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An Evaluation of the Relationships Between Safety Management System Intiatives, Transformational Safety Leadership, Self-Efficacy, Safety Behavior and Safety Related Events Mediated by Safety Motivation in Collegiate Aviation

Daniel Kwasi Adjekum

AN EVALUATION OF THE RELATIONSHIPS BETWEEN SAFETY MANAGEMENT SYSTEM INITIATIVES, TRANSFORMATIONAL SAFETY LEADERSHIP, SELF-EFFICACY, SAFETY BEHAVIOR, AND SAFETY -RELATED EVENTS MEDIATED BY SAFETY MOTIVATION IN COLLEGIATE AVIATION

by

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“It always seems impossible until it’s done” - Madiba Nelson Mandela.

To Yaa Asantewa, Nana and Maame

ABSTRACT

The study conceptualized Safety Management System (SMS) initiative, self-efficacy, and transformational safety leadership as constructs that relates to safety behavior (measured by safety compliance and safety participation) when mediated by safety motivation using a concurrent-triangulation approach. The study also evaluated the relationship between safety behavior and safety -related events. Structural equation modeling techniques was used to derive a final measurement model that fit the empirical data and was used to test the study hypotheses. Utilizing a sample of 282 collegiate flight students and instructors from a large public university, a 46-item survey was conducted to measure respondent's perceptions on the study variables. Semi- structured interviews were also conducted with 4 top-level management personnel to sample their opinions on the effectiveness of the SMS initiative. Factual safety performance data on the flight program over a six-year period was analyzed to complete a triangulation approach. The results indicate that perceptions of SMS policy implementation have direct, positive effect on safety compliance and SMS process engagement has direct, positive effect on safety participation. Self-efficacy had direct, positive effect on both safety compliance and safety participation. Safety motivation fully mediated the effect of transformational safety leadership on safety participation. Safety – related events did not fully mediate the effect between safety compliance and safety participation. There were indications that respondents were not familiar with the Emergency Response Plan. An ANOVA suggests that certified flight instructors significantly had better safety participation and safety compliance than pre-private pilots did. Senior significantly had better safety participation than juniors. A T-test of mean did not reveal any significant differences in safety participation and safety compliance between respondents with formal

SMS training and those without. A review of factual safety data suggests a positive effect on the safety reporting and safety meeting attendance among respondents due to the SMS initiative. Interviews revealed that top-level management support, resource provision and resilience are key elements in the success of any SMS initiative. The theoretical and policy implications of this study to improve proactive safety in collegiate aviation are discussed.

CHAPTER I

INTRODUCTION

A reduction in General Aviation (GA) fatalities has been a top priority of the Federal Aviation Administration (FAA) and that has resulted in a goal to reduce the GA fatal accident rate by 10 percent over a 10-year period (2009-2018). The FAA in partnership with the GA community intends to use safety data and proactive initiatives to identify risk, pinpoint trends through root cause analysis, and develop safety strategies (FAA, 2015c).

Collegiate aviation is generically classified under GA along with other flight training activities and the rigorous operational dynamics of the flight training environment exposes students, instructors and other operational personnel to the risk of incidents and accidents (Hunter, 2006; FAA, 2012; Houston et al., 2012). Even though a lot of effort has been expended by some collegiate programs to ensure safety of flight operations, accidents and incidents do occur from time to time and sometimes with tragic consequences (NTSB, 2007; NTSB, 2010; CBS, 2014). As part of the strategic objective to improve aviation safety, the FAA has also collaborated with the aviation academic community and stakeholders such as Aviation Accreditation Board International (AABI) and the University Aviation Association (UAA) to leverage their expertise and develop best safety practices for improving flight training (FAA, 2015c).

The need to develop best practices and safety initiatives that will identify and proactively manage safety behaviors of all personnel involved in the flight training and operations department is one of the challenges of collegiate aviation safety managers. These safety managers, as part of their duties are tasked with establishing predictive relationships between the perceptions of flight students and flight instructors on the safety culture and how it affects their safety behavior (Hudson, 2001; FAA, 2012). A favourable perception of both flight students and flight instructors on the effectiveness of a safety culture in an aviation-training program has become very essential since it has a moderating influence on their safety behaviors (Dillman, Voges & Robertson, 2010).

Background of the Study

One of the challenges of ensuring proactive safety management, enhanced safety culture, and accident prevention in collegiate aviation programs is continuous improvement of the safety program and the ability to adopt effective methods in establishing a relation between the safety perceptions of students, flight instructors, and their safety behaviors in flight operations (von Thaden, 2008). Previous studies have suggested that the perceptions of flight personnel could influence their safety behavior in an aviation organization and some risky safety behaviors can serve as precursors for safety occurrences like accidents (Hunter, 2006; Dillman, Voges & Robertson, 2010; Adjekum et al., 2015).

An accident in collegiate aviation programs could have a negative impact on effective training and lead to loss of lives, equipment, reputation, and customer confidence in the overall training program of a flight school (ASN, 2008; ICAO, 2009; NTSB, 2010). Some collegiate aviation programs in the United States (U.S.) are also engaged in international contract pilot training and an accident could have dire repercussions on their continuous engagements in such foreign training contracts.

Some collegiate aviation programs in the US have implemented proactive safety initiatives to mitigate risks associated with their training operations and improve the safety culture (Adjekum, 2014b). Effective safety initiatives such as Safety Management Systems (SMS) implementation has positively affected the safety culture, and subsequently enhanced the accident prevention strategies in these aviation programs (Adjekum, 2014b; Adjekum, 2015).

The International Civil Aviation Organization (ICAO) defines SMS as an organized approach to managing safety, including the necessary organizational structures, accountabilities, policies and procedures (ICAO, 2013). The FAA defines SMS as a formal, top-down, organization-wide approach to managing safety risk and assuring the effectiveness of safety risk controls (FAA, 2015b). SMS includes systematic procedures, practices, and policies for the management of safety risk.

