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Safety Culture In Collegiate Aviation: A Cross-Sectional Analysis Between Multiple Universities

Robert Foster

SAFETY CULTURE IN COLLEGIATE AVIATION: A CROSS-SECTIONAL ANALYSIS BETWEEN MULTIPLE UNIVERSITIES

by

Robert Anthony Foster
Bachelor of Science, University of Dubuque, 2010
Master of Aeronautical Science, Embry-Riddle Aeronautical University, 2013
Doctor of Philosophy, University of North Dakota, 2020

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Name: Robert Anthony Foster

Degree: Doctor of Philosophy

This document, submitted in partial fulfillment of the requirements for the degree from the University of North Dakota, has been read by the Faculty Advisory Committee under whom the work has been done and is hereby approved.

DocuSigned by:
DANIEL KWASI ADJEKUM
649F650F80024AA...
Daniel Kwasi Adjekum, Ph.D., Chairperson

DocuSigned by:
0AC0753522AE45C...
Mark Dusenbury, Ph.D.

DocuSigned by:
0BCA0DEB9744497...
James Higgins, Ph.D.

DocuSigned by:
Richard Ferraro
1F0DCCE89ECF416...
Richard Ferraro, Ph.D.

This document is being submitted by the appointed advisory committee as having met all the requirements of the School of Graduate Studies at the University of North Dakota and is hereby approved.

DocuSigned by:
Chris Nelson
2E0AF088C733403...
Chris Nelson
Dean of the School of Graduate Studies

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Date

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Robert Anthony Foster

December 3rd, 2020

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LIST OF ACRONYMS

AABI – Aviation Accreditation Board International

AMOS - IBM® SPSS® AMOS Version 26 SEM Software Package

ATC – Air Traffic Control

CAPSCAS - Collegiate Aviation Program Safety Culture Assessment Survey

CFI – Comparative Fit Index

CFI – Certified Flight Instructor

CFR – Code of Federal Regulations

CMIN – Minimum Discrepancy or Model Chi-Square

CMT – Certificate Management Team

DCT - Data Collection Tools

DMU – Decision Making Unit

FAA – Federal Aviation Administration

GA – General Aviation

GFI – Goodness of Fit Index

IBAC – International Business Aviation Council

ICAO – International Civil Aviation Organization

IFI – Incremental Fit Index

IS-BAO – International Standard for Business Aircraft Operations

IST - Implementation Support Team

MI – Modification Indices

ML – Maximum Likelihood Estimation

NBAA – National Business Aviation Association

NFI – Normed Fit Index

NTSB – National Transportation and Safety Board

PA – Path Analysis

PTRS - Program Tracking and Reporting Subsystem

RMSEA – Root Mean Square Error of Approximation

SA - Safety Assurance

SARPs - Standards and Recommended Practices

SAS - Safety Assurance System

SEM – Structural Equation Modeling

SCB – Safety Compliance Behavior

SME – Subject Matter Experts

SMot – Safety Motivation

SMS – Safety Management Systems

SMSPO – Safety Management System Program Office

SMSPol – SMS Policy Implementation

SMSProc – SMS Process Engagement

SPB – Safety Participation Behavior

SPSS – Statistical Package for the Social Sciences

SRA – Safety Risk Assessment

SRM – Safety Risk Management

TLI – Tucker Lewis Index

UAA – University Aviation Association

UAS – Unmanned Aircraft System

VPP - Validation Project Plan

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To my wife and daughter,

I love you both.

ABSTRACT

A concurrent-embedded mixed method was used to evaluate observed outcomes of safety culture among multiple collegiate aviation programs in the U.S. A hypothesized model that measures the relationships between scales of safety management systems (SMS), safety motivation (mediator), and safety behaviors (safety compliance, safety reporting, and safety participation) was assessed using structural equation modeling/path analysis (SEM/PA). Demographic differences in safety culture were also evaluated. Semi-structured interviews were used further to understand the impacts of SMS on safety culture. Findings suggest significant predictive relationships between SMS and observed safety culture outcomes. There was also a significant mediation role of safety motivation between SMS and some observed safety culture outcomes. An emergent theme from the interviews suggests that flight instructors play a crucial formative role in sustaining a positive safety culture in collegiate aviation programs. Implications for policy and practices in collegiate aviation safety culture and recommendations for future research are highlighted.

CHAPTER I

INTRODUCTION

Safety Management Systems (SMS) are becoming ubiquitous within the aviation industry. The FAA (2015) recently mandated SMS for part 121 carriers (i.e. airlines). There are initiatives throughout the aviation industry to continue the expanse of SMS to include part 135 carriers (NTSB, n.d.) and allow general aviation (GA) organizations participate in SMS through a Federal Aviation Administration (FAA) voluntary program referred to as Safety Management System Voluntary Program (SMSVP) (FAA, n.d.-a).

A driving force behind SMS implementation is the pursuit of improved safety. GA accident rates have seen an uptick in recent years. The NTSB (2019) reported increased GA accident rates between 2017 and 2018 from 331 to 381 accidents, respectively. This resulted in an increased fatal accident rate in GA of 1.029 fatal accidents per 100,000 flight hours in 2018, up from the 0.935 fatal accidents per 100,000 hours in 2017 (NTSB, 2019). Scheduled part 121 carriers continue to see stellar safety performance with 27 accidents and only one fatality in 2018 (NTSB, 2019). The one fatality resulted from an engine failure that damaged a passenger window, ultimately resulting in fatal injuries to one passenger (NTSB, 2018). This results in a fatal accident rate for scheduled 121 carriers of 0.005 fatal accidents per 100,000 hours (NTSB, 2019). There is room for improvement for GA based on these statistics.

Stolzer et al. (2016) suggest that the term "safety culture" originated in 1986 with the Chernobyl nuclear accident. Safety culture has been studied as to its relationship to safety management and organization accident rates for many years (Booth & Lee, 1995). Moreover, safety culture has been studied in multiple settings, including energy (García-Herrero et al., 2013), healthcare (Groves et al., 2011), and aviation (Adjekum, 2014, 2017; Liao, 2015). The link between safety culture and SMS implementation has received more recent attention (Adjekum, 2014, 2017; Robertson, 2016) and requires further research.

Background

Safety culture in collegiate aviation faces some unique challenges and is often how aspiring aviators enter into the aviation industry. Ensuring proper education on safety culture and immersing these aspiring aviators in a positive safety culture will positively affect their future endeavors. This is based on the notion that time has a strong influence on safety culture (Robertson, 2016).

Certain desirable cultures can permeate throughout an organization: informed, flexible, reporting, learning, and just (Stolzer et al., 2016). These cultures contribute to an overall positive influence on the organization. Conversely, there are undesirable cultural states. These include secretive and blame cultures (Patankar & Sabin, 2010). These cultural states are counterproductive to achieving a desirable organizational culture by suppressing information and not seeking solutions to prevent future incidents.

There is also a distinction to be made between safety culture and safety climate. While these terms are related, there are some subtle differences in the research literature. Mearns and Flin (1999) distinguish that safety climate is more of a "snapshot" of

prevailing perceptions, attitudes, and beliefs, while safety culture is more of an enduring trait reflecting values, norms, assumptions, and expectations. One of the distinguishing factors between climate and culture is time. Climate can be considered to be smaller in scope in that it is a "snapshot." Culture is looking at a broader context and the prevailing culture that endures over a more extended period.

An area of research involving safety culture is that of the relationship between safety culture and SMS implementation (Gill & Shergill, 2004; McDonald et al., 2000; Remawi et al., 2011a). Given the initiative to implement SMS, it is critical to evaluate any potential impacts on the organization—especially safety culture. While administrations such as the FAA (2015a) and International Civil Aviation Organization (ICAO) (2009) consider safety culture to be an integral component of SMS, these relationships need to be researched and validated.

Past research on safety culture in collegiate aviation has investigated the relationship between SMS implementation and safety culture (Adjekum, 2014, 2017; Robertson, 2016). Robertson (2016) investigated different approaches to developing and implementing an SMS, different approaches to assessing safety culture, and the relationship between elements/processes of an SMS and strong safety culture. This research was entirely qualitative in its design, and it was suggested to develop quantitative studies to investigate the findings in parallel to the qualitative components.

Adjekum (2014, 2017) has utilized quantitative designs to research safety culture in collegiate aviation. The quantitative analysis was conducted via the Collegiate Aviation Program Safety Culture Assessment Survey (CAPSCAS). This tool was developed and validated by Adjekum (2014, 2017). However, this analysis has only been

performed at one collegiate aviation institution. There is a need to perform this same analysis at other collegiate aviation institutions to add to the instrument's validity and improve the generalizability of the findings.

Problem Statement

Research into the mechanisms behind SMS implementation related to safety culture perceptions in collegiate aviation is beginning, and more research is needed. Since collegiate aviation is considered a subset of GA and GA has been shown to have higher rates of accidents than scheduled 14 CFR 121 carriers (NTSB, 2019), continued research to improve GA's safety is warranted.

Past research into safety culture perceptions in collegiate aviation has been limited to a single university (Adjekum, 2014, 2017). There is a need to perform similar research across multiple universities to further validate previous research findings and provide more generalizability. While SMS is not a requirement for collegiate aviation, it is possible the make it a requirement at some point in the future. Given that, some universities have already pursued SMS preemptively (Pinholster, 2019).

Prior research has not addressed different types of SMS [i.e., FAA SMSVP versus International Business Aviation Council (IBAC) IS-BAO]. An investigation into whether there is a difference in the type of SMS program pursued by a given institution will have a differing effect on safety culture perceptions that have not been addressed. An investigation into any potential differing effects may help collegiate aviation institutions navigate which direction they would pursue SMS.

The findings from Adjekum (2014, 2016, 2017) found effects of year group and nationality on safety culture perceptions. Again, that research was performed at a single

collegiate aviation institution. Research that has been performed across multiple universities was strictly quantitative and did not utilize a mixed-method approach (Adjekum et al., 2015, 2016). The need to test those findings across multiple universities is warranted for generalizability purposes. This will serve other universities when developing their SMS and accommodating international students in a collegiate aviation program.

Purpose of the Study

The purpose of this proposed research is to explore safety culture perceptions in collegiate aviation further. Previous research on this topic studied safety culture perceptions at one university (Adjekum, 2014, 2017). This proposed research will aim to study safety culture perceptions across multiple universities with varying levels and types of safety management system (SMS) implementation. It is expected that there may be differences in safety culture perceptions between universities as well as differences based on varying levels of SMS and types of SMS programs.

The Federal Aviation Administration (FAA) has provided guidance for aviation practitioners to adopt SMS components on a voluntary basis even though it is not required by regulation (FAA, n.d.-b). Collegiate aviation programs may pursue this option if they desire SMS programs and would progress through three different stages: active applicant, active participant, and active conformance. Additionally, some collegiate aviation programs have pursued alternative means of SMS compliance through the International Standard for Business Aircraft Operations (IS-BAO) (NBAA, 2017; Pinholster, 2019). Both systems adhere to an SMS standard associated with either the FAA or IBAC.

Additionally, this proposed research will continue studying the variation of national culture has on safety culture perceptions (Adjekum, 2014, 2017). By examining multiple universities, this will allow for a more robust data set to improve any findings' validity and reliability. This also provides insight into whether variations of safety culture perceptions based on national culture are unique to specific organizations or if this variation in perception is experienced in multiple organizations with diverse students.

Variations based on SMS implementation and nationality will be evaluated based on their perceptions of safety behavior. Safety behavior has been used as an outcome variable in multiple studies and is often comprised of two components: safety participation and safety compliance (Adjekum, 2017; Chen & Chen, 2014; Neal & Griffin, 2006). In addition to the two traditional components of safety behavior, a safety reporting behavior scale will be included based on the CAPSCAS (Adjekum et al., 2015, 2016). Perceptions on these three outcome variables will be assessed to determine any variation based on SMS implementation and nationality.

Previous research and findings have suggested a difference in safety culture perception based on the year group (Adjekum, 2014). The qualitative component of this research will aim to address this finding. The goal will be to explore some of the reasons for such a lag with the ultimate goal of findings ways to expedite or accelerate an improved safety culture perception. Collegiate aviation faces some unique challenges concerning safety culture: limited tenure of students and psychological factors leading to increased risk-taking (Reason, 2008). Further exploration into these factors should provide results that could help collegiate aviation programs foster a favorable safety culture perception earlier on in students' tenure.

Research Questions

The quantitative portion of this study will investigate similar questions as past research (Adjekum, 2017), but at multiple universities. Additionally, by broadening the sample, new opportunities are present. By studying multiple collegiate aviation programs, the opportunity to investigate the potential varying effects of SMS implementation level and type of SMS is presented. Given the continuation of past research utilizing a broader sample, research questions include:

1. What are the strengths of the relationship between SMS process engagement, SMS policy implementation, safety motivation, and the outcome variables safety behavior measured by safety compliance and safety participation and safety reporting behavior across multiple collegiate aviation programs?
2. What are the differences in perceptions among the demographic variables (year group, international student status, SMS status, and flight certification) on safety behavior and safety reporting behavior across multiple universities?
3. Why are there variations in safety culture perceptions based on demographic criteria?

The qualitative portion of this study will build upon past findings (Adjekum, 2017) to explore some of the mechanisms behind why phenomena such as year group have on safety culture perception. This qualitative analysis will be performed utilizing a semi-structured interview based on three primary themes: safety culture and time, SMS implementation, and safety promotion and communication. The semi-structured interview outline can be found in Appendix A.

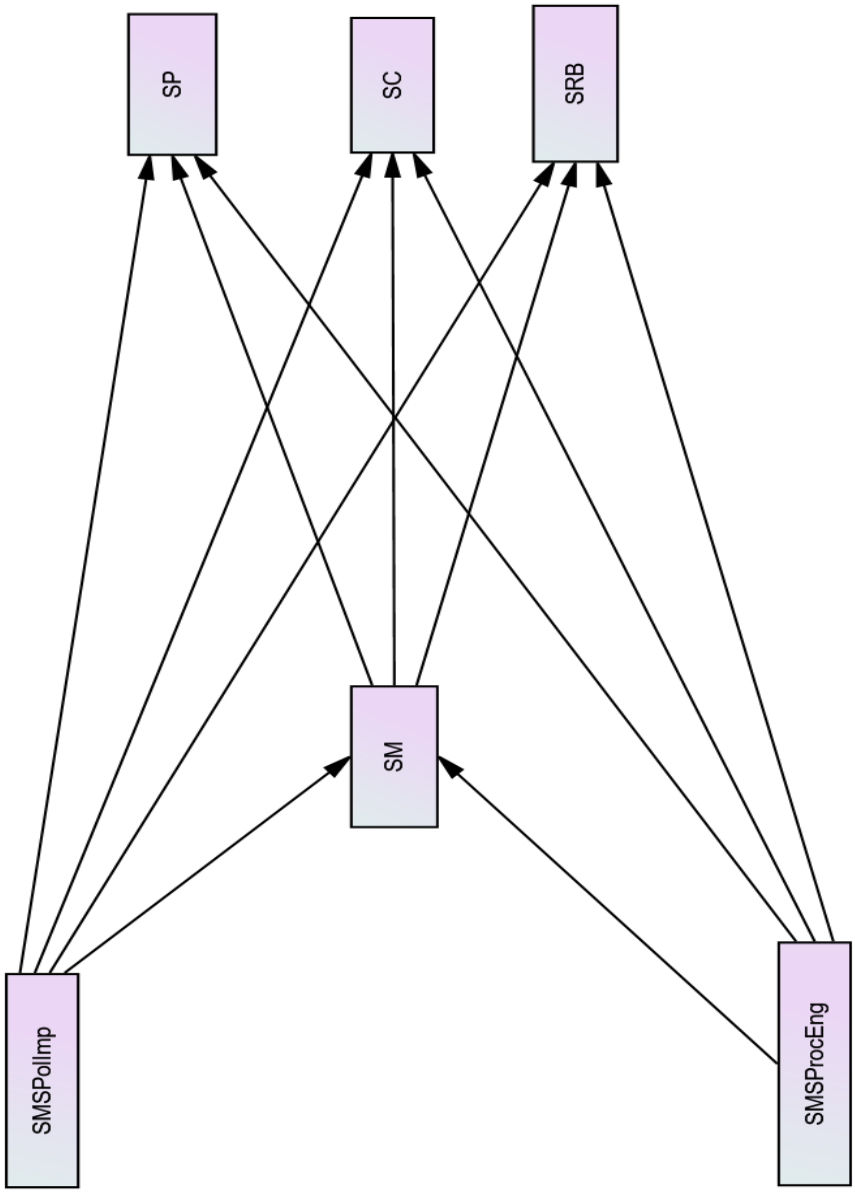


Figure 1. A hypothetical model showing the relationship between SMS process engagement, SMS policy implementation, safety motivation and the outcome variables: safety compliance, safety participation, and safety reporting.

Statement of Hypotheses

SMS Process Engagement, Safety Motivation, Safety Behavior, and Safety Reporting

The present study's proposed model is based on the final measurement model from Adjekum (2017). The original hypothesized model did not include SMS process engagement nor SMS policy implementation. It was a goal of that research to identify the factors that measure the latent construct of SMS initiative (Adjekum, 2017). The SMS initiative scale was based on multiple sources that are directed toward measuring SMS effectiveness (Chen & Chen, 2012, 2014; Transport Canada, 2005). From the findings of the foundational research by Adjekum (2017), two factors emerged: SMS process engagement and SMS policy implementation.

The SMS process engagement scale is directed toward assessing the extent to which, in collegiate aviation, students and flight instructors are included or engaged with SMS processes. This is meant to provide a sense of "buy-in" from the frontline individuals. This sense of involvement or engagement has been shown to be related to overall favorable perceptions of safety culture based on feedback and engagement (Adjekum et al., 2016; Chiu et al., 2019). Based on these findings and prior analysis, the hypothesized direct and indirect effects of SMS process engagement include:

H_1: Respondents' perceptions of their collegiate aviation program's SMS process engagement are related to their safety motivation.

H_2: Respondents' perceptions of their collegiate aviation program's SMS process engagement are related to their safety compliance.

H_3: Respondents' perceptions of their collegiate aviation program's SMS process engagement are related to their safety participation.

H_4: Respondents' perceptions of their collegiate aviation program's SMS process engagement are related to their safety reporting.

H_5: Respondents' safety motivation mediates the relationship between their perceptions of their collegiate SMS process engagement and safety compliance.

H_6: Respondents' safety motivation mediates the relationship between their perceptions of their collegiate SMS process engagement and safety participation.

H_7: Respondents' safety motivation mediates the relationship between their perceptions of their collegiate SMS process engagement and safety reporting.

SMS Policy Implementation, Safety Motivation, Safety Behavior, and Safety Reporting

SMS policy implementation is the second factor identified in the latent measurement model of the SMS initiative (Adjekum, 2017). SMS policy implementation deals with the importance of having a clearly articulated SMS policy where roles, responsibilities, authorities, and communication lines are established. Additionally, it supports the importance of having backing from top-level personnel, which is regarded as a fundamental component of SMS (FAA, n.d.-b, 2015a, 2019a; ICAO, 2009; Stolzer et al., 2016). Moreover, the importance of SMS policy was reflected in the findings by Chen and Chen (2014). Based on these findings and prior analysis, the hypothesized direct and indirect effects of SMS policy implementation include:

H_8: Respondents' perceptions of their collegiate aviation program's SMS policy implementation are related to their safety motivation.

H_9: Respondents' perceptions of their collegiate aviation program's SMS policy implementation are related to their safety compliance.

H_{10}: Respondents' perceptions of their collegiate aviation program's SMS policy implementation are related to their safety participation.

H_{11}: Respondents' perceptions of their collegiate aviation program's SMS policy implementation are related to their safety reporting.

H_{12}: Respondents' safety motivation mediates the relationship between their perceptions of their collegiate SMS policy implementation and safety compliance.

H_{13}: Respondents' safety motivation mediates the relationship between their perceptions of their collegiate SMS policy implementation and safety participation.

H_{14}: Respondents' safety motivation mediates the relationship between their perceptions of their collegiate SMS policy implementation and safety reporting.

Proposed Methods

A concurrent embedded mixed-method approach will be utilized to pursue the research questions. A concurrent embedded design is described as having a primary method that guides the project and a secondary method embedded within the primary method (Creswell, 2009). In this case, the quantitative analysis is considered the primary method, and the qualitative is secondary. In a concurrent triangulation approach, the data from different methodologies is mixed. Given that the research questions being pursued by the quantitative and qualitative portions of this study are different, the concurrent embedded approach better describes the research as there will be a separate analysis of each respective data. However, some comparisons may take place.

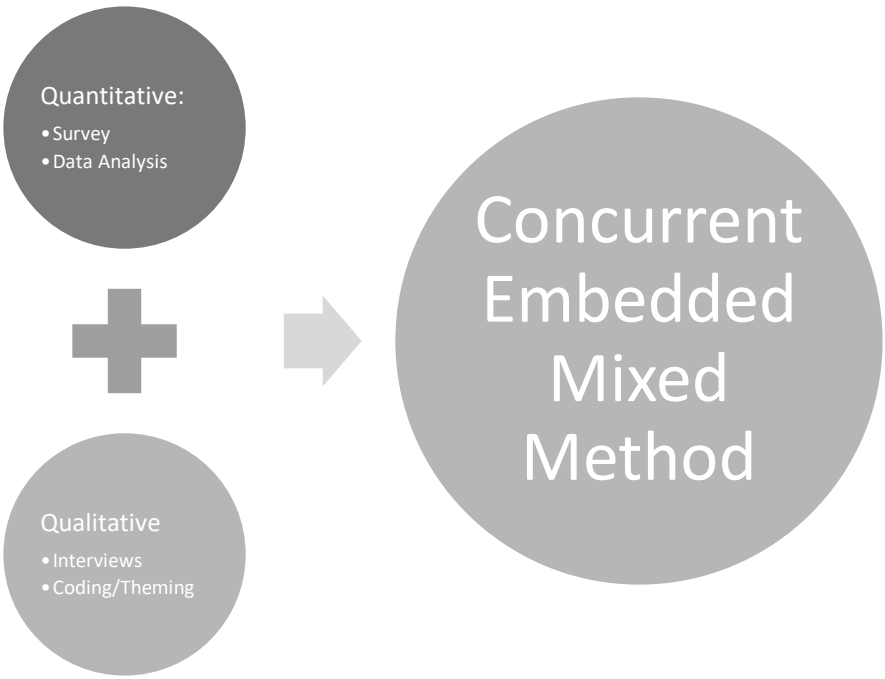


Figure 2. Diagram of proposed research methodology.

The qualitative portion of the study will utilize semi-structured interviews of students, flight instructors, and safety leadership at each collegiate aviation program. The quantitative portion of the study will utilize a previously validated instrument across a larger sampling pool to add to its validity to achieve higher generalizability (Adjekum, 2017).

Participation of multiple collegiate aviation programs will be utilized. These institutions are University Aviation Associations (UAA) members. Given the proposed research model's parameters, a sample size of at least 280 survey participants is desired for the quantitative portion.

A qualitative component will be utilized to investigate some of the previous findings on safety culture perceptions in collegiate aviation. Adjekum (2014, 2017) has found the year group to affect safety culture perception in collegiate aviation. The

quantitative results will tell us if there are meaningful variations in safety culture perception across multiple universities but will not be able to provide answers to why these variations exist. A qualitative component of interviewing students, instructors, and institutional leaders at multiple collegiate aviation programs will explain why any variation exists. Conducting semi-structured interviews among institutional leaders, flight instructors, and students of varying year group would be performed. One leader, two flight instructors, and at least two students at both early and later year groups would be necessary to attain saturation.

The quantitative portion is primarily aimed at validating prior findings across a larger sampling pool. Adjekum (2014) found that the year group significantly affected safety culture perception, but these findings were limited to a single institution. The current study will determine if these same findings occur across multiple universities with SMS programs.

Another opportunity presented by researching multiple universities is investigating any potential effects of having different levels of SMS implementation and types of SMS. Organizations pursuing SMSVP will need to transition through multiple implementation levels before having an FAA acceptable SMSVP (FAA, n.d.-a). Similarly, organizations pursuing SMS through alternative means (i.e., IBAC IS-BAO) present the opportunity to investigate any potential effects these different programs may have on safety culture perception. Moreover, IBAC IS-BAO programs must also be certified through different levels (Pinholster, 2019). Using these differing levels of SMS implementation as well as the type of SMS program as new demographic variables presents a new area of research beyond prior findings.

Rationale for Methods

Interviews seek to explore subjects' personal experiences related to the study topic based on their values, attitudes, and beliefs (Saldana & Omasta, 2017). This study's qualitative portion is meant to delve into individuals' personal experiences at their respective institutions. Moreover, safety culture typically deals with values, norms, assumptions, and expectations (K. J. Mearns & Flin, 1999). A qualitative analysis utilizing semi-structured interviews is a necessary tool to investigate these attributes.

Adjekum (2017) developed the SMS Policy Implementation and SMS Process Engagement scales in prior research. The current study will utilize the same tool for consistency. Additionally, this consistency will provide the opportunity to add to the reliability and validity of past findings. Given that the present study will address multiple universities, this will provide the means to ensure past findings were not localized while expanding on research variables, including implementation level and type of SMS.

Research Assumptions and Limitations

The current study will expand on prior research (Adjekum, 2017) but will not be comprehensive. This study will collect data from multiple institutions. However, there are significantly more UAA members than those included in this study (UAA, n.d.). Future research could broaden the sampling pool to advance knowledge surrounding collegiate aviation safety culture perceptions.

