicators 4c. Accident/incident

Data Collection Procedures

External and internal reliability provide a framework throughout the data collection process. Internal reliability relates to the ability of two researchers to reach the same results using the same ethnographic constructs, while external reliability relates to the ability of the constructs to apply in multiple settings to achieve the same (LeCompte & Goetz, 1982). Researchers followed a well-documented data collection process in order to provide consistent results. A proposed timeline and data collection checklist was included in Appendix B Data Collection Timeline for reference purposes.

Participant selection. As previously described within sample size calculations, the entire population follows a three-step filtering process. An inclusion criterion applies to clarify CNATOs best matching study parameters. Next, a stratified random cluster used three FAA regions to allow geographic focusing. Randomization of the membership database entries after stratification ensured compliance with proper protocol. Without randomizing the stratified participant data set, unintended weight may have occurred because entries appeared in alphabetical order. Finally, a proportionate random sample selected participants at random from the FAA CNATO membership database. CNATO participant contact information resided on publically available FAA Airline Certificate Information database. These databases provided names and contact information for targeted CNATO leaders or those having met inclusion criteria to participate in the study. According to details outlined within the sample size section, the random stratified sample size narrowed using a specific proportionate random sampling calculation by taking the sum of each strata and dividing it by the sample size. Randomization of database entries after stratification ensured compliance with proper confidentiality protocol. The result of the sample selection formula yielded a formula of N/n or 289 divided by 25. Thus, the sampling formula equals 11.56 with an integer of 11. Therefore, each eleventh CNATO within each stratum were included in the sample size as a participant.

Initial contact with CNATOs introducing study objectives and goals uses email to solicit participation. Multiple responses from a single CNATO was possible due to various roles within the organization responding but did not occur. These professional aviators will be from the ages of 25 to 60 (operational boundaries set by regulation), 95% male, earning an average of $85,000, and will have at least a bachelor's degree from an accredited university (FAA, n.d.). Participants had sole discretion in deciding whether to take part in the study. Regulatory agencies and other industry groups had no bearing on the ability of participants to take part, as any information shared is proprietary to each participant.

Survey delivery. Administration of SCISMS and MLQ Form 5X-Short was conducted concurrently and follow the described method. Participants introduced to the study via an initial email sent using the stratified and systematic random sampling method. Upon reaching the Pepperdine Qualtrics study portal, participants land on an informed consent page. Clicking the "I Agree" link indicated a participant was willing to participate. Participants were informed that participation is voluntary and they may opt out at any point in time during the study. The survey was interactive and had basic question logic integrated in order to allow participants to opt-out at any point. Participants not responding to the survey request email after 5 days received a system generated reminder email. Those not responding after 14 days from the reminder email received a final system generated email notice. Failure to respond to the final email did not generate further emails. Due to the nature of online survey results, only the investigator knew the identity of participants, and pseudonyms reference the participant and their respective organization. Data captured in Qualtrics was stored online via a password protected account only available to the principal investigator and research supervisor.

The MLQ Form 5X-Short was optimized by the copyright owner and authorized for use on the Qualtrics platform and memorialized in Appendix F. Previous instances of SCISMS used electronic delivery and had been previously validated for reliability online. SCISMS survey questions included in Appendix A combined with MLQ questions comprised the 106 question survey. MLQ questions were not included in appendices due to compliance with the license agreement. The question order comprised SCISMS then MLQ to build on participants' logical situational thought process. According to the MLQ construct validation guidelines, combining the survey with others does not diminish result efficacy (Avolio & Bass, 2004).

Organizational accident data collection. In order to establish key safety factors for the representative sample, the study used accident databases containing safety information relative to the entire population and a safety culture survey. Accident data sources were publicly available online from the FAA, NTSB, and NASA. Each data set examined used a confirmatory factor analysis to confirm a hypothesized pattern of relationships predicted from the theoretical frameworks referenced. Due to the nature of the intervening variables, the study used multinomial regression testing. This analysis method did not require special consideration nor did it affect data collection procedures.

In order to assist the aviation safety community in accessing information, the FAA created an area within the website to consolidate reporting data critical to the safety of flight. ASIAS AIDS data contains over 98,356 records of aircraft incidents and accidents since 1978. ASRS reporting within the ASIAS accounts for 663,493 records captured since 1988. Collected safety data follows a cross-sectional design from the date of study commencement. ASIAS utilizes a freeze date on all databases to ensure data integrity of snapshot data. Any data collection will occur after the 15th of the month to ensure complete data from the previous month is included in the study. All operational safety data reside on publicly available sources collected and reported by the United States government. As such, consent is not necessary to be compliant with protecting human subjects. The FAA has previously removed any personal information contained in the databases in accordance to privacy laws.

Data collection nomenclature. The study utilized pseudonyms for each CNATO at all times. Participant name assignment followed the convention P^x (strata) followed by x (their randomized database row position). Therefore, a convention example would appear as $P^3$45, meaning Western Pacific FSRO and randomized participant appearing in table row 45. Upon closure of the survey, all data was analyzed and coded by the PI as a large group. Comparing anonymous accident/incident data responses and analyzing for matches allowed no identifying data existed within the relational database. Once complete, anonymously categorized data emerged using subgroup comparisons based on the factors identified by the survey. Further, subgroupings of commonalities were found and identified using distribution analysis methods. Survey results were password protected and stored in a secured via the Qualtrics online tool for a minimum of three years.

Analytic Technique

Due to the sequential transformative design model, large amounts of data collected relied on two primary analytic techniques to describe results from lengthy culture and leadership surveys as well as accident data. Application of meaning to nominal MLQ results using defined descriptive techniques allowed meaning behind leadership architypes. Without analyzing the context afforded by descriptive methods and validating multiple data points for each CNATO, a definitive conclusion was unlikely. In contrast, the interpretive nature of traditional quantitative analysis using interval scale data tabulation within the SCISMS provided concrete values without a need for interpretation. Despite the mixture of categorical and interval values, logistic regression analysis provides a viable measurement method. "The guiding principle with logistic regression is the same: compare observed values of the response variable to predicted values obtained from models, with and without the variable in question" (Hosmer, Lemeshow, &

Sturdivant, 2013, p. 12). Since least squares in a linear regression model will not conform to the study directional hypothesis, a dichotomous outcome conforms to observed values. Analysis of each CNATO data relied upon use interval data tabulation as well as descriptive methods that included central tendencies, subgroup comparison, and distribution.

MLQ Form 5X-Short Survey analysis. In using categorical descriptive analytic techniques, the study will place the reader inside the participants' setting and time. The construction and aligning of multiple categories using subgroup comparisons and identifying patterns among the participants was particularly useful in creating commonality trends. A series of filtering occurred by reviewing the results of the collection after data capture. Each pass at categorical data point values yielded a more refined analysis of CNATO leadership characteristics, also called progressive focusing (Richards & Morse, 2013). The goal was to allow the data to identify key commonalities and clarify a large amount of information into a (or series) of salient points. These "pieces of the puzzle" were then be fit together to provide a "complete, holistic, thick, and rich description of the cultural perspective" (Richards & Morse, 2013, p. 190). The result was a monograph of individual participants' role or thoughts on leadership that tie together with others to form patterns.

Identification of first-level descriptions gathered from participants was critical to form a strong foundation in which the reader can gain understanding about the setting. By analyzing central tendencies, survey data yielded answers critical to understanding the context in which CNATOs live and operate. Each participant holds deep knowledge of the setting and personal experiences of operating within a CNATO. Answers to MLQ 5X-Short survey questions created abstraction aids in describing the site, situation and setting from participant observation. Choosing a stratified random cluster sample method created an opportunity to gain an emic perspective to the study. Aviation is rich in symbolism and signs. Semiotics can be described as a sign that makes sense in the mind of some person, but may be seen usefully as the connection between an expression and a content (Hjelmslev, 1961). The MLQ survey includes questions featuring this method by challenging survey participants to interpret self-reflected actions of leaders into participant feelings. One such example of this would be the question "I re-examine critical assumptions to question whether they are appropriate". This concept uses leader-follower dynamic questions within descriptive scenarios on how followers interpret leader actions. Analyzing MLQ nominal values using descriptive methods of central tendencies and subgroup comparison insights on leadership characteristics within participant CNATOs helped form conclusions on CNATO safety behaviors.

Quantitative analysis. To examine the quantitative research questions, the study conducted a two-phased data analysis approach to describe differences between CNATO operators. Each research question employed various regression analysis methods to identify respondent deviations from statistical norms. Ultimately, a multivariate logistic regression assisted in determining whether leadership influence and safety culture inculcation have a relationship to organizational accidents. Regression is a statistical technique used to predict the behavior of an ordinal level dependent variable multivariate intervening and independent variables. This method of statistical analysis for aviation safety has been well rooted in literature where safety measurements indicate retrospective causes and understanding of complex systems. In logical regression, the dependent variable is the ordered response category variable and the intervening variable may be categorical, interval, or a ratio scale variable. The assumptions of linear regression include only one dependent variable and one regression normally distributed value for each category of the dependent variable. In a multiple logistic regression test using a

Poisson dichotomous approach, data evaluation can occur on nominal and ordinal values. Therefore, a maximum likelihood estimation for variances and covariance matches study objectives for fit (Hosmer et al., 2013). JMP version 12 from SAS Software served as the study statistical tool of choice. Testing included whole model, lack-of-fit and Wald effect tests ensuring data fitness in addition to interval-level regression testing.

Summary

In order to answer the research questions, a two-phased sequential transformative research design guided the study. Performing qualitative and quantitative data collection in a two-phased approach allowed for sufficient analysis of baseline data prior to determining the effect of independent and intervening variables on the dependent variable. Collection of both qualitative and quantitative data required individualized collection and analytic methods to achieve meaningful analysis. Figure 9 demonstrated how the study assigns weight and sequence to each data set. This research strategy aided in evaluating a complex set of variables and their effect on organizational accidents. Qualitative instruments used within this study included the MLQ survey and SMS information gathering. Ethnographic research methodology provided an investigative foundation for qualitative research methodology while progressive focusing data analysis allowed refinement of large information stores into meaningful patterns. Quantitative instruments are the SCISMS survey and multi-agency CNATO accident data. Explanatory correlational research methodology, specifically a multiple logistic regression model, investigates the extent to which variables have an observable relationship to explain participant data. Nominal data regression performed during analysis determined the degree of relationship between accident rates (dependent variable) with leadership and safety culture (intervening variables). The resulting comprehensive mixed method approach to design, collection, and analysis created a framework to answer the research questions.

Chapter IV: Findings

Introduction

The goal of this study was to gather information on an inclusionary subset of CNATOs using a random stratified sample. Data collected from these CNATOs helped researchers discover attitudes and descriptors that aided in answering four research questions. Study findings represented a three-week collection period survey delivered via online technology. A 106-question survey comprised of one qualifying question, five demographic, 55 questions from the SCISMS, and 45 MLQ Form 5X-Short questions yielded a response rate of 20 out of 25 participants identified as the targeted sample size. Every participant who reached the consent page moved forward and indicated acceptance of study conditions. Anticipated time to complete the survey was 18.01 minutes against a stated 20-minute completion time.

An overview of participant demographics begins the findings chapter to provide insight as to study responses. From there, the chapter followed study sequential transformative design methodology where findings are organized by instrument and analyzed individually. Data presented individually provided researchers with an opportunity to examine trends prior to forming consolidated conclusions. Finally, analysis by research question act to tie individual findings together having previously presented analysis for context.

Participant Demographics

As discussed within the Population, Sample Size, and Response Rate section, the total CNATO population equated to 2,046. The total population narrowed to a sampling frame of 286 using inclusion criteria and geographically stratified sample method. An Excel number randomizer selected three numbers that corresponded to eight individual geographic regions from potential FAA flight standards regional offices for participation. This combination of methods created a randomized stratified sampling frame. Finally, using a priori power analysis, it was determined a sample size of 25 was appropriate and valid to survey the total population. After submitting surveys to the sample size per participant selection criterion identified within Chapter III, the total number of participants was 20 ($n = 20$). The difference in sample size power of 0.80 to 0.72 between initial study and final analysis to compensate for response rate results in an 8.0% higher chance in probability of rejecting the null hypothesis. However, due to the homogeneity of CNATO demographic composition, actual CNATO accident rates per operator as reported in government databases compared to sample size, and the nature of CNATO regulated operating parameters; the adjusted power value has little impact on study conclusions.

Table 10 graphically represents respondents by FAA Flight Standards Regional Office. Of 20 responding organizations, half indicated they have held a FAA operating certificate for over 16 years, the other half for between 6 years and 15 years. An inclusion criterion required participant CNATOs operate two or more turbine powered, fixed-wing and non-seaplane aircraft. All participants met inclusion criterion. Four operators indicated 2-5 aircraft on their certificate, eight had 6-10 aircraft, and eight operated 11 or more aircraft meeting the criterion. All of the 20 participating CNATO representatives were male and their self-identified positions fell into the following categories (counts): Director of Operations (6), Chief Pilot (4), Safety Officer (8), and Chief Executive Officer (2). Only one representative from each organization responded. Based on demographic information collected, all responses included participation by someone actively involved in safety for the organization.

Table 10

Participant Demographics by FAA Flight Standards Regional Office

FAA Flight Standards Region (States covered by Region)	CNATO Participants
Eastern (CT, DE, DC, ME, MD, MA, NH, NJ, NY, NC, PA, RI, VT, VA, WV)	10
Western Pacific (AZ, CA, HI, NV)	8
Southwest (AR, LA, MS, NM, OK, TX)	2
Total (*n* =)	20

In keeping data confidential, study investigators assigned participants aliases. Geographic regions remained for comparison purposes only. The database row numerically identifies participants and all original data known only to the researcher on initial entry into the Qualtrics survey collection tool. Therefore, participants appear by strata as P^(1,3, or 5) followed by database row number. An example would be P^5 representing the Southwest FSRO and database row 1802 expressed as $P^5$1802. The following overview of participants contains general knowledge and does not include detailed information beyond roles and organization demographical information.