An SMS is a management device that uses proactive tools, in addition to reactive ones and relies on safety performance with a focus on processes. An SMS is an effective tool in hazards identification and mitigation of risks before operational safety is threatened. An SMS consists of four main components: Safety Policy and Objectives, Safety Risk Management, Safety Assurance, and Safety Promotion. These four main components comprise twelve sub-components (ICAO, 2013). Under SMS, aviation service providers improve safety during service delivery mainly through two operational components. These are safety risk management and safety assurance, with safety policy and objectives as well as safety promotion playing a supporting, yet important, role (ICAO, 2009).

An organizational safety effort cannot succeed just by the mechanic implementation of the referred SMS components and procedures. An effective SMS is built taking due account of the interaction between these components and the human element of aviation operations (Stolzer, Halford & Goglia, 2011). A successful implementation and operation of an SMS is highly dependent on organizational aspects such as individual and group attitudes, values, competencies and patterns of behavior, which are frequently referred to as elements of the organizational safety culture (Cooper, 2000; ICAO, 2009). A positive safety culture is characterized by a shared awareness of organization's personnel of the importance of safety in their operational tasks

Some collegiate aviation programs in the U.S, have on voluntary basis adopted proactive safety initiatives such as SMS. These collegiate programs have allocated resources and manpower to harness the inherent benefits of SMS, which is already being utilized in Part 121 air carriers, some Part 139 airports and Air Traffic Organizations (ATO) in the US (FAA, 2012; UND, 2012; FAA, 2015b). The FAA, as part of a proactive mandate, has been providing technical assistance to these collegiate aviation programs on SMS (FAA, 2012; FAA, 2015b).

There could be challenges for management of collegiate flight programs to ensure that the SMS implementation within the organization positively influences the behavior of personnel such as flight instructors and students (Cooper, 2000; Adjekum, 2014b). It is important for senior level management of collegiate aviation programs to evaluate the effectiveness of SMS implementation, since a lot of time and resources would have been invested and returns on investments such as continuous improvements in safety performance are critically desired (Adjekum, 2014a).

Conversely, the impact of variables such as beliefs, opinions and perceptions of collegiate aviation personnel on transformational leadership attributes among senior level management, personal self-efficacy and safety motivation on safety behavior needs constant assessment. This assessment is essential because of the concomitant effects on safety performance outcomes, such as incidents and accidents (Freiwald, 2013; Adjekum, 2014b; Chen, 2014).

Problem Statement

The general aviation (GA) community of which training organizations such as collegiate aviation is inclusive has been plagued by a historically high accident rates. The preliminary estimate for Flight Year (FY) 2014 showed a fatal accident rate of 1.09 (1 per 100,000 flight hours) with 251 GA fatal accidents and 434 resulting fatalities (FAA, 2015). In an era of competition between constrained resources and increased propensity for productivity, SMS initiative may help to reduce losses due to undesirable safety occurrences, some of which are primed by the attitudes and behaviors of personnel at the “sharp end’’ (ICAO, 2013).

Effective SMS implementation has been shown to have a positive effect on the safety perceptions of front line personnel in high reliability organizations such as aviation, and improved safety behaviors (von Thaden, 2008; Adjekum et al., 2015). Chen (2014) in a study among pilots in Taiwanese airlines suggested significant effects within the interactions between perceptions on SMS practice, safety leadership, self-efficacy, and safety behavior with safety motivation as a mediating variable. Other studies in occupational safety have also examined the role perceptions of personnel on safety climate in various organizations influence safety behaviors (DeJoy, Schaffer, Wilson, Vandenberg, & Butts, 2004; Griffin & Neal, 2000; Mearns, Whitaker, & Flin, 2003; Zohar & Luria, 2004).

Transformational safety leadership is another variable that has been suggested to influence safety behavior and invariably safety related outcomes like violations, incidents and accidents. In studies by Zohar (2002), for example, the role of leadership has been emphasized as a factor in improving safety. Additionally, studies by Barling, Loughlin, and Kelloway (2002) have focused on the effects of transformational leadership on safety promotion.

A challenge and gap in research is establishing a coherent and cogent relationship between these variables using a comprehensive triangulation approach in aviation and specifically collegiate aviation program in the US. This current approach will provide a holistic analysis of quantitative surveys, documentary artifacts and semi-structured interview of senior level management to build a three-dimensional framework of the safety status within a collegiate aviation program in the U.S.

This approach will also afford a clearer picture of gaps both laterally and horizontally within the collegiate aviation safety program. The identification of these disjoint between senior level management view of safety and the operational level personnel view of the safety status of the collegiate aviation program will provide the information needed for the development of safety purpose, realignment and controls to fix these gaps (Patankar, 2003).

Purpose of the Study

The intent of this concurrent triangulation mixed methods study was a follow up on recommendations for further studies on previous works by Freiwald (2013) and Chen (2014). These two researchers recommended further studies on the inter-relationships between SMS initiatives, safety leadership, safety climate, self-efficacy, safety motivation and safety behavior among demography in health and aviation. In terms of specificity of demography, this study builds up on recommendations from previous studies in collegiate aviation safety culture and safety behavior by Adjekum (2014b) and Adjekum et al. (2015).

The study aims to fill a gap in research on SMS initiatives in collegiate aviation programs, reduce the paucity of existing literature, and establish a coherent relationship between these variables using a comprehensive triangulation approach in a collegiate aviation program in the US. The study also establishes a proactive operational safety benchmarks for continuous monitoring and improvements in SMS implementations within collegiate aviation programs.

In this study, a quantitative survey instrument was used to examine the relationship between the perceptions of collegiate aviation flight personnel (Flight students including those with certified flight instructor ratings employed in the program) on Safety Management System (SMS) initiatives, transformational safety leadership (TSL), self-efficacy (SE), and self-reported safety behaviors while mediating with safety motivation. Safety behavior was measured by safety compliance (SC) and safety participation (SP).

Path Models (PA) and Structural Equation Modeling (SEM) technique were used to establish paths and determine the strengths of relationship of these variables. The study also compared a proposed theoretical measurement model with a final measurement model. The analysis would also look at the magnitude of interactions of variables. The relationship between these indicators of safety and safety outcomes (safety behavior and self -reported safety events) will be also be explored.