The cross-sectional approach will investigate safety culture perception at a given point in time but will not address long-term changes or effects. Longitudinal studies may help determine if this study's findings indicate a trend based on the research variables. A

follow-up study at the same institutions after SMS implementation levels have changed would be beneficial to detect any trends.

CHAPTER II

LITERATURE REVIEW

This chapter will focus on providing background on safety culture, providing a framework of the variables on assessing safety culture, fundamental principles of SMS, and reviewing applicable studies about SMS and safety culture. Safety culture is a broad term and can manifest in an organization in various ways (Patankar & Sabin, 2010; Stolzer et al., 2016). Discussion about these different forms of safety culture and relevant literature that discusses the assessment of safety culture will be provided. SMS can be implemented in differing ways. A discussion on these differences will be provided. Finally, a review of recent and noteworthy studies on SMS and safety culture will be reviewed. This review will include an overview of the previous studies, which have laid the foundation for the current study. The focus will be on contemporary studies that apply to the current research and will not be a comprehensive review.

Safety Culture

The concept of safety culture can be traced back to the Chernobyl disaster in 1986 (Stolzer et al., 2016). Since then, there has been a considerable amount of research done into this topic in the context of multiple industries and disciplines including, but not limited to, energy (García-Herrero et al., 2013), healthcare (Groves et al., 2011), and aviation (Adjekum, 2014; Adjekum et al., 2015, 2016; Dillman et al., 2010; Gao & Rajendran, 2017; Gill & Shergill, 2004; Wang, 2018; Wu et al., 2010). Consequently,

several definitions of safety culture have emerged in the literature. A brief exploration of the terms safety and culture will be discussed. The elements of safety culture that emerge from the contributing components and dynamics will be provided, and discourse regarding an overview of some of the specific definitions of safety culture in the academic literature occurs.

Defining Safety and Culture

Patankar and Sabin (2010) approach the definition of safety culture by breaking down the term into its individual components (i.e., safety and culture), considering the contributions of these individual components, and then readdressing the aggregate term of safety culture. Safety, for instance, is subject to multiple definitions and perspectives depending upon the environment (i.e., regulatory bodies, insurance companies, engineers, psychologists, systems theorists). These varying perspectives influence the nature by which safety is referred to, whether it is acceptable levels of risk, failure modes and effects, factors resulting in errors or failures, or factors that contribute to a safe or successful outcome. Although, Patankar and Sabin (2010) state the more contemporary perspectives that address the dynamic and complex nature of high-reliability organizations (HROs) may be more appropriate in safety within aviation settings to include concepts resilience and complex systems theory. Patankar and Sabin (2010) state, "This approach offers a more dynamic perspective: safety, particularly in HROs, is less a matter of individual component reliability and more a matter of overall systemic ability (resilience or adaptability) to cope with threats, errors, and failures. Therefore, resilience engineers express safety as a measure of systemic adaptability" (p. 98).

The intricacies of resilience and resilience engineering are beyond the scope of this research, but these concepts do play a role in defining and understanding safety culture. Therefore, a brief overview of resilience is prudent. The definition of resilience faces similar challenges as safety culture in that there are several definitions. Woods (2015) offers an organized perspective which addresses what resilience is and how to engineer it in complex adaptive systems through four concepts:

1. resilience as rebound from trauma and return to equilibrium;
2. resilience as a synonym for robustness;
3. resilience as the opposite of brittleness, i.e., as graceful extensibility when surprise challenges boundaries;
4. resilience as network architectures that can sustain the ability to adapt to future surprises as conditions evolve.

Another aspect of safety is the nature by which it emerges. Provan et al. (2020) state, "Safety, or the lack of safety, is an emergent property of an operational system" (p. 1). In this description of safety, the concept of emergence is included. Emergence is the spontaneous creation of order and functionality from the bottom up (Page, 2009). This idea of safety being an emergent property suggests that the individual processes or components are not what creates safety, but it is what emerges from the fully operational system—safety is not identifiable when considering individual components or processes.

The cultural aspect of the term safety culture is still to be addressed. Patankar and Sabin (2010) offer anthropological perspectives (e.g., habitat, customs, traditions) as well as social and organizational scientist perspectives (e.g., quality of life, organizational effectiveness, safety performance). This cultural aspect is primarily used to describe a

group of people or the characteristics of an organization. ICAO (2009) refers to culture as a collective programming of the mind. Moreover, ICAO (2009) suggests that organizations and their groups of people are subject to influence from various sources: national culture, professional culture, and organizational culture. These different influences will impact how the organization and its people's shared beliefs, practices, and attitudes.

Once the terms safety and culture have been defined, it is prudent to discuss the aspects which influence the aggregate term safety culture. Patankar and Sabin (2010) discuss the components and dynamics that contribute to safety culture. The components that contribute to safety culture include values, leadership strategies, attitudes, and performance (Patankar & Sabin, 2010).

The dynamics between these components refer to how they interact to yield a dominant cultural state, and these interactions can transcend individual, group, and organizational levels (Patankar & Sabin, 2010). Gill and Shergill (2004) identified "organizational dynamics and positive safety practices" as a critical factor in their analysis of employee perceptions of safety management and safety culture. Although, their findings did suggest this factor was perceived to be the weakest by employees when compared to the three other factors identified: the regulator's role, luck and safety, and safety-management, training, and decision making (Gill & Shergill, 2004).

Dynamics can also be discussed in the context of organizational resilience. Woods (2015) discusses the role of dynamics in relation to two of the four aspects of resilience: resilience as graceful extensibility and resilience as sustained adaptability. Graceful extensibility refers to how a system performs or degrades when operating near system

boundaries, and sustained adaptability refers to the systems' ability to produce sustained adaptability over longer scales (Woods, 2015). Dekker and Woods (2010) use these concepts of resilience and adaptability to support the notion that safety is not something organizations have, but it is something they do by continuously assessing and revising their work to remain sensitive to the possibility of failure.

Defining Safety Culture

There are several available definitions of safety culture in the research literature. A brief review of some of the more notable and frequently cited definitions will be provided. This will include definitions and concepts from regulatory bodies such as the FAA and the research literature.

The FAA addresses safety culture from a variety of perspectives. The FAA (2015a) states that "safety culture" is essential to an organization's safety performance and applies to those organizational aspects that relate to safety performance. Safety culture is not something that can "purchased," but it is something that is a product of the values and actions of organizational leadership and learning (FAA, 2015a). All organizations have a safety culture, whether it is positive or negative. The organization's leadership and management's goal is to cultivate positive aspects through open reporting, just culture, personnel involvement, use of information, commitment to risk reduction, vigilance, flexibility, and learning (FAA, 2015a).

Wiegmann et al. (2004) performed an integrative review of safety culture definitions that reviewed various safety culture definitions to assimilate critical features to derive commonalities. This review included 13 different definitions of safety culture,

albeit from non-aviation industries between 1991 and 2000. The commonalities found from their analysis include:

1. Safety culture is a concept defined at the group level or higher that refers to the shared values among all the group or organization members,
2. Safety culture is concerned with the formal safety issues in an organization and closely related to, but not restricted to, the management and supervisory systems,
3. Safety culture emphasizes the contribution form everyone at every level of an organization,
4. The safety culture of an organization has an impact on its members' behavior at work,
5. Safety culture usually reflected in the contingency between reward systems and safety performance,
6. Safety culture is usually reflected in the organization's willingness to develop and learn from errors, incidents, and accidents, and
7. Safety culture is relatively enduring, stable, and resistant to change (Wiegmann et al., 2004).

A similar review of the literature on safety culture was performed by Guldenmund (2000). Unlike Wiegmann et al. (2004), Guldenmund (2000) considered research on safety climate and safety culture. Consequently, the research on safety climate, as opposed to safety culture, can be traced back to 1951 (Guldenmund, 2000). However, consideration was given to definitions of safety culture and climate that spanned research from 1980 to 1997. Guldenmund (2000) wanted to address the lack of models that

address the relationship between safety culture and climate to safety and risk management or safety performance. From the analysis, a three-layer framework is proposed to redefine safety culture: outer layer – artefacts; middle layer – espoused values/attitudes regarding hardware, software, people/liveware, and risks; and the core – basic assumptions (Guldenmund, 2000). The artefacts are considered the visible contributions, the middle layer or espoused values/attitudes are reflected in policies, training, and manuals, and the core or basic assumptions are implicit and must be inferred from observation. It is within these layers that the distinction between climate and culture is made. Guldenmund (2000) posits that the attitudes reflect climate while it is within the assumptions that culture is represented. The redefined model accounts for differences between attitudes and assumptions.

Cooper (2000) addressed the development of a model of safety culture with the goal of being able to use this model to test hypotheses regarding antecedents, behavior(s), and sequence(s). In developing this model, it was noted that many current definitions of safety culture focused on shared perceptions, meanings, values, and beliefs while not accounting for the goal-directed interactions between people, jobs, and the organization. Therefore, Cooper (2000) suggests organizational culture "…is reflected in the dynamic reciprocal relationships between members' perceptions about, and attitudes towards, the operationalization of organizational goals; members' day-to-day goal-directed behavior: and the presence and quality of the organization's systems and sub-systems to support the goal-directed behavior," (p. 117). This definition takes into account more than the way people think. This definition includes the influences of situational constraints and people's behavior.

Reason (1998) argues, "…a safe culture is an informed culture and this, in turn, depends upon creating an effective reporting culture that is underpinned by a just culture in which the line between acceptable and unacceptable behavior is clearly drawn and understood," (p. 293). This definition differs from others in that it focuses on components (i.e., informed, reporting, and just culture) of an overall safety culture. While other definitions often address attitudes, beliefs, and values, Reason's (1998) approach considers these subcomponents and how they drive an organization in a particular fashion. Reason (1997) identifies four critical subcomponents to safety culture: a reporting culture, a just culture, a flexible culture, and a learning culture. These four subcomponents work together to create an informed culture, which Reason (1997) views as being synonymous with a safety culture.

Reporting Culture. A reporting culture is one in which there is a strong willingness to participate and contribute to collecting safety-related data through hazard reporting systems (Reason, 1997). The FAA (2015a) and ICAO (2009) both list the inclusion of a voluntary, anonymous reporting system as a fundamental and crucial component of an SMS. Moreover, Robertson (2016) has shown a strong connection between SMS implementation, a confidential hazard report system, and safety culture. Similarly, Dekker (2012) highlights the critical role reporting systems play in risk management and accident avoidance for organizations.

Just Culture. There is significant research on the intricacies of a "just" culture (Dekker, 2009, 2012; Dekker & Breakey, 2016; Frankel et al., 2006; Lawrenson & Braithwaite, 2018). Reason (1997) defines a just culture as "an atmosphere of trust in which people are encouraged, even rewarded, for providing essential safety-related

information-but in which they are also clear about where the line must be drawn between acceptable and unacceptable behavior" (p. 195). Much of the research on just culture focuses on the challenges behind differentiating acceptable and unacceptable behavior (Dekker, 2009) and what happens to those that cross the line beyond into the realm of unacceptable behavior (Lawrenson & Braithwaite, 2018). While it has been shown that organizations can improve through just culture practices by encouraging their employees to report weaknesses without fear of reprisal (Frankel et al., 2006), complexity is added when considering the influences of national culture on the perception of just culture (ICAO, 2009; Liao, 2015).

Flexible Culture. A flexible culture relates to the concepts of HROs and resilience. Reason (1997) describes a flexible culture as one that can shift between hierarchal organizational structures to flatter structures when faced with emergencies to accommodate the extent of the emergency, high-tempo environment. This ability to adapt to emergencies and similar unforeseen circumstances is a hallmark of HROs and allows these organizations to operate safely when faced with disruptions (Provan et al., 2020). Having the ability to adapt, as opposed to resist, to disturbances is viewed as a desirable quality to ensure resilience (Woods, 2015).

Learning Culture. A learning culture refers to "the willingness and the competence to draw the right conclusions from its safety information system, and the will to implement major reforms when their need is indicated" (Reason, 1997, p. 196). This approach changes the perception of accidents and incidents from potentially being viewed as shameful events but encourages them to be viewed as opportunities to learn (Liao, 2015). When safety data is contributed and collected, the lessons learned from this

data's conclusions should be implemented in changes to procedures or similar variations (Mearns et al., 2013).

Informed Culture. Reason (1997) posits that the four aforementioned subcomponents (i.e., reporting, just, flexible, and learning) create an informed culture. In an informed culture, all employees know an organization's safety status and priorities (Wang, 2018). Wang (2018) states that an informed culture is accomplished through two steps: individuals know the difference between acceptable and unacceptable behavior, and most errant behaviors can be identified and reported without fear of reprisal.

Positive and Negative Safety Cultural States

Multiple sources allude to positive or favorable cultural states as well as negative or unfavorable cultural states (FAA, 2015a; Patankar & Sabin, 2010; Wiegmann et al., 2004). In fact, it is suggested that all organizations have a safety culture, but the dominant state of the safety culture exists on a continuum and can be viewed from a positive or negative perspective (FAA, 2015a; Gibbons et al., 2006). Negative safety culture would exist when the contributing components of safety culture (e.g., reporting culture, just culture) work against the organization instead of for the organization. Some additional cultural states can be said to exist that represent these negative cultural states, such as blame culture or secretive culture (Patankar & Sabin, 2010).

These cultural states are, in a way, the reverse or opposite of their respective positive representative. For instance, Reason (1997) described a reporting culture as a strong willingness to participate and contribute to collecting safety-related data through hazard reporting systems. When organizational personnel do not willingly participate and contribute to collecting safety-related data, a secretive culture can prevail. Similarly,

when a just culture is not present, the opposite manifestation would be considered a blame culture (Patankar & Sabin, 2008). These secretive and blame cultures do not encourage communication of systemic problems or latent failures, which are considered counterproductive to safety and overall positive safety culture (Patankar & Sabin, 2010).

Organizations can also be described along a spectrum between three culture models that describe the nature by which they process information: generative, bureaucratic, and pathological (Westrum, 2004). These models also will describe the nature by which organizations respond to information. These models can help understand how leadership and the organizations as a whole manage power and awareness of potential issues.

Generative Organizations. When the concentration is on the mission itself instead of persons or positions, a generative culture can emerge (Westrum, 2004). These organizations experience high levels of cooperation, messengers are training, risks are shared, bridging encouraged, failure results in inquiry, and novelty is implemented (Westrum, 2004). This cultural model represents an organization that puts power- and rule-oriented behavior aside. When there is a response to failure, the organization responds with a global fix and inquiry into the situation to determine a root cause (Westrum, 2004).

Bureaucratic Organizations. Rule-oriented organizations can be categorized as bureaucratic (Westrum, 2004). These organizations can be characterized by being having modest cooperation, messengers are neglected, narrow responsibilities, bridging is tolerated, failure results in seeking justice, and novelty creates problems (Westrum, 2004). The response to failure or anomaly is a public relations response and local fix.

These two characteristics are described as an organization providing a response that puts the message "in context" of the events as to frame it in a manner that reduces the negative appearance of the failure. Moreover, in contrast to a generative organization, bureaucratic organizations will not seek a global fix. Instead, the bureaucratic organizations will merely address the issue at the local level without performing further inquiry into potentially related issues that could result in similar failure cases.

Pathological Organizations. The last of the three culture models proposed by Westrum (2004) is the pathological organization. These organizations are power-oriented and are characterized by having low cooperation, messengers are "shot," responsibilities shirked, bridging discouraged, failure results in scapegoating, and novelty is crushed (Westrum, 2004). When anomalies occur, the reaction from the organization is suppression and encapsulation (Westrum, 2004). These responses imply that the organization will actively stop or even punish individuals looking to bring information regarding anomalies forward. Moreover, the messengers that attempt to bring this information forward will be isolated to avoid sharing that information, and no fix is implemented.

Predictive, Proactive, and Reactive Organizations. The work done by Westrum (2004), which identified three cultural models or stages (i.e., generative, bureaucratic, and pathological), was later expanded to add two more stages: proactive and reactive (Hudson, 2007). Considering these five stages on a spectrum, the progression would follow from one to the other as follows pathological, reactive, bureaucratic/calculative, proactive, and generative (Hudson, 2007). It should be noted that the term calculative was used in place of bureaucratic. Calculative organizations refer to those who have systems

in place to manage all hazards but have not gotten to a point where they use these tools to attempt to anticipate safety problems (i.e., proactive) (Parker et al., 2006). While reactive organizations give the appearance that they care about safety, however, they do not use their resources in an attempt to anticipate safety issues and merely deploy these resources after an accident or other safety issues arise after the fact (Parker et al., 2006).

ICAO (2009) addresses the concepts of reactive, proactive, and predictive organizations as part of their implementation phases. In phase II of SMS implementation under ICAO (2009) guidance, an organization would utilize safety management processes in response to threats but not to the extent that the organization can anticipate or predict potential incidents or accidents. Phase III entails the implementation of these proactive and predictive elements (ICAO, 2009). These elements are forward-looking in nature. The mechanisms being implemented will use data collection and analysis tools to direct attention to threats that have not resulted in an incident or accident yet, but the potential risk is present. These tools utilize statistical analysis of data that would not indicate system threats on an individual basis, but when viewed in the aggregate, can identify these threats (ICAO, 2009). An example of such a method would be flight data analysis (FDA). The data being analyzed is not specific to incidents or accidents but can provide insight into potential system threats that could manifest in an incident or accident if not acted upon by safety personnel.

Safety Culture vs. Safety Climate

Safety culture and safety climate are terms that are sometimes used interchangeably and have been found to have similar definitions in some instances (Wiegmann et al., 2004). However, work has been done to distinguish between these two

terms (M. D. Cooper, 2000; Guldenmund, 2000; Wiegmann et al., 2004). A clear distinction between these two terms is necessary in order to be able to measure or assess either phenomenon.

Guldenmund (2000) proposed a model that accounts for the differences between safety culture and safety climate. Based on this model, safety climate represents the *attitudes* of organizational personnel instead of the *assumptions* of personnel, which is representative of organizational culture (Guldenmund, 2000). Guldenmund (2000) also argues that the emphasis when assessing organizations should be placed on the assumptions, or safety culture, as that is thought to be explanatory of the attitudes. This concept is based on the three-layer model proposed by Guldenmund (2000). Since the organization's implicit assumptions represent the core of the model, the outer layers of the model would be subject to influence by the core. These outer layers include more of the explicit elements, which include attitudes and these attitudes are representative of safety climate (Guldenmund, 2000).

Wiegmann et al. (2004) approach the distinction of safety culture and safety climate by analyzing numerous definitions of each term. From this analysis, some common themes were noted in the research literature:

1. Safety clime is a psychological phenomenon that is usually defined as the perceptions of the state of safety at a particular time;
2. Safety climate is closely concerned with the intangible issues such as situational and environmental factors; and
3. Safety climate is a temporal phenomenon, a "snapshot" of safety culture, relatively unstable and subject to change (Wiegmann et al., 2004).

Wiegmann et al. (2004) suggest that the distinction between safety culture and safety climate is analogous to personality states versus traits. Using this analogy can provide insight into the temporal nature of a safety climate. Since personality states can manifest in temporary states such as anger, that is more akin to safety climate. That is also due to the fact that personality states are subject to current circumstances. In contrast, personality traits are more enduring and are not subject to the same level of fluctuation. This enduring concept is more in line with safety culture (Wiegmann et al., 2004).

Cooper's (2000) work on developing a safety culture model took safety climate into account when addressing the methods by which to assess safety culture and safety climate. The determination to measure safety culture or safety climate will dictate the tools and mechanisms by which to assess. If dealing with attitudes and perceptions, a safety climate survey would be appropriate (M. D. Cooper, 2000). This implies that safety climate is more geared toward attitudes and perceptions, while safety culture is more concerned with antecedents, behaviors, and consequences (M. D. Cooper, 2000).

Assessing Safety Culture

Wiegmann et al. (2004) introduce the limitations of assessing safety culture and begin their analysis by introducing two primary assessment methods: qualitative and quantitative. Each of these strategies includes different types of assessments within the broader category. For instance, qualitative assessment can include employee observations, focus group discussions, historical information reviews, and case studies (Wiegmann et al., 2004). Quantitative assessments typically include highly structured interviews, surveys and questionnaires, and Q-sorts (Wiegmann et al., 2004). Each

method has its strengths. Qualitative methods can obtain intensive and in-depth information, while quantitative methods are often easier to use and, specifically, useful when performing cross-sectional comparisons (Wiegmann et al., 2004).

Another consideration proposed by Wiegmann et al. (2004) is the validity of the measurement tools and specifically construct and discriminant validity. Construct validity ensures that the instrument being used measures what it is intended to measure (Wiegmann et al., 2004). Construct validity is usually demonstrated through repeated applications, the phrasing of specific questions during an interview, or reflecting an enduring organizational trait on a survey (Wiegmann et al., 2004).

Discriminant validity refers to an instrument's power to differentiate between organizations or groups that possess different levels of safety (Wiegmann et al., 2004). While some form of objective indicator (such as accident frequency) may be considered ideal, this metric is not necessarily valid in the context of HROs given the low frequency of these events (Wiegmann et al., 2004). Therefore, Griffin and Neal (2000) suggest looking at safety compliance behavior and employee participation as objective safety data sources.

Griffin and Neal (2000) refer to safety compliance and safety participation variables holistically as safety performance. A key distinction is made between safety compliance and safety participation, as they are suggested to discriminate between two distinct behaviors. These distinctions aim to discriminate between prescriptive compliance instead of behaviors that contribute to the greater organizational context. Safety compliance refers to prescriptive behaviors, and an example of such behavior is following the policies on personal protective equipment (PPE). Safety participation refers

to individuals who actively participate in a safety meeting and potentially encourage colleagues to do the same. Safety participation is said to enhance the team's safety, the work environment, or the organization as a whole (Griffin & Neal, 2000).

Patankar and Sabin (2010) propose one additional safety culture assessment method beyond the aforementioned qualitative and quantitative methods: quasi-experimental. When randomization is not possible, a quasi-experimental approach may be appropriate in an attempt to determine causality when a proper experimental design would be ideal, according to Creswell (as cited in LaPoint, 2012). A quasi-experimental design can be utilized when an intervention is performed, and the measurement of its effect on an outcome variable is desired. This method was utilized by LaPoint (2012) in an attempt to determine if implementing crew resource management (CRM) training in a healthcare setting affected attitudes toward safety and medical errors among perioperative personnel. The quasi-experimental quantitative design results indicated a correlation between CRM training and changes in safety attitudes (LaPoint, 2012).

It is essential to keep the goal of a safety culture assessment in mind. The assessment is not meant to simply determine whether an organization has a safety culture or not, but to determine the extent of shared or conflicting norms perceived by individuals in an organization (Grote & Künzler, 2000). The FAA (2015a) shares this perspective with their SMS guidance in that they proclaim all organizations have a safety culture, but this culture exists on a continuum between positive and negative safety culture.

Organizational Culture. Safety culture is considered a sub-set of the broader organizational culture (Booth & Lee, 1995). Hopkins (2006) addresses this from the

perspective that while safety culture is often subject to different interpretations and definitions, organizational culture suffers from less variation in definition and measurement. Specifically, some definitions of culture emphasize the way people think (i.e., values), and others emphasize how people behave (i.e., practices). Hopkins (2006) posits neither an emphasis on values or practice results from a conflict but points to what is being emphasized with the assessment. Hopkins' (2006) conclusion is that organizational culture must be included when considering safety culture.

One study that looked at these varying levels of cultural influences addressed how organizational climate impacted group climate and safety performance (Brondino et al., 2012). One finding showed that improving organizational climate significantly improved co-worker and supervisor safety climate perceptions at the individual and group level (Brondino et al., 2012). Another significant finding was the different influences co-workers had on one another when compared to supervisors. Co-workers' perceptions played a stronger mediating role in safety climate than did supervisors (Brondino et al., 2012). Further investigation into these lateral relationships is suggested.

Safety Behavior. Safety behavior refers to two different constructs: safety participation and safety compliance. This breakdown is based on work from Borman and Motowidlo (1993), who proposed that there are two majors components of performance: task performance and contextual performance (as cited in Griffin & Neal, 2000). The use of safety behavior as an outcome variable in the study of safety culture and SMS to include safety participation and safety compliance has been used in multiple recent studies (Adjekum, 2017; Chen & Chen, 2014; Neal & Griffin, 2006). Assessing safety behavior is included in much of this research due to its relationship to safety climate and

accident rates. It is suggested that safety climate predicts safety behavior, and safety behavior has an effect on accident rates (Neal & Griffin, 2006).

Another behavioral component that will be included in the current research is that of safety reporting behavior. Effective safety reporting is a critical component of an effective SMS (FAA, 2015a; ICAO, 2009). Trust in a confidential safety reporting system is a sign of positive safety culture (Robertson, 2016). Determining ways to improve or increase safety reporting behavior is considered a necessary and worthwhile research topic to improve the performance of SMS (Jausan et al., 2017).

Safety Culture in Collegiate Aviation. Safety culture and safety climate have been actively studied for years (Gao et al., 2013; Liao, 2015; Taylor & Thomas III, 2003; Wang, 2018). There has also been extensive research performed on safety culture and safety climate in industries outside aviation (Barbaranelli et al., 2015; Brondino et al., 2012; Fugas et al., 2012; Groves et al., 2011; Kapp, 2012; Neal et al., 2000; Stemn et al., 2019; Wu et al., 2010). An area of research that is developing is safety culture in collegiate aviation and similar flight training organizations (Adjekum, 2014, 2017; Adjekum et al., 2016; Chiu et al., 2019; Dillman et al., 2010; Gao & Rajendran, 2017; Robertson, 2016). This research area requires further investigation and a review of some of the key findings that have laid the foundation for the proposed research.