1. Participant $P^1$143: more than 11 aircraft, held certificate over 16 years, performs Chief Pilot role, Eastern FSRO
2. Participant $P^1$371: operates 2-5 aircraft, held certificate between 6-15 years, performs Director of Operations role, Eastern FSRO
3. Participant $P^1$399: more than 11 aircraft, held certificate between 6-15 years, performs Safety Officer role, Eastern FSRO
4. Participant $P^1$482: operates 6-10 aircraft, held certificate between 6-15 years, performs Safety Officer role, Eastern FSRO

5. Participant P^{1}577: operates 6-10 aircraft, held certificate between 6-15 years, performs Director of Operations role, Eastern FSRO
6. Participant P^{1}750: operates 2-5 aircraft, held certificate between 6-15 years, performs Director of Operations role, Eastern FSRO
7. Participant P^{1}784: more than 11 aircraft, held certificate over 16 years, performs Safety Officer role, Eastern FSRO
8. Participant P^{1}921: operates 6-10 aircraft, performs Safety Officer role, Eastern FSRO
9. Participant P^{1}1009: operates 2-5 aircraft, held certificate over 16 years, performs Chief Executive Officer role, Eastern FSRO
10. Participant P^{1}1015: more than 11 aircraft, held certificate over 16 years, performs Safety Officer role, Eastern FSRO
11. Participant P^{3}1098: operates 6-10 aircraft, held certificate over 16 years, performs Chief Pilot role, Western Pacific FSRO
12. Participant P^{3}1112: more than 11 aircraft, held certificate between 6-15 years, performs Safety Officer role, Western Pacific FSRO
13. Participant P^{3}1158: operates 6-10 aircraft, held certificate between 6-15 years, performs Chief Pilot role, Western Pacific FSRO
14. Participant P^{3}1218: more than 11 aircraft, held certificate between 6-15 years, performs Safety Officer role, Western Pacific FSRO
15. Participant P^{3}1294: operates 2-5 aircraft, held certificate over 16 years, performs Chief Executive Officer role, Western Pacific FSRO
16. Participant P^{3}1303: more than 11 aircraft, held certificate over 16 years, performs Director of Operations role, Western Pacific FSRO

17. Participant $P^3$1324: operates 6-10 aircraft, held certificate between 6-15 years, performs Chief Pilot role, Western Pacific FSRO
18. Participant $P^3$1326: operates 6-10 aircraft, held certificate over 16 years, performs Director of Operations role, Western Pacific FSRO
19. Participant $P^5$1802: operates 6-10 aircraft, held certificate over 16 years, performs Director of Operations role, Southwest FSRO
20. Participant $P^5$1936: more than 11 aircraft, held certificate over 16 years, performs Safety Officer role, Southwest FSRO

Research Questions

The study addressed the gap in knowledge as to whether inculcation of a safety culture in CNATOs has an effect on organizational accidents. The study (a) examined the way leadership introduces and reinforces safety culture within an organization, (b) how the safety culture is implemented by followers, (c) investigated the types of artifacts used by the aircraft operator to provide reinforcement of established safety processes, and (d) determined the extent to which safety culture has an effect on overall safety results. Using the following research questions, answers to these key themes emerged:

1. What safety culture characteristics does a typical CNATO organization possess? (descriptive)
2. To what extent, if at all, does organizational culture have a relationship with performance outcomes, including accident rates? (relational)
3. To what extent, if at all, is there a difference in accident rates of CNATOs that use safety management system programs and those that do not? (comparative)

4. To what extent, if at all, does CNATO leadership style have a relationship with the development of a safety culture and accident rates? (relational)

Analysis of Findings

Sequential transformative design as explained by Creswell (2009) and previously displayed as Figure 9, allowed for collecting data in iterative phases. Analysis of data in aggregate allowed an organized review of data within a specific lens prior to reviewing within a global context. Phased analysis of each instrument created an individual finding that aided understanding of potential interaction between variables. This method of data analysis fit nicely into a traditional logistical regression framework. Calculation for independence and homogeneity of variance of the sample data used Levene's Test for group comparisons. The resulting Levene's Test indicated $F > 1.798$ at $\alpha = 0.05$ and therefore conclude that there is insufficient evidence to claim that the variances are not equal.

Analyzed data from the SCISMS survey created an overall understanding of organizational safety attitudes and characteristics within four dimensions. Four dimensions identified by the survey authors created categories as organizational commitment (OC), operation interactions (OI), formal safety indicators (FS), and informal safety indicators (IS). Each quantitative measurement provides insight to how organizations perceive and treat safety elements, directly aiding to instrumentation of study research questions expressed in Table 9, Instrumentation of Variables. RQ1, RQ3, and RQ4 all relied upon quantitative data gathered from the SCISMS survey.

Examination of MLQ 5X-Short data indicates which type of individual leadership style existed within each organization. An organizational variable value revealed measurable characteristics by determining individual style of leadership. Analysis tools supplied by survey author Mind Garden allowed each participant organization to fit within three leadership styles and seven behavior traits. Identification of leadership traits assisted in assigning variable values to RQ2 and RQ4. Specific MLQ 5X-Short data was presented in aggregate due to specific copyright requirements by survey authors. Appendix F specifies only five specific questions could be presented within this study. Therefore, data findings focused on traits and results rather than actual survey questions.

Once organizational characteristics were analyzed, generalized quantitative accident data from the ASIAS was reviewed categorized by FSRO. Prior to survey distribution, a review of database information after application of inclusion criteria yielded no participants had accidents or incidents since database collection began in 1978. Since more than half of participants held their operating certificates for 16 years or more, any ASIAS entries would appear. One participant organization had an accident or incident according to the data. As a result, specific FSRO accident data referenced each organization in the findings for contextual purposes. RQ2, RQ3, and RQ4 used ASIAS data to support interrelationships between intervening variables culminating in organizational accidents. More details about possible relevance of accident or incident data appear further in discussion and conclusions.

Findings

Findings are presented in various formats due to the large volume of data collected for multiple variables and 20 participants aid in creating more comprehensive picture of CNATO characteristics. Sequential transformative design demanded individual evaluation of each data set individually prior to applying a specific research question lens. To assist in creating a clearer picture of each individual participant based on their organizational context, data presented by instrument preceded research question findings. Presentation of different data included within the appendices aided clarity when presenting conclusions. The order of presentation follows Figure 9 and chronologically includes SCISMS, MLQ Form 5X-Short, SMS, and ASAIS data. Findings directly answering research questions were then presented to synthesize disparate elements, represented by variables, into a more comprehensive presentation format allowing further analysis.

SCISMS questionnaire. Qualtrics presented SCISMS questions to participants and described the survey tool as a dynamically generated survey that measured overall safety culture at the organization level. Questions taken directly from the Safety Culture Indicator Scale Measurement System (SCISMS) survey appear in Appendix A and use a Likert scale. Four dimensions measured overall safety culture within the organization. The following quantitative data relied upon descriptive statistics to identify broad themes that emerged. Descriptive statistics data gathered by the survey follow categories of formal safety system, informational safety systems, operation interactions, and organizational commitment combined into organizational dimensions.

Formal safety system (FS). Survey results started by measuring formal safety systems. These questions centered on organizational uses of safety reporting systems, response and feedback safety actors receive from reporting systems, and operationalization of information by safety personnel. Existence of safety management systems demonstrate each CNATO organization utilized a SMS. Table G1 displays formal safety data responses for all participants and a $\mu = 6.12$. Results within this section present verification of broad SMS usage and the standard deviation among all 280 participant responses was $\sigma = 0.790$. A value less than one sigma indicates very little difference in overall responses across all participants according to Chebyshev's Theorem. Tight responses in this section also reflect existence of reporting and responding processes. Safety culture relies upon these tightly coupled systems. Two outliers emerged where $\mu = 6.14$ was below expected. After performing a MANOVA fit model on survey results, $P^{1}371$ and $P^{3}1324$ were significantly below mean score at $r^2 = 5.142$ and $r^2 = 5.285$ respectively and therefore warrant observation in subsequent data points for potential commonalities. Figure 14 showed the entire data set least square means results where two results fall below other participants. The following question in Section 5.2 scored the lowest among all participants.

- Section 5.2, Question 4: Pilots don't bother reporting near misses or close calls since these events don't cause any real damage

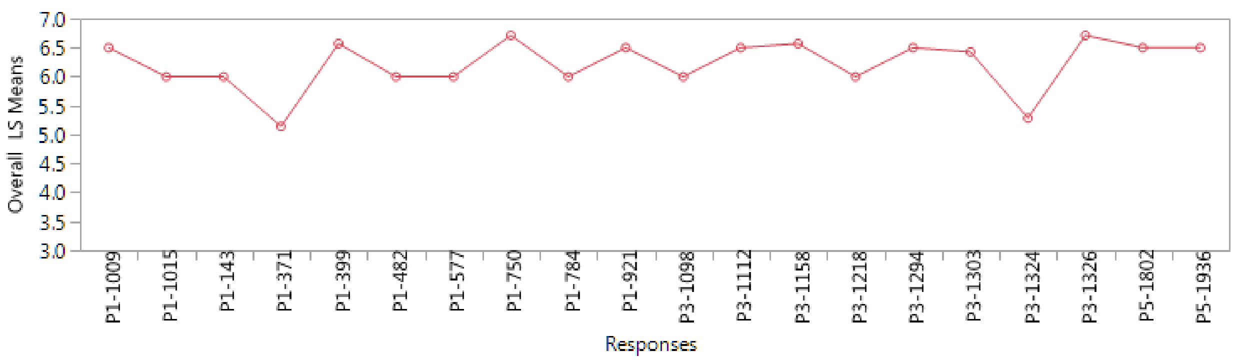


Figure 14. Formal Safety Systems dimension least square means chart.

A willingness to report all types of potential hazards serves as a critical component of safety improvement methodology. Rationale centers on a basic concept that if CNATOs do not have sufficient data, discovering reoccurring issues is impossible.

Informational safety systems (IS). SCISMS measured informational systems by focused questions related to accountability, pilot's authority, and professionalism. Culturally speaking, this dimension was one of the most critical since aircraft operations directly relate to these core functions. Professionalism in aviation broadly defined by industry leaders is defined as the pursuit of excellence through discipline, ethical behavior, and continuous improvement (National Business Aircraft Association, n.d.). The concept of professionalism was included within both pre-packaged SMS measures and suggested customized SMS literature as a core element. Informational safety responses in Table G2 begin to show unique patterns emerging. With a dimension $\mu = 5.94$, the data reveals participants high reliance and belief in organizational informational safety systems.

Responses in this section begin to deviate from expected results. An assumption that all respondents were pilots, despite not holding a positional title explicitly stating a flying role, may be implied. Deviation in responses centered on survey section 5.5 - Accountability described as "These items refer to the ways in which pilots are treated based on their safe or unsafe behavior at your organization" and 5.7 – Professionalism described as "items refer to the attitudes you perceive among your fellow pilots in regard to safety" (von Thaden & Gibbons, 2008, p. 15). Despite pilots having a perceived reputation for extreme self-confidence and arrogance, the data must be analyzed for its value in determining trends. Two questions emerged as areas of interest due to low mean scores.

- Section 5.5, Question 1: Management shows favoritism to certain pilots
- Section 5.7, Question 5: Pilots don't cut corners or compromise safety regardless of the operational pressures to do so

Management showing favoritism and pilots cutting corners scored $\mu = 5.10$ against a 5.94 mean for all informational systems. By running a MANOVA least square fit model, analysis showed once again, P^{1}371 and P^{3}1324 scored significantly below the mean section score at 4.79 ($r^2 = 3.928$) and 4.36 ($r^2 = 4.35$) respectively and warrant observation within the research question context. Figure 15 shows results from analysis where the two participants demonstrated below average least square means where N = 14 and DF = 13. A pattern has started to emerge between these two CNATOs based on raw SCISMS data.

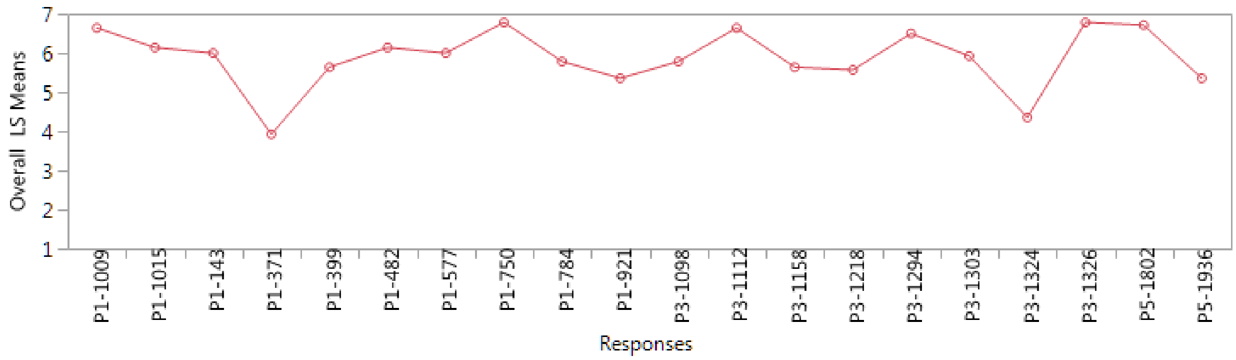


Figure 15. Informational Safety Systems dimension least square means chart.

Operations interaction (OI). CNATOs are complex organizations with interdependencies among various roles. While pilots are ultimately responsible for the safe operation of aircraft, policies set by Chief Pilots, flight parameters and planning performed by Dispatchers, and training or instruction received by pilots all have a profound effect on safety culture. Operations interaction data in Table G3 captured participant attitudes regarding these interactions. Non-responses within OI answer banks were intentional and caused by a participant selected Chief Pilot primary role. SCISMS authors believed inaccurate information would be gathered by asking those participants to measure a role in which they were directly responsible. This approach deserves debate; however, initial academic review provided data reliability and validity using this approach.

An outlier question posed within the Chief Pilot responsibilities demonstrated a mean below norms. When asked about safety reporting habits, respondents believe reporting safety deviations to Chief Pilots over the safety department. This phenomenon was understandable seeing that safety department personnel could be less understanding about such deviations. The extent to which respondents answered where $\mu = 5.06$ provided insight as to the extent organizational members had a difficult time relying upon established SMS protocol. Question wording allowed a truthful answer by using "often" as actual verbiage below demonstrates.

- Section 5.8, Question 5: Pilots often report safety concerns to their chief pilot rather than the safety department

Survey results in this section centered on actions taken by dispatchers due to below mean scores. Dispatch questions had below mean scores across the all questions in survey Section 5.9. The lowest scoring question involved dispatchers sharing information having a value $\mu = 5.20$ against an overall section where $\mu = 6.03$. The specific question has been included below.

- Section 5.9, Question 1: Dispatch consistently emphasizes information or details (e.g., weather requirements, NOTAMs) that affect flight safety.

Overall, Instructors/Trainers scored the highest within this section, $\mu = 6.38$, leaving little statistical doubt of their positive impact to safety culture. CNATOs are required to complete recurrent training every 6-months and therefore, some line pilots have more interaction with that constituency than any other. Chief Pilots were slightly above the mean at $\mu = 6.05$ despite their exempted answers which presumably would have boosted scores. Three participants scored below least square mean in operations interaction, $P^{1}371$, $P^{1}1015$, and $P^{3}1324$. Analysis in this category showed less conclusive evidence, as several participants scored below average. Figure 16 showed operations interaction dimension less effective in statistically differentiating respondents. At this point in the SCISMS it should be noted two participants consistently scored below mean in every section and now constitute a statistical trend.