Concurrently, the strategic perspectives of a selected group of senior level management personnel of the collegiate aviation program (An accountable executive, two functional department heads/process owners and a faculty member with management oversight) on the state of the SMS initiative in the program was assessed through semi-structured interviews. The final triangulation process to integrate the quantitative data, qualitative data and document analysis included a review of documented aggregate data (statistics) of safety performance indicators since the implementation of the SMS initiative in the aviation program of the university.

The forty-six survey items (Appendix A) representing the seven constructs for the quantitative section of this study and six demographic variables are fully described in Chapter IV and are outlined below:

a) SMS initiative- Chen and Chen (2012), Chen (2014), Transport Canada (2005).
b) Self-efficacy – Schwazzer and Jerusalem (1995).
c) Safety motivation- Neal and Griffin (2006).
d) Safety behavior (Safety compliance and Safety participation) - Neal, Griffin, and Hart (2000), Neal and Griffin (2006).
e) Transformational safety leadership – Survey of Transformational Leadership (STL) developed by Edwards, Knight, Broome and Flynn (2010).

f) Safety- related events – Collegiate Aviation Perception of Safety Culture Assessment Scale (CAPSCAS) developed by Adjekum (2014).

The required permissions were sought from the copyright owners of these instruments. Some items from these validated instruments were used in their entirety, albeit in a randomized order. Slight modifications to some instrument items; to cater to the unique demography of collegiate aviation respondents were made. A beta testing of the composite instruments was done through a pilot study, using a selected sample of respondents within the collegiate aviation program. The composite instrument has been outlined in the Appendix.

Research Questions

The quantitative aspect of this research, which involved a survey instrument administered to flight students and flight instructors in the collegiate aviation program sought to answer the following questions:

1. What are the factors that measure the latent construct of SMS initiative?
2. What are the strengths of the relationship between SMS initiative, transformational safety leadership, self-efficacy, safety motivation and the outcome variable safety behavior measured by safety compliance and safety participation?
3. What is the effectiveness of a proposed measurement model as compared to that of a final measurement model that assesses 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?
4. What are the strengths of the relationship between Safety behavior (Safety participation and Safety compliance) and Safety-related events?

5. What are the differences in perceptions among the demographic variables (years in program, age group, SMS training status, and flight certification) on safety behavior and self-reported safety events?

Semi-Structured Interview Questions

The following questions was posed to selected senior management personnel during the semi-structured interview in order to find out the leadership perspective on levels of implementation of the SMS initiative and the current safety performance of the collegiate aviation program:

1. What roles have leadership played in the safety policy implementation and expectations of the SMS program?
2. What are the effects of SMS implementation on the operational performance (number of unstable approaches captured in flight data monitoring (FDM), runway incursions, ground collision events, flight holds due to alcohol, number of voluntary safety reports filed and participation in safety meetings) of the aviation program?
3. What have been some of the challenges in the implementation process of SMS in the aviation program?
4. How are continuous monitoring and improvement of the SMS, sustained in the aviation program?
5. What recommendations do you have for collegiate aviation programs that intend to implement or are in the process of implementing SMS?

The final phase of this research was a discussion and recommendation section that involved a concurrent –triangulation of the quantitative findings, qualitative findings and artifact/document analysis to identify degrees of convergence or divergence on the overall

SMS initiative status of the collegiate aviation program. A hypothetical model as shown in Figure1 provides a relational path way between the variables that were measured.

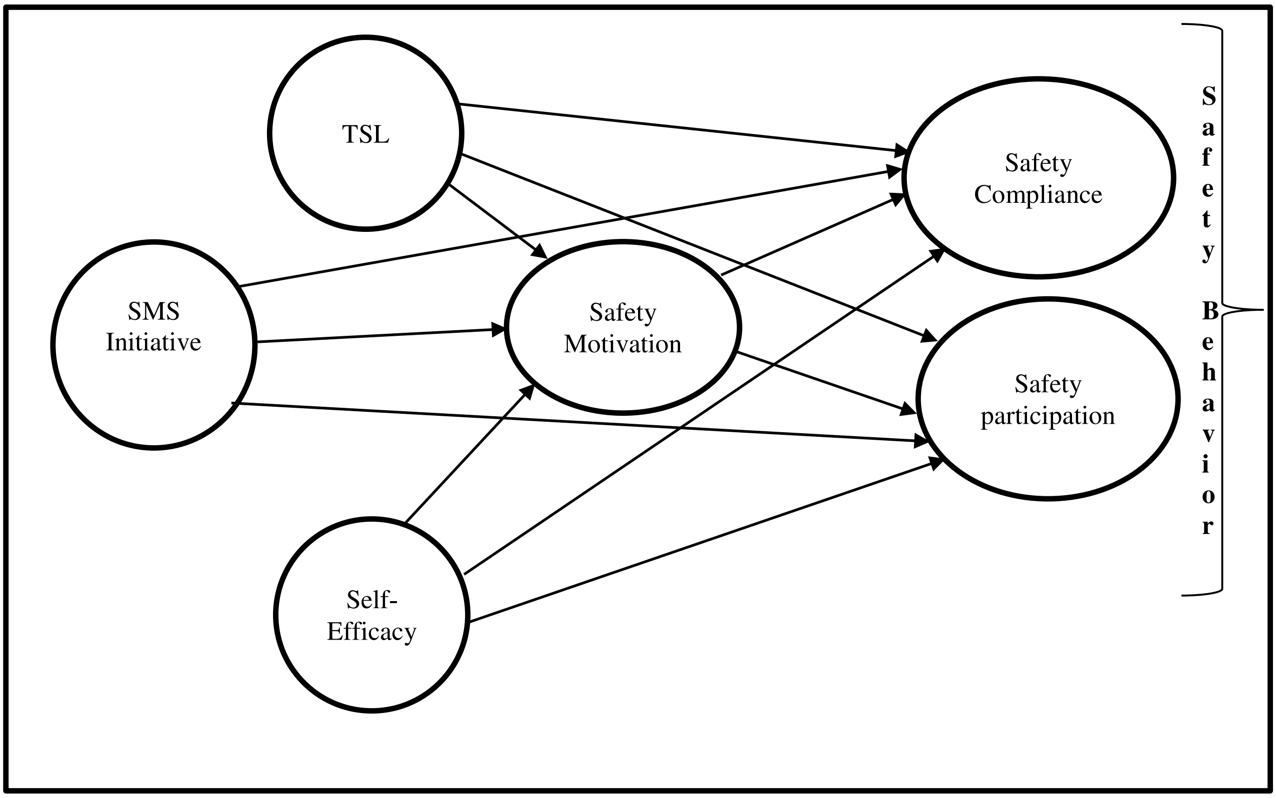

Figure 1. A hypothetical model showing the relationship between Transformational safety leadership, SMS initiative, Self-efficacy, Safety motivation and Safety behavior (Safety compliance and Safety participation).