Freiwald et al. (2013) performed one of the first safety culture assessments in collegiate aviation, and this was in response to some significant hull losses that warranted a more in-depth investigation. This analysis utilized a quantitative instrument called the Commercial Aviation Safety Survey (CASS) for the quantitative portion of their sequential mixed-method explanatory research. The CASS was initially developed and

validated in commercial aviation (Gibbons et al., 2006). The CASS is designed to assess the overall safety culture for a given organization through five constructs: organizational commitment to safety, managerial involvement in safety, employee empowerment, accountability system, and reporting system (Gibbons et al., 2006). Six schools were assessed via the CASS for this research, and one of the significant findings was a lack of accountability (Freiwald et al., 2013). Through the quantitative and qualitative analysis, it was perceived that pilots should avoid hazards since it was in their best interests. Another interesting finding was that many of the respondents believed that reporting systems were critical, but many of the respondents had not participated in it themselves (Freiwald et al., 2013). It was suggested that the implementation of SMS and safety culture should be the result of these findings.

Adjekum et al. (2015) performed a cross-sectional assessment utilizing a new instrument developed from the CASS, referred to as the Collegiate Aviation Perception of Safety Culture Assessment (CAPSCAS). The CAPSCAS assessed six dimensions: Formal Safety, Informal Safety, Operations Interactions, Organization Commitment, Aviation Department Safety Record, and Safety Behavior (Adjekum et al., 2015). Some of the findings from their quantitative analysis included safety reporting behavior that could be predicted by safety culture perceptions, and respondents' age was a significant predictor of safety reporting behavior (Adjekum et al., 2015).

Adjekum (2014) used the CAPSCAS in an assessment of a single collegiate aviation program to determine if SMS implementation affected safety culture perceptions. This analysis utilized four major scales: Formal Safety Program, Informal Safety Program, Operations Interaction, and Organizational Commitment (Adjekum,

2014). The findings suggested that the year group had an effect on safety culture perceptions among students (Adjekum, 2014). This suggested that students that have been in the program longer have a better understanding of safety culture within the institution as opposed to newer students without the same level of experience or exposure. Another finding was the variance between domestic and international students (Adjekum, 2014). The international students did not have a favorable perception of safety culture when compared to the domestic students.

The effect of national culture is not unique to collegiate aviation. Liao (2015) has found similar effects when assessing Chinese and Western pilots' differences regarding just culture, reporting culture, and learning culture. Liao (2015) utilized a mixed-method approach, including a questionnaire directed at measuring perceptions of just culture, reporting culture, and learning culture. Interviews were performed for the qualitative assessment (Liao, 2015). Findings suggested cultural differences between Chinese and Western pilots concerning trust and satisfaction when implementing just culture, reporting culture, and learning culture (Liao, 2015). The Western pilots were more satisfied with these safety culture components, while Chinese pilots were not as accepting. Moreover, the Chinese showed strong influences of power distance and a traditional hierarchy of authority, which affected their willingness to report—especially superiors (Liao, 2015). Reporting culture is vital for overall positive safety culture (Reason, 1997), and Liao (2015) acknowledges the challenges of power distance need to be addressed for Chinese pilots to improve the safety culture.

In addition to national culture effects, the year group is another effect that has been shown in other research literature when assessing safety culture in a collegiate

environment. Gao and Rajendran (2017) assessed students from an Australian collegiate aviation program using a self-constructed instrument. Their instrument identified four themes: safety reporting culture, safety reporting procedures, organizational culture practice, and general safety knowledge (Gao et al., 2013). When performing a more in-depth analysis, they found that first-year students had a more positive perception than the students who have been in the program for longer. The vertical mingling of the students was suggested as a means to integrate these differing perceptions (Gao & Rajendran, 2017).

Adjekum et al. (2016) evaluated the effects of safety culture perceptions concerning non-aviation students. Positive safety culture is desirable throughout a given organization as a whole and should not be limited to a particular subsection of employees (M. D. Cooper, 2000). Adjekum et al. (2016) sought to investigate safety culture perceptions for Air Traffic Control (ATC), management, and Unmanned Aircraft Systems (UAS) students. This study also sought to continue investigating age or year group effects and utilized the CAPSCAS instrument, which provided further insight into the relationships posited by the instrument. The findings suggest a relationship between non-flight majors and the general trends, attitudes, and perceived safety values in their collegiate program (Adjekum et al., 2016). This finding suggests that interaction with flight majors influences safety culture perceptions for the non-flight majors and supports the need to include non-flight majors in safety training and other related safety promotion activities.

Another significant finding from this study was the influence of response and feedback (Adjekum et al., 2016). Providing feedback and providing the feedback

promptly was shown to have a strong relationship with safety behavior, which includes the process of filing safety reports. This effect relates to age/year-group effects in that younger students receive their initial safety training and may feel more inclined to participate in the safety program by filing safety reports. However, lack of response and feedback may lead to students not seeing the value in filing the safety report, which could explain the age/year-group effects observed of older students showing a reduction in safety reporting behavior.

Adjekum et al. (2016) also found relationships between safety values, safety fundamentals, and reporting frequency. Safety fundamentals had a strong effect on safety values, and while safety values were not found to be a strong predictor of reporting frequency, safety fundamentals were found to predict reporting frequency (Adjekum et al., 2016). The lack of predictive power safety values had concerning reporting frequency suggested a more complex relationship between safety culture and reporting frequency. Adjekum et al. (2016) suggested this could be attributed to other confounding variables, socio-cultural bias, or hazard observability/identification coupled with motivation.

Given the importance of participation in reporting systems and related safety behavior, Dillman et al. (2010) investigated perceptions surrounding reporting systems and why some students in collegiate training institutions fail to file a hazard report for actions or any other hazardous condition a safety department would need. Two collegiate aviation programs were utilized, and a total of 254 students participated in the quantitative study. Their findings suggested a lack of time, ridicule from others, and embarrassment from peers were driving forces for students not participating in the provided reporting systems. It was noted that more than 50% of respondents reported not

having experienced a reportable event, but this was acknowledged to possibly be attributed to inexperience (Dillman et al., 2010).

Chiu et al. (2019) did not study safety culture specifically. However, they attempted to determine if there was a difference in perceived safety valuation between flight students versus general Australian pilots and attempting to find a predictive model for Australian students or recently trained pilots' valuation of safety (Chiu et al., 2019). The definition of safety valuation in this contest referred to how participants valued three sub-cultures (i.e., just culture, reporting culture, and learning culture) (Chiu et al., 2019). Neither of the research questions resulted in significant findings, but it was noted that this study was performed within a specific culture (i.e., Australian flight training). It was suggested that similar studies be performed in different cultures to evaluate any potential cultural influences. There was one significant finding between Engagement as a predictor of safety valuation. Engagement considered individuals' level of engagement with their training organization/employer (Chiu et al., 2019). The Engagement construct investigated the perceptions of flight instructors and other organizational personnel caring for students, encouragement for development, other students committed to quality work, opportunities provided to learn and grow, and the presence of "school friends" at the institution. Chiu et al. (2019) concluded that much more research is needed to investigate the extent of engagement's influence and the need to perform this same research in other settings.

Another point of interest within the study of safety culture and safety behavior is planned unsafe behavior. Fogarty and Shaw (2010) sought to research this by exploring potential mechanisms explaining planned unsafe behavior through various constructs.

Their works builds upon the theory of planned behavior (Ajzen, 1991, as cited in Fogarty & Shaw, 2010, p. 1546). Fogarty and Shaw (2010) used the theory of planned behavior to conceptualize their model, which included management attitudes, own attitudes, group norms, and work pressure as variables to measure how they affect intention to violate, which could lead to violations. The potential for work pressure to directly have an effect on violations was also built into the model. Their model was able to show the effect of management attitudes and group norms as direct and indirect predictors of violation behavior. These findings could be beneficial for addressing issues with violations in their organization.

SMS: An Overview

While SMS is being mandated at the airlines (FAA, 2015b) and recommend for corporate operations (NTSB, n.d.), there is no current requirement to have an SMS for GA practitioners. Collegiate aviation falls under the definition of GA and does not have a mandate for SMS guidance. Therefore, if a GA organization wishes to pursue and implement an SMS, they have the option to choose from different possibilities. Currently, two primary regulating bodies oversee SMS implementation: the FAA and ICAO.

SMS can vary in how it is implemented and the entity that will provide oversight of the SMS (FAA, n.d.-a; NBAA, 2017). While there may be differences in implementation and oversight, the overarching goals of any SMS are based on similar principles. Stolzer et al. (2016) offer a comprehensive definition of SMS, "A dynamic risk management system based on quality management system (QMS) principles in a structure scaled appropriately to the operational risk, applied in a safety culture

environment" (p. 22). Moreover, Stolzer et al. (2016) state that SMS is a dynamic risk management system at its core.

Despite the differences in implementation and oversight, there are many commonalities between SMS types. A brief review of these differences and commonalities will be provided. This could provide a GA organization the background to make an informed decision on which direction to take their organization when beginning the implementation of an SMS.

SMS Studies

Remawi et al. (2011) wanted to investigate the effects of SMS implementation on employee attitudes toward unsafe acts. They hypothesized that SMS implementation at an airport would improve safety attitudes when testing two different airports. One airport was being used as the experiment in that this airport was undergoing SMS implementation, and then a control airport where no SMS implementation was taking place was used for comparison purposes. A safety culture survey was administered to participants from both locations in two phases to test changes to the participants' attitudes toward safety across time. The findings supported their hypothesis. SMS's introduction resulted in improved perceptions from the two phases on safety rules, supportive environment, personal risk appreciation, work environment, and involvement (Remawi et al., 2011b). It was suggested to continue efforts in measuring changes in these perceptions over time. Longitudinal studies and their need are commonly cited among SMS research (Adjekum, 2017; Adjekum et al., 2016; Chen & Chen, 2014).

Given the push for SMS implementation as a mandate in multiple settings such as the airlines (FAA, 2015b), a scale to measure the essential dimensions is warranted. Chen

and Chen (2012) sought to develop such a scale to evaluate the company's SMS performance. Five factors were identified in their analysis: documentation and commands; safety promotion and training; executive management commitment; emergency preparedness and response plan; and safety management policy (Chen & Chen, 2012). These findings can be used by airlines and similar organizations when undergoing the process of SMS implementation when looking to gauge employee perceptions of how SMS concepts relate to the employees' work. This tool can be used by management to determine how well the SMS performs based on their employee perceptions.

Since pilot behavior is considered a key factor for safety performance, Chen and Chen (2014) sought to analyze multiple antecedents that are suggested to influence pilot behavior. Three factors were considered for the model: Perceived SMS Practices, Morality Leadership, and Self-Efficacy. Safety Motivation was also included to assess the mediating effect. The outcome variable was safety behavior, which is broken down into two constructs: Safety Compliance and Safety Participation. This proposed model considers the organizational, group, and individual influences on safety behavior. Perceived SMS Practices were shown to affect both safety behavior outcome variables directly and were further strengthened by the mediating role of safety motivation. Morality Leadership did not have any direct effects on safety behavior factors. However, Morality Leadership was found to positively influence Safety Motivation, which fully mediated the relationship between Morality Leadership and both safety behavior variables. Self-Efficacy, the individual influence level, was shown to have direct positive effects on both safety behavior variables and experience a strengthened relationship when

mediated through safety motivation. These findings can be used by safety professionals as guidance when attempting to implement SMS policies and determine best practices for improving safety behavior.

While the FAA (2015b) is pushing for SMS to be implemented, ongoing research is needed to measure such systems' effectiveness. Brady and Stolzer (2016) performed some initial work in this field by utilizing the approach of Input-Output (IO) economics theory along with Data Envelope Analysis (DEA). While IO has been used primarily in economic fields, it is suggested based on the literature that IO concepts can be applied to practically anything that is a system (Brady & Stolzer, 2016). DEA uses the inputs and outputs to determine the efficiency of the effectiveness of decision-making units (DMUs), in which these measurements of efficiency may be compared to best-observed performance (Brady & Stolzer, 2016). The initial findings supported the efficacy of such a method to evaluate SMS implementation in different organizations. In the sample, inefficiencies were able to be identified to give feedback and direction to the management of where these inefficiencies exist to improve the SMS. This initial work was performed on a small sample of subjects, and a larger sample is required further to validate the use of such an evaluation method.

Stolzer et al. (2018) continued to explore the use of DEA as a method to measure the effectiveness of SMS. Interviews were initially conducted on Subject Matter Experts (SMEs) in SMS. The findings from these interviews and relevant research literature were used to develop a survey instrument to collect the data necessary to utilize DEA. Once the collected data was validated, DEA models were developed and tested to measure SMS effectiveness across the sampled organizations. The findings supported the notion

that DEA may be used for evaluating SMS effectiveness in organizations. The results were able to show efficiencies in different organizations. Such data could be useful for management and top-level personnel when determining where to allocate resources to improve their SMS.

Moreover, these evaluative methods are in response to the lack of guidance from regulatory bodies, such as the FAA, that have not provided methods for measuring SMS effectiveness. The findings from Stolzer et al. (2018) are promising, but they are based on the findings from a small sample. Further research is needed across a larger sampling pool to add to the validity of the proposed instrument and DEA models for effectiveness measurement.

SMS, Safety Culture, and Collegiate Aviation

Collegiate aviation programs are beginning to pursue SMS for various reasons, including, but not limited to, proactive measures to improve safety and safety culture or to meet increasing accreditation standards from accrediting bodies. Further research into the relationship between SMS implementation and safety culture is needed—especially in collegiate aviation, where the research is limited (Adjekum, 2017; Mendonca & Carney, 2017).

Adjekum (2017) has performed some of the initial research into factors that measure the latent construct of SMS initiative and has proposed a measurement model to assess the relationships between SMS initiative, transformational safety leadership, self-efficacy, and the outcome variable safety behavior measured by safety compliance and safety participation when mediated by safety motivation in a collegiate aviation setting. Under the SMS initiative, two factors were identified: SMS policy implementation and

SMS process engagement (Adjekum, 2017). SMS Policy Implementation refers to the organizational leadership's implementation practices and strategies to ensure the SMS initiative's effectiveness, and SMS Process Engagement refers to the degree of involvement and acceptance of organizational personnel towards the SMS initiative processes.

Adjekum (2017) also found various significant relationships in the proposed measurement model assessing the relationships between SMS initiative, transformational safety leadership, self-efficacy, and the outcome variable safety behavior measured by safety compliance and safety participation, when mediated by safety motivation. SMS policy was noted to have shown importance in the study, consistent with previous SMS studies (e.g., Chen & Chen, 2014). It should be noted that the final measurement model with the best goodness-of-fit indices split SMS Initiative into the two aforementioned factors: SMS Policy Implementation and SMS Process Engagement. SMS Policy Implementation was found to have a significant direct effect on Safety Motivation, a significant direct effect on Safety Compliance, and a more substantial total effect on Safety Compliance when mediated by Safety Motivation. SMS Process Engagement had a significant direct effect on Safety Participation and an even more substantial effect when mediated by Safety Motivation. However, there was no significant direct effect of SMS Process Engagement on Safety Motivation or Safety Compliance. These findings can support collegiate aviation programs in guiding their SMS policy development by showing these policies' effect on components such as Safety Motivation, Safety Compliance, and Safety Participation.

Other findings were related to the other constructs being test in the proposed measurement model: Self-Efficacy and Transformational Leadership (Adjekum, 2017). Self-efficacy refers to people's beliefs in their ability to influence events that affect their lives (Bandura, 2010), and Transformational Leadership is defined as "leadership that inspires and motivates followers to achieve outcomes beyond expectations and helps followers grow and develop by responding to their individual needs," ("Transformational Leadership," n.d.). Chen and Chen (2014) had included Self-Efficacy in their measurement model, which was shown to have effects on Safety Participation and Safety Compliance. At the same time, Barling et al. (2002) and Zohar (2002) have shown the effects of Transformational Leadership on safety climate and safety behavior, respectively.

Adjekum (2017) findings regarding Transformational Leadership showed a direct negative effect on Safety Motivation. It was suggested this could be attributed to chief instructors and other senior staff that exhibit high transformational leadership traits, which could result in front-line individuals (i.e., students in the case of collegiate aviation) developing a sense of complacency and assuming inherently safe systems. This was an exciting finding and perhaps counter-intuitive, which suggests further research needed in other settings. Transformational Leadership was also shown to have a direct positive effect on Safety Participation, and despite a negative effect on Safety Motivation, a positive total effect was found between Transformational Leadership and Safety Participation when mediated by Safety Motivation (Adjekum, 2017).

Safety Motivation was the last construct variable to be discussed in the measurement model. Safety Motivation was found to directly affect the two outcome

variables of Safety Compliance and Safety Participation (Adjekum, 2017). These findings suggest beneficial effects from providing positive reinforcement, awards, public recognition, and other promotional material to encourage Safety Motivation, which will, in turn, are shown to have positive effects on Safety Compliance and Safety Participation.

SMS Types

FAA SMSVP. A GA organization, such as a collegiate flight training program, may pursue SMS through the FAA's SMSVP program (FAA, n.d.-b). This option does not require any formal membership to the governing body and follows guidance published within the Flight Standards Information Management System Volume 17 (FAA, 2019a). The GA organization will use this guide to structure its SMS and determine what elements are needed to meet the FAA's standard.

There are several steps in the process of getting an SMSVP accepted by the FAA. The phases include Preparation Phase, Certificate Management Team (CMT) Implementation Plan Review Phase, Documentation Validation Phase, Design Demonstration Phase, Administrative Process Phase, and Continued Operational Safety (COS) (FAA, 2019a). Furthermore, the certificate holder will pass through multiple categories denoting their progress: Active Applicant, Active Participant, and Active Conformance (FAA, 2019a).

Preparation Phase. The Preparation Phase of implementing an SMSVP will be initiated by the certificate holder sending a letter or email to the SMS Program Office (SMSPO). This will trigger coordination between the certificate holder and Certificate Management Team (CMT) to commit to SMS implementation. Also, the SMSPO will provide materials to the certificate holder and CMT to review.

The certificate holder and CMT will need to meet together with a representative from the SMS Implementation Support Team (IST) for an initial workshop. This workshop is designed to familiarize both the certificate holder and CMT with SMSVP principles. These include Program Tracking and Reporting Subsystem (PTRS) and Safety Assurance System (SAS), Data Collection Tools (DCT), best practices and lessons learned, and communication with the SMSPO (FAA, 2019a). Moreover, the workshop will provide information on organizational concepts and considerations, description of the SMSVP standard, description of the service provider SMS tools, the SMSVP implementation, and validation processes, SMS "Active Participant" acknowledgment, and COS oversight expectations (FAA, 2019a).

The certificate holder will also generate an implementation plan as part of this Preparation Phase (FAA, 2019a). The implementation plan is described as a *roadmap* to conforming to the SMSVP standards (FAA, 2019a). The implementation plan will cover the relevant section from the SMSVP standard, a brief narrative where processes conform to the SMSVP Standard or what actions the certificate holder will take to comply, identification of specific employees by title with implementation responsibilities, estimated target dates expectations will be met, and estimated target dates the certificate holder will be ready for CMT design demonstration phase (FAA, 2019a). This implementation plan is to be submitted to the CMT within 12 months of the initial workshop with the ultimate goal of getting SMSVP acceptance within three years.

CMT Implementation Plan Review Phase. Upon receipt of the certificate holder's implementation plan, the CMT will begin to review the plan. This initial review entails the CMT checking the certificate holder's plan against the SMSVP standard to ensure it

addresses all sections and is in conformance (FAA, 2019a). This review process can result in an acceptable or unacceptable conclusion.

An acceptable conclusion implies that the CMT has found the certificate holder's implementation plan was comprehensive of all the required elements and met the SMSVP standard. This will initiate the CMT to begin the Validation Project Plan (VPP) (FAA, 2019a). The VPP is designed based on the implementation plan submitted by the certificate holder. Given the resources and processes identified in the certificate holder's implementation plan, the CMT will design the VPP to address those elements to allow the certificate holder to validate its processes. A meeting between the CMT and the certificate holder will take place to review the VPP. This meeting requires both the certificate holder and CMT to agree on the terms of the VPP. If there are discrepancies regarding the standards or method of validation, the SMSPO will get involved to resolve any disagreements. Once the implementation plan and VPP are agreed upon, both will be submitted to the SMSPO for review.

An unacceptable implementation plan could result due to a variety of reasons. If the implementation plan is unacceptable, the CMT will notify the certificate holder in writing to explain the deficiencies (FAA, 2019a). A meeting between the certificate holder and CMT could take place to review the discrepancies, if necessary. Again, if there is a disagreement between the certificate holder and CMT, the SMSPO will intervene to resolve these disagreements.

Once the SMSPO has received the implementation plan and VPP, the SMSPO will perform a quality review (FAA, 2019a). The SMSPO will ensure the expectations and plans within the implementation plan and VPP are realistic and appropriate for the

organization's scope seeking SMSVP acceptance. The SMSPO will consider the size, scope, and complexity of different organizations when reviewing these plans. Organizations of different sizes will have different resources available, which will lead to different processes at each organization. However, any organization will still need to show they can meet all of the SMSVP standards. For example, a smaller organization may utilize one team for all risk management processes, where larger organizations may have separate teams for separate functional groups. Once the SMSPO has agreed the certificate holder's implementation plan meets the SMSVP standard, the certificate holder's status will be updated to "Active Participant."

The certificate holder may be managed, and their SMSVP progress tracked through one of two FAA systems: PTRS or SAS (FAA, 2019a). The CMT utilized these systems to validate the progress being made by the certificate holder as they complete different steps along their path to SMSVP acceptance to allow the SMSPO to track the progress. Both systems are meant to provide a means for data collection and oversight of the functional groups being managed in a standardized manner. Currently, the FAA is working to PTRS into SAS to provide a single oversight system (FAA, 2019b).

Documentation Validation Phase. The CMT will review the certificate holder's documentation to ensure it is designed adequately to include all the required SMS activities and processes (FAA, 2019a). The certificate holder must perform their own internal assessment and provide evidence to the CMT upon request to assist with this validation process. In addition to the inclusion of activities and processes, the assignment of critical responsibilities to applicable personnel and the use of appropriate language in the guidance is to be addressed. Concerning the appropriate language, this refers to using

passive language that may be included in manuals. For instance, the SMS guidance being drafted by the certificate holder should not use passive language to describe actions required to occur. This could include a statement regarding the required safety or hazard reports. The certificate holder should phrase this statement in a clear, affirmative manner. Safety or hazard reports *will* be filed is an example of an affirmative use of language. Safety or hazard reports *should* be filed is an example of passive language and should be avoided.

Design Demonstration Phase. The certificate holder will now need to demonstrate the processes that were described in their SMSVP documentation (FAA, 2019a). The certificate holder will have to show that their processes are being applied operationally and are working as designed. Similar to the documentation validation phase, the design demonstration phase will require the certificate holder to show evidence of their internal assessments to the CMT upon request. The certificate holder should perform their internal assessments to validate their processes and show that they are working.

The CMT will record evidence and report its findings using the data collection tools (DCT) (FAA, 2019a). The CMT will update the respective oversight and tracking system (i.e., SAS or PTRS). The CMT will be using their VPP previously agreed upon between the CMT and certificate holder for the demonstration phase. The extent of the demonstrations expected will be dependent upon the size and scope of the operation being performed by the certificate holder. Processes that apply organization-wide may be performed once, while processes that may have some variance may be demonstrated from those different perspectives.

The CMT must complete two demonstrations in collaboration with the SMSPO, which include the SMS Accountable Executive Review Design Demonstration and SMS Safety Risk Management (SRM) (Organisational) Design Demonstration (FAA, 2019a). The Accountable Executive is required to participate in this demonstration either in person or virtually. Successful completion of these two steps is required in order to close out the CMT's VPP.

Administrative Process Phase. This final phase is primarily for documenting and closing out the previous steps of the SMSVP acceptance process. The CMT will record and enter all required documentation into the appropriate oversight and tracking system (i.e., SAS or PTRS). The SMSPO will perform a quality review of the material and ensure all steps have been completed. Once satisfactory, the certificate holder's status will be updated to "Active Conformance." (FAA, 2019a).