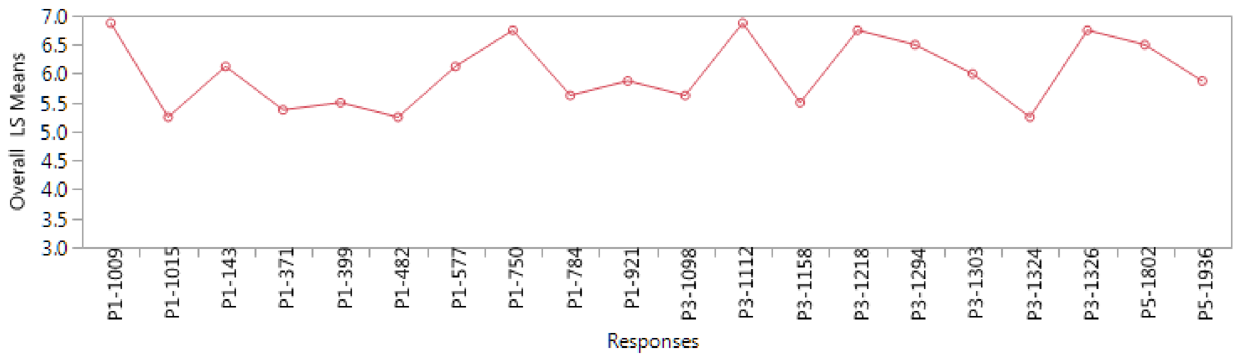


Figure 16. Operations Interaction dimension least square means chart.

It is interesting to note this section had the highest variance and standard deviation of any other section. Questions contained in operations interaction deal a great deal with feelings about others' role and function as related to safety. A lack of objectivity could explain this statistical phenomenon. However, the section deviation of $\sigma = 1.092$ is not statistically significant to cause doubt as to survey results. In order to verify its fitness, a Chi-square model performed in JMP for all responses in this section sought to validate the data. The results included indicated acceptance of a null hypothesis of N_0 = the data within the SCISMS OI section is valid with a result of $p > 0.0423$.

Table 11

Verification of All SCISMS Responses in OI Section

Model	-LogLikelihood	DF	χ^2	p> value
Difference	10.796731	12	21.59346	0.0423*
Full	22.547610			
Reduced	33.344342			

Organizational commitment (OC). The final section of the SCISMS survey ask specific questions regarding safety culture organizational commitments, typical safety culture practices, and management commitment to safety. Measuring safety culture commitment involved 14 questions and covered the aforementioned dimensions as displayed in Table G4. Two questions identified areas below mean and attracted further review. Section 5.11 question 5 discussed organizational tendencies to deviate from safety norms. This question scored $\mu = 5.40$ against a section mean of 6.35. Another question which scored $\mu = 5.25$ against a section mean of 6.13 pertained to pilot scheduling. Past safety has been compromised when flight crews were not properly rested and this issue was identified by NTSB officials as a necessary improvement area (National Transportation Safety Board, 2015b). Both questions are included below for reference.

- Section 5.11, Question 5: Management does not cut corners where safety is concerned
- Section 5.13, Question 2: Management schedules pilots as much as legally possible, with little concern for pilots' sleep schedule or fatigue

Worthy of note in this section were three non-responses to the questions in Section 5.13 related to management commitment. Two of these responses were by survey design because they answered as CEO of the participants. One respondent simply did not choose to complete a section displayed on the final page prior to completing the MLQ. As such, the excluded data removed from that section for the participant became necessary. Survey design allowed participants to voluntarily avoid answering questions. Lack of data in this participant field did not affect survey outcomes. Three participants scored below mean in this section. $P^{1}374$ indicated $\mu = 5.57$, $P^{1}784$ scored $\mu = 5.86$, and $P^{3}1324$ responded with $\mu = 5.79$. While $P^{1}784$ appears for the first time, the other two appeared as below mean in every SCISMS statistical dimension. Figure 17 also graphically demonstrates the appearance of $P^{1}784$ is not at an intercept significantly below other study participants. Based on SCISMS author conclusions, these two CNATOs could be at risk for an organizational accident.

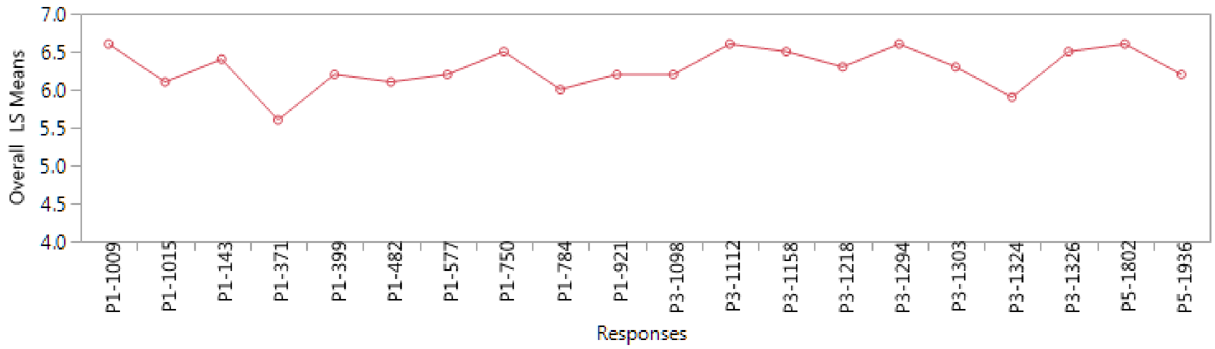


Figure 17. Organizational Commitment dimension least square means chart.

SCISMS dimension summary. The SCISMS survey provides critical quantitative data for participant comparatives. Four dimensions comprised of 55 questions on critical areas of safety culture and gave insight to activities within the 20 participant CNATOs. Core safety elements such as professionalism, management commitment, and functionality of formal systems measured in the SCISMS were important to measure inside each CNATO, but also for comparison purposes.

Comparing participant safety dimension mean scores across each FSRO showed very little difference. Table 12 indicated regional differences are not significant enough to justify varying treatment in future studies. Consistently higher than average mean scores across dimensions also supported safety culture being familiar to CNATOs. If CNATO responses corresponded to original SCISMS safety culture grid constructs, regions could be described as "collaborative". Von Thaden & Gibbons (2008) characterized collaborative organizations as "safety is seen as a primary integrated concern throughout the organization. Organizational leadership encourages employees to share in decision-making and problem solving, and keeps employees informed about matters that affect them. Leaders are visible and approachable. A generative approach" (p. 31).

Table 12

SCISMS Safety Dimension Responses by FSRO

	FS	IS	OI	OC	Mean
P^1 - Eastern	6.14	5.93	5.89	6.14	6.03
P^3 - Western Pacific	6.25	5.92	6.10	6.33	6.15
P^5 - Southwestern	6.50	6.04	6.23	6.46	6.31

Table 13 displays participant dimension in one table, allowing easy identification of broad themes. As can be viewed, FS and OC dimensions had higher mean scores than IS and OI. Placing data in this format also quickly identified low performers such as P^{1}371 and P^{3}1324 in comparison to other participants.

Table 13

SCISMS Dimension Mean Score Comparison

	Safety Culture Dimension			
Participant	Formal Systems	Information Systems	Operations Interactions	Organizational Commitment
P^{1}1009	6.50	6.64	6.54	6.60
P^{1}1015	6.00	6.14	5.62	6.14
P^{1}143	6.00	6.00	6.13	6.21
P^{1}371	5.14	4.79	5.38	5.57
P^{1}399	6.57	5.64	5.62	6.14
P^{1}482	6.00	6.14	5.62	6.10
P^{1}577	6.00	6.00	6.15	6.07
P^{1}750	6.71	6.79	6.15	6.50
P^{1}784	6.00	5.79	5.69	5.86
P^{1}921	6.50	5.36	6.00	6.21
P^{3}1098	6.00	5.79	5.63	6.00

(continued)

	Safety Culture Dimension			
Participant	Formal Systems	Information Systems	Operations Interactions	Organizational Commitment
$P^3$1112	6.50	6.64	6.54	6.71
$P^3$1158	6.57	5.64	6.18	6.36
$P^3$1158	6.00	5.71	6.69	6.36
$P^3$1294	6.50	6.50	6.46	6.60
$P^3$1303	6.43	5.93	5.92	6.36
$P^3$1324	5.29	4.36	5.25	5.79
$P^3$1326	6.71	6.79	6.15	6.50
$P^5$1802	6.50	6.71	6.46	6.71
$P^5$1936	6.50	5.36	6.00	6.21

Mean score over all participants averaged a full point higher in four of five dimensions compared to airlines surveyed in the original survey. Figure 18 shows a comparison histogram of CNATO to airline mean scores. While sample size of the original SCISMS survey was n = 503 airlines and study only n = 20 CNATOs, demographic similarities with personnel and general operating requirements provided valid similarities. An exception exists in only one category. The μ = 0.30 difference in CNATOs organizational commitment could be attributed to SMS programs being newly implemented to this industry segment. Questions within OC strictly addressed management opinions toward safety culture methodologies and processes. Data results indicated an internal struggle between procedural burdens of SMS and operational flexibility.

Multifactor Leadership Questionnaire, Form 5X (MLQ). Specific questions from the MLQ cannot be disclosed due to copyright protections imposed by Mind Garden. As a result, generalized data using three suggested qualitative themes has been included. Descriptive coding frameworks in Table 14 demonstrate arrangement according to MLQ leadership characteristic descriptions. Each final coding framework used descriptive data to answer research questions. It is important to note that MLQ measures characteristics against norms rather than definitively labeling a leader. Therefore, results contained herein provide broad understanding as to leader behavior and not meant to label leaders as transformational, transactional, or passive avoidant.

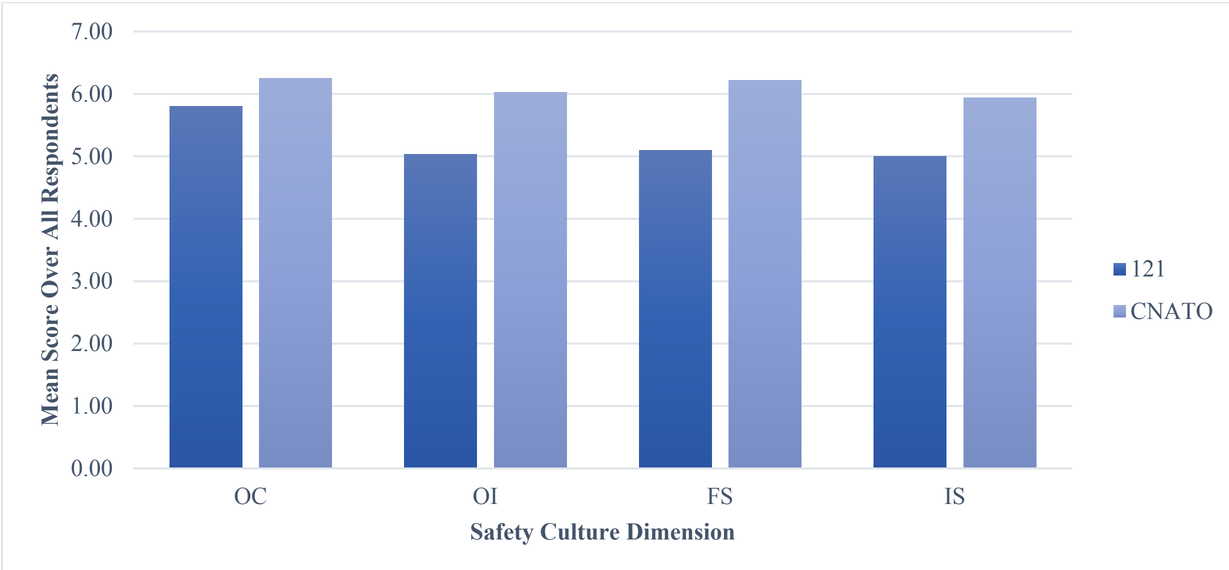


Figure 18. SCISMS comparison of Airlines vs. CNATO mean score. Airline data adapted from "The Safety Culture Indicator Scale Measurement System (SCISMS)", by the Office of Aviation Research and Development, T.L. von Thaden and A.M. Gibbons, 2008. In the public domain.

Table 14

MLQ Form 5x Leadership Themes

Final coding framework theme (characteristic)	Initial thematic coding framework (scale)
1. Transformational	• Individualized consideration
	• Idealized influence (attributed)
	• Idealized influence (behavior)
	• Inspirational motivation
	• Intellectual stimulation
2. Transactional	• Contingent reward
	• Management-by-exception (active)
3. Passive Avoidance	• Laissez-faire
	• Management-by-exception (passive)

MLQ participant leadership type findings. In order to understand leadership influences on organizations and their willingness to inculcate safety culture, an examination was necessary of each participants' leadership characteristics. The summary contained in Table 15 represented a participant leadership characteristics and dominant scale. An absence of passive avoidance is consistent with the highly regulatory nature of CNATOs and supports previous assumptions of passive avoidance leadership being a below normal phenomenon within the industry. Where transactional characteristic was above the norm in five participant organizations, a dominant scale of contingent reward (CR) existed in every response. This phenomenon should not go unnoticed and four MLQ questions determined a CR dominant scale.

Table 15

Participant Leadership Characteristic and Dominant Scale

Participant	Characteristic	Dominant Scale
P^{1}143	Transformational	IC, IB, IS
P^{1}371	Transactional	CR
P^{1}399	Transformational	IM, IC
P^{1}482	Transformational	IC
P^{1}577	Transactional	CR
P^{1}750	Transformational	IA
P^{1}784	Transactional	CR
P^{1}921	Transformational	IB, IM
P^{1}1015	Transformational	IB, IM
P^{1}1009	Transformational	IB, IM, IS
P^{3}1098	Transformational	IC
P^{3}1112	Transformational	IB, IS
P^{3}1158	Transactional	CR, MBEA
P^{3}1218	Transformational	IA, IS
P^{3}1294	Transformational	IA
P^{3}1303	Transactional	CR
P^{3}1324	Transformational	IM
P^{3}1326	Transformational	IA, IM
P^{5}1802	Transformational	IA
P^{5}1936	Transformational	IC

Note. Idealized attributes (IA), Idealized behaviors (IB), Inspirational motivations (IM), Intellectual stimulation (IS), Individualized consideration (IC), Contingent reward (CR), Management by exception – active (MBEA), Management by Exception – passive (MBEP), Laissez-faire (LF).

Comparing participant geographic strata in Table 16 provides insight as to similarities and differences between CNATOs operating in different regulatory oversight FSRO jurisdictions. Generally, higher than normal transformational leadership style emerged as predominant within CNATOs across strata. Transactional appears in two of three stratum. Presence of these two leadership characteristics was consistent to literature assessments of aviation organizations discussed in Chapter II. MLQ measures described as outcome of leadership were also consistent with high reliability organizations in overwhelmingly selecting effectiveness. Strict focus on compliance and safety heavily rely upon effectiveness over other behavioral outcomes. Extra effort and satisfaction behaviors closely followed in each case. The P^1 and P^3 strata indicated satisfaction as a behavior outcome while P^5 responded extra effort as second behind effectiveness.

Table 16

Mean Percentage of Leadership Characteristics by Strata

	Participant leadership characteristic percentage		
MLQ Description	P^1 (N = 10)	P^3 (N = 8)	P^5 (N = 2)
Leadership Characteristic			
Transformational	70.0% (7)	62.5% (5)	100.0% (2)
Transactional	30.0% (3)	37.5% (3)	0.0% (0)
Passive Avoidant	0.0% (0)	0.0% (0)	0.0% (0)
Outcome of Leadership (behaviors)			
Effectiveness	100%	100%	100%
Extra Effort	0%	0%	0%
Satisfaction	0%	0%	0%

Aggregate responses to MLQ leadership characteristics expressed in Table 16 initially seem heavily skewed toward an existence of transformational leadership dominance, but examining data further reveals mean transactional data closely follows transformational styles among participants. Table 17 shows leadership characteristic means within strata and by comparison to other FSRO participants. A large gap existed between both transactional and transformational and passive avoidant. The data suggests passive avoidant leadership is not prevalent in participant organizations and therefore to the CNATO population.