Statement of Hypotheses

SMS Initiatives, Safety Motivation and Safety Behavior

On the basis of existing literature (Neal, Griffin & Hart, 2000; Neal & Griffin, 2006; Freiwald, 2013; Chen, 2014) this study predicted that a better perception of the SMS initiative implemented in their collegiate aviation programs, by pilots will provide a stronger motivation to engage in proactive safety behaviors. This study also predicted that there existed a relationship between SMS initiative and safety behavior (safety compliance and safety participation). This study hypothesized that safety motivation will mediate the relationship between SMS initiative and pilots' safety behaviors (safety compliance and safety participation). The direct and indirect effects of SMS initiative on these variables were hypothesized, as follows:

H_1: Pilots' perceptions of their collegiate aviation program SMS initiative are related to their safety motivation.

H_2: Pilots' perceptions of their collegiate aviation SMS initiative are related with to safety compliance.

H_3: Pilots' perceptions of their collegiate aviation SMS initiative are related with to safety participation.

H_4: Pilots' safety motivation mediates the relationship between their perceptions of their collegiate SMS initiative and safety compliance.

H_5: Pilots' safety motivation mediates the relationship between their perceptions of their collegiate SMS initiative and safety participation.

Transformational Safety Leadership, Safety Motivation and Safety Behavior

Extant literature suggested that a higher level of transformational leadership would motivate subordinate personnel to put more effort into their work and go above and beyond the call of duty for their leaders (Barling & Kelloway, 2002). Consistent with the suggestion of prior research that transformational leadership is positively related to flight crew's operational safety behavior (Chen, 2014), it was hypothesized that collegiate aviation program flight supervisory management's transformational safety leadership styles would motivate flight students and instructors to exhibit acceptable safety behaviors with greater diligence. The hypotheses outlined below explored the relationships and the mediating effect of safety motivation on these relationships:

H_6: Collegiate aviation program transformational safety leadership style is related to pilot's safety motivation.

H_7. Collegiate aviation program transformational safety leadership style is related to pilot's safety compliance.

H_8. Collegiate aviation program transformational safety leadership style is related to pilot's safety participation.

H_9. Collegiate aviation program transformational safety leadership style is related to pilot's safety compliance when mediated by safety motivation.

H_{10}. Collegiate aviation program transformational safety leadership style is related to pilot's safety participation when mediated by safety motivation.

Self-Efficacy, Safety Motivation and Safety Behavior

This study explored the relationships between pilots' perceived self-efficacy, safety motivation and safety behaviors. The related hypotheses proposed are as follows:

H_{11}: Collegiate aviation pilots' perceived self-efficacy is related with their safety motivation.

H_{12}: Collegiate aviation pilots' perceived self-efficacy is related to their safety compliance.

H_{13}: Collegiate aviation pilots' perceived self-efficacy is related to their safety participation.

H_{14}: Collegiate aviation pilots' safety motivation mediates the relationship between perceived self-efficacy and safety compliance.

H_{15}: Collegiate aviation pilots' safety motivation mediates the relationship between perceived self-efficacy and safety participation.

Safety Behavior, Safety –Related Events and Safety Motivation

In this study, the relationship between safety behavior (safety compliance and safety participation) and safety-related events was examined. Finally, the relationship between safety motivation and safety behavior was explored. The related hypotheses are stated below:

H_{16}: Collegiate aviation pilot's safety motivation is related to safety participation.

H_{17}: Collegiate aviation pilot's motivation is related to safety compliance.

H_{18}: Collegiate aviation pilot's safety compliance is related to safety participation.

H_{19}: Collegiate aviation pilot's safety compliance is related to safety participation when mediated by safety –related events.

H_{20}: Collegiate aviation pilot's safety compliance is related to safety –related events.

The hypothesized SEM-PA models of all the study variables and their inter-relationships are shown in Figures 2 and 3.