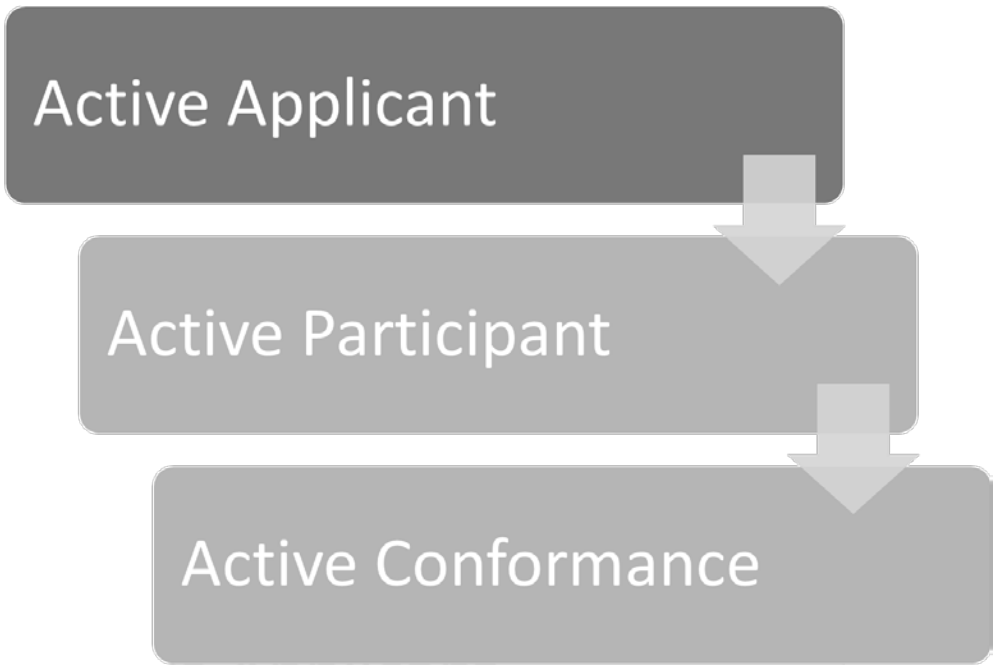


Figure 3. Diagram of the FAA SMSVP acceptance process.

International Business Aviation Council (IBAC). Another option to implement SMS within GA organizations, such as collegiate aviation, is to pursue the IS-BAO standard through IBAC based on ICAO Standards and Recommended Practices (SARPs) (IBAC, n.d.-b). One immediate difference between pursuing the SMS through the FAA's SMSVP program and IS-BAO is cost. IS-BAO requires membership and fees in order to be certified through IS-BAO. However, pursuing IS-BAO has some advantages, including generic manuals organizations can alter to meet the specific needs of their organization and advisors to assist with developing SMS principles in pursuit of the IS-BAO standard.

The certification process is also different for IS-BAO. IS-BAO follows three distinct auditing levels for certification, similar to that of the FAA's SMSVP, but they differ in their purpose and scope (IBAC, n.d.-a). IS-BAO certification begins by purchasing a membership to the service, which initiates a six-step process in pursuit of Stage I of III (IBAC, n.d.-a). These three stages reflect the level of SMS implementation within the organization:

1. Stage I: confirms that the SMS infrastructure is established and that safety management activities are appropriately targeted,
2. Stage II: ensures that safety risks are being effectively managed,
3. Stage III: verifies that safety management activities are fully integrated into the operator's business and that a positive safety culture is being sustained (IBAC, n.d.-b).

In pursuant of Stage I certification, an organization will need to complete a six-step process designed to provide the necessary foundation for a given organization to

achieve higher certification (IBAC, n.d.-a). These six steps include purchasing the standard, attending a two-day workshop, conduct a gap analysis, defining procedures and acceptable risk levels, integrate the processes, and, finally, complete the Stage I audit (IBAC, n.d.-a). This audit is at the expense of the organization and not included in registration fees. However, the team of auditors is approved and provided through IBAC (IBAC, n.d.-a).

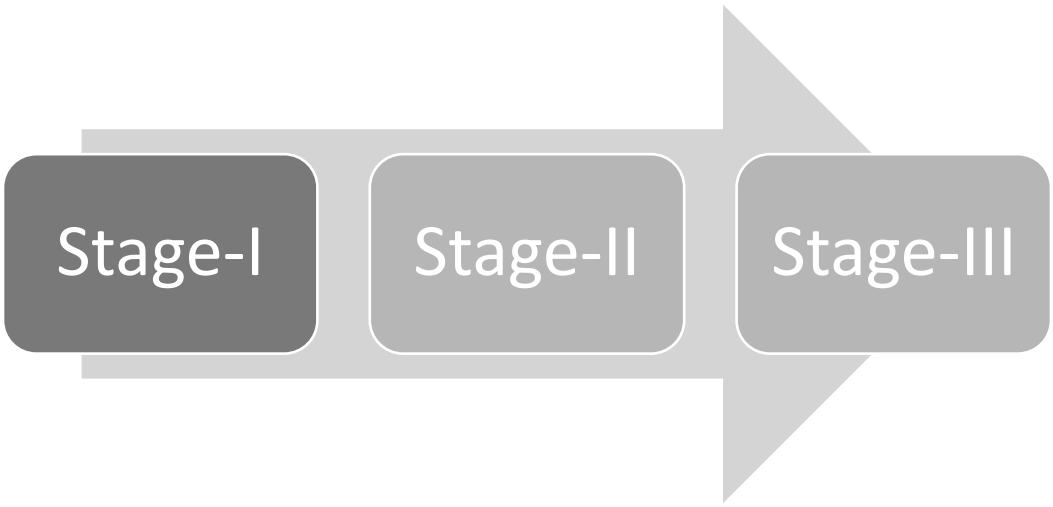


Figure 4. Diagram showing the progressive auditing stages of IBAC IS-BAO SMS.

Summary

This literature review serves as a foundation for the background of the current study. This was not a comprehensive review of all literature on safety culture and SMS. This review was meant to address the relevant research that will be most applicable to the present study. There is a need for additional research into safety culture and SMS in collegiate aviation, given the relatively new push for collegiate aviation programs to adopt and implement SMS programs in their institutions. Attention to how this relates to and affects safety culture is needed to ensure SMS's effective implementation without causing any potential adverse effects.

CHAPTER III

METHODOLOGY

The current study will utilize a concurrent embedded mixed-method approach. Some of the current research is building upon prior research to add to the previously developed models and concepts' validity. Similar methods from this prior research will be utilized to add to these prior research efforts' validity and reliability. Further use of quantitative and qualitative methods will be utilized to address previously unanswered questions while also seeking to address new research questions.

Adjekum (2017) proposed a model to evaluate the relationship between SMS initiative, self-efficacy, transformational safety leadership, and safety behavior mediated by safety motivation. The current study will utilize the final measurement model, which differed from the initially proposed model in that two factors were identified to have composed the SMS initiative construct. Therefore, the final measurement model utilizes SMS policy engagement and SMS process engagement (see figure 1). The original research was performed at a single collegiate aviation program. The current study will test the model across multiple collegiate aviation programs with differing SMS levels and types.

Past research has shown year-group effects (Adjekum, 2014; Adjekum et al., 2016; Gao & Rajendran, 2017) and differing perspectives on safety culture based on nationality (Adjekum, 2014; Liao, 2015). The current research will investigate these same

variables across multiple universities to determine variations in safety behavior perceptions. Much of the past research has been limited in terms of the number of institutions being assessed. The current research seeks to broaden the scope of the assessment by evaluating multiple collegiate aviation programs in this cross-sectional assessment to add to the generalizability of these prior findings. Moreover, the cross-sectional approach to include multiple universities will provide the opportunity to explore any potential effects of different types of SMS programs or levels of SMS implementation. The collegiate aviation programs included in the current study all have different levels and types of SMS implementation. This current research will explore any potential effects of these varying levels and types of SMS implementation.

Qualitative methods will be necessary in order to address the third and final research question. Exploration as to the potential mechanisms as to why there may be variations in perceptions regarding safety behavior based on year-group, SMS type, and SMS implementation is needed. Saldana and Omasta (2017) have suggested that interviews seek to explore a subject's personal experiences related to the study topic based on their values, attitudes, and beliefs. Therefore, a qualitative assessment of any potential variation on perceptions of safety behavior based on the aforementioned variables could prove beneficial for collegiate aviation programs seeking SMS implementation at their institutions.

Research Design

Concurrent Embedded Mixed Method Approach

The current study is using a combination of quantitative and qualitative tools for data collection and analysis. This study's primary scope is to expand upon prior research

performed in collegiate aviation by adding to the validity and reliability of the proposed model (Adjekum, 2017). The current study will test this proposed model across multiple collegiate aviation programs with similar research goals. Additionally, past findings will be assessed at these varying institutions (e.g., year-group effects, nationality effects) to ensure these findings were not unique to the sampled populations in those particular studies (Adjekum, 2014, 2017; Adjekum et al., 2016; Gao & Rajendran, 2017; Liao, 2015).

Moreover, these past findings will be investigated through a qualitative approach. Prior research has found quantitative effects from SMS implementation, but aspects of these effects cannot be quantified. Morse has noted, "…qualitative data could be used to describe an aspect of a quantitative study that cannot be quantified" (as cited in Creswell, 2009, p. 215). SMS implementation's effects, potential effects of varying levels/types of SMS, and year-group effects need to be investigated to a deeper level. A qualitative approach can provide this deeper level of analysis.

Methodology

Population

The quantitative and qualitative components of this study utilized different sampling pools. The quantitative portion sought respondents from various collegiate aviation programs. These programs offer 14 CFR Part 141 flight training and are UAA members. The student populations at these institutions vary from as low as 300 students to as high as 1,500. Moreover, these institutions all have varying levels and types of SMS programs. Some are in the earlier stages of building formal SMS programs, and others have well-established, recognized SMS programs. Seeking programs with these varying

SMS implementation levels and type was necessary, given the research goals of determining any potential effects based on these factors.

The qualitative portion of the study was limited to three of the four aforementioned collegiate aviation programs. It was initially desired to perform the qualitative analysis at all four institutions, but access to the fourth organization was not granted for that portion of the research. Therefore, three of the four initially proposed collegiate aviation programs were utilized for the qualitative portion. These three organizations still provided a mix of varying levels and types of SMS implementation and type. One school is just beginning the pursuit of FAA recognized SMSVP and is considered in the *active applicant* stage, the second school has reached the level of *active conformance* through the FAA's SMSVP, and the last school has reached the third and final stage of IS-BAO's SMS program. This sampling pool will provide insight into any potential differences in the SMS type. Additionally, the varying levels of implementation (e.g., *active application* versus *active conformance*) will provide insight into any potential differences based on the implementation level.

Sampling Procedures

Power Analysis and Sample Size Selection

When considering the sample size for SEM, the model itself must be considered. A base recommendation of minimum sample size may not suffice for specific models. Kline (2011) suggests considering the model parameters when determining an adequate sample size as simpler models may work with a smaller sample. More complex models require a larger sample. More specifically, Jackson (2003) offers the *N:q rule,* which is applicable when using the maximum likelihood estimation method and suggests a ratio of

20:1. That is 20 participants to each parameter in the model. Given that the proposed model has 14 parameters, a minimum suggested sample size of 280 participants is suggested. The proposed sampling pool of four collegiate aviation programs, some of which have over 1,000 students, should provide ample participants for analysis.

Given that one of the variables being tested with this study is year-group effects, it is prudent to include students and CFIs. Many students will graduate and get hired by their respective institutions as CFIs to build time. This increased time at a given institution provides insight into the potential year-group effects. This sample will provide responses from first-year students to graduated students working as CFIs who may have been at the institution for longer than four years.

During the qualitative portion, it is desired to seek two first-year students or sophomores, two juniors or seniors, two CFIs, and a leader from the safety department at each institution. This is to gather data from multiple perspectives at different critical points in one's tenure at a given institution. First-year students and sophomores will have the least amount of exposure to the organization's culture and provide that initial perspective. Juniors and seniors will most likely have been at the institution for many years, assuming the student is not a transfer, and has likely experienced a shift in safety culture perceptions. Moreover, assuming the CFI was a previous student and has been at the institution for potentially longer than four years, this perspective, along with the change in the role, can provide insight into any potential effects associated with either of those factors.

Interviewing safety leadership will provide a point of comparison from which to consider the student and CFI perspectives. Since those in safety leadership positions are

responsible for promoting their institution's safety culture, they will provide insight into their desired cultural perception. A comparison between those in safety leadership positions to the frontline personnel (i.e., students and CFIs) will provide useful insight into how and how well safety culture is being promoted, communicated, and instilled throughout each organization.

Procedures for Recruitment, Participation, and Data Collection

The Institutional Review Board (IRB) reviewed the research protocols proposed and approved. Representatives from each institution selected to participate in the study were contacted to request access to students, CFIs, and safety leadership personnel for this study. These representatives provided letters of assurance that they would grant access to all of the requested individuals.

For the quantitative portion of this study, a link was generated to grant access to an anonymous survey generated using Qualtrics®. This link was distributed to the representatives previously contacted at each institution to be sent to the student and CFI body. The link was also distributed to different UAA representative members for distribution. Each representative sent the link to their respective students and CFI body through institutional email. Each participant would access the link through their institutional email. Upon opening the link, they would review the terms of the survey and provide implied consent by opting to complete the survey. Once in the survey, each participant has the option to cease participation at any point without any potential for negative repercussions. The responses to any completed surveys were stored online through the Qualtrics® server as approved by the IRB.

Subjects for interviews were recruited similarly to the quantitative survey. A request letter was sent to each institution representative for distribution to the student and CFI body. The letter was then emailed to the student and CFI population at each institution requesting volunteers to participate in semi-structured interviews. Participation was voluntary, and there were no incentives offered in any case.

A combination of stratified, deliberate, and convenience sampling was utilized. Stratified sampling was used when there are several potential candidates to select from for the interviews. This was to attain the desired distribution of multiple year-group candidates along with CFIs. An individual considered to be in a safety leadership position was interviewed at each institution except for the authors. Given the author's employment at one institution and a recent role in a safety leadership position, it was deemed redundant to interview someone within the institution.

Volunteers selected were sent an invitation to conduct the interview through Zoom®. Before conducting the interview, each participant was sent a copy of the interview outline to review the questions ahead of time. Participants were also sent the consent forms for electronic signature before conducting the interviews. The interviews were recorded and transcribed for analysis. After the interview was complete, each participant was sent a copy of the transcript to validate the transcript's contents.

The transcripts were analyzed through a combination of automated tools included in NVivo® and manual coding. “Coding is the process of organizing the material into chunks or segments of text before bringing meaning to information” (Rossman & Rallis, 1998, p. 171, as cited in Creswell, 2009). Moreover, Saldana and Omasta (2017) describe the process of coding as, “Coding is symbolizing—the condensation of a datum into a

richer, more compact form of meaning" (p. 181). Interview transcripts generate a high quantity of data and coding allows the researcher to condense the data into manageable portions with the intent to elicit themes and meaning from the data.

Field notes and analytic memo writing were additional methods employed for the qualitative analysis. Field notes, or jottings, while performing an interview can supplement the audio-recordings to add to data by recalling details or facts the audio-recordings are incapable of capturing (Saldana & Omasta, 2017). Analytic memos are described as "…reflective narratives that expand and expound on observations by taking researchers' thinking and writing up a notch. With memoing, researchers attempt to transcend the descriptive of their field notes and venture into richer analytic connections and insights" (Saldana & Omasta, 2017, p. 97). Analytic memos were written after each interview, or sometimes after a series of closely conducted interviews, with the purpose of developing connections. After multiple interviews, reflecting on common themes to determine associations between the interviewees' data helped the researcher condensing the qualitative data to derive themes effectively.

Demographic Details

The demographic information collected from the survey included year-group (i.e., first-year, sophomore, junior, senior, or not applicable), gender, international student status, University attending or employing the participant, type of SMS in place or pursuing, and functional group (i.e., student, permanent employee/staff, or faculty). These demographic variables were selected to perform further analysis on past findings regarding year-group effects (Adjekum, 2014; Adjekum et al., 2016) and nationality effects (Adjekum, 2014; Liao, 2015). The IRB approved these demographic variables and

data collection methods. Given the large sample size between multiple universities, it is unlikely that personal identifying information could be derived from the responses. No personal identifying information was collected outside of the aforementioned demographic details.

Instrumentation and Operationalization of Constructs

All of the constructs being used in the measurement model will be discussed below. A five-point Likert scale (1 = strongly disagree to 5 = strongly agree or 1 = never to 5 = always) will be used to measure all scales. Upon completing the data collection, composite reliability will be assessed. A minimum value ($\alpha = 0.70$) will be utilized in all cases, which is considered acceptable (Field, 2018).

SMS Process Engagement and SMS Policy Implementation

The first two scales to be assessed are the result of prior work by Adjekum (2017). This foundational work sought to determine the latent factors that measure the latent construct of the SMS initiative (Adjekum, 2017). The original scale was developed from various sources directed toward assessing SMS (Chen & Chen, 2012, 2014; Transport Canada, 2005). Some of the questions were modified from their original form to better suit the scope of collegiate aviation. For instance, the use of "Dean" or "University President" when referring to the Accountable Executive was changed.

Using exploratory factor analysis (EFA), two factors emerged: SMS policy implementation and SMS process engagement (Adjekum, 2017). For the current study's purposes, six items were selected with the highest factor loadings to represent each scale based on the findings in the original study (Adjekum, 2017). All items selected had

strong factor loadings, and additional confirmatory factor analysis (CFA) will be performed to validate consistency.

Safety Motivation

The safety motivation scale was initially developed by Neal et al. (2000) and has since been used in other studies involving the assessment of safety culture and climate (Adjekum, 2017; Neal & Griffin, 2006). Neal and Griffin describe the safety motivation scale as "…the extent to which individuals viewed safety as an important part of their work life" (2006, p. 948). Safety motivation will be used as a mediating measure between the two aforementioned SMS scales (i.e., SMS process engagement and SMS policy implementation) and the outcome variables (i.e., safety behavior as measure by safety participation and safety compliance and safety reporting).

Safety Behavior

Safety behavior refers to two different constructs: safety participation and safety compliance. This breakdown is based on work from Borman and Motowidlo (1993), who proposed that there are two majors components of performance: task performance and contextual performance (as cited in Griffin & Neal, 2000). Griffin and Neal (2000) use this definition to apply safety compliance and safety performance concepts to represent safety behavior. Safety compliance refers to activities that need to occur to exist for a safe work environment. In comparison, safety participation refers to voluntary activities that may enhance safety but is not considered to have the same direct effects that safety compliance has on a safe working environment.

Safety Reporting

Multiple studies have been performed on the relationships between different variables on collegiate aviation safety reporting behavior (Adjekum et al., 2015, 2016; Robertson, 2016). A strong reporting culture is considered to be a sought after cultural state (Dekker, 2012; FAA, 2015a; ICAO, 2009; Reason, 1997). Therefore, measuring the different effects variables can have on reporting culture is key to encouraging further safety advancements.

The safety reporting behavior scale in the present study is based on prior work from Adjekum (2014). Adjekum (2014) developed the CAPSCAS, and this instrument included questions to assess the reporting system within the *Formal Safety Program* scale. The CAPSCAS and reporting system questions are based on work from Gibbons et al. (2006), in which the CASS was developed. Modifications have been made to the CAPSCAS since its conception (Adjekum et al., 2015, 2016).

CHAPTER IV:

DATA ANALYSIS AND RESULTS

Demographic Information

After four weeks, the survey was closed. Four hundred and fifty-one (n = 451) responses were considered for analysis, which completed the survey past the consent page. Sixty (n = 60) responses were deleted due to not consenting to the survey and did not provide adequate data for analysis. Any missing data were replaced using a regression-based single input method. A regression-based imputation method replaces missing scores with a "…predicted score using multiple regression based on non-missing scores on other variables" (Kline, 2011, p. 58). A limitation of single-imputation methods is that they tend to underestimate error variance, especially if the proportion of missing observations is relatively high (Vriens & Melton, 2002, as cited in Kline, 2011).

Considering the student group responses, ninety-four (n = 94) first-year students, seventy-seven (n = 77) sophomores, eighty-two (n = 82) juniors, one hundred thirty-four (n = 134) seniors, and sixty-four (n = 64) "Other" were recorded. The respondents in the "Other" category included CFIs, students who have completed their course work but were still flying, and graduate students. Those in the "Other" category do not fit into a traditional year group category as they do not retain traditional student status, but they do continue to play a significant role within the collegiate aviation operation. Respondents were also asked for their functional group. Three hundred seventy-seven (n = 377) were

students, sixty-one (n = 61) were permanent employee or staff, twelve (n = 12) were faculty, and one (n = 1) respondent did not provide their functional group status.

Respondents were asked to provide their highest flight certificate held. One hundred twenty-seven (n = 127) respondents held a student pilot certificate, one hundred ninety-eight (n = 198) held a private pilot certificate, forty-five (n = 45) held a commercial pilot certificate, eighty (n = 80) held a CFI or Airline Transport Pilot (ATP) certificate, and one (n = 1) did not answer this question. All the responses in this study were from ten (n = 10) different collegiate aviation programs across the United States.

Respondents were also broken down by international student status and gender. Three hundred sixty (n = 360) respondents were male, eighty-eight (n = 88) were female, and three (n = 3) did not disclose their gender. Thirty-six (n = 36) respondents were classified as international students, four hundred fourteen (n = 414) were domestic, and one (n = 1) did not disclose their student status as being international or domestic. For the purposes of this study, domestic students are those that are U.S. citizens or have alien resident status.

Respondents were also asked to provide information about their SMS status. This demographic question was meant to determine what type of SMS program their institution was pursuing or currently had accepted and whether the respondents were aware of this status. Two hundred forty-six (n = 246) answered as having or pursuing a FAA accepted SMSVP, nine (n = 9) answered IBAC IS-BAO, one hundred eighty-eight (n = 188) answered "Do not know," seven (n = 7) answered "None," and one (n = 1) did not answer. See tables 1, 2, and 3 for demographic distributions.

Table 1. Demographic variables Year Group, Flight Certificate Held, and Gender.

Variable	N	Percentages
Year Group		
First-year student	94	20.8%
Sophomore	77	17.1%
Junior	82	18.2%
Senior	134	29.7%
Other	64	14.2%
Total	**451**	**100%**
Highest Flight Certificate Held		
Student	127	28.2%
Private	198	43.9%
Commercial	45	10.0%
CFI or ATP	80	17.7%
Missing	1	0.2%
Total	**451**	**100.0%**
Gender		
Male	360	79.8%
Female	88	19.5%
Missing	3	0.7%
Total	**451**	**100.0%**

Table 2. Demographic Variables of International Status, SMS Status, and Functional Group.

Variable	N	Percentages (%)
Are you an international student?		
Yes	36	8.0%
No	414	91.8%
Missing	1	0.2%
Total	**451**	**100.0%**
What kind of Safety Management System (SMS) does your institution have or currently pursuing?		
FAA SMSVP	246	54.5%
IS-BAO / Third Party	9	2.0%
SMS		
Do not know	188	41.7%
None	7	1.6%
Missing	1	0.2%
Total	**451**	**100.0%**

Table 3. Demographic Variables of Functional Group and University Attending.

Variable	N	Percentages (%)
What is your functional group?		
Student	377	83.6%
Permanent Employee/Staff	61	13.5%
Faculty	12	2.7%
Missing	1	0.2%
Total	**451**	**100.0%**
What University do you attend for flight training or currently employs you?		
Unknown	10	2.2%
University A	7	1.6%
University B	4	0.9%
University C	20	4.4%
University D	4	0.9%
University E	50	11.1%
University F	13	2.9%
University G	142	31.5%
University H	1	0.2%
University I	16	3.5%
University J	184	40.8%
Total	**451**	**100.0%**

Quantitative Data Analysis and Validation

The quantitative data were downloaded from Qualtrics® into IBM SPSS Statistics 27® and IBM SPSS Amos 26 Graphics® for analysis. All analyses were assessed for statistical significance at the 0.05 alpha level (2-tailed) unless otherwise specified. Given the use of previously validated scales in the present study, Confirmatory Factor Analysis (CFA) was used to determine whether scale items that measured various latent constructs such as SMS and Safety Participation (SPB) are consistent with the researcher's understanding of the nature of that construct. It was also used to test whether the research data fit hypothesized measurement models of the relationships between study constructs/variables. The reliability of the scale is tested using the composite reliability method. Field (2018) recommends a value of 0.70 or higher when assessing reliability. See Appendix F for a visual depiction of the final measurement model with regression weights and Appendix G for a table containing the goodness-of-fit indices for the final measurement model.

Additionally, convergent validity was assessed using the average variance extracted method (AVE). Fornell and Larcker (1981) suggest a value above 0.50 when assessing the presence of convergent validity. Discriminant validity was assessed by comparing each AVE's square root with the correlation coefficients for each construct.

A first-order uni-dimensional CFA (Confirmatory Factor Analysis) was performed on each construct explored in this study: SMS Policy Implementation (SMSPol), SMS Process Engagement (SMSProc), Safety Reporting Behavior (SR), Safety Compliance (SCB), Safety Participation (SPB), and Safety Motivation (SMot). IBM SPSS Amos 26 Graphics® was used for this analysis to determine the goodness of

fit indices and factor loadings. This first assessment resulted in post hoc modification to the initial measurement model of the SMSProc construct. Some low factor loadings affected the fitness of the model. The modification resulted in removing two items (Q4.5, Q4.6), which had low loading from the original six. There were no other modifications made to scale items.

Composite reliability was calculated for all items in the measurement model to assess the reliability of the items on each scale. All items assessed were above the 0.70 thresholds except for SRB ($\alpha = .60$). The relatively fair reliability of SRB could be due to inadequate understanding and responses to the construct items by respondents or the low number of items that explained the construct (3). These factors need to be considered when making inferences using this SRB scale. Table 4 has the values of composite reliability for all scales.

Descriptive analyses were conducted using IBM SPSS Statistics 27®. Descriptive analysis included mean, median, standard deviation, standard error of the mean, normality tests (kurtosis and skewness), and visual inspection of normal distribution curves. High indications of kurtosis were observed for two variables: SMot (Safety Motivation) and SCB. Given that regression-based single-imputation was used to replace missing values, there is the possibility that a high frequency of common values reduced the variance (Vriens & Melton, 2002, as cited in Kline, 2011). Visual inspection of the histogram for these variables showed positive peaks near the normal distribution curve's mean representative of these shared values. This is a limitation of any single-imputation method for replacing missing data (Vriens & Melton, 2002, as cited in Kline, 2011). See table 4 for all the descriptive statistics for the study variables.