Table 17

Comparison of Leadership Characteristics Scores by Strata

	P^1 ($N = 10$)		P^3 ($N = 8$)		P^5 ($N = 2$)	
Leadership Characteristic	M	SD	M	SD	M	SD
Transformational	4.00	0.1458	4.05	0.1118	3.60	0.2404
Transactional	3.55	0.7071	3.72	0.3977	3.06	0.4419
Passive Avoidant	1.45	0.0707	1.41	0.1326	0.88	0.1768

Existence of Safety Management System (SMS). Previous academic research attributed statistically significant decreases in accident rates among airlines upon implementation of a SMS. Participants revealed within Section 5.1 of the SCISMS whether a formal SMS existed in their organization. When responding affirmatively, survey logic inquired whether that SMS was commercially available or developed internally. Each participant response captured in Table 18 show all participants have implemented SMS and a high use of commercially available programs. Only $P^1$482 neither used a commercial package nor developed an internal program. It was unclear from survey responses what type of SMS this outlier employs.

Table 18

CNATO Use of SMS by Participant

Participant	SMS Implemented	Commercial	Internal
P^{1}143	Yes	Yes	No
P^{1}371	Yes	No	Yes
P^{1}399	Yes	Yes	No
P^{1}482	Yes	No	No
P^{1}577	Yes	Yes	No
P^{1}750	Yes	Yes	No
P^{1}784	Yes	Yes	No
P^{1}921	Yes	Yes	No
P^{1}1009	Yes	Yes	No
P^{1}1015	Yes	Yes	No
P^{3}1098	Yes	No	Yes
P^{3}1112	Yes	Yes	No
P^{3}1158	Yes	Yes	No
P^{3}1294	Yes	Yes	No
P^{3}1303	Yes	No	Yes
P^{3}1324	Yes	Yes	No
P^{3}1326	Yes	Yes	No
P^{5}1802	Yes	Yes	No
P^{5}1936	Yes	Yes	No

Note. Commercial heading indicates SMS sourced from for-profit entities specializing in providing pre-packaged programs. Internal signifies participant created SMS in-house.

Aviation Safety Information Analysis and Sharing (ASIAS). Safety data contained within the ASIAS accident and incident database includes any *aircraft accidents* and *incidents*. The study treats either type of ASIAS entry as an *organizational accident* due to theoretical constructs identifying events within high-reliability organizations, however small, as a process failure. Table 19 expresses ASAIS data for each confidential participant. The data showed only one study participant had any type of organizational accident since ASAIS began collection data in 1978. P^{3}1324 incurred an accident in 2014 and an incident in 2006. Accident investigation conclusions suggested controlled flight into terrain (CFIT) as the primary cause. The accident resulted in a loss of five souls and total destruction of the airframe. NTSB data did not cite any organizational culture or operations elements as contributory causes to the accident. An ASIAS entry was also included for 2006. Database entry concluded this issue was a gear collapse attributed to a hard landing. No loss of life was noted and airframe was only slightly damaged with prop strikes and engine damage. While this incident is common and appears not to have included any organizational accident elements, an 11-year old NTSB report does not speak to safety climate that may have existed at the time of the incident. Generally, NTSB reports are limited to facts only and rarely contain supposition or comments which could be construed as opinion.

Table 19

ASIAS Accident and Incident Data for Study Participants

Participant	Accident	Incident	Year of accident and/or incident
P[1]143	No	No	NA
P[1]371	No	No	NA
P[1]399	No	No	NA
P[1]482	No	No	NA
P[1]577	No	No	NA
P[1]750	No	No	NA
P[1]784	No	No	NA
P[1]921	No	No	NA
P[1]1009	No	No	NA
P[1]1015	No	No	NA
P[3]1098	No	No	NA
P[3]1112	No	No	NA
P[3]1158	No	No	NA
P[3]1294	No	No	NA
P[3]1303	No	No	NA
P[3]1324	Yes	Yes	2014*, 2006
P[3]1326	No	No	NA
P[5]1802	No	No	NA
P[5]1936	No	No	NA

Note: Accidents indicated by * otherwise chart entries are Incidents.

It is important to note that CNATOs do not include highly hazardous flying conditions such as air ambulance or helicopter tours, which have a higher instance of accidents among all aviation related groups (FAA, n.d.).

Findings by research question. While the raw data provided in the appendices was helpful in giving context to participants, the complexity of multiple data points for each research question required greater understanding of how data operationalization occurs. As described previously, an instrumentation of variables describes each relevant variable and corresponding data point. Table 9 reappears from Chapter III to assist in understanding section organization of findings by research question. For comparative purposes, P³1324 is bolded in each result table and represents the only participant who experienced an organizational accident.

Table 9

Instrumentation of Variables

Hypothesis	Variable name	Variable type	Measure name	Type of measurement
RQ1: Safety culture characteristics of CNATO (descriptive)	1. Safety Culture	1. Intervening	1. SCISMS	1.Safety culture dimension; (FS, IS, OI, OC)
RQ2: Organizational culture impact on performance (relational)	2a. Leadership type 2b. Organizational accidents	2a. Independent 2b. Dependent	2a. MLQ-5X 2b. ASIAS; 2 measures	2a. Leadership type; 9-factors 2b. Accident/incident
RQ3: Accident rates of CNATOs usage of SMS (comparative)	3a. Regulatory influence	3a. Independent 3b. Independent	3a. SCISMS 3b. SCISMS	3a. Formal safety indicators; 2-factors (OC, FS)

(continued)

Hypothesis	Variable name	Variable type	Measure name	Type of measurement
	3b. SMS use 3c. Organizational accidents	3c. Dependent	3c. ASIAS; 2 measures	3b. Formal safety indicators; SMS use 3c. Accident/incident
RQ4: Leadership style relationship to culture and accidents (relational)	4a. Leadership type 4b. Safety culture 4c. Organizational accidents	4a. Intervening 4b. Intervening 4c. Dependent	4a. MLQ-5X 4b. SCISMS 4c. ASIAS	4a. Leadership type; 9-factors 4b. Dimension safety indicators 4c. Accident/incident

Research question 1. What safety culture characteristics does a typical CNATO organization possess? (descriptive)

As described by the study instrumentation table, research question one involves a descriptive analysis of participants using SCISMS safety culture dimensions. Overall mean dimension scores and consolidated score provides a general description of CNATOs in a safety culture context. Participants having an above average tendency for formal safety systems (FS) indicated a proclivity toward orderly process oriented practices and processes. Heavy reliance on informational systems (IS) suggests command and control methods for safety adherence. High operations interaction (OI) scores indicated a more people centric reliance to achieve safe operating environments. Finally, organizational commitment (OC) used leadership and policy as the primary motivator for safety culture development. Each dimension provided insight into culture characteristics participant organizations subscribe. Table 20 shows each mean dimension score and dominant dimension by participant. Top quartile SCISMS mean scores include $P^3$112,

$P^3$1802, $P^1$1009, P1750, and $P^3$1326 ranked in that order. Bottom quartile mean scores from highest to lowest were $P^1$482, $P^3$1098, $P^1$784, $P^1$371, and $P^3$1324.

Table 20

SCISMS Composite Safety Dimension Responses by Participant

Participant	FS	IS	OI	OC	Dominant Dimension
$P^1$1009	6.50	6.64	6.54	6.60	IS
$P^1$1015	6.00	6.14	5.62	6.14	IS, OC
$P^1$143	6.00	6.00	6.13	6.21	OC
$P^1$371	5.14	4.79	5.38	5.57	OC
$P^1$399	6.57	5.64	5.62	6.14	FS
$P^1$482	6.00	6.14	5.62	6.10	IS
$P^1$577	6.00	6.00	6.15	6.07	OI
$P^1$750	6.71	6.79	6.15	6.50	FS
$P^1$784	6.00	5.79	5.69	5.86	OC
$P^1$921	6.50	5.36	6.00	6.21	FS
$P^3$1098	6.00	5.79	5.63	6.00	FS, OC
$P^3$1112	6.50	6.64	6.54	6.71	OC
$P^3$1158	6.57	5.64	6.18	6.36	FS
$P^3$1158	6.00	5.71	6.69	6.36	OI
$P^3$1294	6.50	6.50	6.46	6.60	OC
$P^3$1303	6.43	5.93	5.92	6.36	FS
$P^3$1324	**5.29**	**4.36**	**5.25**	**5.79**	**OC**
$P^3$1326	6.71	6.79	6.15	6.50	IS
$P^5$1802	6.50	6.71	6.46	6.71	IS, OC
$P^5$1936	6.50	5.36	6.00	6.21	FS

Three participants exhibited multiple dominant dimensions with instances of identical mean scores for each dimension. It is relevant to note that $P^1$1015 and $P^3$1098 ranked 15th and 17th respectively in overall SCISMS score while $P^5$1802 ranked second. Therefore, it cannot be said that a presence of multiple dimensions equated to higher overall SCISMS scores. Further, $P^1$1015, ranked 15 of 20, and $P^5$1802, ranked 2 of 20, shared exactly the same dominant dimensions. CNATOs holding a specific dominant safety culture dimension had no correlation with higher overall mean scores. Data suggests the degree to which safety dimension exists, as represented by a higher mean score, was far more important than which dimension was represented.

Using safety culture dimension as a CNATO descriptor may give insight to organizational objectives, however, commonalities among participants was inconclusive. As demonstrated in Figure 19, OC appeared the most among participants, but only slightly over FS, followed closely by IS. Therefore, no dominant dimension emerged to describe the entire CNATO population. It can be said about study participants that all scored significantly above SCISMS average as a group with $\mu = 6.16$ on a scale of 1.0 to 7.0 where 4.0 represented average.

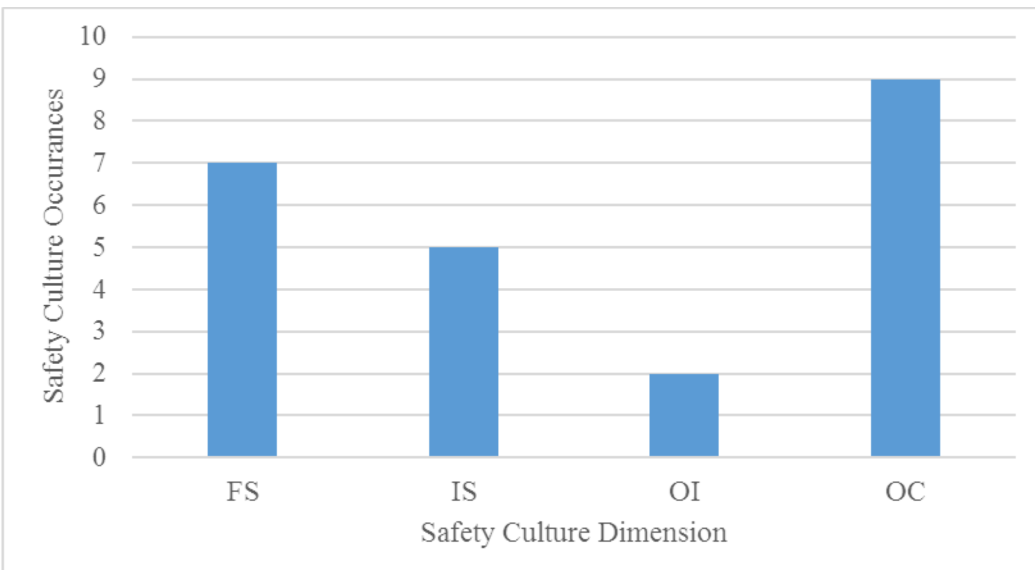


Figure 19. Study participant culture dimension dominance. Displays a breakdown of number of responses to each dominant dimension within the SCISMS safety survey. Participants may have more than one dominant dimension.

Research question 2. To what extent, if at all, does organizational culture have a relationship with performance outcomes, including accident rates? (relational)

Reviewing accident data, then comparing trends in leadership characteristics yielded an unexpected finding. Data contained in Table 21, a composite of Table 15 and Table 19, for relationships between leadership and organizational accidents yielded information relevant to answering the research question. P^{3}1324, the only operator with organizational accidents, identified themselves as having transformational leadership behavior above norm. Due to 14 other participants exhibiting transformational characteristics and five others with the same dominant IM scale not incurring any organizational accidents, no conclusive data can support transformational leadership had a relationship to enhanced safety culture. Further, study data indicated to a reasonable certainty IM dominance had no relationship with a higher accident rate risk since no accident existed in other IM participants.

Table 21

Leadership Behavior and Organizational Accident Relationship Outcomes

Participant	Characteristic	Dominant Scale	Organizational Accident
P^{1}143	Transformational	IC, IB, IS	No
P^{1}371	Transactional	CR	No
P^{1}399	Transformational	IM, IC	No
P^{1}482	Transformational	IC	No
P^{1}577	Transactional	CR	No
P^{1}750	Transformational	IA	No
P^{1}784	Transactional	CR	No
P^{1}921	Transformational	IB, IM	No
P^{1}1015	Transformational	IB, IM	No
P^{1}1009	Transformational	IB, IM, IS	No
P^{3}1098	Transformational	IC	No
P^{3}1112	Transformational	IB, IS	No
P^{3}1158	Transactional	CR, MBEA	No
P^{3}1218	Transformational	IA, IS	No
P^{3}1294	Transformational	IA	No
P^{3}1303	Transactional	CR	No
P^{3}1324	**Transformational**	**IM**	**Yes**
P^{3}1326	Transformational	IA, IM	No
P^{5}1802	Transformational	IA	No
P^{5}1936	Transformational	IC	No

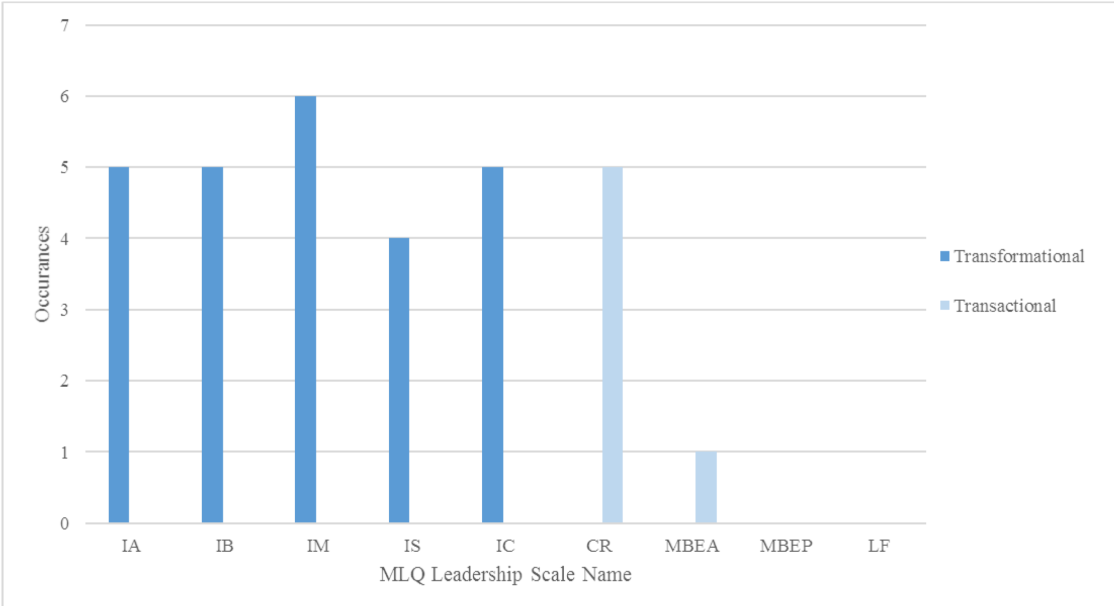


Figure 20. MLQ participant dominant leadership scale. Compiled from respondents answers within each leadership characteristic. Participants could have more than one scale attributed.