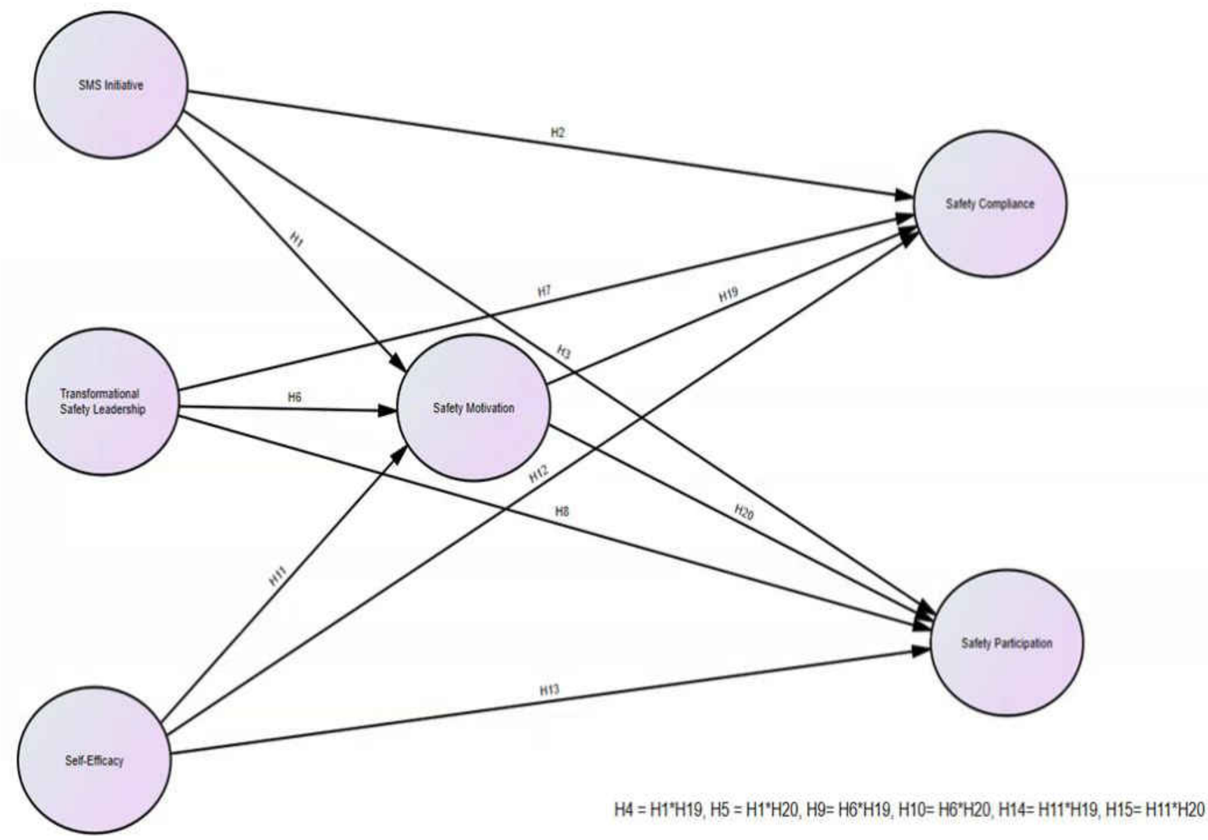

Figure 2. SEM-PA of hypothesized measurement model of relationship between SMS, TSL, SE, SM, SP and SC.

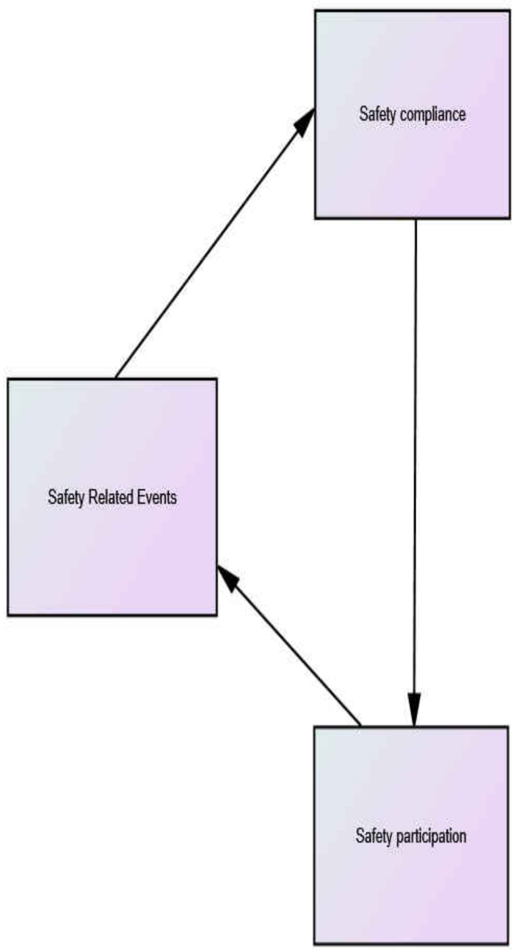

Figure 3. Hypothesized Path Model for Relationship between Safety Compliance, Safety Participation and Safety-Related Events.

Concurrent Triangulation Mixed Method Approach

A concurrent triangulation strategy of mixed-methods design was used to collect quantitative, qualitative and documentary/artifactual data. A comparison of the three databases was done to determine whether there exists convergence, divergence, or some combinations. This approach has been found helpful in comparing and cross-validating multiple-source findings. This approach generally uses separate quantitative and qualitative methods as a means to offset the inherent weaknesses in one method with the strength of the other (Creswell, 2009).

The quantitative method can also add to the strength of the qualitative method and in this approach, data collection was done concurrent, happening within the same collection phase of the other. Using this approach, normally the weight is generally equal among the methods, even though after the collection of data, there might arise some skewness in favor of one over the others (Plano Clark & Creswell, 2008). The findings from the data were integrated and further analyzed during the discussion and recommendation section of this study.

Rationale for Method

This approach was particularly selected for this study because in collegiate operations safety while quantitative evidence may depict a specific state of safety, the qualitative data, may reveal a more comprehensive and holistic understanding of why that state existed. Also the qualitative data from senior level leadership on safety within an organization presumably added strategic and corporate level insight to the normal operational safety details available through the artifacts and perceptions of personnel.

The advantages of this approach were rooted in the fact that it was cost effective and familiar to the researcher (Creswell, 2009). This approach also resulted in well-validated and substantiated findings and helped to triangulate diverse information to provide evidence for the effectiveness of a process or policy in an organization (Creswell & Plano Clark, 2007). The approach also helped to align gaps of safety within the collegiate aviation program (Patanker, 2003). It also had a shorter data collection period, since all the data were collected at the same time and within the same organization.

Limitations of the Concurrent Triangulation Mixed Method Approach

The approach required great effort and expertise in attempting to conduct an enquiry with separate methods. The other challenge faced was comparing the results of analysis from different methods. Resolving discrepancies that arose during the comparative analysis of the findings was also a challenge and some adapted remedies included a thorough overview of the both qualitative and quantitative database to clarify the disparity in the data (Creswell, 2009).

Research Assumptions and Limitations

The proposed path model for this study was subjected to critical testing for goodness-of-fit to estimate relationships among the constructs, resulting in a final path model that aimed at adequately representing the constructs under investigation. Another limitation was the use of factor analysis (Exploratory and Confirmatory) as a data reduction tool and that resulted in a series of modifications of the final path model relative to the proposed model.