Table 4. Details of Descriptive Statistics of all the Study Variables

	SMot	SPB	SCB	SR	SMSProc	SMSPol
N	451	451	451	451	451	451
Mean	3.99	3.61	4.46	4.63	2.78	3.83
Median	4.07	3.61	4.55	4.63	2.78	3.96
Std. Deviation	0.249	0.538	0.379	0.755	0.523	0.685
Skewness	-5.902	-0.958	-4.225	-1.041	-1.072	-2.379
Std. Error of Skewness	0.115	0.115	0.115	0.115	0.115	0.115
Kurtosis	59.489	2.079	28.625	1.024	1.356	6.087
Std. Error of Kurtosis	0.229	0.229	0.229	0.229	0.229	0.229
Composite Reliability	0.80	0.79	0.83	0.60	0.79	0.93
Number of Items in Scale	3	3	3	3	4	6

Convergent validity was assessed using the AVE method (Fornell & Larcker, 1981). The AVE method is used to assess the amount of variance captured by the construct in relation to the variance explained by error (Fornell & Larcker, 1981). The values for all scales were above the 0.5 thresholds apart from SR (0.36). This suggests evidence of convergent validity in the SR scale with other scales. Discriminant validity was assessed by comparing the square root of each AVE with the correlation coefficients for each construct. If the square root of each AVE is more than the correlation coefficient, discriminant validity is believed to exist (Fornell & Larcker, 1981). Based on

the analysis, discriminant validity can be assumed. See table 5 for the values of AVE and correlations.

Table 5. The square root of the AVE (diagonal) and correlations between constructs (off-diagonal)

	AVE	SPB	SMSPol	SMSProc	SR	SCB	SMot
SPB	0.56	**0.746**					
SMSPol	0.68	0.205	**0.823**				
SMSProc	0.50	0.094	0.219	**0.698**			
SR	0.36	0.358	0.318	0.412	**0.599**		
SCB	0.63	0.453	0.310	0.276	0.295	**0.791**	
SMot	0.57	0.332	0.394	0.286	0.318	0.493	**0.758**

Question One

What are the strengths of the relationship between SMS process engagement, SMS policy implementation, safety motivation, and the outcome variables safety behavior measured by safety compliance and safety participation and safety reporting behavior across multiple collegiate aviation programs?

After the construct and discriminant validity for constructs were determined, and the reliability of scale items assessed, the next phase of determining the goodness-of-fit for all measurement models was done. The Structural Equation Model (SEM) approach was used to determine the fit of measurement models. A variety of fit indices are Chi-square (χ^2), Root Mean Square Error of Approximation (RMSEA), Comparative Fit

Index (CFI), Tucker-Lewis Index (TLI), Normed Fit Index (NFI), and Incremental Fit Index (IFI). All these values will be reported as part of the structural model assessment.

The chi-square (χ^2) test is commonly reported. However, it is sensitive to sample size (Vandenberg, 2006). Kline (2011) suggests that a significant chi-square test with between 200-300 cases (n = 200-300) can be indicative of significant issues to reject the model, but the current sample size is more than 450 cases.

RMSEA is another commonly reported statistic to assess model fit. The RMSEA statistic is not sensitive to sample size like chi-square but can be sensitive to model complexity (Brown, 2006). RMSEA of less than 0.05 is ideal, and greater than 0.10 would indicate issues (Kline, 2011).

The Bentler Comparative Fit Index (CFI) is another statistic often used. The CFI is "an incremental fit index that measures the relative improvement in the fit of the researcher's model over that of a baseline model" (Kline, 2011, p. 208). The CFI statistic can range from 0 – 1.0, and greater than or equal to 0.95 is considered an acceptable fit (Kline, 2011).

The Tucker-Lewis index (TLI) is a non-normed fit index. The TLI can have values outside of the range of 0 – 1.0, but it is ideal to have a value approaching 1.0 (Brown, 2006). Similar to CFI, if TLI is greater than 0.95, this is considered indicative of a good model fit.

The last two statistics reported are the Normed Fit Index (NFI) and Incremental Fit Index (IFI). NFI and IFI should be above .90; otherwise, it suggests the need for model improvements (Bentler & Bonett, 1980). A combination of reported fit indices can help with assessing the best model fit. According to Hu and Bentler (1999), using cutoff

values of 0.95 for TLI and CFI in conjunction with a cutoff value close to 0.06 for RMSEA seems to result in lower Type II error rates with acceptable costs of Type I error rates.

An initial assessment was done on the hypothesized measurement model that showed the relationships between the variables. The initial analysis of the fully mediated measurement model did not yield adequate goodness-of-fit indices. See figure 5 for the measurement model. Based on recommendations suggested by IBM SPSS Amos 26 Graphics® modification indices function, covariances were added between the error terms to improve model fit.

Covariances were added between e2/e3, e2/e4, and e5/e6. Additionally, the direct path from SMSProc to SPB was removed for theoretical reasons. SMSProc was expected to have a higher predictive power as it relates to other scales; therefore, it was not expected to see a significant impact between these SMSProc and SPB. Subsequent iterations were done on the measurement model to improve the fit indices. Competing models were evaluated, and the best-fitting model was selected.

IBM SPSS Amos 26 Graphics® did suggest further modifications (i.e., the covariance between e3/e4), but these modifications were not implemented. When the analysis was run with the covariance between e3/e4, model fit indices suggested an overfit model, which is not conducive to hypothesis testing (Brown, 2006; Kline, 2011). See Model II fit indices in table 6 and figure 6 for a graphic representation of the overfitted model.

After making the adjustment suggested by IBM SPSS Amos 26 Graphics®, model fit indices were improved to acceptable levels: $\chi 2$ (2, n = 451) = 6.188, CMIN/DF

= 3.094, p = .045, NFI = 0.992, IFI = 0.994, TLI = 0.958, CFI = 0.994, RMSEA = .068 (.009 - .132). It was determined that this model showed the best fit for the data among the other competing structural models and was used for hypothesis testing. See figure 7 for a graphic representation of the final structural model showing the relationships between the study variables.

Table 6 shows all reported goodness-of-fit statistics for the competing models. See table 7 for a summary of the maximum likelihood estimates (MLE), standard error (SE), critical ratios (CR), p-values, estimated effect sizes, and hypotheses of the final measurement model with best goodness-of-fit. Table 8 contains significance values for mediating effects and squared multiple correlations (R^2) for effect size, which provides the amount of variance explained by the predictor variables (Byrne, 2010).

Hypothesis Testing

This study seeks to address the effects of SMSPol and SMSProc on safety behavior as measured by SCB, SPB, and SR. Additionally, the SMot mediating role on the relationships between SMS components and the outcome variables measuring safety behavior. The 14 hypotheses were assessed via SEM-PA. Standardized regression coefficients will be reported throughout the results to show the effect the predictor variables have on outcome variables.

Hypothesis 1. The first hypothesis tested the respondents' perceptions of the relationship between their collegiate aviation program's SMS process engagement and safety motivation in the program. The results indicated that the relationship between SMSProc and SMot was statistically significant ($\beta = 0.243$, SE = 0.020, C.R. = 5.737, $p < .001$), and supported the hypothesis. The direct effect of SMSProc on SMot was .243.

Table 6. Goodness-of-Fit Estimates for Various Structural Models.

Iteration	Chi-square ($\chi 2$)	NFI	IFI	TLI	CFI	RMSEA
Model I	$\chi 2$ (4, n = 451) = 175.797, CMIN/DF = 43.949, p < .001	0.768	0.772	0.134	0.769	.309 (.271 - .349)
Model II	$\chi 2$ (1, n = 451) = .200, CMIN/DF = .200, p = .655 (Covary e2/e3, e2/e4, e3/e4, and e5/e6. Removal of SMSProc --> SPB)	1.000	1.001	1.016	1.000	.000 (.000 - .096)
Model III	$\chi 2$ (2, n = 451) = 6.188, CMIN/DF = 3.094, p = .045 (Covary e2/e3, e2/e4, and e5/e6. Removal of SMSProc --> SPB)	0.992	0.994	0.958	0.994	.068 (.009 - .132)

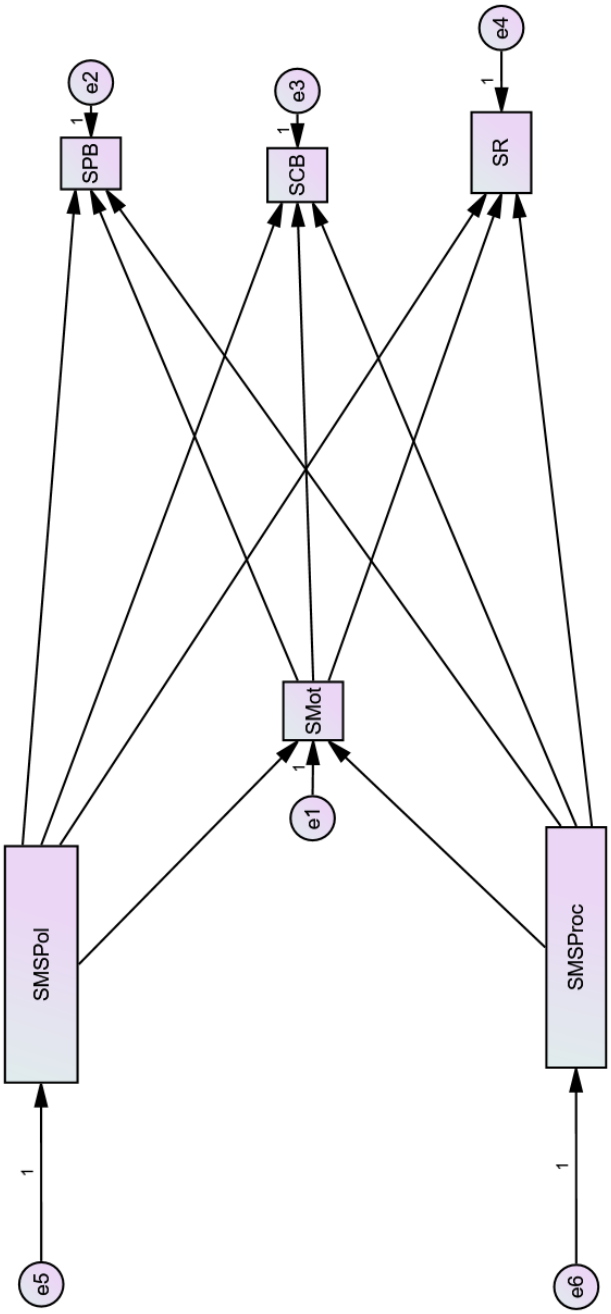


Figure 5. Model I – The fully mediated model.

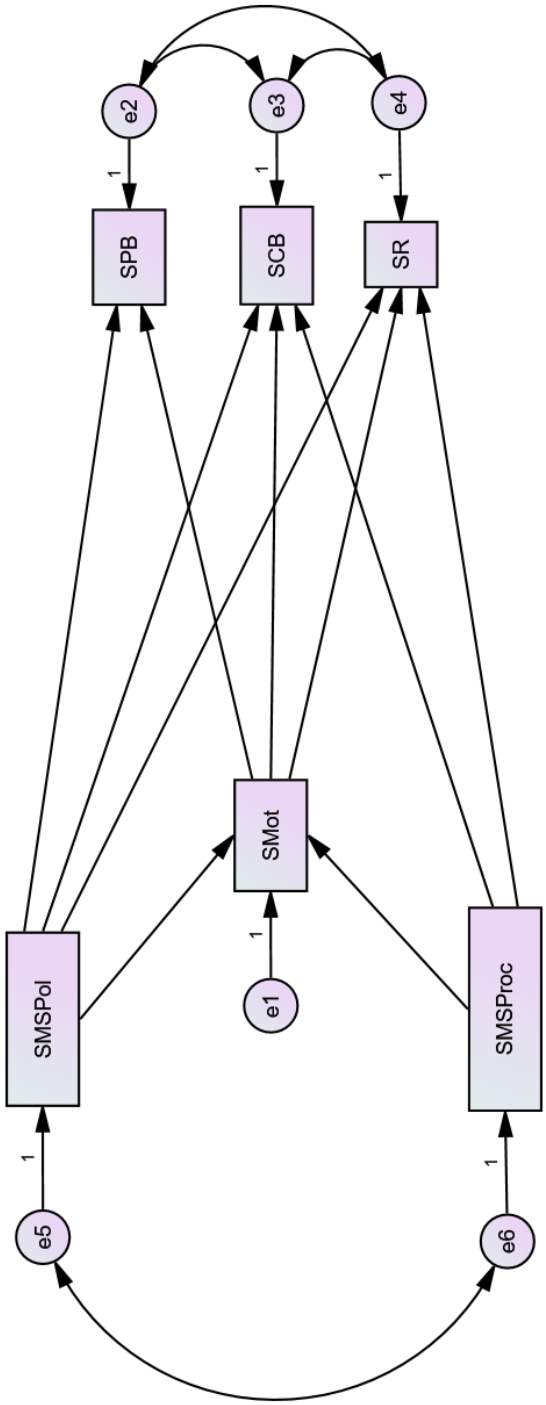


Figure 6. Model II – The overfit model.

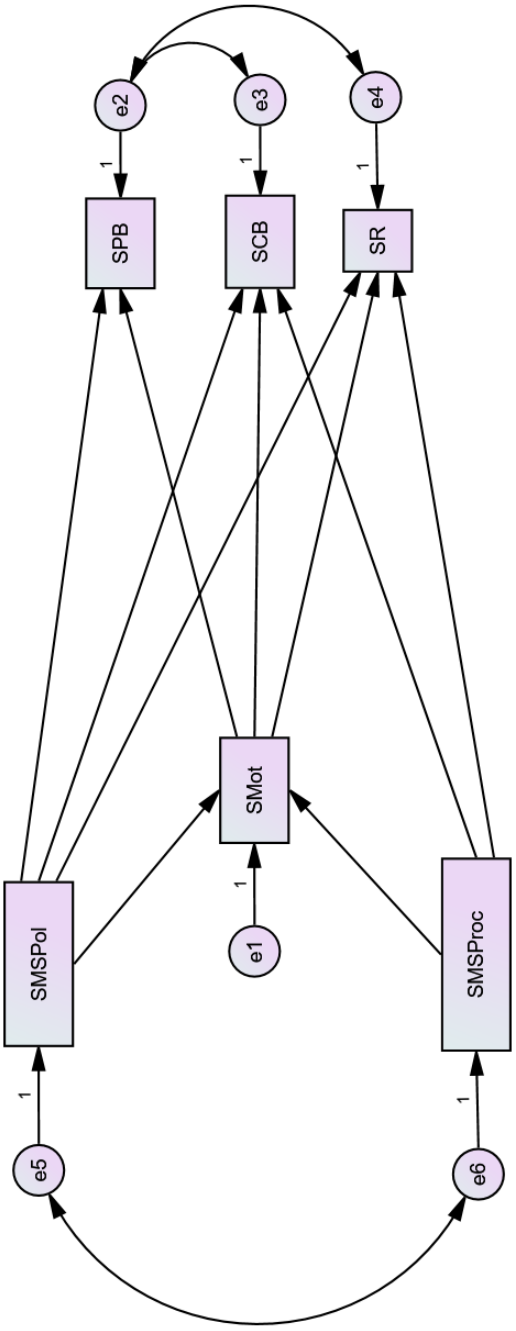


Figure 7. The final structural model with best-fit indices.

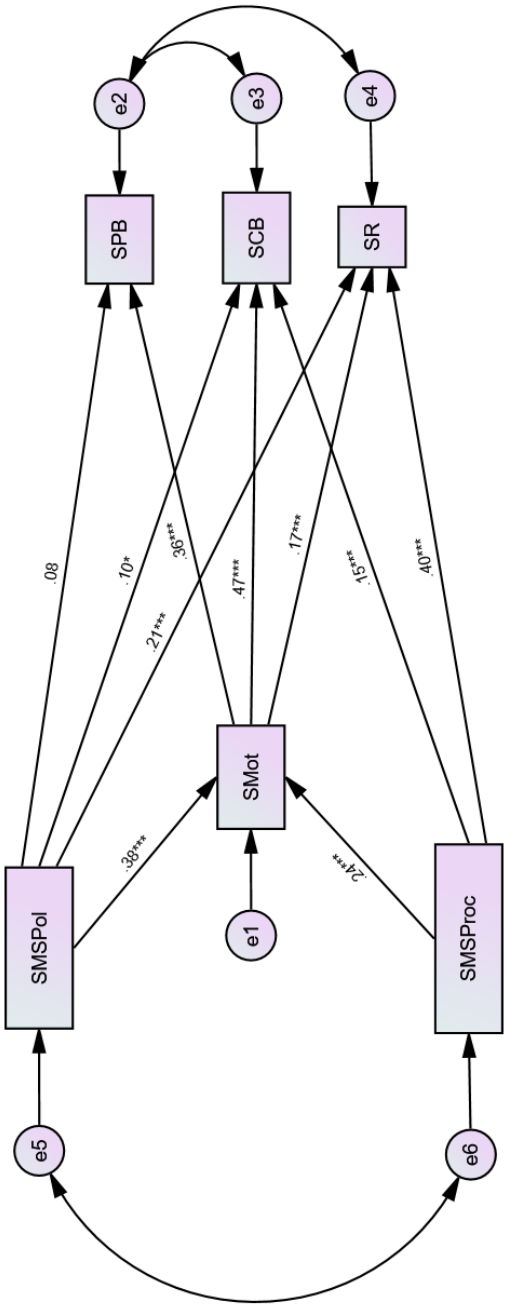


Figure 8. Model III – The final structural model with standardized regression weights.

Table 7. Estimates of Final Measurement Model of the Relationship Between SMSPol, SMSProc, SMot, SPB, SCB, and

		Interactions	Estimate	S.E.	C.R.	P	β	Direct Effect	Indirect Effect	Total Effect	Hypothesis Testing
SPB	<---	SMSPol	0.062	0.037	1.656	0.098	0.080	0.080	0.135	0.214	Not
SMot	<---	SMSPol	0.137	0.015	8.889	***	0.376	0.376	0.000	0.376	**Supported**
SCB	<---	SMSPol	0.057	0.024	2.408	0.016	0.103	0.103	0.175	0.278	**Supported**
SR	<---	SMSPol	0.228	0.047	4.857	***	0.206	0.206	0.065	0.271	**Supported**
SPB	<---	SMot	0.765	0.102	7.471	***	0.359	0.359	0.000	0.359	**Supported**
SCB	<---	SMot	0.710	0.067	10.661	***	0.466	0.466	0.000	0.466	**Supported**
SR	<---	SMot	0.523	0.132	3.954	***	0.172	0.172	0.000	0.172	**Supported**
SCB	<---	SMSProc	0.105	0.028	3.830	***	0.145	0.145	0.113	0.258	**Supported**
SR	<---	SMSProc	0.580	0.055	10.484	***	0.401	0.401	0.042	0.443	**Supported**
SMot	<---	SMSProc	0.116	0.020	5.737	***	0.243	0.243	0.000	0.243	**Supported**

Note ***p<.000, **p<.001, *p<.05

Table 8. Indirect Effects - Two Tailed Significance and R^2 Effect Size.

	SMSProc	SMSPol	R^2
SMot	...	...	0.245
SPB	0.006	0.006	0.160
SR	0.008	0.007	0.351
SCB	0.003	0.003	0.344

That is, due to the direct (unmediated) effect of SMSProc on SMot, when SMSProc goes up by one standard deviation, SMot goes up by 0.243 standard deviations. Standardized regression coefficients will be reported throughout the results to show the effect the predictor variables have on outcome variables.

Hypothesis 2. The hypothesis tested the relationships between respondents' perceptions of their collegiate aviation programs SMSProc and SCB. The results indicated the that the relationship between SMSProc and SCB was statistically significant ($\beta = 0.145$, SE = 0.028, C.R. = 3.83, $p < .001$), and supported the hypothesis. The direct effect of SMSProc on SCB was 0.145.

Hypothesis 3. The hypothesis stated the relationships between respondents' perceptions of their collegiate aviation program's SMS process engagement are related to their safety participation. The final model did not have any relational pathway between the two variables, and, therefore, the hypothesis was not supported.

Hypothesis 4. The hypothesis stated the relationships between respondents' perceptions of their collegiate aviation program's SMS process engagement are related to their safety reporting. The results indicated the that the relationship between SMSProc

and SR was statistically significant (β = 0.401, SE = 0.055, C.R. = 10.484, $p < .001$), and supported the hypothesis. The direct effect of SMSProc on SR was 0.401.

Hypothesis 5. The hypothesis stated that safety motivation mediates the relationship between respondents' perceptions of their collegiate SMS process engagement and safety compliance. The results indicated SMot significantly mediated the path between SMSProc and SCB. The indirect effect coefficient was 0.113 and was statistically significant ($p = .003$). The standardized total (direct and indirect) effect of SMSProc on SCB is .258. Due to both direct (unmediated) and indirect (mediated) effects of SMSProc on SCB, when SMSProc goes up by one standard deviation, SCB goes up by 0.258 standard deviations.

Hypothesis 6. The hypothesis stated that safety motivation mediates the relationship between respondents' perceptions of their collegiate SMS process engagement and safety participation. While the direct path from SMSProc to SPB was not included in the final model, the mediated model showed statistical significance ($p = .006$). The indirect effect coefficient was small (.087), and the standardized total (direct and indirect) effect of SMSProc on SPB is .087. The results do support the hypothesis.

Hypothesis 7. The hypothesis stated that safety motivation mediates the relationship between respondents' perceptions of their collegiate SMS process engagement and safety reporting. The results showed a statistically significant effect for SM mediating the relationship between SMSProc and SR ($p = .009$). The indirect path coefficient was .042, and the standardized total (direct and indirect) effect of SMSProc on SR is .443. These results supported the hypothesis.

Hypothesis 8. The hypothesis stated the relationships between respondents' perceptions of their collegiate aviation program's SMS policy implementation are related to their safety motivation. The results indicated a statistically significant relationship (β = 0.376, SE = 0.015, C.R. = 8.889, $p < .001$), and supported the hypothesis. The direct path coefficient between SMSPol and SMot was .376. Due to the direct (unmediated) effect of SMSPol on SMot, when SMSPol goes up by one standard deviation, SMot goes up by 0.376 standard deviations.

Hypothesis 9. The hypothesis stated the relationships between respondents' perceptions of their collegiate aviation program's SMS policy implementation are related to their safety compliance. The results indicated a statically significant relationship (β = 0.103, SE = 0.057, C.R. = 2.408, $p = .016$), and supported the hypothesis. The direct path coefficient between SMSPol and SCB was .103.

Hypothesis 10. The hypothesis stated the relationships between respondents' perceptions of their collegiate aviation program's SMS policy implementation are related to their safety participation. The result did not indicate a statistically significant relationship between SMSPol and SPB ($p = .098$) and did not support the hypothesis.

Hypothesis 11. The hypothesis stated the relationships between respondents' perceptions of their collegiate aviation program's SMS policy implementation are related to their safety reporting. The results indicated a statistically significant relationship between SMSPol and SR (β = 0.206, SE = 0.047, C.R. = 4.857, $p < .001$), and supported the hypothesis. The direct path coefficient between SMSPol and SR was .206.

Hypothesis 12: The hypothesis stated that safety motivation mediates the relationship between their perceptions of their collegiate SMS policy implementation and

safety compliance. The results indicated a statistically significant mediating role of SMot between SMSPol and SCB (p = .003). The indirect path coefficient between SMSPol and SCB was .175, with a total path coefficient of .278.

Hypothesis 13. The hypothesis stated that safety motivation mediates the relationship between their perceptions of their collegiate SMS policy implementation and safety participation. The results showed a statistically significant mediating effect of SMot between SMSPol and SPB (p = .006). The indirect path coefficient between SMSPol and SPB was .135, with a total effect of .214. Despite the direct path between SMSPol and SPB not being statistically significant (p = .098), the mediated path through SMot was statistically significant and supported the hypothesis.

Hypothesis 14. The hypothesis stated that safety motivation mediates the relationship between their perceptions of their collegiate SMS policy implementation and safety reporting. The results indicated a statistically significant mediating effect of SMot between SMSPol and SR (p = .007). The indirect path coefficient between SMSPol and SR was .065, with a total path coefficient of .271. These results supported the hypothesis.

Question Two

What are the differences in perceptions among the demographic variables (year group, international student status, SMS status, and flight certification) on safety behavior and safety reporting behavior across multiple universities?

A one-way between-subjects Analysis of Variance (ANOVA) was used to assess differences in the mean of perception scores for respondents on outcome variables based on various demographical groups. Visual inspection of histograms shows a normal distribution, but there was a higher representation of single values due to the data

imputation. The *Levene test* for homogeneity was used before all tests to verify normal variances among the data. If assumptions of normal variance could not be assumed, a robust ANOVA will be used.