Research question 3. To what extent, if at all, is there a difference in accident rates of CNATOs that use safety management system programs and those that do not? (comparative)

SMS programs include formalized, systematic, and methodical processes for aviation operations. These comprehensive written processes serve as the basis for safety culture formation. Presence of CNATO participants with a SMS program indicate basic understanding and presence of safety culture. SMS existence indicated an organization already applied airline style safety into normal operations. Verifying SMS in participant organizations appeared through formal safety systems SCISMS questions and a demographic question included by the researcher. Both responses served as a crosscheck during sequential transformative individualized findings to insured integrity.

Table 22 combined relevant data from SCISMS, accident data from ASAIC, and a demographic question. As shown, all participants had implemented a SMS program. Formal system score, a dimension of SCISMS provided an informal measure as to the extent SMS appears across 20 degrees of freedom. In addition to $P^3$1324, which suffered an organizational accident, one other CNATO participant scored even lower. Presence of a lower formal system score and the absence of an organizational accident from $P^1$374 provided conflicting statistical proof of safety risk. Since all participants implemented a SMS, any conclusions based on this data point would be inconclusive. For all these reasons, data analysis proved to high degree of certainty there is no difference in accident rates of those who use SMS programs and those who do not.

Table 22

SMS Program Existence Comparison

Participant	SMS Implemented	Formal System Score	Org Commitment Score	Organizational Accident
$P^1$143	Yes	6.00	6.21	No
$P^1$371	Yes	5.14	5.57	No
$P^1$399	Yes	6.57	6.14	No
$P^1$482	Yes	6.00	6.10	No
$P^1$577	Yes	6.00	6.07	No
$P^1$750	Yes	6.71	6.50	No
$P^1$784	Yes	6.00	5.86	No
$P^1$921	Yes	6.50	6.21	No
$P^1$1015	Yes	6.50	6.60	No
$P^1$1009	Yes	6.00	6.14	No
$P^3$1098	Yes	6.00	6.00	No
$P^3$1112	Yes	6.50	6.71	No
$P^3$1158	Yes	6.57	6.36	No
$P^3$1218	Yes	6.00	6.36	No
$P^3$1294	Yes	6.50	6.60	No
$P^3$1303	Yes	6.43	6.36	No
$P^3$1324	**Yes**	**5.29**	5.79	**Yes**
$P^3$1326	Yes	6.71	6.50	No
$P^5$1802	Yes	6.50	6.71	No
$P^5$1936	Yes	6.50	6.21	No

Note. SCISMS dimensional FS and OC scores indicated as mean for entire dimension.

Research question 4. To what extent, if at all, does CNATO leadership style have a relationship with the development of a safety culture and accident rates? (relational)

Research question four combines each data set into one and asked the question whether observed values from participant surveys result in predictable relationship with organizational accidents as identified in the ASIAS database. Using non-experimental research method, an analysis of data in Table 23 showed key participant responses for each variable. Using JMP, data analysis revealed some interesting results.

Table 23

Survey Results Composite Snapshot

Participant	Leadership Characteristic	Leader Average by Scale	Dominant Dimension	SCISMS Mean Score	Organizational Accident
P^{1}143	Transformational	3.80	OC	6.08	No
P^{1}371	Transactional	3.55	OC	5.22	No
P^{1}399	Transformational	3.60	FS	5.99	No
P^{1}482	Transformational	4.25	IS	5.96	No
P^{1}577	Transactional	4.00	OI	6.05	No
P^{1}750	Transformational	3.70	FS	6.53	No
P^{1}784	Transactional	3.50	OC	5.83	No
P^{1}921	Transformational	3.75	FS	6.01	No
P^{1}1009	Transformational	4.40	IS	6.57	No
P^{1}1015	Transformational	4.35	IS, OC	5.97	No
P^{3}1098	Transformational	3.60	FS, OC	5.85	No
P^{3}1112	Transformational	3.60	OC	6.59	No
P^{3}1158	Transactional	4.50	FS	6.18	No
P^{3}1158	Transformational	4.00	OI	6.19	No
P^{3}1294	Transformational	3.70	OC	6.51	No
P^{3}1303	Transactional	3.50	FS	6.15	No
P^{3}1324	**Transformational**	**3.40**	**OC**	**5.17**	**Yes**
P^{3}1326	Transformational	3.60	IS	6.53	No
P^{5}1802	Transformational	4.60	IS, OC	6.59	No
P^{5}1936	Transformational	2.60	FS	6.01	No

The following two figures represent multivariate analysis of leadership characteristics in comparison to SCISMS mean score. Figure 21 represented a multivariate analysis scatterplot of transformational responses to SCISMS mean scores. The trend line and elliptical boundaries indicate some relationship among transformational leadership characteristic scale and SCISMS mean score. While there are two outliers out of 15 data points, the reliability value of $r = 0.3134$ (existing between -1 and 1) does indicate a predictable trend. Conversely, a scatterplot for transactional responses to SCISMS also had an $r = 0.4915$ and its five data points extrapolated to include predictable values. However, the research question did not ask simply if there was a leader-safety culture relationship. The addition of organizational accident yielded different results.

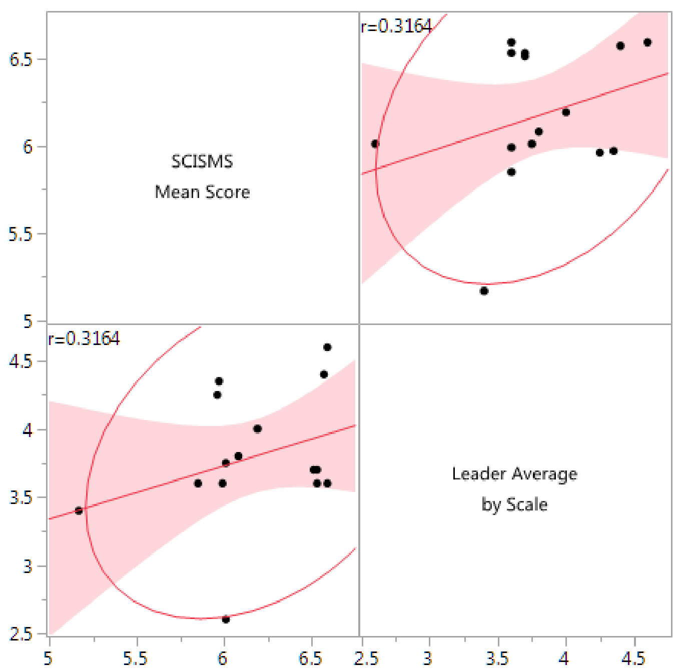


Figure 21. Multivariate scatterplot of transformational leadership characteristic.

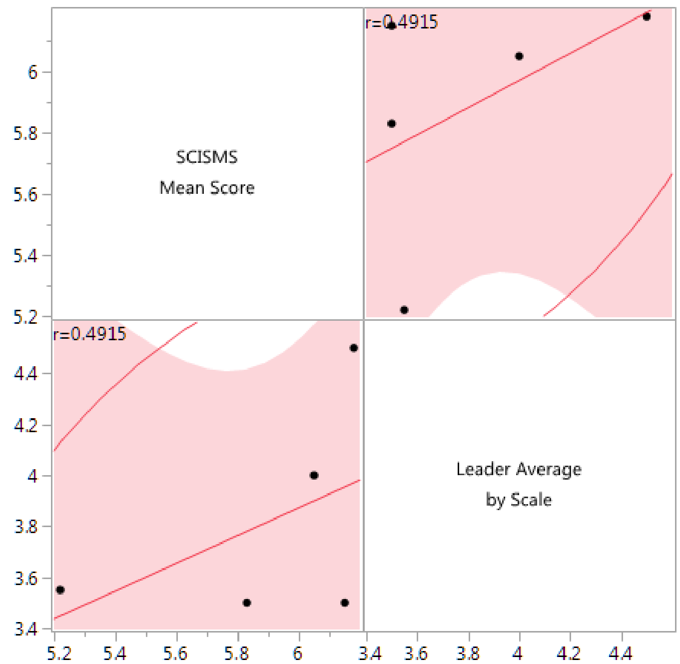
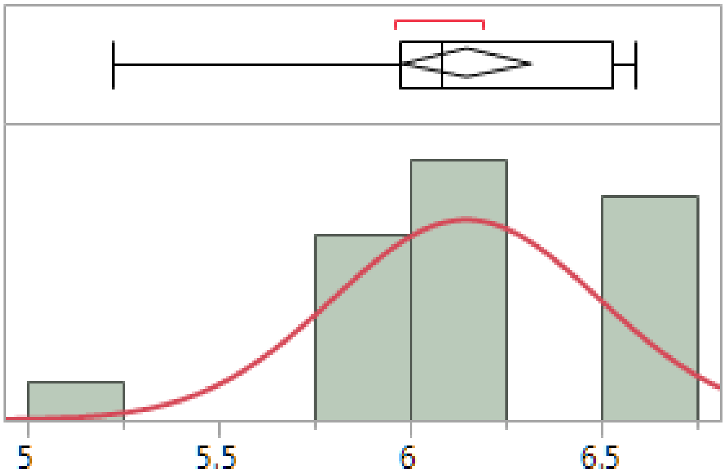


Figure 22. Multivariate scatterplot of transactional leadership characteristic.

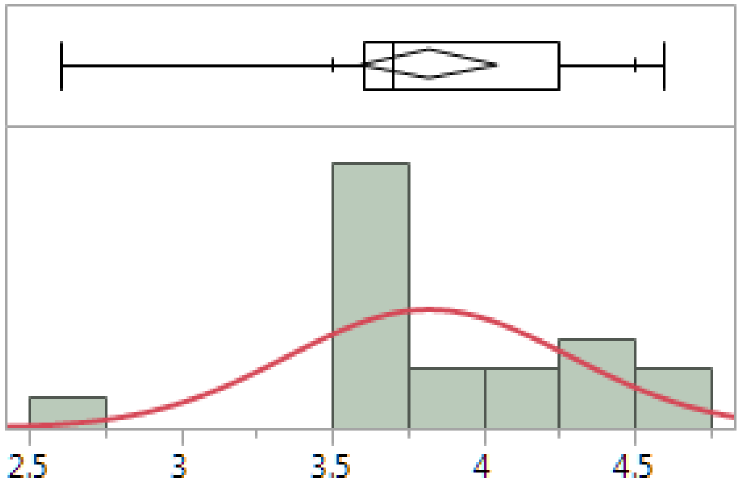
Adding the organizational accident parameter to statistical calculations yielded the following results. Figure 23 shows a box plot of CNATO SCISMS mean score responses with no organizational accidents overlaid with a normal continuous fit distribution line. Since only one participant experienced an organizational accident, the graphics for results is inconclusive. However, it showed a value of 5.17 as mean response. This value would place it at the lower end of the distribution curve, but within the range of values for participants without organizational accidents.



Parameter	Estimate	Lower CI	Upper CI	1-Alpha
Mean	6.147895	6.009134	6.286655	0.900
Std Dev	0.348801	0.27542	0.482915	0.900

Figure 23. SCISMS mean score of CNATOs with no organizational accident.

Considering a leadership characteristic scale using an organizational accident lens yields the same result. Figure 24 represents a box plot of leadership scale averages among CNATOs without organizational accidents with the normal distribution line added. Results for participant $P^3$1324, the only participant that experienced an organizational accident, scored a 3.40 on the transformational scale. As noted, 3.40 falls well within the normal range of non-accident participants, and would fall in the last 10% of those CNATOs. It is also important to note that 3.40 is only 0.3 points off being within the median.



Parameter	Estimate	Lower CI	Upper CI	1-Alpha
Mean	6.147895	6.009134	6.286655	0.900
Std Dev	0.348801	0.27542	0.482915	0.900

Figure 24. MLQ leader average by scale with no organizational accident.

Despite finding that transformational leadership characteristic can predict SCISMS safety culture dimension mean score, the research question asked whether a relationship existed between organizational accidents and leadership influence on safety culture development. Based on the data presented, it appears there is no relationship between those variables.

Summary of Key Findings

Numerous data points collected using individual instrument resulted in creating mountains of data. Using theoretical frameworks presented in prior chapters, measurements yielded definitive results based on specific research questions posed. Respondents appeared to answer survey questions honestly and completely. The quality of overall data was encouraging since 106 questions can sometimes be onerous to complete. Participants have a commitment to improving industry safety as evidenced by participating and offering their experiences. Further study may help identify CNATOs using safety culture best practices and unlock key influencing factors.

Data collected suggests CNATO safety culture best practice existed in several participants. There was ample evidence of data providing mixed or conflicting data when attempting to answer research questions. One such example was $P^3$1112 who scored highest in SCISMS mean score at 6.59 but last among all transformational respondents with a MLQ Form 5X-Short score of 3.60. This juxtaposition revealed itself in RQ4 since 14 other organizations scored higher in transformational leadership. Study results proved that the degree to which an organization exhibited a specific characteristic did not correlate to high scores in other measures.

This chapter presented results obtained from quantitative and qualitative survey instruments used to measure safety culture and leadership attitudes of selected CNATO participants. Study findings contribute to a limited body of research focused on increasing safety culture within a narrow industry segment that has higher organizational accident rates than their airline counterparts. Major findings and implications to policy, CNATO practices, and conclusions are discussed in greater detail in the following chapter.

Chapter V: Discussion and Conclusions

The final chapter discusses findings in the context of each variable, draws conclusions about data sets, addresses implications for policy and practices, and recommends future research on the study topic. Chapter I introduced a theoretical directional hypothesis and discussed potential implications should the data suggest relationships exist. Study findings indicated CNATOs are hard to uniformly compare and while organizational accidents were rare, the participants were not immune from safety lapses.

Discussion of Key Findings

Beyond study research questions was an overall goal to better understand the motivations, variable weights, and their relationship with safety culture. In performing this study, it became apparent that CNATO employees directly responsible for implementing safety culture have limited exposure to safety leaders. Based on the results of OI section of the SCISMS, participants indicated a strong positive opinion of instructors and trainers. This finding was encouraging and discouraging at the same time. It uncovered a divide in organizational trust, described in Chapter IV as a core component of organizational accident avoidance, between CNATO departments. However, it was encouraging because CNATO pilots undergo recurrent training every 6-months and had frequent exposure to instructors and trainers. Subsequent sections address this finding in more detail.