The concepts of transformational safety leadership and self-efficacy are highly subjective and were measured as the perceptions of the respondents. Neither the instrument nor the study differentiate among levels of management relative to the respondents, as they may come into various contacts with diverse people, who at any particular time may represent operational safety leadership. Even though all the respondents in this study were flight students, there may have been respondents who may have acquired additional aeronautical experience outside the confines of the program and that experience may have affected their safety behavior.

Cross-sectional studies, unlike longitudinal studies, may be constrained in determining cause and effect relationships. The method was also limited to a snapshot of perceptions of SMS initiative implementation within the study period and may not have reflected the general trend over a long period. The dynamic nature of flight operations and the real-time occurrence of a safety –related event during the study period may have unfavorably skewed the perceptions of respondents.

Scope of Research and Exclusive Criteria

This study did not attempt to address all possible safety behaviors or safety events that were likely to be observed in the collegiate aviation operational environment. Although not every possibility could be examined, the prevalent conditions evaluated were hypothesized to be representative of the constructs under examination. This study was limited to respondents from the collegiate aviation program. Data collection was purposefully limited to a three-week period of the 2016 fall academic semester.

Non-flight students, graduate students, management pilots, faculty and staff were excluded from the survey instrument phase of this study. Details of the populations are addressed in Chapter IV. Finally, due to the scope of this study, factual safety performance data from the collegiate program were compared to self-reported data, even though the ultimate value existed in the relationship between the self-reporting of safety events and individual respondents' perception of SMS, self-efficacy, safety transformational leadership, safety motivation, and safety behavior.

Acronyms

AMOS- IBM® SPSS® AMOS Version 23 SEM software package

CFI -Comparative Fit Index

CMIN -Minimum Discrepancy or Model Chi-Square

GFI- Goodness of Fit Index

IFI -Incremental Fit Index

MI -Modification Indices

ML -Maximum Likelihood Estimation

NFI- Normed fit index

PA- Path Analysis

PCFI- Parsimony Comparative Fit Index

PNFI- Parsimony Normed Fit Index

RMSEA- Root Means Square Error of Approximation

SE – Self –Efficacy Scale Items

SEM -Structural Equation Modeling

SEV – Safety Events Scale Items

SC - Safety Compliance Scale Items

SM – Safety Motivation Scale Items

SMS- Safety Management System

SMS Initiative - SMS initiative Scale Item

SMSPol.Imp- SMS Policy Implementation Scale Items

SMSPro.Eng- SMS Process Engagement Scale Items

SP – Safety Participation Scale Items

TLI -Tucker Lewis Index

TSL - Transformational Safety Leadership Scale Items

CHAPTER II

SAFETY MANAGEMENT SYSTEM (SMS) CONCEPTS AND IMPLEMENTATION

The FAA has outlined four basic components for the SMS structure. These components are safety policy, safety risk management, safety assurance and safety promotion (FAA, 2015a). All the four components must exist and be implemented in order to have a fully effective and functional SMS. A basic understanding of the role of each component is crucial to any aviation service provider's SMS implementation drive and sustainability. The four components must be implemented on the baseline that there would be the highest leadership commitment and support in providing the necessary financial, human and material resources required for the implementation process (ICAO, 2009; FAA, 2015b).

Safety Policy

The foundation and bedrock on which any SMS stands is its policy. An organizational management system must clearly define policies, procedures and structures to be able to attain its stated goals (IATA, 2011). The policy statement for any SMS must explicitly describe core responsibility, authority, lines of accountability and pursuable targets. Safety must assume a core value and a requisite business management function within the organization (Wood, 2003). The roles, responsibility and relationship outlined in safety policies of collegiate aviation programs can have a manifold effect on the sustenance of high operational safety standards. These roles must be clearly defined for an effective SMS implementation (ICAO, 2009).

The SMS policy statement must originate from the highest echelon of authority in the organization and have ample evidence of top leadership initiatives, commitment and support for the implementation drive (FAA, 2015b). The safety policy statement must be documented and enshrined in the core mission and vision statement. The safety policy must be visible, communicated wide across the structures of the organization, and must be widely known and accepted by all employees as a bona-fide safety policy (Wood, 2003; IATA, 2012). The policy must be explicit on the personal and material involvement of top leadership in safety activities.

The safety policy statement should outline the key safety goals and objectives, which must be attainable and pragmatic (Stolzer, Halford & Goglia, 2008). The safety goals must be included in the overall corporate strategic plan. The safety goals should be subjected to periodic management review. Policy documentation should include guidelines and requirement for all departments to document their procedures, controls, training, processes, and measurement and change management systems. (ICAO, 2009). Even though the safety of any aviation operation depends on a collective responsibility of all employees, the ultimate accountability for safety in collegiate aviation operation is the preserve of the top leadership and cannot be delegated (Stolzer, Halford & Goglia, 2011).

Safety Risk Management

In order for an implementation of an SMS in collegiate aviation operations to be effective, there should be a well-designed safety risk management (SRM) system that describes operational processes across departmental and unit boundaries, identifies key performance indicators and periodically measures them (IATA, 2011). A formal hazard identification and risk management is essential to bring inherent high risk of flight training operations to a level that is tolerable for the collegiate program (Transport Canada, 2005)

Hazard identification falls under risk management. Once the process is well understood, inherent hazards associated with any operation and in the system can be identified, documented and controlled (ICAO, 2009). The identification of every possible hazard in collegiate aviation operations may be impractical, but the onus lies on program management to make every effort to identify significant and reasonably predictable hazards related to their operations (Adjekum, 2014b).

Collegiate aviation operators should create a system for risk analysis and assessment. These are very important aids to decision making when accepting risk. Risk is inherent in every aspect of flight operation. The systematic and consistent process of acceptance criteria needs to be lined with a designation of authority and responsibility for risk management decisions (ICAO, 2009). Top management of collegiate aviation programs juggles the merits of efficient productivity and the essential need to protect assets through effective safety management systems (Stolzer, Halford & Goglia, 2008).

The rationale for safety management as a core business function can be extended into one final argument that bears considerable relevance to the processes underlying hazard identification and safety risk management. This rationale underscores the need for effective risk identification and analysis. After the process of identifying the risk and conducting analysis, there would be the need for control measures (FAA, 2012). Risk management should aim at providing a proactive and predictive safety approach and environment (FAA, 2012). Risk management can be an effective means of auditing, analyzing and reviewing the results of a safety program (ICAO, 2002; Transport Canada, 2005).