The first demographic group assessed was the year-group. The results indicated that there was a significant difference on means score for SR based on year-group, F (4, 446) = 2.706, p = .001, η^2 = .042. Since the sampling size between groups was slightly different, Gabriel's procedure was used for post-hoc analysis (Field, 2018). The post-hoc analysis revealed that there were significant differences in mean reported scores on SR. Seniors had a lower perception score (M = 4.41, *S.D.* = .82) than first-year students (M = 4.71, *S.D.* = .75), Sophomores (M = 4.81, *S.D.* = .67), and Other (M = 4.76, *S.D.* = .82). Recall, the Other category included CFIs, graduated students still completing flight training, and graduate students. The results suggest that sophomores had the highest mean scores.

International student status was also assessed to determine any varying perceptions on the outcome variables. Levene's test of homogeneity was significant, F (1, 448) = 6.40, p = .012, therefore, an independent samples t-test with bootstrapping was performed to address assumptions of normality (Field, 2018). . International students had lower means scores (M = 4.32, *S.D.* = .92) as compared to non-international students (M = 4.66, *S.D.* = .73). This difference, -.34, BCa 95% CI [-.67, -.03], was significant, t (38.96) = -2.17, p = .036 which represented an effect of d = .75. This result suggests that domestic students had better perception of SR than international students.

Respondents were asked to provide information regarding their university's SMS implementation status. This question was meant to determine if the school was actively

pursuing a formal SMS (i.e., FAA SMSVP or IBAC IS-BAO), already had an SMS implemented, was not pursuing a formal SMS, or did not know what their university's intentions were regarding intentions regarding SMS implementation. Notably, a considerable proportion of respondents answered that they did not know their university's SMS implementation plans (n = 188).

A one-way ANOVA was run to determine if there were any differences in the mean of responses to SCB, SPB, or SR based on this SMS status question. The results suggested significant differences in the mean scores on SPB based on SMS status, F (3, 446) = 2.71, p = .045, η^2 = .018. Post-hoc analysis using Hochberg's GT2 procedure was conducted, and it showed that respondents that answered *Do Not Know* (M = 3.52, *S.D.* = .53) had significantly lower mean scores than respondents that indicated their institution was pursuing a formal SMS through the FAA's SMSVP (M = 3.67, S.D. = .54).

A one-way ANOVA was run to determine if there were any significant differences in responses to the outcome variables based on respondents' flight certificates. Respondents were asked to indicate their highest certificate to include Student, Private, Commercial, and CFI or ATP. No significant differences were found based on this demographic variable were found.

Question Three

Why are there variations in safety culture perceptions based on demographic criteria?

Qualitative Data Analysis and Validation

All interviews were conducted remotely using Zoom®. Zoom® is a video-conferencing software that allows audio and video communication through an online

platform. Zoom® creates a transcript of recorded meetings. The trustworthiness of verbatim recorded transcripts was confirmed using the playback of audio recording. Upon completing the initial validation, a copy of the transcript was sent to each participant for their review and acceptance as true reflections of their views on interview questions.

After all respondents had validated the recorded transcripts, the transcripts were imported into NVivo 12® for coding and theming. The transcripts were coded and themed to address all qualitative research questions. These themes were then analyzed to determine trends in participants' responses. Field notes and analytic memos were used in conjunction with the interview transcripts to develop themes and conclusions from the qualitative analysis.

The semi-structured interviews were meant to probe deeper into past findings. One of these past findings to be addressed was year-group effects (Adjekum, 2014, 2017; Adjekum et al., 2016; Gao & Rajendran, 2017). These past findings found differences in safety culture perceptions across differing year-groups. The present study aims to investigate why these effects exist and how positive safety culture can be developed more efficiently.

Three primary areas were considered for the qualitative portion of this research: safety culture, SMS implementation, and safety promotion and communication. The field notes and memos aided in the analysis to reduce the data and derive themes. These themes are provided below as they relate to the elements in question with these interviews.

Safety Culture

The first series of questions in the semi-structured interviews were aimed at perceptions of safety culture. These questions were designed to gauge their overall perception of safety culture at their institution, what factors have had the most influential impact on their perception of safety culture, how their perception of safety culture may have changed over time, and what their organization could be doing to improve how the safety culture is perceived by students and CFIs.

The role of the CFI. There were two questions from the interviews that regularly referenced the CFI's role in their responses on the perception of safety culture: *How has your perception of safety culture at your institution changed over time,* and *What has had the most significant impact on your perception of safety culture*. The CFI's role was more frequently referenced compared to Directors of Safety, Accountable Executives, or the presence of an SMS.

The students and CFIs that were interviewed would refer to how the CFI set the example for behaving. While it was noted that those in Safety Leadership would advocate for certain behaviors, the CFI had a more considerable influence over the day-to-day behavior. Many of the interviewees had experienced multiple CFIs over their flight training, which exposed them to various perspectives on how to approach safety. These varying experiences further confirmed that the CFI significantly influenced the student's development of essential attributes of a safety culture, such as proactive hazard identification and safety risk reporting during their time at their program.

The interviewees would sometimes reflect on differences in CFIs and how that affected their own behavior. In some cases, a given CFI may show a disregard for

particular safety policies or procedures, and that leads to a situation where such disregard for existing safety policy by these CFIs adversely impacts the perceptions of their students on the relevance of such policies and procedures in ensuring safety in flight operations. Later, after transitioning to a new CFI, they would gain a new perspective. This could be differences between instructors on the importance of safety reporting or the risk associated with specific hazards in the flight training environment. The reflection on their past experiences highlighted the influence of the CFI. Regardless of written policy and procedure, the CFI's influence could supersede these policies and procedures promoted by those in Safety Leadership positions.

The role of the CFI on safety culture also highlights the importance of people in an SMS. Multiple interviewees noted how a written policy is not necessarily enough to encourage the desired behavior. The people involved in the system must execute that policy. This sentiment was echoed by students, CFIs, and those in Safety Leadership positions. While a Safety Policy is a vital component of an SMS, it needs to be understood and implemented by all organization stakeholders. Consider the following quotes from flight instructors reflecting on their past CFIs and students reflecting on their current experiences from varying institutions generating the theme for the *Role of the CFI*:

Flight Instructor A:

"As a student, having an instructor submit an ASAP report was pretty significant to seeing them do it you, you know, use the program when a mistake has been made."

Flight Instructor B:

"Oh god, without a doubt, without a doubt, it's definitely [the CFI]. I feel like even if you can't, if you got a student who wasn't very safety-oriented, I feel like if you had the right CFI and the right mindset. I think you could change that, so without a doubt the CFIs are that frontline, backline, middle on everything. Honestly, at least in my opinion."

Student A:

"I think maybe if there was more encouragement from our instructors. I know, like in the beginning of my training. It's just at the beginning, my training is a lot different than it is now, and I was with a different instructor at the time. So I think the perception that I was given from that individual really shaped what I thought to be a bother. And so it took something. It took something small happening and me coming out and talking to safety individuals to realize that it's okay, and as long as you're safe and it pertains to your safety that it's okay to do that and bring that up rather than to not and hide it and have something worse happened to you."

Student B:

"That's where you have to have flight instructors that do that because the first flight instructor I had always… he didn't want to admit his mistakes and you always want to put these mistakes on students. So you kind of had this like, okay, you don't want to. You don't want to seem stupid. You don't want to make mistakes. But then I had a bunch of other flight instructors. After that, who were kind of echoed that and they were great. And then it just kind of made you see what it really was. So yeah, it's definitely having the flight instructors to iron out

all the creases and give the students more of a look under a magnifying glass like a more specific."

Student C:

"I would say, like the biggest influence is instructors and students just because if we don't abide by the... because it's, I mean, it does come from the top, but if it's not being adhered to by like the I mean, there's only one Director of Safety and then there's hundreds of flight students and instructors, you know, so the it's up to the moving pieces more. So I'd say in terms of the day to day."

The role of safety leadership. Students and instructors were interviewed across varying points on their institutional experience. When asked who or what played the most significant role in shaping their perception of the safety culture, the Director of Safety was often cited as a critical individual. Although, Safety Leadership was admittedly not as crucial of an influence as the CFI. Moreover, students earlier in their experience at a given institution were more likely to reference those in safety leadership positions as having a powerful influence on their safety culture perception. Once the students have been in the institution for a longer time, the CFI took over as the predominant influencing force for safety culture perceptions.

First-year and sophomore students at a given institution would reference safety leadership as having the most profound influence. Upper-level students would reference their CFI as having a more powerful influence. This seemed to suggest that a CFI's influence could overpower the influence of safety leadership. Even the CFIs that were interviewed would refer to their past CFIs and how they influenced their behavior. This finding supports findings from Brondino et al. (2012), where they suggested the stronger

role co-workers play over supervisors when assessing safety climate perceptions. Their findings suggested that co-workers' safety climate can reduce or cancel the effects of the group level association between the supervisor's safety climate and co-worker's safety climate (Brondino et al., 2012). This, along with findings from Chiaburu and Harrison (2008), suggest that co-worker support was a better predictor of employee outcomes than leader support.

The role of safety policy. The organization's safety policy would come into consideration when students and CFIs were asked how they would describe the safety culture at their institution. Students and CFIs often mentioned that the policy clearly articulated non-punitive reporting and just culture philosophy. The students and CFIs relate the safety policy to the reporting system. This finding makes sense at an intuitive level. Since the primary interaction students and CFIs have with the SMS is through reporting, both groups relate their perception of the SMS and prevalent safety culture to their collegiate programs' safety reporting system.

When asked if this policy were enough to encourage reporting, students and CFIs both said it took time to build trust in the system to begin reporting. Despite a clearly stated policy, it took additional influence to facilitate participation in reporting systems. This additional influence was typically a first exposure to the reporting system through their CFI or hearing of other student's experiences. Again, the CFI seems to play a critical role in shaping students' perceptions of the safety culture and encouraging reporting behavior. Consider the following quotes from CFIs and students reflecting on their initial exposure to the reporting system:

Flight Instructor A:

"As a student, having an instructor submit an ASAP report was pretty significant to seeing them do it for you, you know, use the program when a mistake has been made."

Student A:

"Actually, seeing how it remained anonymous and that it wasn't just you guys saying it. You know, this is how we do it. But actually going through the process once and realizing that. Because, you know, sometimes you don't trust the system until you're actually going through the system, and that's probably what really made me open my eyes, and I guess really trusting the whole procedure and process."

Once students and CFIs had made their first report and experienced the process, they were more willing to participate in the future. This first exposure suggests a critical component to encouraging reporting behavior from students and CFIs in collegiate aviation. An emphasis from the CFI to students to file a report early on in training could encourage a swifter adoption of reporting behavior.

Safety reporting feedback and safety behavior. Providing feedback for submitted safety reports was noted as a perceived critical influence on the institutions' safety culture by those in safety leadership positions. When students and CFIs participate in the reporting system, it is viewed that those who take that time to report deserve feedback for their effort. This, in turn, is believed to encourage future reporting.

Students and CFIs also addressed the importance of feedback. Feedback provided by the safety office for reports filed by students and CFIs creates a positive indicator that

their concerns are taken seriously by top-leadership. When discussing the role of feedback, one student said, “It's probably just going to go sit on the desk and build dust,” when commenting on the lack of feedback. When students and CFIs do not receive feedback for their efforts to file a safety report, the adverse perception that nothing will happen with that report is further enhanced. Providing a form of feedback could mitigate this perception. One student said, “That helps me know whether it's going to be continually pursued or not,” when discussing the effects of receiving feedback after a safety report.

SMS Implementation

Given that many collegiate aviation programs are beginning to pursue formal SMS programs (i.e., FAA SMSVP or IBAC IS-BAO), the following SMS implementation questions were designed to gauge perceptions related directly to these systems. Since institutions can pursue formal SMS programs through diverse sources, some of the questions were meant to determine if there were any perceived differences in safety culture based on these different programs. Students, CFIs, and safety leadership personnel were interviewed from schools that had varying types and levels of SMS implementation for this research.

There were also questions designed to assess how well students and CFIs understood SMS. Those in safety leadership positions had a robust understanding, but the question of how well students and CFIs understood it and how this may impact their perception of safety culture was addressed. All interviewed were also asked if the SMS's presence had a significant impact on their perception of safety culture.

SMS type. Of all the students and CFIs interviewed between three different collegiate aviation programs with varying levels and types of SMS programs, no student or CFI accurately identified what kind of SMS they had in place or was pursuing. Moreover, when students and CFIs were asked what kind of SMS they had, they would reply with a description of the safety reporting system (e.g., non-punitive, voluntary). As previously mentioned, when discussing the role of safety policy on student and CFI perceptions of safety culture, students and CFIs view the SMS through the lens of their role (i.e., reporting). Students and CFIs perceive that their role within the SMS is to contribute safety reports, which seems to be how they relate to the SMS.

Those in safety leadership positions were able to discuss the type and level of implementation of their respective SMS programs. When asked what role their SMS played with their students and CFIs, none believed it was critical for students. The formal elements of the SMS were viewed as more critical for those responsible for safety processes. The SMS was thought of as a guide, and the people were responsible for executing it.

One response that highlighted this perspective was, "So our SMS is literally just a document. It doesn't define who… We could have the best document in the world, and it does nothing for you if leadership doesn't follow it. If the students don't follow the responsibilities within that. So it's a guide, but I don't think the document itself makes the organization, how the organization uses the document that makes the culture actually thrive and exists." Another quote echoing this sentiment was, "It does more for those of us to say [SMS]. It means a lot more to those of us in this office in our, in our

management flight department management. To the student, I don't think it means anything, or the instructor even."

SMS knowledge and understanding. It was clear based on responses received from students and instructors that their knowledge and understanding of what SMS is and how it works is lacking. This is highlighted by student and CFI responses, indicating that their SMS is "voluntary" or "non-punitive." While these are attributes of a safety reporting system, these do not represent the SMS. Safety reporting is one element, albeit a critical one, of an SMS.

It should be noted that students and CFIs participating in the interviews were sent a copy of the interview questions ahead of time to review and begin thinking through their responses. In this case, students and CFIs were aware that they would be asked what kind of SMS their institution had in place or was implementing. Despite being aware of this question, still, no respondents were able to answer the question correctly. Some admitted they did not know, and others answered by offering answers describing the non-punitive or voluntary nature of the safety reporting system.

This finding shows a gap between the organization's SMS status and frontline stakeholder's understanding of this status. Determining the effect of this gap was not the scope of this research. Although, the prospect of improving SMS knowledge and understanding as discussed with students and CFIs during interviews to gain their perspective if they believed it would have an impact or not. For instance, one student responded to the question of what effect a deeper understanding of SMS would have, and they replied, "Yeah, probably. I think the more you learn about anything is gonna tie into your performance."

Those in safety leadership positions agreed that there is potential to address the gap between student and CFI SMS knowledge and understanding. All of those in safety leadership positions acknowledged that their students and CFIs do not fully understand everything that goes into their organization's SMS. Moreover, all acknowledged that students and CFIs having a more profound understanding could impact their behavior or perception of safety.

SMS impact on safety culture. Despite respondents being unable to explicitly state the type of SMS implemented or being pursued at their institution, students and CFIs were aware of SMS as an entity. Students and CFIs were aware of their organization's safety policies and procedures. They were aware of these policies and procedures' robust nature, which did influence their perception of safety culture. According to respondents, having these policies in place had a positive impact on their perception of safety and safety culture.

When students and CFIs were asked to describe this impact, responses often alluded to a foundational influence. Moreover, the presence of the SMS was said to be an initial primary influence early on in their flight training. To illustrate this point, one respondent had the following response when asked what impact the presence of SMS had on their perception of safety culture, “Now I will say that that has very foundational. I mean, when you go into, you know, you're learning straight away from private pilot you learn about SMS.”

Students and CFIs would occasionally allude to the high volume of policies and procedures present at their institutions. They did not indicate that this had a negative impact on their perception of safety culture. Instead, they acknowledged the presence of

those policies and how it relates to SMS as being there for a reason. One respondent highlighted the role of these policies by stating, “And I feel like that, that alone, knowing that if I'm a student, knowing that or just me knowing that, that lets me know that we're trying to set ourselves apart even more and doing more so that perception definitely in a positive way would increase, I guess.”

Safety Promotion and Communication

This final area being addressed in the semi-structured interviews was directed at determining how SMS is taught and how effective it is at promoting SMS. Themes arose surrounding SMS training, formal versus informal SMS training, and the role of the Accountable Executive. These will be discussed, and quotes will be provided.

SMS training. When discussing the extent of SMS training offered at different institutions, those in Safety Leadership discussed classes that are offered which cover SMS. There is typically some formal class or similar delivery method to provide SMS training to students. Given that SMS training is considered a requirement by the FAA (2015a), it is expected to have explicit training. Additionally, different collegiate programs embed SMS training in dedicated safety classes as part of the curriculum and ensure it is addressed on the flight training side.

The role of this initial safety training is not necessary to provide a robust understanding of SMS to students as viewed by those in Safety Leadership positions. Instead, this training is viewed to provide students with the necessary knowledge to function within the SMS. This is the way to articulate the role of students in SMS. For instance, one respondent stated, “That is literally it. They are. They are the eyes and ears

of what we do. Day in and day out, because I am not sitting in a cockpit for 50 hours in a week, the CFIs and the students are, and they are the ones that see it."

The student responses would refer to these classes offered. However, when asked if these classes played a vital role in developing their perception of safety culture, they did not believe it was as important as other elements such as day-to-day interactions with their CFI. The influence of CFIs, peers, and stories was typically cited as playing a more important role in functioning with the SMS. For instance, one quote addressing the impact of formal classes compared to interacting with their CFI stated, "I think they've made it effect for sure, but I don't think it was: It wasn't as profound as I would hope it would have been, I think, that the CFI is still the foundation of that."

Formal versus informal training. The discussion of the role of SMS training with students and CFIs developed a theme around the way these students and CFIs learn SMS. All students and CFIs referenced formal classes, but these were not viewed as having the most profound impact on how they learned SMS and their role in the SMS. This distinction can be viewed as a difference between a theoretical versus practical approach to learning SMS. Thus, the theme of formal versus informal training.

Given the CFI's role in developing students' understanding of SMS and their role in SMS, this was thought of as the practical application of the concepts. Students and CFIs would reference their interactions with their CFIs and how that shaped their understanding of how the SMS worked. Many times, the students would refer to their CFIs as being more like a peer. Learning from the example of CFIs and the stories CFIs tell influenced how students developed their SMS understanding. This point was articulated by one student when saying, "I think the theoretical side definitely comes

from the professors, but the practical side of seeing where the theoretical side needs to the practical side is done by the flight instructors."

The Accountable Executive's role. SMS touts the importance of support from the Accountable Executive as a critical element (FAA, 2015a; ICAO, 2009). Students and CFIs were asked how well the relationships between top-level individuals and front-line personnel are managed and what impact their relationships have on safety culture perceptions. Students and CFIs would typically address salient individuals within their institution that represent safety. This was usually the Director of Safety. Comments would address how approachable these individuals are and the importance of an open-door policy. These initial responses would not include those associated with the Accountable Executive's role.

When students and CFIs were asked what role the Accountable Executive would play in their perception of safety, they did agree that it was crucial. The support from these top-level individuals was necessary for the functionality of the SMS. It is believed that this support has a "trick down" function, which is in line with the traditional top-down implementation of SMS (FAA, 2015a; ICAO, 2009). One quote that addressed this concept stated:

> *"I think [the Account Executive] definitely plays a major role because if he didn't care about safety. It wouldn't trickle down: When you know I think we [the CFIs] have the most influence directly but I don't think we would care about it as much if we didn't have that the top leaders who were constantly talking about safety how important safety is."*

This concept seems to tie together the role of the Accountable Executive and the CFI. While the CFIs seem to have a substantial amount of influence on students and students' development of SMS knowledge and safety culture, this is only possible with the support of higher-level individuals—namely, the Accountable Executive. One student participant highlighted this relationship well:

> *"So there's definitely a closer generally a closer connection between students and flight instructors and because there's a close connection between them and you know say higher-ups, they're more willing to listen to the flight instructor."*

CHAPTER V

DISCUSSION, LIMITATIONS, AND CONCLUSIONS

Discussion

This study sought to build upon past research into SMS and safety culture in collegiate aviation programs (Adjekum, 2014, 2017; Adjekum et al., 2015; Gao & Rajendran, 2017; Hasan & Younos, 2020; Robertson, 2016). SMS implementation in collegiate aviation is still relatively in a stage of infancy, and few collegiate aviation programs have managed to implement formal SMS programs recognized by a regulatory body such as the FAA or an industry trade organization such as IBAC. Although, entities such as AABI and UAA encourage SMS, and more programs pursuing formal SMS programs will increase. This research seeks to assess current methods to evaluate these programs' effectiveness while comparing potential differences in colleges with and without formal SMS programs.

This concurrent-embedded mixed-method approach utilized quantitative methods to address two research questions and qualitative methods to address the third research question. A concurrent-embedded approach is characterized as having a primary research purpose with some smaller research questions embedded or nested within this primary question. In this case, this research's primary purpose was to utilize past methods to evaluate SMS implementation in collegiate aviation programs across multiple universities to add to these methods' validity and reliability. Extant research (Adjekum, 2014; Adjekum et al., 2015, 2016; Gao & Rajendran, 2017) generated some findings and

conclusions through quantitative methods, which need to be further validated and investigated through qualitative methods. These past findings are about varying demographic effects on outcomes such as safety behavior. The investigation of why these variations exist is the embedded question.

SMS Implementation and Safety Behavior

The first research question was directed at utilizing a past model developed by Adjekum (2017). Some modifications were made based on this initial study's findings, which included removing some predictor variables (i.e., transformational leadership and self-efficacy) and adding an outcome variable (i.e., safety reporting behavior). Therefore, a direct comparison of findings and conclusions will not be possible. However, the SMS initiative's core elements (i.e., SMSPol and SMSProc) are still present in the current study, and comparisons as to the effects of these variables on the outcome variables will be made.

SMS Policy Implementation. SMSPol was found to have a significant effect on three variables: SMot, SR, and SCB. The effect of SMSPol on SPB was not found to be significant. The insignificant effect relationship between SMSPol and SPB corroborates findings from Adjekum (2017). In both cases, the direct line from SMSPol and SPB was not significant but only became significant when mediated by SMot. This suggests that an SMS policy is not enough to encourage safety participation behavior. Safety motivation is needed to encourage safety participation.

The impact of SMSPol was primarily seen in how it affected SMot, SR, and SCB. The latter two, SR and SCB, are expected. The SR scale was designed to assess the willingness and frequency by which respondents utilized the safety reporting system.

Similarly, the SCB scale assessed the extent to which participants followed policies and procedures stipulated by their organization. Active participation in safety reporting behavior and safety compliance behavior is the desired outcome for organizations looking to implement SMS. The effect of SMSPol on these two behaviors shows the importance of having a clearly articulated safety policy for safety reporting and compliance behavior.

The predictive relationship between SMSPol and SMot was one of the larger relationships found in this study ($\beta = .376$). The role of leadership and safety climate could explain the impact of SMSPol on SMot. When leadership articulates the importance of safety as a core value, that guides desired behavior and can encourage a higher level of commitment to the organization's goals (Ford & Tetrick, 2008). Given that the SMS policy is meant to convey an organization's stance on the role of safety within their organization and provide safety objectives, this could explain the impact seen on SMot by SMSPol. These results suggest that a well-defined SMS policy can motivate stakeholders while encouraging the desired safety behavior.

SMS Process Engagement. The final measurement model included direct paths from SMSProc to SCB, SR, and SMot. All these paths were found to be significant. The direct path from SMSProc to SPB was removed.

The results of this study differed from past research. Adjekum (2017) found a significant effect of SMSProc on SPB. However, due to low factor loading and, in turn, model improvements, this path was removed for the current study. Moreover, Adjekum (2017) did not find a significant effect from SMSProc on SCB, while the present study did find a significant effect.

The SMSProc scale assesses how the stakeholders perceive the policies defining conditions that warrant punitive action, safety-related points of contact, reportable events, and the reporting system's confidentiality. Since the SCB scale deals with assessing how respondents comply with the organization's expectations, ensuring these expectations are clearly defined is essential. This finding suggests that ensuring these organizational expectations being clearly defined positively influences safety compliance. When stakeholders are provided with clearly defined expectations, they can better comply with these expectations.

The SMSProc scale also addresses expectations for safety reporting. Therefore, the positive effect SMSProc had on SR was expected. The predictive relationship between SMSProc and SR was one of the larger relationships found in this study (β = .401). Since some of the items in the SMSProc scale include elements defining what is supposed to be reported and the nature of the non-punitive reporting system, it is intuitive that these elements should have a positive influence on SR. Nonetheless, this finding supports the notion that is having clearly defined expectations of what is supposed to be reported through the organization's safety reporting system and implementing a non-punitive reporting system encourages reporting behavior.

SMSProc also had a positive effect on SMot. This is another difference from past research studying the relationship of SMSProc on SMot. Adjekum (2017) did not see a significant effect from SMSProc on SMot. The time differences between the previous study and the present research could play a role in the different findings. Adjekum (2017) argued that collegiate aviation programs are needed to engage students and CFIs in SMS

processes. Perhaps these initiatives have begun to occur, accounting for the different results observed in the present study.

Additionally, the larger sampling pool to include multiple universities with varying SMS implementation levels and status and safety culture could also impact why these findings are different. However, this research's significant findings suggest that SMSProc plays a positive role in motivating stakeholders' safety behaviors. This finding also suggests that the expectations for engagement provided through SMSProc have the potential to motivate stakeholders. Organizations providing clear guidance of the desired behavior can encourage stakeholders to exert effort to follow through with the outcome variables related to exemplary safety behavior.