Describing CNATOs was generally not possible in the context of safety culture. Findings suggested that categorizing CNATOs into safety culture dimensions (a) does not determine whether they run a higher risk of organizational accidents, and (b) individualized nature of CNATOs dictate various approaches to safety culture development. RQ1 could have uncovered this phenomenon, but inconclusive evidence existed to broadly describe CNATOs. While it was not the question asked by RQ2, findings did uncover that CNATOs overwhelmingly characterize themselves in transformational and transactional terms. Of participants responding, 75% indicated transformational characteristic and 25% transactional. None responded passive avoidant.

RQ3 asked a binary question as to whether CNATOs had implemented SMS in their organizations. SMS usage emerged as more important than a mere existence of a program. Since the only participant suffering an organizational accident indicated the presence of a SMS, the degree to which CNATOs use the SMS became a factor. SCISMS formal safety systems scores were inconclusive in identifying issues related to SMS usage primarily because $P^{1}371$ scored below $P^{3}1324$ in formal safety system (FS) mean score, yet had no accident or incidents. Therefore, future studies should investigate the type and the degree to which CNATOs use SMS as a variable to organizational accidents.

Perhaps the most encouraging result from the study revolved around a question that was not asked, but uncovered because of the study sequential transformative design methodology. SCISMS scores of CNATOs identifying as transformational was predictable. Figure 21 conclusively demonstrated safety culture scores across all dimensions followed predictable and reliable trends. While there were outliers, respondents were inside the boundaries of the scatterplot and JMP multivariate modeling proved reliability was high related to these datasets.

Examination of Variables

Leadership. Literature meta-analysis determined aviation safety culture is best cultivated under a transformational-transactional leadership style (Clarke, 2013). While this may be true, data collected in this study does not support MLQ measured leadership characteristics having an impact on safety culture outcomes. What is less clear was any influence it may have on daily attitudes surrounding safety culture. CNATO employees mostly operate outside direct influence from organizational leaders. Isolation in the cockpit and spending an extended period of time away from headquarters lend itself to individualized action. It makes sense a line pilot may only see an organizations leadership once every six months when regulations dictate mandatory recurrent training, or at other company-sponsored events. This lack of daily, direct contact places heavy reliance upon hiring practices. Leadership influence on hiring practices and hiring in one's image emerges as a possible variable not contemplated by this study.

Study results uncovered a clear fracture among departments within a CNATO. Examination of SCISMS OI dimension scores demonstrated an overall distrust of safety culture behaviors within dispatch. Dispatchers are directly responsible for crew scheduling, passenger coordination, logistical arrangements, and flight planning. Data showed dispatch scored below OI average across all questions. While one or two occurrences may be normal, as was the case with chief pilot questions, scores below average across all questions raise concerns. This phenomenon deserves closer evaluation in future studies.

Use of MLQ Form 5x provided a large amount of data as to CNATO characteristics and scale. However, the MLQ instrument did not measure a degree of each scale, only behavioral fit within nine constructs. The degree to which a CNATO demonstrated individualized consideration, or inspirational motivation would be helpful to potentially describe CNATO operators. Figure 24 showed scale distribution, but there were several instances where a CNATO demonstrated evenly distributed scores across multiple scales. Therefore, no real conclusions emerged about leadership scale and CNATO participants.

Organizational accidents. Identification of data leading to avoidance of any CNATO organizational accident was an aspirational goal of this study. Due to the nature of being either subject of an accident/incident or not, data was very straightforward. Few similarities existed by examining data from the only participant to suffer an organizational accident.

Safety culture. Conclusions drawn from study data allowed insight as to how CNATOs use different strategies to achieve safety culture and to what degree safety existed in the organization. As discussed previously within the findings, $P^3$1324 did score lowest on SCISMS aggregate scores, but did not score lowest on every dimension. Data suggested that just like 15 other participants, they identified themselves as having transformational leadership characteristics and like five others identified as having high inspirational motivation scale. Safety culture as a construct involves numerous factors and this study attempted to narrow the focus to stated SCISMS variables.

The SCISMS uncovered numerous individualized findings worth noting. First, dominant dimensions identified in Figure 19 resulted in organizational commitment being common in most CNATOs. When looking at the components of that dimension, it included broad organizational aspirations as driving culture. A close second was a more expected result of formal safety systems. Reliance upon humans rather than predicable processes does pose an interesting question as to how sustainable safety culture can be when relying upon a human element.

Another area of analysis granted by the sequential transformative nature of the study was within the informational systems dimension. Scores across all CNATOs were very low in professionalism. Safety culture development relies upon everyone in an organization. Flying passengers for compensation has a high reliance upon professionalism. Low scores presented a concern and were consistent with original airline mean responses being lowest in the IS dimension. This SCISMS dimension may have long-term consequences and would benefit from a longitudinal study.

In general, SCISMS survey results failed to relate with other variables to discover larger trends resulting in organizational accidents. However, CNATO data gathered reveled a great deal about safety culture attitudes. As stated previously, scores across the study sample size indicated higher awareness than airlines at roughly the same safety culture development stage. Figure 18 displayed this achievement in histogram form. This finding was encouraging and exhibited a general understanding of safety culture importance within CNATO operations.

Safety programs. Capturing SMS usage through the SCISMS and demographic question also yielded unexpected results. Since CNATO implementation of SMS programs is voluntary, expectations existed that not all participants would have already complied. While it is true participants may be more actively involved in safety culture activities due to their voluntary participation, the stratified random sample method would equalize any potential bias. Data did uncover that how a CNATO uses an SMS program was more important than a mere existence of a program. Since all operators implemented SMS, any relationship to other variables seemed unlikely. Had a respondent indicated no SMS usage, the study would have been able to assess if a relationship existed. There was no other remarkable information related to SMS program use.

Conclusions

Voluminous data collected during this study allowed researchers to reach three generalized conclusions. The study used four bodies of data to answer four research questions and attempted to find descriptive, comparative, and relational findings of CNATOs.

Conclusion 1: Safety culture within a CNATOs is difficult to describe. Early in the study, Table 5 described the challenge researchers had agreeing on a definition for safety culture. Theoretical framework used for this study relied upon an aviation specific construct that borrowed from culture luminaries Schein, Perrow, Pidgeon, and Reason. "The safety culture of an organization is the product of individual and group values, attitudes, perceptions, competencies, and patterns of behavior that determine the commitment to, and the style and proficiency of, an organization's health and safety management" (Cox & Flin, 1998, p. 191). SCISMS survey captured these behavioral patterns through four dimensions following exactly the Cox and Flin definition. CNATOs exhibited a strong indication of developing safety culture in their organizations as evidenced by Figure 18 where higher means existed in comparison to airlines for the same stage in safety program development. Unfortunately, a pattern did not emerge suggesting safety culture was more or less present if certain SCISMS safety dimension scores were achieved. This lack of fit along with a potential for CNATOs to hold more than one dominant dimension created a situation where a single conclusion could not be reached as to defining an ideal safety culture to avoid organizational accidents.

Analyzing SCISMS data for each CNATO participant did allow some generalized results to emerge. While the only CNATO to suffer and organizational accident did not score lowest in every dimension, it did have the lowest aggregate mean score. This could suggest that the degree to which a CNATO scores on the SCISMS may have a bearing on overall organizational accident risk. In both IS and OC, participant P^1371 had lower scores. Following this participant long-term could determine whether a low score had a relationship to at-risk safety behaviors. Based on the finding they scored lower than another who already suffered an accident, it seems reasonable this CNATO is at risk. SCISMS measures provide data that FAA inspectors should have access to monitor activities and actively engage in accident prevention.

Conclusion 2: Sequential transformative design was appropriate. Research design was critical to gain an overall profile of study participants using individualized results. The use of sequential transformative design allowed a complete picture of each participant to emerge over extended study analysis. When conducting research from afar and not benefiting from on-site visits with CNATOs, conducting data collection and analysis in sequence was critical to gaining an understanding of the participants. By the time it was necessary to review data within the research question lens, an intimate knowledge of each CNATO was already obtained. RQ1 asked for descriptions for CNATO using safety culture dimensions. Placing each into context of leadership also allowed an understanding of organizational culture beyond safety constructs. RQ2 sought to answer a relational question about organizational accidents and leadership types. Knowing that all participants fell into either transformational or transactional assisted in determining no relationship existed without much effort. Sequential transformative design was a significant help in gaining detailed understanding of CNATO participants.

Conclusion 3: Safety culture, as a broad construct, is hard measure. The study found that while categorization of CNATOs provided an easy way to define characteristics, it did not give any insight as to organizational accident predictability. Using a single survey gained valuable data that answered the research questions sufficiently, but use of more than one survey may have provided more detail as to safety culture. Participant fatigue is always a concern when designing research and inclusion of The Organization Safety Culture Questionnaire (Kelly & Pantakar, 2004), a 50-item survey, would most certainly have been too much for participants. Conducting a follow-up survey to the same participants using this measure would give additional insight to culture and specifically professionalism. As identified earlier, responses surrounding professionalism were remarkably low in comparison to expected results. Additional data would help clarify SCISMS dimensions to assess whether those have a greater relationship with organizational accident avoidance.

Directional hypothesis analysis. Figure 3 contained in Chapter I presented a directional hypothesis based on researcher general observation and personal assumptions. The research question posed as follows:

H_1: Organizational accidents moderate the curvilinear relationship between safety culture and leadership influence in such a way that an intermediate level of detail of leadership influence is associated with higher safety culture when the priority of safety is high rather than low.

Data collected in this study was inconclusive to prove the quantitative research question. Conclusive data would have included a larger sample size and response rate including purposeful sample size having organizational accidents in the past, but not presently. One participant in a geographically diverse group cannot obtain a level of specificity to answer the question.

Implications for Policy and Practice

Study implications for policy and practice centered on two constituencies: the CNATO and its industry groups, and federal regulators. Results contained within this study suggest actionable steps that effect safety culture. Focused interaction between researchers and industry influencers allow open a dialog about how data is captured, shared, and disseminated. All CNATOs need to participate in the process if any hope exists in creating a near accident free environment. Regulation alone rarely modifies behavior, but industry leaders and groups can convince CNATOs widespread cooperation is in everyone's best interest.

Commercial safety auditor involvement. Aviation has long relied upon outside agencies to assess and advise CNATOs. Agencies such as ARGUS International, Wyvern, or IS-BAO commonly certify CNATOs through a safety audit. Each of these providers use various safety criterion for certification. A unified, universal, industry recognized measurement tool is necessary to provide researchers and regulators an opportunity to benchmark the industry.

Anonymous data sets submitted for honest and thoughtful review would help all CNATOs in developing best practices and pre-organizational accident prevention identification. Disparate nature of current data does not allow CNATOs to effectively predict at-risk organizations. Airlines realized this flaw early on and collectively solved the issue. Safety auditors have a professional responsibility to promote unification of safety measurement tools.

Impartial safety collection practices. Non-profit industry groups have attempted to address data collection concerns. Air Charter Safety Foundation created a voluntary reporting system called Aviation Safety Action Program (ASAP). Presently, there are only 40 participants in the program and data is not available to non-members. These small-scale efforts have limited ability to impact safety. This same type system should be expanded to include all CNATOs and made mandatory. NASA already collects massive amounts of voluntary data through existing programs and would be well suited to serve as an impartial conduit for information of this nature. Status quo will not change without industry leaders calling for unification of data collection and developing solutions. Airline safety leaders realized this early in the process and a cue from their example may be effective in convincing CNATO leaders to adopt similar voluntary safety practices and reporting.

Highly regulatory CNATO operating environments make voluntary reporting programs operated by government officials unlikely. Industry groups serve as a likely conduit to broker a mandatory program accepted by CNATO leaders. Some private safety consultants hold monthly calls to allow safety officers a forum to hear others challenges and solutions. This should happen on a broader scale to include the entire CNATO population. Voluntary programs are effective, but psychology proves participants in those programs already value safety and strive to improve. These operators are not the ones at greatest risk. Inclusion of all CNATOs, and especially those who score below average through a common assessment tool such as SCISMS would benefit future study outcomes. Professionalism and accountability mentioned earlier in this study continue to play an active role in determining safety culture development. It is incumbent upon every CNATO, potentially through industry groups, to hold every operator accountable to professional standards that includes constant evaluation for at-risk safety behaviors including variables discussed in this study.

FAA policy development. Extensive safety culture development practices developed jointly by airlines, regulators, and the NTSB have nearly eliminated air carrier organizational accidents (Logan, 2008). This same level of stakeholder scrutiny does not currently apply to CNATOs. Studies such as this one help to identify factors involved in identifying numerous challenges preventing safety culture inculcation. One clear point gained from this study revolved around SMS usage and effectiveness. The mere presence of a SMS does not reduce the risk of organizational accidents. How it is used and which party developed a SMS program further complicates effectiveness. Many other factors comprise an effective SMS and detailed instrumentation addressing overall effectiveness did not appear within this study. Because the FAA is directly responsible for flying public safety, policies should be developed addressing CNATO safety inculcation.

Extensive paperwork is required of every CNATO during certification, including a full SMS plan and demonstration. This review and evaluation occurs prior to the first passenger flight. Very rarely does the FAA review safety programs once an operator obtains certification. They require pilot skills be reviewed every six months, aircraft maintenance standards upheld, and a myriad of other checks, but safety is only addressed post organizational accident. Policies that periodically measure safety culture as a part of the Principal Operations Inspector (POI) routine evaluation address current gaps in regulatory oversight. POIs are FAA FSDO employees directly responsible for oversight of each CNATO. Current POI staffing levels make it impractical for routine inspections outside spot-checks or crisis response. Simply conducting an open conversation between CNATOs and POIs about how a safety program is evolving after real-life application could help establish best practice. Properly staffing these positions and adding routine assessment of safety culture elements would begin to mark a worthy and significant policy change.

A change in FAA policy to include a standardized instrument such as the SCISMS to measure safety culture against averages would serve as a good start in identifying where POI best resource allocation to avoid an organizational accident occurs.

Recommendations for Future Research

As evidenced by the study literature review, CNATOs received little research focus. Safety inculcation and development of safety culture directly effects aviation accident prevention. At some point, the FAA will modify regulations to include mandatory safety program usage in CNATOs. Understanding how airlines succeeded and adapting best practices to unique idiosyncrasies of CNATOs provide a blueprint to successful implementation. The following ideas for future research could assist that transition.

- A study to repeat methods used and adjust inclusion criterion to a purposeful method including CNATOs with identified organizational accidents and compare those to safety culture best practice organizations.
- A study using these same CNATO participants and conduct a longitudinal research project to determine changes in scores over time and whether low scores identified here relate to higher accident risk.