Safety Assurance

Safety assurance is that component of SMS that validates the effectiveness of the stated safety goals in any collegiate aviation SMS implementation (FAA, 2015c; IATA, 2012). The establishment of policies, procedures, measures, assessment and controls will require periodic organizational management review to assure the top management that safety goals are being achieved and are in line with the overall strategic corporate benchmarks of productivity and safety (FAA, 2015b; Stolzer, Halford & Goglia, 2011).

There are various means of implementing safety assurance program in collegiate aviation operations and notably are safety performance monitoring, internal audits and external audits (ICAO, 2009). Internal audits are normally the preserve of the line managers and process owners (Transport Canada, 2005). They normally have domain technical experience in the aviation operations and are more versed with the technical intricacies of the processes involved (ICAO, 2002). Line managers should therefore be assigned the responsibility for monitoring their own process. (Stolzer, Halford & Goglia, 2008).

The aim of any safety evaluation is to ensure that the processes and procedures outlined in the safety policy and plan are accomplishing the collegiate aviation operational goals (ICAO, 2002). A safety evaluation program gives top management the information for decision-making required to sustain the overall SMS (IATA, 2012). All the various assurance systems and the relevant oversight system should be subject to periodic management review (IATA, 2011). An external audit can also provide a collegiate aviation operator an objective and unbiased evaluation of safety processes from a third party source (ICAO, 2002). There is the need to continually monitor the operational environment to assess new threats. The safety assurance component in the SMS must provide the assessment on a routine basis (FAA, 2015b).

Safety Promotion

Safety promotion is a major component of the Safety Management System (SMS) (ICAO, 2009) and together with the collegiate aviation safety policy and safety objectives are important enablers for continuous safety improvement. Safety promotion sets the tone that predisposes both individual and organizational behavior and fills in the blank spaces in the organization’s policies, procedures and processes, providing a sense of purpose to safety efforts (IATA, 2011). Through safety promotion, a collegiate aviation operator adopts a culture that goes beyond merely avoiding accidents or reducing the number of incidents, although these are likely to be the most apparent measures of success (Wood, 2003).

Safety Promotion supports and advocates positive safety culture, communication, dissemination of lessons learnt and enables a continuous improvement in the safety process (FAA, 2010). Safety promotion initiatives should include all efforts to modify structures, environment, attitudes and behaviors aimed at improving safety. Safety Promotion should be geared toward matching competency requirements to system requirements (FAA, 2012). Finally, an important aspect of safety promotion is training in SMS. Collegiate aviation programs must endeavor to include SMS training as part of their academic curriculum and have students and personnel grounded in the core principles and basics of SMS (Adjekum et al., 2015). Figure 4 shows all the SMS components in a single frame.

Figure 4. The SMS Components adapted from FAA Model (FAA, 2012).

Safety Management System (SMS) Implementation Methods

There are basically three types of safety management system implementation methods available to collegiate aviation programs in the US. These are Reactive, Proactive and Predictive methods (Stolzer, Halford & Goglia, 2008; ICAO, 2013). It is the responsibility of every aviation service provider to utilize any of these methods to assure both the regulator and customers of the capacity to deliver safe services and products. All aviation service providers retain the responsibility for safety management and for integrating SMS into their business model (IATA, 2012).

Reactive Method

Reactive safety management makes use of investigatory tools to find out the contributory factors that caused the problem in the aftermath of an accident or incident. It is forensic in nature and scientific methods are applied to understand the relevant factors. Accident and incident investigations, incident analysis, and the determination of contributory factors and findings as to risk are all examples of reactive methods (ICAO, 2013).

Proactive Method

This method aims at actively probing a system for potential safety problems, before they actually happen. The major examples are trend analysis, hazard analysis; operational monitoring, surveys and safety audits are effective. In airline operations statistical analysis, visualization and reporting programs have contributed to improving safety (FAA, 2011). Some viable and effective proactive safety management methods among aviation service providers such as Part 121 airlines in the US are Flight Operations Quality Assurance (FOQA), Line Operation Safety Audits (LOSA), and Aviation Safety Action Program (ASAP).

Other proactive safety initiatives are Internal Evaluation Program (U.S Federal Register, 2015). Line Operational Safety Audits (LOSA) has gained worldwide use. In 1999

ICAO endorsed LOSA as the primary tool to develop countermeasures to human error in aviation operations and made LOSA the central focus of its Flight Safety and Human Factors Program for the period 2000 to 2004 (ICAO, 2002). The techniques of LOSA can easily be adopted in collegiate aviation programs (Adjekum, 2014b).

Predictive Method

In the complex and technologically advanced environment that aviation service providers operate, there would be the need for the highest form of safety. Safety improvements and accident rates for airlines have reduced drastically, however that for general aviation (GA) has not been very good (FAA, 2015c). Since collegiate aviation operations fall under GA, new and sophisticated tools for safety trend analysis are required (Adjekum, 2014b). The advantage of predictive safety methods is that it pushes the bar higher by using probabilistic tools and models to analyze complex systems and predict where the failures will manifest (FAA, 2015a). Predictive safety enables safety analyst to find those failure points and eliminate them. Monte- Carlo Simulations, Stochastic models, Probabilistic Risk Assessment and Data Mining are examples of predictive methods. (Stolzer, Halford & Goglia, 2008, ICAO, 2013).

Phased SMS Implementation Approach

The three implementation methods that have been highlighted are the building blocks for a phased or level-based SMS implementation recommended by both ICAO and FAA to ensure an effective and sustainable safety initiative. These implementation levels also ensure that metrics and acceptable benchmarks are monitored and attained (FAA, 2015a; IATA, 2011; ICAO, 2013). The implementation levels also provide aviation service provider such as airlines, the flexibility to implements the SMS in a step-wise pattern according to the scale and complexity of operations (FAA, 2015b).