Adjekum (2016) found out from interviews that collegiate aviation leadership believed that engaging students, student organizations, and flight instructors during SMS implementation could address some concerns regarding apathy toward the SMS initiative. Keeping these stakeholders involved could better inform them of their role in the SMS and address relationship barriers between frontline personnel and top management (Adjekum, 2016). The role of safety leadership has been shown to impact safety behavior (Clarke, 2013; D. Cooper, 2015; Shen et al., 2017).

Safety Motivation. The role of safety motivation continues to play a crucial role in predicting and influencing safety behavior. Past research has highlighted the role of safety motivation as it relates to safety behavior (Adjekum, 2017; Chen & Chen, 2014; Christian et al., 2009; Ford & Tetrick, 2008; Ji et al., 2017; Neal & Griffin, 2006; Vinodkumar & Bhasi, 2010). The present findings corroborate these past findings while adding to the growing research base of collegiate aviation safety behavior.

There was a significant predictive relationship between SMot and SPB (β = .359) and SCB (β = .466). Moreover, the inclusion of safety reporting behavior as an outcome variable was also found to be predicted by SMot. However, the impact of SMot on SR was not as large (β = .172) as SPB or SCB. In all cases, the effect of SMot on the outcome variables was statistically significant. This adds to the validity of the notion that safety motivation is a strong predictor of safety behavior.

Another key takeaway from the findings regarding SMot was the mediating role it played for SMSPol and SMSProc as they related to the outcome variables. In all cases, SMot played a statistically significant role in mediating the path from SMSPol or SMSProc to the outcome variables. Administrators should consider special consideration to ensuring motivated stakeholders.

This is especially interesting when considering the effects of SMSPol on SPB or SMSProc on SPB. SMSPol did not have a statistically significant direct effect on SPB, and the direct path from SMSProc to SPB was removed due to low factor loading for model improvements. However, when SMot was included in the path as a mediator, the effect became significant. Based on these findings, it suggests that SMSPol and SMSProc are not strong enough predictors of SPB. Only when stakeholders are motivated do they begin to exhibit SPB. Again, these results emphasize the critical role of SMot in predicting safety behaviors.

SMot was also shown to play a significant role in amplifying the effects of SMSPol and SMSProc on SCB and SR. While both SMSPol and SMSProc were shown to affect SCB and SR significantly, these effects were amplified when SMot was included as a mediator. The larger indirect effects observed were on SCB. These results show a

direct effect of SMSPol and SMSProc on SCB, but SMot amplifies these effects. This suggests that SMSPol and SMSproc can encourage SCB, but consideration motivating stakeholders will encourage better SCB.

Implication for Policy. The findings from this study support the SMS initiative. The positive impact observed on safety behavior as the result of SMS policy implementation and SMS process engagement has been reliably validated across multiple universities. More collegiate aviation programs to fully implement SMS are needed to facilitate best practices for SMS in collegiate aviation.

Demographic Effects

Past research has found effects on safety-related outcome variables based on different demographic variables such as year-group (Adjekum et al., 2015; Gao & Rajendran, 2017) and international student status (Adjekum, 2014; Adjekum et al., 2015; Noort et al., 2016). The present research aimed to investigate these effects across multiple universities in which some have fully implemented SMS programs. Moreover, given the implementation of SMS at some collegiate programs, it was desired to seek whether there are differences in safety-related behaviors based on SMS implementation status.

Year-Group Effects. Respondents were asked to provide their year-group instead of age. Since age can sometimes be a misleading indicator of student status (i.e., non-traditional students who are older but just beginning their college experience), year-group was determined to be a better indicator of experience in the collegiate aviation program. The present study found statistically significant differences in safety-reporting behavior based on year-group. Specifically, Senior students were found to have significantly lower

reported safety reporting behavior. This corroborates previous findings investigating this same topic (Adjekum et al., 2015, 2016).

Interestingly, students with more experience at their institution tend to have better perceptions regarding safety culture (Adjekum, 2014), but yet the present study observed a decrease in reporting by senior students similarly to prior studies investigating reporting behavior in collegiate aviation (Adjekum et al., 2015, 2016). These findings showing decreased reporting behavior from senior students warrants administrators' attention and those in safety leadership positions. Safety reporting is considered an essential element for SMS (FAA, 2015a; ICAO, 2009) and, therefore, this decreased frequency of reporting is concerning.

Jausan et al. (2017) performed a thorough review of barriers to reporting in a military setting to determine reporting barriers. Their findings suggested that organizational barriers were the primary factor affecting reporting behavior (Jausan et al., 2017). Lack of leader commitment and lack of feedback were two organizational barriers that negatively impacted reporting behavior (Jausan et al., 2017). This corroborates prior suggestions to encourage management and leaders not to disregard senior students to focus on younger students and ensure adequate feedback (Adjekum et al., 2015, 2016).

Respondents categorized under the *Other* category had increased reporting. The respondents who selected *Other* were CFIs, graduate students, or flight students who have completed their coursework but still need to fly. Even though some upper-classmen were included in this group, they still exhibited increased safety reporting as measured by the SR scale. Some respondents in this group would be considered *more* senior than senior level students. While this group had higher reported mean scores for reporting

behavior than senior-level students, there were no statistical differences compared to first-year, sophomore, or junior students.

International Students. Variations in reporting behavior between domestic and international students were found to be statistically significant. Specifically, domestic students were found to have higher scores for reporting behavior compared to international students. This, again, has been found multiple times with prior research (Adjekum et al., 2015; Liao, 2015; Noort et al., 2016). These findings highlight the role of cultural influences on student behavior.

Given that these two groups exhibit variations in safety reporting behavior, there is a need to consider these cultural differences when structuring and managing the SMS. Encouraging reporting behavior from all stakeholders is desired, and these findings show a gap between domestic and international students. This quantitative study cannot determine the reasoning for this variation.

Future research could further investigate why international students exhibit decreased reporting behavior and ways to improve this behavior. Consideration of language barriers may serve as a viable explanation for this decreased reporting behavior. If international students do not utilize English as their primary language, that may play a role in their willingness to participate in the reporting system. Future research could explore this possibility.

Liao (2015) had addressed this question and provide three recommendations: leadership, power distance, and incentive programs. Leadership was believed to play a substantial role in building subordinate trust to encourage reporting. Power distance has the potential to influence reporting behavior based on cultural norms and perceptions

negatively. Addressing these barriers and ensuring no negative repercussions will come from participating is suggested as a means to address these power distance concerns.

Lastly, the bonuses and incentives could facilitate better participation from those reluctant to share information for fear of receiving negative responses from colleagues. These findings were based on findings comparing Chinese and Western pilots. Collegiate aviation programs may have international students from a variety of countries besides China. Consequently, these recommendations may not address all cultural differences which influence variations in reporting behavior. Further investigation into more cultural differences is warranted.

SMS Status. Respondents were asked to provide their SMS implementation status by answering the question *What kind of Safety Management System (SMS) does your institution have or currently pursuing?* This question was originally designed to assess the potential effects of differing levels of SMS implementation on the outcome variables. However, the findings showed a sizable proportion of respondents that did not know what kind of SMS their institution had in place or was pursuing. This was an intriguing finding as even institutions with fully implemented SMS programs responded as not knowing or even indicating the wrong type of SMS.

As a result of this finding, an analysis was done to determine any potential effect of respondent understanding of their SMS status on the outcome variables. The results indicated that respondents who did not know their institution's SMS status had statistically significantly lower mean scores on the SPB scale compared to respondents who responded with the correct type. This shows a knowledge gap between respondents

and their institutions' SMS status. It also reinforces the positive role an awareness of SMS initiative can have on respondent's safety participation behaviors.

This knowledge gap is something that could be addressed by safety leadership. Evidence exists that shows individuals take more pride in their work when they have a sense of ownership (Adjekum, 2017; Patankar & Sabin, 2008). While it was evident in the qualitative portion of this study that SMS training exists at all institutions that participated in the interviews, there is still a knowledge gap. These findings could be used as evidence to restructure this training.

An improved understanding of what SMS is and how it works could improve safety participation. Implementing variations of initial and recurrent training, focusing on more applied concepts could be used as an assessment of the potential effects of enhanced SMS knowledge on safety behavioral factors such as participation. Ensuring training is provided to all stakeholders, and not just students, would be another element to verify. Future research could address this in a quasi-experimental manner by implementing an SMS training initiative to determine if there are effects on safety participation perceptions.

Qualitative Component Discussion

This qualitative component addressed three primary areas: safety culture, SMS implementation, and safety promotion and communication. Given the limited tenure of students and CFIs at collegiate aviation programs, efficient adoption of positive safety culture attributes is desirable. Determining the mechanisms which facilitate this adoption is prudent. Moreover, the implementation of SMS and related functions is still relatively

new within collegiate aviation. Determining what effect, if any, this is having on safety culture is necessary.

Safety Culture. A resounding theme of the influential role the CFI plays in developing safety culture and on safety behavior was a critical finding. Students and CFIs interviewed from all institutions pointed to their current and past CFIs as playing a significant role in how they themselves developed their sense of safety culture. The CFIs would set the example for proper behavior. This is not surprising given the number of contact hours CFIs have with students. Students and CFIs are typically meeting multiple times per week and engaging in what is considered front-line operations. The influence of this high frequency of meetings is likely to contribute substantially to how students will perceive acceptable safety behavior in their organization.

This finding also corroborates some of the points made by those interviewed in safety leadership positions. Those in the safety leadership positions did not believe the presence of their SMS or their policies were powerful enough on their own to influence behavior. The people were responsible for carrying out those expectations. While the policy statements were a guide for describing desired behavior and outcomes, people (i.e., students, CFIs, Chiefs, managers, etc.) were responsible for carrying out the policies outlined in that document. While the document can serve as a top-down influence of guiding desired behavior, the document alone is not sufficient.

This limited role of safety policy to determine safety behavior was also corroborated by the quantitative findings in this study. SMS policy implementation did not have a significant direct effect on safety participation. Only when mediated by safety motivation did safety policy implementation have a significant effect on safety

participation. This suggests that it takes more than a safety policy to encourage proper behavior.

The safety policy must lead to proactive safety procedures and guidelines that modify safe practices and acceptable behavioral outcomes, but the stakeholders must exhibit the expected behavior, and the CFI has a powerful influence in this role. Even with a well-written safety policy and directed guidance from higher-level individuals in the organization, the CFIs can positively or negatively impact how these policy guidelines are adhered to by flight students operationally. The CFI can, directly and indirectly, influence students' safety behavior and may enhance strict adherence to these safety policies or negatively lead to non-compliance. The proximal effects of CFI on safety policy implementation within a collegiate aviation program cannot be under-estimated.

The nature of how the CFI can explicitly exert a more considerable influence on the operational level implementation of higher-level policy guidance from leadership is not a novel finding. Research has shown that lateral or peer relationships can have a more significant impact than managerial influences (Brondino et al., 2012; Chiaburu & Harrison, 2008). Nonetheless, these findings suggest that attention should be given to CFIs to ensure they are setting proactive examples of safety behaviors worthy of emulation. Students and CFIs are considered the front-line of collegiate aviation. Therefore, their role in establishing and optimizing the desired safety behavioral traits among personnel and students is critical.

Another critical finding on how students and CFIs develop their safety culture is their first exposure to the safety reporting system. Frequently stated during the interviews

was how it took an initial exposure to the reporting system to build trust. This first exposure seemed like a critical barrier that needed to be overcome before students and CFIs were willing to contribute to the reporting system. Given the influential role of CFIs on student behavior, CFIs should prioritize exposing students to the reporting system early on in their training. This initiative could surmount the first exposure barrier and set the example for future behavior and participation.

In addition to the first exposure, the feedback was another component of safety reporting that was commonly cited by students, CFIs, and those in safety leadership positions. Feedback has been shown to affect safety reporting behavior in previous quantitative studies (Adjekum et al., 2015, 2016; Jausan et al., 2017). These findings further validate those claims and suggest that collegiate aviation programs pursuing SMS should ensure they incorporate a feedback mechanism for their stakeholders.

SMS Implementation. A key finding from the quantitative and qualitative component of this research was the knowledge gap students and CFIs have regarding the SMS implementation at their institutions. A sizable proportion of respondents did not know what kind of SMS their institution had or was pursuing when answering the survey. Additionally, none of the students or CFIs interviewed correctly identified what kind of SMS their institution had in place or was pursuing.

Interestingly, most respondents in the interviews would reply by describing the reporting system. This response suggests an association of the safety reporting system with their perceived role in the SMS. This is a critical component for students and instructors. These individuals do need to know their role with the SMS. However, it begs

the question of what impact an understanding of SMS implementation's various components could have on their perceived safety behavior.

Further research is needed to determine what effect a deeper understanding of SMS could have on safety behaviors if any. Perhaps involving students in applied aspects of SMS processes, such as safety risk assessment or develop policy and objectives, could provide this more profound understanding.

Those in safety leadership positions did not believe students and CFIs needed to have a deep understanding of SMS. This perspective referred to SMS processes' technical aspects to include but not limited to risk assessments and safety assurance processes. It was viewed as being more important for students and CFIs to understand their role in the SMS implementation.

Once it was determined that students and CFIs did not have an in-depth knowledge of SMS, they were asked if a more profound understanding would influence how they perceive SMS and their perception of safety culture. The students and CFIs indicated that it could have an effect, and this may be due to an increased sense of ownership (Adjekum, 2017; Patankar & Sabin, 2008). This gap is an area that could be addressed with future research and an initiative for institutions to restructure their method for training their students and CFIs about SMS.

Velazquez and Bier (2015) analyzed the status of safety and SMS training in collegiate aviation programs and found many programs offer a single class addressing SMS and that there is not much standardization to the way SMS is taught in collegiate aviation. This study's qualitative findings showed that SMS education is embedded in flight training and classes, but the knowledge gap still exists. SMS is a complex topic

with many components such as safety policy and objectives formulations, safety risk management strategies, safety assurance processes, and documentation and record-keeping. Providing some form of initial and recurrent training to address smaller SMS components may make it easier for students to retain and understand SMS. Expecting students to learn SMS in its entirety from a single course may not be effective.

Recent research into teaching safety science has suggested the approach of pragmatism as a means to educate safety-orientated professionals (Klockner et al., 2020). Pragmatism can be defined as "…centered on linking theory, research, ideas, actions to practical effects and focuses on aligning these with the student's experience and environment" (Klockner et al., 2020, p. 3). This position seems to align with the desired methods suggested by participants in the interviews. Students and CFIs seem to desire this pragmatic approach. Structuring SMS training for students and CFIs around the "4P's of Pragmatism" (i.e., practical, pluralistic, provisional, and participatory) could be a beneficial approach for administrators (Klockner et al., 2020). Utilizing scenarios has also been proposed as a method to allow students and CFIs to apply SMS skills in a practical manner (Adjekum, personal communication, 2020).

The outcomes from SMS processes are likely to generate controls and mitigations, resulting in various safety policies and procedures (FAA, 2015a). The presence of these policies and procedures was viewed as favorable by students and CFIs. While there may be a high volume of policies and procedures, students and CFIs recognize their importance and make a conscious effort at strict compliance or adherence. This seems to suggest that students and CFIs respect and appreciate the presence of SMS based on their perception of SMS outcomes.

The findings from the semi-structured interviews revealed that those in safety leadership did not believe the presence of SMS inherently played a role in the students' and CFIs' perception of safety culture. This assertation is based on comments received from those in safety leadership positions referring to their SMS as "a guide" and that it does more for the administration to say SMS than for students. However, it is evident that SMS implementation outcomes, such as cogent safety policies and procedures, play a significant role in moderating desired safety behaviors.

This perspective echoes advocates of the *Safety-II* approach. Proponents of the *Safety-II* approach address people's role within the organization and posit that cultural influences drive compliance with organization policies and procedures (Hollnagel, 2014). This perspective is shared with the dichotomous perspective of *Old-View* and *New-View* of safety (Dekker, 2017). This perspective posits that organizations cannot regulate or proceduralize their way to safety (Dekker, 2014). Moreover, some suggest that this emphasis on relying on policies and regulations to address cultural factors is putative (Grote & Weichbrodt, 2017).

Nonetheless, those in Safety Leadership positions that were interviewed did view the implementation of SMS in their institutions as a positive change. While the implementation and presence did not explicitly impact their perspective regarding safety culture, the improvements to processes, such as enhanced accountability and robust audits, provided better outcomes from their previous safety programs. These audits' robust nature would ensure no aspect of the organization's processes was missed. If the audits identified system weaknesses, this would guide the development of policies and

procedures to address these deficiencies. This improved the overall accountability of the organization.

This enhanced accountability provided a more comprehensive approach to safety. While these improvements were not perceived to improve safety culture directly, the effects of SMS implementation improved the organization's function. The outcomes from these SMS functions would provide the guidance to ensure organization stakeholders have the proper direction on the desired behavior. While these written policies may not explicitly dictate behavioral outcomes for stakeholders, they serve as the guide for all levels below top-level management to follow and promote. The connection seems to be that SMS can improve elements related to safety policy from a top-down perspective (FAA, 2015a). Stakeholders must then promote this policy and motivate stakeholders to ensure participation and compliance based on the safety policy's guidance. This approach is substantiated by this study's quantitative findings where safety motivation was the strongest predictor of safety participation and safety compliance behavior. Additionally, safety motivation played a significant mediating role for both SMS policy implementation and SMS process engagement.

Safety Promotion and Communication. The training provided to students in programs with and without fully implemented SMS programs does not seem to provide students and CFIs with an in-depth knowledge of SMS. While students and CFIs are well educated in their respective roles within the SMS, there is clearly a gap in SMS deeper understanding. Formal training on SMS and its components can be challenging and needs to be viewed within a collegiate aviation program's scope and complexity. A suggested approach based on these research findings will be a step-wise building block approach in

SMS training that is incorporated as part of the syllabus for the degree program in aviation. Fundamentals of SMS can be introduced as a required course at the first-year class, and subsequent intricate details on SMS introduced at the upper-class levels. Subject-matter experts may be brought in occasionally to build the capacity of professors who teach SMS to enhance course delivery and ensure a cogent link between theory and practices.

Moreover, students and CFIs often mentioned a need for a practical application of SMS. Involving students or CFIs in some of the higher-level SMS processes, such as safety risk assessments (SRAs), could be a way to address this issue. Additionally, these applied exercises would give students the experience they could use moving forward in their careers. Many aviation students aspire to be airline pilots, and part 121 carriers are required to have SMS (FAA, 2015b), and there is a demand for SMS in the part 135 environment (NTSB, n.d.). Another benefit of this approach is providing students and CFIs with a sense of ownership in the SMS process, which can improve safety behavior (Adjekum, 2017; Patankar & Sabin, 2008).

Implication for Theory. Safety administrators should heed the role of safety motivation as a critical function for facilitating desired safety behaviors. Initiatives to ensure motivation for stakeholders has been shown to be a strong predictor of desired safety behaviors. Moreover, the flight instructors' role may play a significant part in promoting safety and ensuring safety motivation. Proper attention should be given to flight instructors to promote safety, given their critical role in guiding students' behavior. Developing a means to motivate flight instructors could permeate these attitudes and behaviors throughout the organization.

Adjekum (2016) investigated the role of transformational leadership on safety motivation and safety behavior. Adjekum's (2016) findings suggested that transformational leadership had a direct positive effect on safety participation. Another interesting finding was the negative relationship between transformational leadership and safety motivation (Adjekum, 2016). It was suggested that this finding could imply that leaders exhibiting high levels of transformational leadership could result in complacency from the perception that the system is inherently safe.

Given the role of leadership on behavior, Cooper (2015) investigated the role of multiple leadership styles on safety behavior (i.e., transformational, transactional, and servant). All of these leadership styles were found to have effects on safety behavior, either directly or indirectly. Some of these indirect effects include improving employee engagement, which can improve behavior or provide a supportive environment that can, in turn, affect employee engagement and behavior. Clarke (2013) had similar conclusions showing that transformational leadership primarily encouraged safety participation, and transactional leadership primarily affected safety compliance. All of these findings suggest that an active leadership style can have a positive impact on safety behavior. Passive approaches to safety have been shown to have adverse effects, such as non-compliance (Kjellevold Olsen et al., 2020).

Implication for Practice. Developing or revamping the methods to teach students and CFIs could enhance perceptions surround the SMS initiative. Currently, there seems to be a knowledge gap for both groups (i.e., students and CFIs) in organizations with and without fully implemented SMS. The increased sense of ownership provided by this enhanced knowledge and understanding could improve

perceptions surround the SMS initiative (Adjekum, 2017; Patankar & Sabin, 2008). Emphasis on a pragmatic approach to safety education may provide a more practical and applied approach, which seems to be desired by research participants (Klockner et al., 2020)

Limitations

While the researcher targeted a purposive sample from the population of respondents from U.S collegiate aviation programs with SMS, there were still issues with unequal sample sizes from the survey part of the research. This leads to higher and lower representations of individual institutions' perceptions regarding the studied variables. Therefore, the findings cannot represent the population of collegiate aviation programs.

Quantitative surveys are sometimes prone to biases and subjectivity. Self-serving bias, framing effects, and response biases can affect responses and need to be considered when making inferences from surveys. However, every effort was made to minimize these biases and subjectivity through face validity test of items and reverse-coding of some items to minimize framing effects. For some scales, the low-reliability scores, such as safety reporting, suggest comprehensibility issues with items in the scale and may need future re-wording and re-validation of items in that scale.

All the analyses were done based on respondents' perceptions, which can be influenced by environmental factors and incidental safety occurrences in the program. Adverse perceptions may be captured due to such one-time safety occurrences that may not be reflective of the actual long-term safety culture in the program. The results from such methods should be considered when utilizing the findings. Evidence existed that

there may have been issues with response bias and reliability on some scales. The reader must consider these limitations when making conclusions from the research findings.

Conclusions

This study utilized a previously validated tool to measure the SMS initiative's effectiveness as measured by SMS Policy Implementation and SMS Process Engagement on different safety behaviors. The findings suggested that these SMS initiatives work well to predict safety behavior—predominantly when mediated by safety motivation. Collegiate aviation programs considering or pursuing SMS should consider evaluating their institutions to determine their SMS initiative's effects on safety behavior.

Multiple demographic effects found in previous studies, such as year-group effects and differences based on international student status, are still present across multiple universities. Those in safety leadership positions should be cognizant of these effects and structure initiatives to address these variations. Ensuring desired safety behavior for all student groups is crucial for optimal performance. Addressing the year-group effects by ensuring appropriate safety promotion to all levels of stakeholders within collegiate aviation programs could be one approach to mitigating the year-group effects. Similarly, developing initiatives to ensure international students' involvement is necessary based on the presence of variations in safety behavior found across multiple universities.

SMS implementation in most U.S collegiate aviation programs is still in its preliminary stages, with only one program attaining the FAA SMSVP status of active conformance. However, findings from the semi-structured interviews suggest an apparent knowledge gap among respondents on the SMS implementation phases and some

essential attributes of a fully-functional SMS program. Structuring or restructuring SMS training for students and CFIs could improve safety behaviors for stakeholders. Further research is needed to investigate this finding.

The CFI plays a critical role in developing the student's perception of safety culture. The CFI sets the example for desired safety behavior and can play a significant role in exposing students to the safety processes institutions have in place. Initiatives to address the role of the CFI to empower them to be leaders for students and encourage active participation can influence the efficiency and effectiveness by which students develop their sense of safety culture.

Recommendations for Future Research

There is still a need to perform longitudinal studies to investigate safety culture in collegiate aviation programs in the U.S. Analyzing a cohort of students across the span of their tenure at an institution would provide a new perspective of how some of the variables are affected over time. This could require identifying these cohorts early on in their tenure and evaluating them yearly to determine these effects.

An evaluation of the potential effects of enhanced SMS training for students and CFIs is needed. Given the knowledge gap found in the current research, there is potential to address this finding. A quasi-experimental approach before and after an SMS training initiative may determine any potential effects of enhanced SMS knowledge on safety behavior.

As more collegiate aviation programs pursue and implement SMS, additional research will be needed to evaluate the effects of SMS in collegiate aviation continuously. The current research is still limited to universities with fully implemented

SMS and others which have only begun the implementation process. As more programs successfully implement SMS, an investigation into effectiveness and impacts on safety performance in terms of observed safety behaviors and attitudes (safety culture) is necessary.

Appendix A
Semi-Structured Interview Outline

Semi-Structured Interview Session Guide

Date:

Time:

Interview Code Number:

Location of Interview:

Parts of the Interview	Interview Questions
Introduction	Hi, I am Tony Foster, the principal investigator for this study. Thank you very much for agreeing to be participants in this semi-structured interview. As you were informed earlier in the invitational email, the purpose of this interview is to seek your views of safety culture within your institution and how Safety Management Systems (SMS) has affected that perspective. This interview session should last about an hour. Please be reminded that this session will be audio-recorded and contemporaneous notes will also be taken. After the interview, I will organize and transcribe your responses, which will be coded and themed for our study. Please be reminded that every effort will be made by the researchers to ensure that no personal identifying information about you such as name or employee number inadvertently divulged during the session will be used in our final report. All audio recordings of this session will be deleted once the transcription process is completed and you have had the opportunity to validate the contents of the transcript which will be sent to you for your comments. You can choose to stop this interview at any time or decline to answer any question you feel uncomfortable with. I once again remind you that this interview will be audio recorded for transcription purposes. You will also have to read and sign the informed consent statement sheet before we start the interview.