- A study to examine to what extent leaders influence hiring practices and to what extent do characteristics of hires mirror that of the leader since CNATO employee exposure to organizational leadership is limited due to a unique work environment.
- A study further clarifying other academic research that examine variable relationships between SMS programs and overall safety culture effectiveness.
- A study to target bottom quartile SCISMS mean score participants within a FSRO for more qualitative details on why survey yielded lower than norm results and correlate whether organizational accident risk is higher.
- A study to examine a potential CNATO disconnect in safety culture as evidenced by below average SCISMS safety culture dimension scores describing dispatchers.

Summary

This study sought to find relationships, describe phenomenon, and seek to describe a population that does not get the academic attention it deserves. Quantitative methodology allowed an impartial statistical look into ordinal and interval variable values. Use of sequential transformative collection and analysis provided an opportunity to examine data individually for their trends outside a more rigid research question lens. Data collected during this study was interesting and valuable if for no other reason than having never been measured before. The stratified random cluster and systematic random sampling revealed sufficient participant pool for data diversity. While priori power analysis proved study sample size was sufficient, broader patterns may have emerged with a larger sample. Randomization of the sample size unexpectedly yielded a CNATO who suffered not one, but two organizational accidents; remarkable since CNATO accidents remain rare as percentage of overall aviation accidents. Analysis of data gathered for participant $P^3$1324, the only participant to experience an organizational accident, did yield a lower than norm score across all instruments. Findings suggest efficacy of safety measures determine the degree to which at-risk organization may be valid. Only further research using a longitudinal research study would determine whether mean scores truly relate to increased accidents. It is worth noting that a further qualitative field visit may have also reinforced mean score validation.

Instrumentation used during the study provided easy to understand and measurable data sets. After testing SCISMS in numerous ways throughout this process, it proved resilient in identifying participants consistently in the top and bottom quartiles. The stalwart MLQ Form 5x and its evaluation tools created easily obtained classification of leadership scales. Information is power and there remains no better source of information than aviation regulators and evaluators. Making accident data so accessible through ASAIS helped study data become meaningful in a larger context. Hopefully, data gathered through this process can be repurposed and evaluated by the five participants who requested a copy of this study. Expanding future studies to a larger sample size represents no harm to CNATOs and benefit the industry. Therefore, methods being sound, examination of each research question could occur based on observed results.

Finding descriptive commonalities among any group presents challenges and CNATOs were no different. Using 106 questions, the study sought to find similar leadership characteristics between 20 participants, but no pattern emerged. Transformational leadership was present in 16 of 20 participants and suggests CNATO commonality with this leadership characteristic. Early in the study, literature identified that transactional and transformational leadership types are prevalent in aviation. That stated fact proved valid through data collected. However, as measured against the nine leadership scales, no pattern emerged within either the sample size or strata. An extensive safety culture measurement attempted to find relationships among those who had organizational accidents and those who did not. None was found. Despite finding no relationship existed, data gathered showed CNATOs were ahead of airlines in understanding safety culture importance as shown by higher mean scores at the same stage. When complex safety system processes appeared, organizational accidents would be reduced. Participant data demonstrated that is not true. Data showed CNATOs used safety programs across all participants, eliminating any distinction indicating a relationship existed. CNATOs seem to understand an implemented safety system provided the first step in cementing organizational safety culture evidenced by high formal safety system mean scores. Finally, how do all these variables interact and was there a relationship between one or more variables. Again, nothing found to indicate a relationship. However, we know more detailed investigation beyond cursory variable analysis will be necessary to achieve a goal of CNATO safety culture inculcation.

The goal when embarking on an academic journey such as this was gathering data leading to a new and innovative finding. Structuring research questions focused on how leadership may impact aviation safety in a meaningful way led to many important answers. While the data did not support any quantitative measures which suggested leadership influence on safety at CNATOs, it did remind this researcher of the philosophical fallacy theory *post hoc ergo propter hoc*. Aviation serves as an example of a highly complex process where millions of factors determine either positive or negative outcomes. Remembering “after this, therefore because of this” underscored complex processes subjected to millions of operations may never be explained simply by a finite set of defined variables. Interaction between external and internal variables controlled by no one action created an accident. Even if study data concluded leadership did have an impact on safety, the argument would still be subject to inductive reasoning. Leadership may very well be an influencer to overall safety and perhaps the correct combination of variables were simply not examined by this study. Scientific study has proven statistical correlation does not imply causation. This realization underscored a study ancillary finding of causal relationships, especially in aviation contexts, may actually provide inconclusive evidence as to accident cause.

Despite the challenges of identifying accident precedents, our continued quest for knowledge serves as a motivator to find answers through scholarly investigation. Hopefully, building on this and previous studies may unlock a finding which breaks the highly complex code of CNATO accidents. The question is not how research questions could have been changed or clarified to get the expected result. In reality, the study did exactly what any good scientific study was intended to do – prove facts. CNATO safety continues to evolve and encouragement of academic research assisting forward movement must continue. The study identified a higher than industry average accident rate currently exists among CNATOs in comparison to scheduled carriers. Safety will remain a challenge until the industry embraces the professionalism and accountability required to address challenges. Continuing to investigate variable relationship is key to CNATOs reaching unprecedented safety levels currently achieved by airline operators.

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APPENDIX A

SCISMS Sample Questionnaire

Formal safety program

Reporting system

Please rate your airline's ***official*** *system for reporting safety issues and concerns.*

1. The safety reporting system is convenient and easy to use.
2. Pilots can report safety discrepancies without fear of negative repercussions.
3. Pilots are willing to report information regarding marginal performance or unsafe actions of other pilots.
4. Pilots don't bother reporting near misses or close calls since these events don't cause any real damage.
5. Pilots are willing to file reports about unsafe situations, even if the situation was caused by their own actions.

Response and feedback

These items refer to the response pilots receive from your airline's ***official*** *safety system.*

6. Safety issues raised by pilots are communicated regularly to all other pilots in this airline.
7. When a pilot reports a safety problem, it is corrected in a timely manner.
8. Pilots are satisfied with the way this airline deals with safety reports.
9. My airline only keeps track of major safety problems and overlooks routine ones.

Safety personnel (e.g., director of flight safety)

These items refer to the person or people in your airline who are formally designated as responsible for safety. (This does not include union representatives.)

10. Personnel responsible for safety hold a high status in the airline.
11. Personnel responsible for safety have the power to make changes.
12. Personnel responsible for safety have a clear understanding of the risks involved in flying the line.
13. Safety personnel have little or no authority compared to operations personnel.
14. Safety personnel demonstrate a consistent commitment to safety.

Informal Aspects of Safety

Accountability

These items refer to the ways in which pilots are treated based on their safe or unsafe behavior at your airline.

15. Airline management shows favoritism to certain pilots.
16. Standards of accountability are consistently applied to all pilots in this organization.
17. When pilots make a mistake or do something wrong, they are dealt with fairly by the airline.
18. When an accident or incident happens, management immediately blames the pilot.

Pilots' authority

These items refer to the extent to which pilots have the authority to provide input and make decisions regarding safety.

19. Pilots are seldom asked for input when airline procedures are developed or changed.
20. Pilots are actively involved in identifying and resolving safety concerns.

21. Pilots who call in sick or fatigued are scrutinized by the chief pilot or other management personnel.

22. Pilots have little real authority to make decisions that affect the safety of normal flight operations.

23. Management rarely questions a pilot's decision to delay a flight for a safety issue.

Professionalism

These items refer to the attitudes you perceive among your fellow pilots in regard to safety.

24. Pilots view the airline's safety record as their own and take pride in it.

25. Pilots who don't fly safely quickly develop a negative reputation among other pilots.

26. Pilots with less seniority are willing to speak up regarding flight safety issues.

27. Decisions made by senior pilots are difficult to challenge.

28. Pilots don't cut corners or compromise safety regardless of the operational pressures to do so.

Operations Personnel

Chief pilots

These items refer to the chief pilots with whom you interact regularly.

29. Chief pilots do not hesitate to contact line pilots to proactively discuss safety issues.

30. Chief pilots are unavailable when line pilots need help.

31. As long as there is no accident or incident, chief pilots don't care how flight operations are performed.

32. Chief pilots have a clear understanding of risks associated with flight operations.
33. Pilots often report safety concerns to their chief pilot rather than the safety department.

Dispatch

These items refer to your airline's dispatch procedures.

34. Dispatch consistently emphasizes information or details (e.g., weather requirements, NOTAMs) that affect flight safety.
35. Dispatch inappropriately uses the MEL (e.g., use when it would be better to fix equipment).
36. Dispatch is responsive to pilots' concerns about safety.
37. Dispatch would rather take a chance with safety than cancel a flight.

Instructors/trainers

These items refer to your airline's flight instructors or trainers.

38. Instructors/trainers have a clear understanding of risks associated with flight operations.
39. Safety is consistently emphasized during training at my airline.
40. Instructors/trainers teach shortcuts and ways to get around safety requirements.
41. Instructors/trainers prepare pilots for various safety situations, even uncommon or unlikely ones.

Organizational commitment

Safety values

These items refer to the value that your airline's upper level management places on safety.

42. Safety is a core value in my airline.
43. Management is more concerned with making money than being safe.

44. Management expects pilots to push for on-time performance, even if it means compromising safety.
45. Management doesn't show much concern for safety until there is an accident or incident.
46. Management does not cut corners where safety is concerned.

Safety fundamentals

These items refer to your airline's typical practices related to safety in various areas.

47. Checklists and procedures are easy to understand.
48. My airline's manuals are carefully kept up to date.
49. My airline is willing to invest money and effort to improve safety.
50. My airline is committed to equipping aircraft with up-to-date technology.
51. My airline ensures that maintenance on aircraft is adequately performed and that aircraft are safe to operate.

Going beyond compliance

These items refer to upper level management's commitment to meeting or exceeding safety requirements.

52. Management goes above and beyond regulatory minimums when it comes to issues of flight safety.
53. Management schedules pilots as much as legally possible, with little concern for pilots' sleep schedule or fatigue.
54. Management tries to get around safety requirements whenever they get a chance.
55. Management views regulation violations very seriously, even when they don't result in any serious damage.

APPENDIX B

Data Collection Timeline

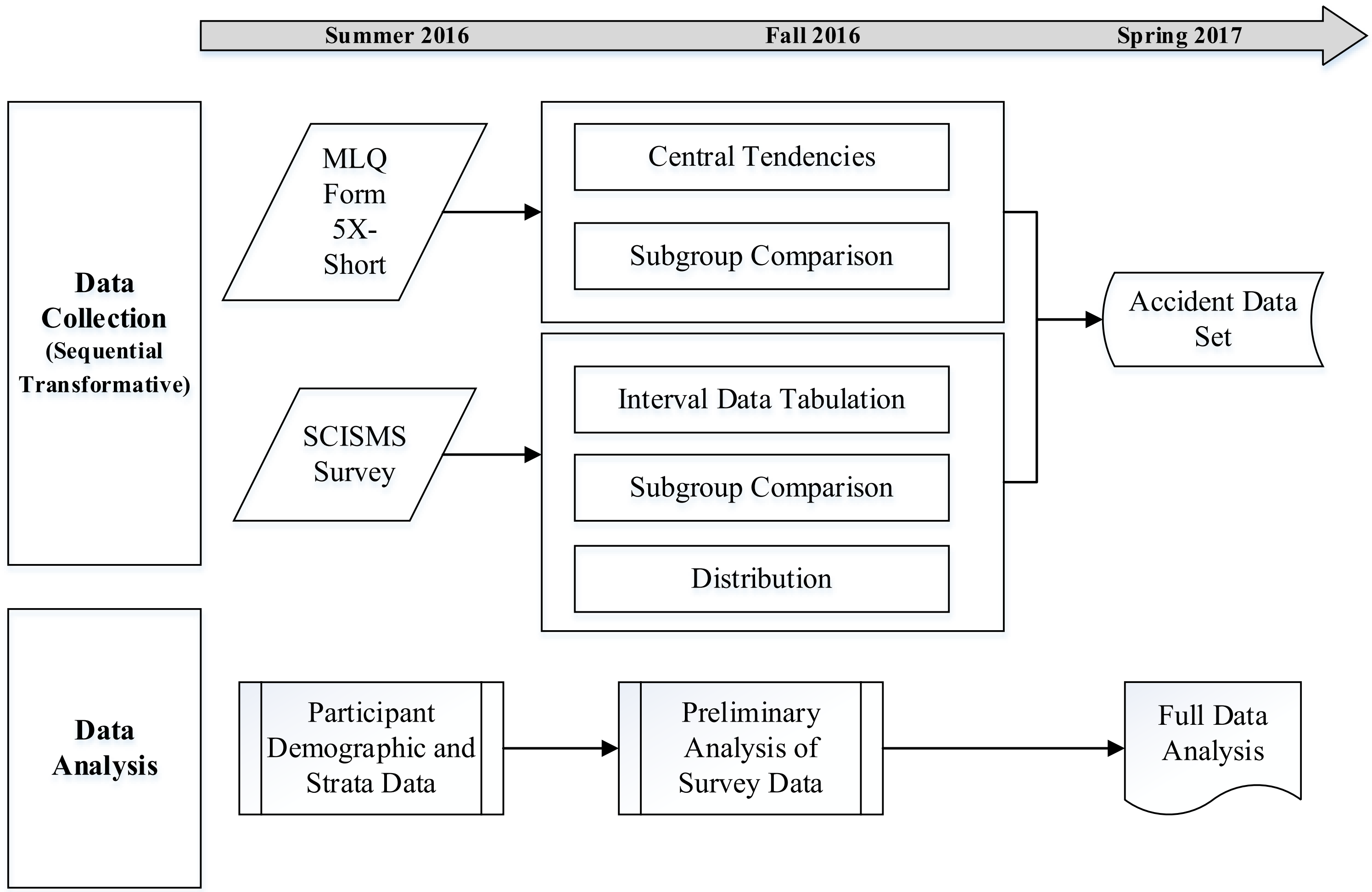

Figure B1. Data collection timeline.

APPENDIX C

Participant Email Solicitation

The subject line of the email will clearly state that it is an advertisement for a research study, such as: "Seeking participants for an important aviation safety research study"

Dear [CNATO PARTICIPANT],

You are receiving this email because you and your organization have been randomly selected as a Part 135 operator meeting specific study inclusion criterion. Your email address was obtained from the FAA Aviation Data Systems Branch Part 135 “active air operator” database.

The study seeks to investigate intervening variables that lead to organizational accidents in Part 135 Air Carriers. Using the data collected, various theoretical frameworks will be used to measure the relationship between an existence of strong safety culture and organizational accidents. Participants will take part in an online survey delivered via a secure and anonymous Pepperdine University survey platform. Your participation will assist in advancing the understanding of aviation safety within organizational contexts.

I would greatly appreciate your participation by clicking on the following link to proceed to the anonymous online survey: [INSERT QUALTRICS LINK HERE]

Thank you,

[COMPLETE CONTACT INFORMATION SIGNATURE]

APPENDIX D

Informed Consent

PEPPERDINE UNIVERSITY

INFORMED CONSENT FOR PARTICIPATION IN RESEARCH ACTIVITIES

SAFETY CULTURE INCULCATION IN CERTIFIED NON-SCHEDULED AIR TAXI OPERATORS: ASSESSING THE PROBABILTY OF ORGANIZATIONAL ACCIDENTS USING MULTIVARIATE FACTORS

You are invited to participate in a research study conducted by Stephen Birch, under the direction of Dr. Eric Hamilton, at Pepperdine University, because you are over the age of 18, a member of a Certified Non-Scheduled Air Taxi Operator (CNATO), and have operational responsibility at your respective company to significantly influence safety activities.