	Do you have any questions? Are you ready to begin?
Part A	**Biographic Data (Taken for each participant)**
	Age: Sex: Year group (if student) or position: Level of education: Number of years at institution:
Part B	**Safety Culture**
	1. In your own words, how would you describe the safety culture at your institution? 2. How has your perception of safety culture at your institution changed over time? 3. What has had most significant impact on your perception of safety culture? 4. Why? 5. Is there something that your institution could do to further promote safety culture that they are currently not doing?
Part C	**SMS Implementation**

	6. What kind and level of safety management systems (SMS) does your institution currently have in place? 7. Does this have a significant impact on how you perceive safety culture in your institution? 8. How? 9. Are there any negative impacts of SMS implementation at your institution? 10. If so, how could they be better addressed? 11. If not, were there ever and how did you remedy them?
Part D	**Safety Promotion and Communication**
	12. What kind of SMS training does your institution provide? 13. How does this training impact safety culture perception at your institution? 14. How frequently is SMS training offered and/or repeated? 15. How are the relationships between front-line personnel (students) and top-level (accountable executive) personnel managed at your institution? 16. Does this have an effect on safety culture perception? 17. How could this be improved? 18. How well do you understand the SMS process?

	19. Do you feel you have a responsibility in your role to know and understand these processes? 20. Why?
Part E	**Close**
Close	21. Do you have anything else you'd like to share? 22. Do you have any questions for me? 23. Thank you for your time and we will get in touch with you later with the transcript for your validation before the data analysis. Goodbye.

Appendix B
Quantitative Survey Questions

Safety Culture in Collegiate Aviation

Start of Block: Consent Page

The University of North Dakota Consent **to Participate in Research**
Project Title: **Safety Culture in Collegiate Aviation: A Cross-sectional Analysis Between Multiple Universities**

Principal Investigator: Tony Foster Phone/Email Address (PI): 563.249.9167/robert.a.foster@ndus.edu

Department (PI): Aviation Advisor: Daniel Kwasi Adjekum, Ph.D., CSP.

Email/Phone: daniel.adjekum@ndus.edu (701-777-6689)

What should I know about this research?

Taking part in this research is voluntary. Whether you take part is up to you. If you don't take part, it won't be held against you. You may take part now and later drop out, and it won't be held against you. If you don't understand, ask questions. Contact the investigator with any questions before you decide to participate.

How long will I be in this research?

We expect that your participation in this research will last approximately 10 minutes (taking the survey un-interrupted). This survey will be online for a maximum period of 6 weeks.

Why is this research being done?

The purpose of this research is to assess safety culture perceptions at various collegiate aviation institutions due to Safety Management Systems (SMS) implementation. Different collegiate aviation programs around the United States have varying types of Safety Management Systems (SMS) as well as varying levels of implementation. This research is meant to gauge variations in safety culture and specifically safety behavior based on the perceptions of respondents in these programs.

What happens to me if I agree to take part in this research?

If you decide to take part in this research study, you will be required to read and agree to this online consent statement by clicking on the YES radio button at the end of the statement. If you click No, you will be directed to the end of the survey and you can close the survey.
After agreeing to take part in the survey by clicking YES, you will be asked to complete an online survey about your perceptions on safety culture in your collegiate aviation program. Included in

the survey will be questions on year group, gender, functional group, and collegiate aviation program. If for any reason you feel that some or all of the questions are such that you prefer not to answer, you are at liberty to skip it or end the survey without any adverse effect on you.

Could being in this research hurt me?

There are no risks participating in this research beyond those experienced in everyday life.

Will being in this research benefit me?

It is not expected that you will personally or financially benefit from the research. However, you may choose to be part of the shared responsibility for safety within your collegiate aviation program by taking part in this study. The study will provide data and tools for continuous improvement of safety culture and encourage proactive safety behaviors. The study will enhance effective safety report management, hazard identification and safety risk mitigations in collegiate aviation. The study will also provide a better framework for SMS implementation for other collegiate aviation programs throughout the United States.

How many people will participate in this research?

Approximately 1,000 students, staff, and faculty various collegiate aviation programs will take part in this study.

Will it cost me money to take part in this research?

You will not have any costs for being in this research study.

Will I be paid for taking part in this research?

There will be no financial incentive for taking part in this survey.

Who is funding this research?

There is no funding being provided for this research.

What happens to information collected for this research?

The survey does not ask for any information that would identify who the responses belong to (anonymous online). Therefore, your responses are recorded anonymously. If this research is published, no information that would identify you will be included since your name is in no way linked to your responses.

All survey responses that we receive will be treated confidentially and stored on a secure server. However, given that the surveys can be completed from any computer (e.g., personal, work, school), we are unable to guarantee the security of the computer on which you choose to enter your responses. As a participant in our study, we want you to be aware that certain "key logging" software programs exist that can be used to track or capture data that you enter and/or websites that you visit.

What if I agree to be in the research and then change my mind?
If you decide to leave the study early, we ask that you close the link by skipping to the end of the survey and opting out. You may contact the principal investigator using the email address and telephone number provided in this consent statement. Skipping questions or deciding to opt out of the survey will not have to adverse impact on you.

Who can answer my questions about this research?
If you have questions, concerns, or complaints, or think this research has hurt you or made you sick, talk to the PI of the research team at the phone number listed above on the first page.

This research is being overseen by the UND Institutional Review Board ("IRB"). An IRB is a group of people who perform an independent review of research studies. You may talk to them at 701.777.4279 or UND.irb@UND.edu If You have questions, concerns, or complaints that are not being answered by the research team. You are not getting answers from the research team. You cannot reach the research team. You want to talk to someone else about the research. You have questions about your rights as a research subject. You may also visit the UND IRB website for more information about being a research subject: http://und.edu/research/resources/human-subjects/research-participants.html

○ Yes (1)

○ No (2)

End of Block: Consent Page

Start of Block: Demographic Details

Q2.1 Year Group

○ Freshman (1)

○ Sophomore (2)

○ Junior (3)

○ Senior (4)

○ Other (5) _____

Q2.2 Highest Flight Certificate Held

- ○ Student (1)
- ○ Private (2)
- ○ Commercial (3)
- ○ Certified Flight Instructor or Air Transport Pilot (4)

Q2.3 Gender

- ○ Male (1)
- ○ Female (2)

Q2.4 Are you an international student?

- ○ Yes (1)
- ○ No (2)

Q2.5 What University do you attend for flight training or currently employs you?

_____

Q2.6 What kind of Safety Management System (SMS) does your institution have or currently pursuing?

- ○ FAA accepted SMS Voluntary Program (SMSVP) (1)
- ○ International Standards-Business Aircraft Operations (IS-BAO) / Third-Party Vendor SMS (2)
- ○ Do not know (3)
- ○ None (4)

Q2.7 What is your functional group?

- ○ Student (1)
- ○ Permanent Employee/Staff (2)
- ○ Faculty (3)

End of Block: Demographic Details

Start of Block: Policy Implementation

Q3.1 Please provide your degree of agreement regarding the following statements about the Safety Management System (SMS) in your flight program

---

Q3.2 The safety policy is signed and approved by the University President, Dean, or other Accountable Executive, who demonstrates a commitment to safety through active and visible participation in the SMS.

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q3.3 The results of safety performance reviews are used by the program leadership as input for safety improvement processes.

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q3.4 There is a process that provides for the capture of information on hazards, incidents, accidents and other data relevant to SMS

- Strongly disagree (1)

○ Somewhat disagree (2)

○ Neither agree nor disagree (3)

○ Somewhat agree (4)

○ Strongly agree (5)

Q3.5 Safety professionals with appropriate skills, knowledge, and experience conduct SMS training

○ Strongly disagree (1)

○ Somewhat disagree (2)

○ Neither agree nor disagree (3)

○ Somewhat agree (4)

○ Strongly agree (5)

Q3.6 There is a high emphasis on providing adequate financial and technical resources to improve the SMS

○ Strongly disagree (1)

○ Somewhat disagree (2)

○ Neither agree nor disagree (3)

○ Somewhat agree (4)

○ Strongly agree (5)

Q3.7 Policies and procedures in SMS manual are easy to understand

○ Strongly disagree (1)

○ Somewhat disagree (2)

○ Neither agree nor disagree (3)

○ Somewhat agree (4)

○ Strongly agree (5)

End of Block: Policy Implementation

Start of Block: Process Engagement

Q4.1 Please provide your degree of agreement regarding the following statements about the SMS in your flight program

---

Q4.2 Conditions under which punitive disciplinary action would be considered (e.g. illegal activity, negligence or willful misconduct) are not clearly defined.

○ Strongly disagree (1)

○ Somewhat disagree (2)

○ Neither agree nor disagree (3)

○ Somewhat agree (4)

○ Strongly agree (5)

Q4.3 Students/Personnel are not informed on the primary contacts for aviation safety-related matters.

○ Strongly disagree (1)

○ Somewhat disagree (2)

○ Neither agree nor disagree (3)

○ Somewhat agree (4)

○ Strongly agree (5)

Q4.4 The scope of the safety-related hazards that must be reported are not explained to students/personnel.

○ Strongly disagree (1)

○ Somewhat disagree (2)

○ Neither agree nor disagree (3)

○ Somewhat agree (4)

○ Strongly agree (5)

Q4.5 Safety concerns reported through the safety reporting system are corrected in a timely manner

- ○ Strongly disagree (1)
- ○ Somewhat disagree (2)
- ○ Neither agree nor disagree (3)
- ○ Somewhat agree (4)
- ○ Strongly agree (5)

Q4.6 Knowing how and where to report safety concerns is easy

- ○ Strongly disagree (1)
- ○ Somewhat disagree (2)
- ○ Neither agree nor disagree (3)
- ○ Somewhat agree (4)
- ○ Strongly agree (5)

Q4.7 Safety reporting system does not provide confidentiality for safety reports filed and feed-back received

- ○ Strongly disagree (1)
- ○ Somewhat disagree (2)

○ Neither agree nor disagree (3)

○ Somewhat agree (4)

○ Strongly agree (5)

End of Block: Process Engagement

Start of Block: Safety Reporting Behavior

Q5.1 Please provide your degree of agreement

Q5.2 I file reports about unsafe situations, even if the situation was caused by my own actions

○ Never (1)

○ Sometimes (2)

○ About half the time (3)

○ Most of the time (4)

○ Always (5)

Q5.3 I file reports on safety deviations without fear of negative outcomes

○ Never (1)

○ Sometimes (2)

○ About half the time (3)

○ Most of the time (4)

○ Always (5)

Q5.4 I do not report unsafe actions of others because I am not empowered to do so

○ Never (1)

○ Sometimes (2)

○ About half the time (3)

○ Most of the time (4)

○ Always (5)

End of Block: Safety Reporting Behavior

Start of Block: Safety Compliance

Q6.1 Please provide your degree of agreement regarding the following statements about yourself

---

Q6.2 I pay full attention to pre-flight briefing during flight operations

○ Strongly disagree (1)

○ Somewhat disagree (2)

○ Neither agree nor disagree (3)

○ Somewhat agree (4)

○ Strongly agree (5)

Q6.3 I follow correct safety procedures in flight operations

○ Strongly disagree (1)

○ Somewhat disagree (2)

○ Neither agree nor disagree (3)

○ Somewhat agree (4)

○ Strongly agree (5)

Q6.4 I ensure the highest level of safety in flight operations

○ Strongly disagree (1)

○ Somewhat disagree (2)

○ Neither agree nor disagree (3)

○ Somewhat agree (4)

○ Strongly agree (5)

End of Block: Safety Compliance

Start of Block: Safety Participation

Q7.1 Please provide your degree of agreement regarding the following statements about yourself

Q7.2 I promote the safety program within the flight program

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q7.3 I put in extra effort to improve the flight safety program

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q7.4 I volunteer for safety-related task in the flight program

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

End of Block: Safety Participation

Start of Block: Safety Motivation

Q8.1 Please provide your degree of agreement regarding the following statements about yourself

Q8.2 It's worthwhile to improve personal safety

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q8.3 It's important to maintain safety at all times

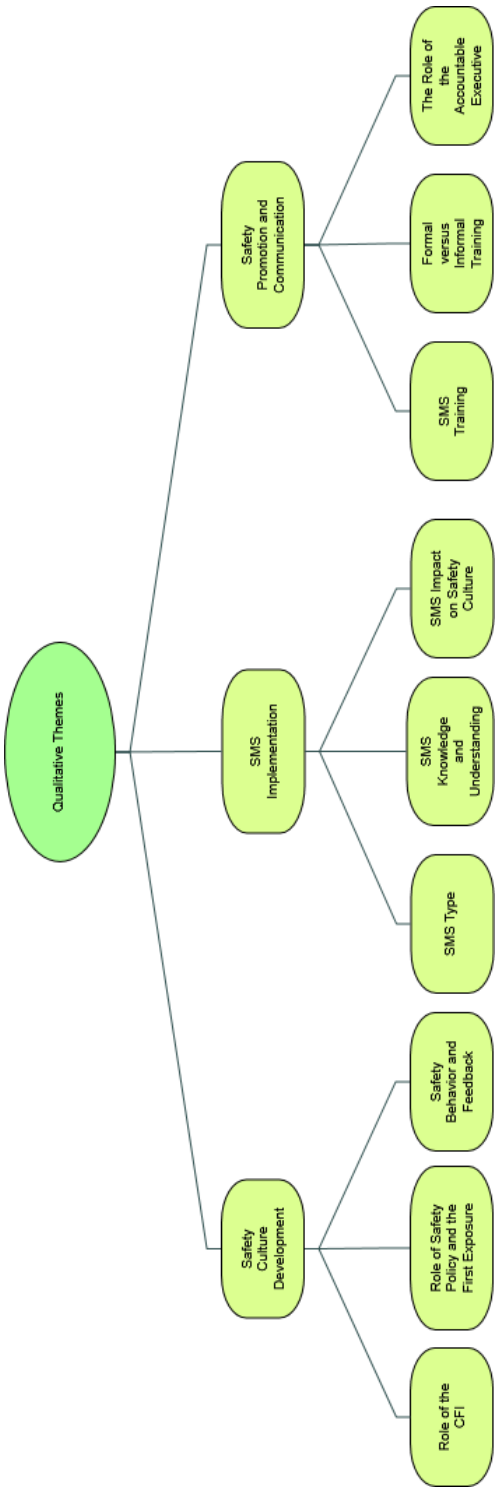
- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q8.4 It's important to reduce the risk of safety events in flight operations

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

End of Block: Safety Motivation

Appendix C
Tree Diagram of Emergent Themes from Qualitative Analysis



Appendix D
IRB Approval (Survey)

UNIVERSITY OF NORTH DAKOTA

UND.edu

Office of Research Compliance & Ethics
Tech Accelerator, Suite 2050
4201 James Ray Drive Stop 7134
Grand Forks, ND 58202-7134
Phone: 701.777.4279
Fax: 701.777.2193

September 1, 2020

Principal Investigator:	Robert Foster
Project Title:	Safety Culture in Collegiate Aviation: A Cross-Sectional Analysis Between Multiple Universities (Survey)
IRB Project Number:	IRB-202008-034
Project Review Level:	Expedited 7
Date of IRB Approval:	8/31/2020
Expiration Date of This Approval:	8/30/2021

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

The waiver of written consent has been approved under 45 CFR 46.117(c)(2).

Prior to implementation, submit any changes to or departures from the protocol or consent form to the IRB for approval. No changes to approved research may take place without prior IRB approval.

You have approval for this project through the above-listed expiration date. When this research is completed, please submit a termination form to the IRB. If the research will last longer than one year, an annual review and progress report must be submitted to the IRB prior to the submission deadline to ensure adequate time for IRB review.

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

Sincerely,

Michelle L. Bowles, M.P.A., CIP
RC&E Manager

MLB/sy

Cc: Daniel Adjekum, Ph.D.

Appendix E
IRB Approval (Interviews)

UND UNIVERSITY OF NORTH DAKOTA

DIVISION OF RESEARCH & ECONOMIC DEVELOPMENT

UND.edu

Institutional Review Board
Tech Accelerator, Suite 2050
4201 James Ray Dr Stop 7134
Grand Forks, ND 58202-7134
Phone: 701.777.4279
Fax: 701.777.2193
UND.irb@UND.edu

April 8, 2020

Principal Investigator:	Robert Foster
Project Title:	Safety Culture in Collegiate Aviation: A Cross-Sectional Analysis Between Multiple Universities
IRB Project Number:	IRB-202004-262
Project Review Level:	Expedited 7
Date of IRB Approval:	04/01/2020
Expiration Date of This Approval:	03/31/2021
Consent Form Approval Date:	04/01/2020

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

Attached is your original consent form that has been stamped with the UND IRB approval and expiration dates. Please maintain this original on file. ***You must use this original, stamped consent form to make copies for participant enrollment. No other consent form should be used.*** It must be signed by each participant prior to initiation of any research procedures. In addition, each participant must be given a copy of the consent form.

Prior to implementation, submit any changes to or departures from the protocol or consent form to the IRB for approval. No changes to approved research may take place without prior IRB approval.

You have approval for this project through the above-listed expiration date. When this research is completed, please submit a termination form to the IRB. If the research will last longer than one year, an annual review and progress report must be submitted to the IRB prior to the submission deadline to ensure adequate time for IRB review.

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

Sincerely,

Michelle Bowles

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

MLB/sy
Enclosures

Cc: Daniel Adjekum, Ph.D.

The University of North Dakota is an equal opportunity / affirmative action institution.

THE UNIVERSITY OF NORTH DAKOTA
CONSENT TO PARTICIPATE IN RESEARCH

Project Title: Safety Culture in Collegiate Aviation: A Cross-sectional Analysis Between Multiple Universities

Principal Investigator: Robert "Tony" Foster

Phone/Email Address: robert.a.foster@ndus.edu

Department: Aerospace Sciences

Research Advisor: Daniel Kwasi Adjekum

Research Advisor Phone/Email Address: 701-777-6689 / daniel.adjekum@ndus.edu

What should I know about this research?

- Someone will explain this research to you.
- Taking part in this research is voluntary. Whether you take part is up to you.
- If you don't take part, it won't be held against you.
- You can take part now and later drop out, and it won't be held against you
- If you don't understand, ask questions.
- Ask all the questions you want before you decide.

How long will I be in this research?
We expect that your taking part in this research will last approximately one hour

Why is this research being done?
The purpose of this research is to explore the nature by which collegiate aviation students and staff adopt a safety culture. Furthermore, exploration as to the effect of Safety Management Systems (SMS) implementation has on safety culture will be conducted.

What happens to me if I agree to take part in this research?
If you decide to take part in this research study, you will participate in a semi-structured interview that will be audio recorded.

Could being in this research hurt me?
There is minimal risk expected with these interviews. Although, some discomfort could arise from sharing potentially sensitive information regarding your organization. Since these interviews will be conducted via phone or video conference, full confidentiality will be dependent upon the setting of both parties. This researcher will ensure complete isolation while conducting the interview. However, you will be responsible for ensuring privacy prior to

Approval Date: APR 1 2020
Expiration Date: MAR 31 2021
University of North Dakota IRB

Date: _____
Subject Initials: _____

conducting the interview. Since the interview could last up to an hour, this could result in some fatigue. You may take breaks as necessary.

Will being in this research benefit me?
The most important benefits that you may expect from taking part in this research include contributing to the advancement of encouraging a positive safety culture at collegiate aviation institutions while exploring best practices for SMS implementation.

Possible benefits to others include other collegiate aviation programs learning best practices to encourage a positive safety culture at their institutions and to learn the best practices associated with SMS implementation.

How many people will participate in this research?
Approximately seven people will take part in this study at the University of North Dakota. There will be an additional 21 participants from different institutions (i.e. seven from three different universities).

What other choices do I have besides taking part in this research?
The alternative choice is to not participate in the study.

Will it cost me money to take part in this research?
You will not have any costs for being in this research study.

Will I be paid for taking part in this research?
You will not be paid for being in this research study.

Who is funding this research?
The University of North Dakota and the research team are receiving no payments from other agencies, organizations, or companies to conduct this research study.

What happens to information collected for this research?
Your private information may be shared with individuals and organizations that conduct or watch over this research, including:

- The Institutional Review Board (IRB) that reviewed this research
- The research advisor and committee

We may publish the results of this research. However, we will keep your name and other identifying information confidential. We protect your information from disclosure to others to the extent required by law. We cannot promise complete secrecy.

Data or specimens collected in this research will not be used or distributed for future research studies, even if identifiers are removed.

Approval Date: APR 1 2020
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Date: _____
Subject Initials: _____

The audio recorded interviews will be stored on a computer and protected by password. While there is a minimal risk associated with this study, complete confidentiality cannot be guaranteed. Protecting names and identities will be performed to the best of the research team's ability by de-identifying responses and not publishing names in the results. You will have the ability to review the transcriptions from the interviews to validate accuracy.

What if I agree to be in the research and then change my mind?
You are allowed to end the interview at any time and may choose not to answer any questions. If you wish to not participate, please contact the principal investigator.

Who can answer my questions about this research?
If you have questions, concerns, or complaints, or think this research has hurt you or made you sick, talk to the research team at the phone number listed above on the first page.

This research is being overseen by an Institutional Review Board ("IRB"). An IRB is a group of people who perform independent review of research studies. You may talk to them at 701.777.4279 or UND.irb@UND.edu if:

- You have questions, concerns, or complaints that are not being answered by the research team.
- You are not getting answers from the research team.
- You cannot reach the research team.
- You want to talk to someone else about the research.
- You have questions about your rights as a research subject.
- You may also visit the UND IRB website for more information about being a research subject: http://und.edu/research/resources/human-subjects/research-participants.html

Your signature documents your consent to take part in this study. You will receive a copy of this form.

Subject's Name: _____

_____ _____
Signature of Subject Date

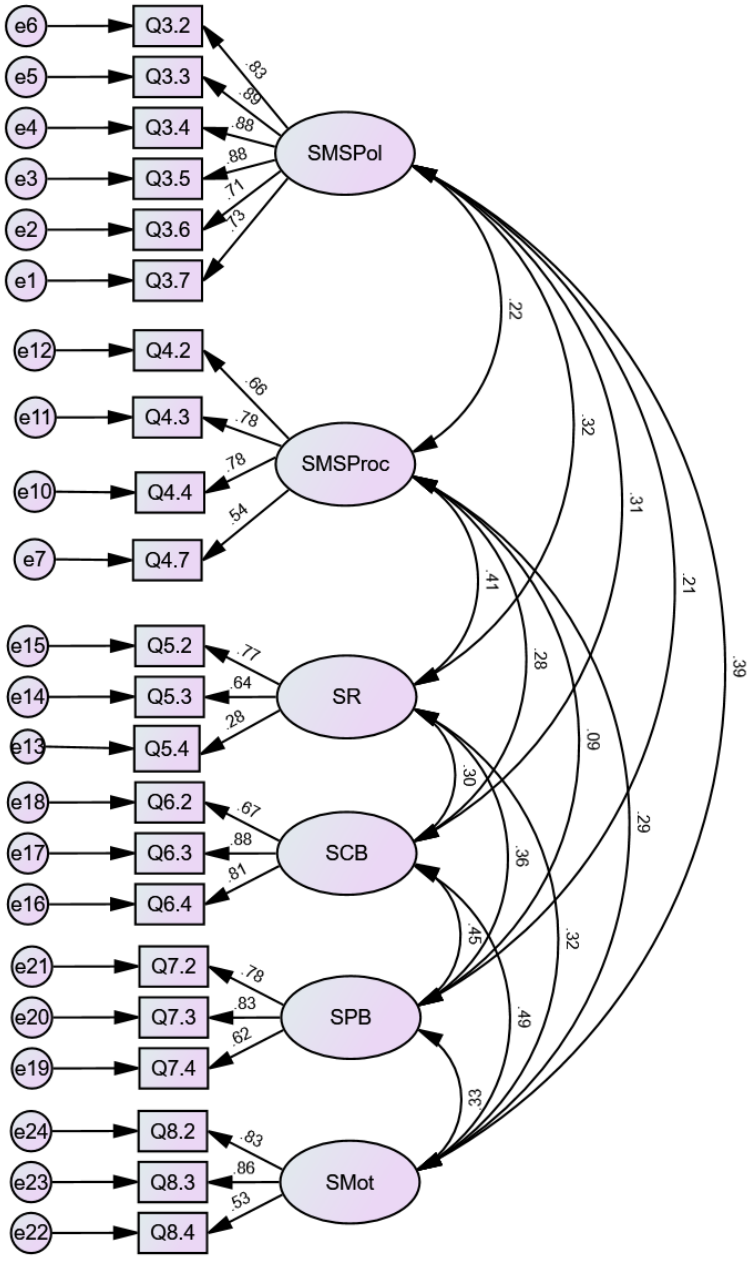
I have discussed the above points with the subject or, where appropriate, with the subject's legally authorized representative.

_____ _____
Signature of Person Who Obtained Consent Date

Approval Date: APR 1 2020
Expiration Date: MAR 31 2021
University of North Dakota IRB

Date: _____
Subject Initials: _____

Appendix F
Final Measurement Model



Appendix G
Final Measurement Model Goodness-of-Fit Indices

Table 9. Final Measurement Model Goodness-of-Fit Indices

Iteration	Chi-square (χ^2)	NFI	IFI	TLI	CFI	RMSEA
Final Measurement Model	χ^2 (194, n = 451) = *467.542*, CMIN/DF = 2.410, $p < .001$	0.903	0.941	0.929	0.941	.056 (.050 - .062)

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