Your participation is voluntary. You should read the information below, and ask questions about anything that you do not understand before deciding whether to participate. Please take as much time as you need to read the consent form. You may also decide to discuss participation with your family or friends.
If you choose to participate, please select AGREE. By selecting AGREE, you are indicating that you freely and voluntarily are participating in this study. Completion of the survey is considered to be giving full consent. It is recommended that you print a copy of this consent page for your records before you begin the study.

PURPOSE OF THE STUDY

The study aims to address the gap in knowledge as to whether inculcation of a safety culture in CNATOs has an effect on organizational accidents. The study will (a) examine the way leadership introduces and reinforces safety culture within an organization (b) how the safety culture is implemented by followers, (c) discover investigate the types of artifacts used by the aircraft operator to provide reinforcement of established safety processes, and (d) determine the extent to which safety culture has an effect on overall safety results.

STUDY PROCEDURES

This online research study will involve completion of an online questionnaire. The questionnaire will ask for general perceptions and personal opinions and reflections regarding leadership and safety experiences in your organization. You may skip any questions that you do not wish to answer. Participants will be expected to complete the questionnaire only once. It should take you about thirty (30) minutes to complete.

POTENTIAL RISKS AND DISCOMFORTS

The potential and foreseeable risks associated with participation in this study do not exceed risks associated with day-to-day activities. Potential risks subjects may be exposed to include fatigue, boredom, or feeling uncomfortable with certain questions. Other risks may include disclosures of internal policies and procedures in reference to participant’s role at their relative place of employment, which may impact their relationship with their employer.

POTENTIAL BENEFITS TO PARTICIPANTS AND/OR TO SOCIETY

While there are no direct benefits to the study participants, there are several anticipated benefits to society by contributing to the current gap in literature.

CONFIDENTIALITY

I will keep your records for this study confidential, as far as permitted by law. However, if I am required to do so by law, I may be required to disclose information collected about you. Examples of the types of issues that would require me to break confidentiality are if you tell me about instances of child abuse and elder abuse. Pepperdine's University's Human Subjects Protection Program (HSPP) may also access the data collected. The HSPP occasionally reviews and monitors research studies to protect the rights and welfare of research subjects.

Any identifiable information obtained in connection with this study will remain confidential. Audio recordings from the interview will be immediately transcribed, and all recordings will be destroyed. Your responses will be coded with a pseudonym and transcript data will be maintained separately. Any reference made to you, or respective institution will be redacted from the transcripts. Upon completion of each transcript, the associated audio file will be immediately destroyed. The transcribed data will be stored on a password protected computer in the principal investigators place of residency. The transcribed file will not be named, to ensure additional confidentiality. All records, handwritten and electronic, will be stored in a secure file cabinet in a locked office, in the principal researcher's home. The data will be stored for a minimum of three years, after which the data will be destroyed. Reporting of the data will be done in aggregate. Participants will be provided a copy of the formal report, upon completion of the study.

PARTICIPATION AND WITHDRAWAL

Your participation is voluntary. Your refusal to participate will involve no penalty or loss of benefits to which you are otherwise entitled. You may withdraw your consent at any time and discontinue participation without penalty. You are not waiving any legal claims, rights or remedies because of your participation in this research study.

ALTERNATIVES TO FULL PARTICIPATION

The alternative to participation in the study is not participating or completing only the items which you feel comfortable.

INVESTIGATOR'S CONTACT INFORMATION

I understand that the investigator is willing to answer any inquiries I may have concerning the research herein described. I understand that I may contact Dr. Eric Hamilton at eric.hamilton@pepperdine.edu if I have any other questions or concerns about this research.

RIGHTS OF RESEARCH PARTICIPANT – IRB CONTACT INFORMATION

If you have questions, concerns or complaints about your rights as a research participant or research in general please contact Dr. Judy Ho, Chairperson of the Graduate & Professional Schools Institutional Review Board at Pepperdine University 6100 Center Drive Suite 500, Los Angeles, CA 90045, 310-568-5753 or gpsirb@pepperdine.edu.

APPENDIX E

IRB Exempt Study Approval

PEPPERDINE

Pepperdine University
24255 Pacific Coast Highway
Malibu, CA 90263
TEL: 310-506-4000

NOTICE OF APPROVAL FOR HUMAN RESEARCH

Date: October 06, 2016

Protocol Investigator Name: Stephen Birch

Protocol #: 15-10-072

Project Title: Inculcation of Safety Culture in General Aviation Charter Operators: Assessing the Probability of Organizational Accidents Using Multivariate Factors

School: Graduate School of Education and Psychology

Dear Stephen Birch:

Thank you for submitting your application for exempt review to Pepperdine University's Institutional Review Board (IRB). We appreciate the work you have done on your proposal. The IRB has reviewed your submitted IRB application and all ancillary materials. Upon review, the IRB has determined that the above entitled project meets the requirements for exemption under the federal regulations 45 CFR 46.101 that govern the protections of human subjects.

Your research must be conducted according to the proposal that was submitted to the IRB. If changes to the approved protocol occur, a revised protocol must be reviewed and approved by the IRB before implementation. For any proposed changes in your research protocol, please submit an amendment to the IRB. Since your study falls under exemption, there is no requirement for continuing IRB review of your project. Please be aware that changes to your protocol may prevent the research from qualifying for exemption from 45 CFR 46.101 and require submission of a new IRB application or other materials to the IRB.

A goal of the IRB is to prevent negative occurrences during any research study. However, despite the best intent, unforeseen circumstances or events may arise during the research. If an unexpected situation or adverse event happens during your investigation, please notify the IRB as soon as possible. We will ask for a complete written explanation of the event and your written response. Other actions also may be required depending on the nature of the event. Details regarding the timeframe in which adverse events must be reported to the IRB and documenting the adverse event can be found in the *Pepperdine University Protection of Human Participants in Research: Policies and Procedures Manual* at community.pepperdine.edu/irb.

Please refer to the protocol number denoted above in all communication or correspondence related to your application and this approval. Should you have additional questions or require clarification of the contents of this letter, please contact the IRB Office. On behalf of the IRB, I wish you success in this scholarly pursuit.

Sincerely,

Judy Ho, Ph.D., IRB Chair

cc: Dr. Lee Kats, Vice Provost for Research and Strategic Initiatives

Page: 1

APPENDIX F

Mind Garden MLQ 5X Survey Copyright Approval

mind garden

www.mindgarden.com

To whom it may concern,

This letter is to grant permission for the above named person to use the following copyright material for his/her research:

Instrument: ***Multifactor Leadership Questionnaire***

Authors: ***Bruce Avolio and Bernard Bass***

Copyright: ***1995 by Bruce Avolio and Bernard Bass***

Five sample items from this instrument may be reproduced for inclusion in a proposal, thesis, or dissertation.

The entire instrument may not be included or reproduced at any time in any published material.

Sincerely,

Robert Most
Mind Garden, Inc.
www.mindgarden.com

APPENDIX G

Raw SCISMS Survey Results

Table G1

SCISMS Formal Safety System Participant Reponses

	Formal Safety System (FS)													
	Reporting System - Q5.2					Response and Feedback - Q5.3				Safety Personnel - Q5.4				
Participant	1	2	3	4	5	1	2	3	4	1	2	3	4	5
P[1]1009	1	1	2	6	3	1	1	1	7	1	2	1	6	2
P[1]1015	2	1	2	4	3	3	2	2	5	1	1	1	6	1
P[1]143	3	1	2	6	2	2	2	2	6	2	2	2	6	2
P[1]371	2	2	3	3	5	2	2	3	6	3	3	2	5	3
P[1]399	1	1	1	6	1	1	3	3	7	1	1	1	7	2
P[1]482	2	1	2	4	3	3	2	2	5	1	1	1	6	1
P[1]577	3	1	2	6	2	2	2	2	6	2	2	2	6	2
P[1]750	1	1	2	7	2	1	1	2	6	1	1	1	7	1
P[1]784	3	1	2	6	2	1	2	2	5	2	2	2	6	2
P[1]921	2	1	3	6	2	1	1	2	7	2	1	1	7	1
P[3]1098	3	1	2	6	2	1	2	2	5	2	2	2	6	2
P[3]1112	1	1	2	6	3	1	1	1	7	1	2	1	6	2
P[3]1218	2	2	3	3	5	2	2	3	6	3	3	2	5	3
P[3]1158	1	1	1	6	1	1	3	3	7	1	1	1	7	2
P[3]1294	1	1	2	6	2	1	2	1	6	1	2	1	6	1
P[3]1303	3	2	4	4	4	3	2	3	5	2	2	2	6	2
P[3]1324	3	2	4	4	4	3	2	3	5	2	2	2	6	2
P[3]1326	1	1	2	7	2	1	1	2	6	1	1	1	7	1
P[5]1802	1	1	2	6	2	1	2	1	6	1	2	1	6	1
P[5]1936	2	1	3	6	2	1	1	2	7	2	1	1	7	1

Table G2

SCISMS Informational Safety System Participant Reponses

	Informational Safety Systems (IS)													
	Accountability - Q5.5				Pilot's Authority - Q5.6					Professionalism – Q5.7				
Participant	1	2	3	4	1	2	3	4	5	1	2	3	4	5
P[1]1009	6	7	7	7	6	7	7	7	7	6	6	7	6	7
P[1]1015	4	6	7	6	7	7	7	7	7	7	6	6	3	6
P[1]143	6	6	6	6	6	6	6	6	6	6	6	6	6	6
P[1]371	6	5	5	6	5	5	6	5	3	4	5	2	7	5
P[1]399	5	7	6	6	6	7	6	2	7	7	6	7	5	4
P[1]482	4	6	7	6	7	7	7	7	7	7	6	6	3	6
P[1]577	6	6	6	6	6	6	6	6	6	6	6	6	6	6
P[1]750	7	7	7	7	7	7	7	7	7	6	6	7	7	6
P[1]784	6	6	7	5	6	6	6	6	7	6	5	6	5	4
P[1]921	3	6	5	5	6	6	7	6	6	5	6	5	3	6
P[3]1098	6	6	7	5	6	6	6	6	7	6	5	6	5	4
P[3]1112	6	7	7	7	6	7	7	7	7	6	6	7	6	7
P[3]1158	3	7	6	6	6	7	6	2	7	7	6	7	5	4
P[3]1158	2	3	5	6	5	5	6	5	3	4	5	2	1	6
P[3]1294	7	7	7	6	7	7	6	7	7	7	7	7	2	7
P[3]1303	7	6	6	5	7	6	6	6	7	4	6	7	4	6
P[3]1324	3	4	4	5	5	3	2	5	2	4	6	6	6	6
P[3]1326	7	7	7	7	7	7	7	7	7	6	6	7	7	6
P[5]1802	7	7	7	6	7	7	6	7	7	7	7	7	6	6
P[5]1936	3	6	5	5	6	6	7	6	6	5	6	5	3	6

Table G3

SCISMS Operations Interaction Participant Reponses

	Operations Interaction (OI)												
	Chief Pilots - Q5.8					Dispatch - Q5.9				Instructors - Q5.10			
Participant	1	2	3	4	5	1	2	3	4	1	2	3	4
P[1]1009	6	6	7	7	4	7	7	7	7	6	7	7	7
P[1]1015	7	5	7	7	5	4	4	4	4	6	7	7	6
P[1]143						6	6	6	6	6	6	7	6
P[1]371	3	6	6	6	6	3	6	5	5	6	6	6	6
P[1]399	7	5	6	7	4	4	4	6	5	7	6	6	6
P[1]482	7	5	7	7	5	4	4	4	4	6	7	7	6
P[1]577	7	6	6	7	5	6	6	6	6	6	6	7	6
P[1]750	1	6	7	7	5	6	7	7	7	7	7	7	6
P[1]784	6	6	6	6	5	3	6	6	6	6	6	7	5
P[1]921	6	6	7	7	5	6	5	6	6	6	7	6	5
P[3]1098						3	6	6	6	6	6	7	5
P[3]1112	6	6	7	7	4	7	7	7	7	6	7	7	7
P[3]1158	8			8	8	4	4	6	5	7	6	6	6
P[3]1158	3	6	6	6	6	3	6	5	5	6	6	6	6
P[3]1294	7	7	6	7	5	7	7	6	6	7	6	6	7
P[3]1303	6	7	6	6	4	6	5	6	6	6	6	7	6
P[3]1324						3	6	4	4	6	6	7	6
P[3]1326	1	6	7	7	5	6	7	7	7	7	7	7	6
P[5]1802	7	7	6	7	5	7	7	6	6	7	6	6	7
P[5]1936	6	6	7	7	5	6	5	6	6	6	7	6	5

Table G4

SCISMS Organizational Commitment Participant Reponses

	Organizational Commitment (OC)													
	Organizational Commitment – Q5.11					Safety Fundamentals – Q5.12					Management Commitment – Q13			
Participant	1	2	3	4	5	1	2	3	4	5	1	2	3	4
P[1]1009	7	7	7	7	4	7	7	7	6	7				
P[1]1015	7	6	6	6	5	6	5	6	7	7				
P[1]143	6	7	7	7	8	6	6	6	6	6	6	5	6	6
P[1]371	5	6	6	6	6	5	5	5	6	6	5	6	6	5
P[1]399	7	6	6	6	4	7	5	7	7	7	7	4	6	7
P[1]482	7	6	6	6	5	6	5	6	7	7				

(continued)

Organizational Commitment (OC)

	Organizational Commitment – Q5.11					Safety Fundamentals – Q5.12					Management Commitment – Q13			
Participant	1	2	3	4	5	1	2	3	4	5	1	2	3	4
P^{1}577	6	7	7	7	5	6	6	6	6	6	6	5	6	6
P^{1}750	7	7	6	7	5	7	7	6	6	7	6	6	7	7
P^{1}784	6	7	7	7	5	5	5	6	6	6	6	3	7	6
P^{1}921	7	7	7	7	5	6	6	6	5	6	6	6	6	7
P^{3}1098	6	7	7	7	7	5	5	6	6	6	6	3	7	6
P^{3}1112	7	7	7	7	4	7	7	7	6	7				
P^{3}1158	7	6	6	6	7	7	5	7	7	7	7	4	6	7
P^{3}1158	5	6	6	6	6	5	5	5	6	6	5	6	6	5
P^{3}1294	7	7	6	7	5	7	7	6	7	7	7	7	7	7
P^{3}1303	7	6	6	7	6	6	7	6	6	6	7	6	7	6
P^{3}1324	6	6	6	7	7	4	6	6	4	7	6	3	7	6
P^{3}1326	7	7	6	7	5	7	7	6	6	7	6	6	7	7
P^{5}1802	7	7	6	7	5	7	7	6	7	7	7	7	7	7
P^{5}1936	7	7	7	7	5	6	6	6	5	6	6	6	6	7