FAA SMS Implementation Level One - Planning and Organization

Level one begins when a service provider's top management commits to providing the resources necessary for full implementation of SMS throughout the organization (FAA, 2015a; FAA, 2015b; ICAO, 2013). Level one includes a thorough understanding of the service provider's organizational structure and a comparison (gap analysis) between the Part 5 requirements and the service provider's organizational structure (FAA, 2015a). The service provider will develop an implementation plan to bridge identified gaps. The final implementation plan must be approved by a Certificate Maintenance Team (CMT) (FAA, 2015b).

The first step in developing an SMS is for the service provider to analyze its existing programs, systems, and activities with respect to the SMS functional expectations found in the *SMS Framework*. This analysis is a process and is called a "gap analysis". The "gaps" are those elements in the *SMS Framework* that are not already being performed by the service provider (IATA, 2012). The Gap Analyses process would consider and encompass the entire organization (e.g., functions, processes, organizational departments, etc.) to be covered by the SMS (ICAO, 2009). The Gap Analysis should be continuously updated as the service provider progresses through the SMS implementation process (FAA, 2015b).

Once a gap analysis has been performed, an implementation plan is prepared. The implementation plan is simply a "road map" describing how the service provider intends to close the existing gaps by meeting the objectives and expectations in the *SMS Framework*. The service provider organizes resources, assigns responsibilities, sets schedules and defines objectives necessary to address all gaps identified. It should be noted that at each level of implementation, top management's approval of the implementation plan must include allocation of necessary resources (FAA, 2015a, 2015b; ICAO, 2013).

FAA SMS Implementation Level Two- Basic Safety Management

At level two, the service provider develops and implements a basic SRM process and plan, organize and prepare the organization for further SMS development. Information acquisition, processing, and analysis functions are implemented and a tracking system for risk control and corrective actions are established (Stolzer, Halford & Goglia, 2011). At this phase, the service provider corrects known deficiencies in safety management practices and operational processes and develops an awareness of hazards and responds with appropriate systematic application of preventative or corrective actions (FAA, 2015a). This allows the service provider to react to unwanted events and problems as they occur and develop appropriate remedial action. For this reason, this level is termed "reactive."

FAA SMS Implementation Level Three: Fully-Functioning SMS

The *SMS Framework* expects Safety Risk Management to be applied to initial design of systems, processes, organizations, and products, development of operational procedures, and planned changes to operational processes (Wood, 2003; Stolzer, Halford & Goglia, 2008). The activities involved in the SRM process involve careful analysis of systems and tasks involved; identification of potential hazards in these functions, and development of risk controls (FAA, 2015a). The risk management process developed at level two is used to analyze, document, and track these activities. Because the service provider is now using the processes to look ahead, this level is termed "proactive". At this level, however, these proactive processes have been implemented but their performance has not yet been proven (ICAO, 2013)

FAA SMS Implementation Level Four: Continuous Improvement

The final level of SMS maturity is the continuous improvement level. Processes have been in place and their performance and effectiveness have been verified. The complete SA process, including continuous monitoring and the remaining features of the other SRM and

SA processes are functioning (Transport Canada, 2005). A major objective of a successful SMS is to attain and maintain this continuous improvement status for the life of the organization. Figure 5 shows the FAA recommended implementation levels.

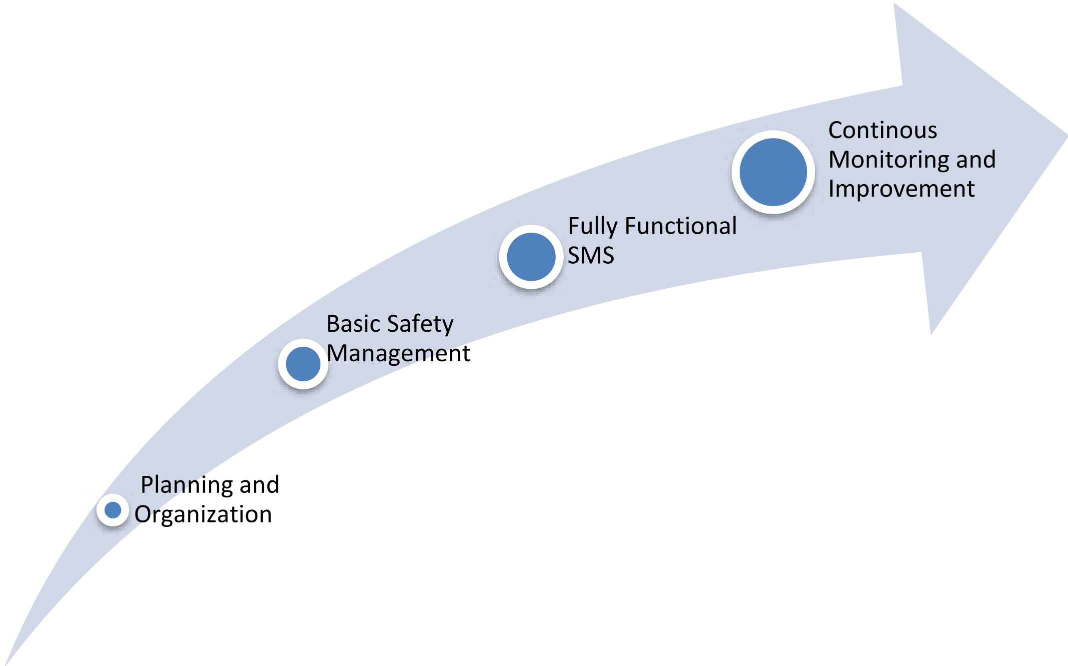

Figure 5. Safety Management System (SMS) Implementation Levels (FAA, 2015a).

Safety Management System Voluntary Programs (SMSVP)

As part of an effort to encourage service providers, who do not fall under the mandatory requirements of the Part 5 SMS program to voluntary initiate and implement SMS programs, the FAA has a program that provides assistance to such service providers (FAA, 2015b). Most of the collegiate aviation programs implementing an SMS program in the US fall under this category (UND, 2012). Collegiate Aviation programs as certificate holder should continue following existing regulations and certificate requirements and once the FAA recognizes their SMS initiative; their certificate maintenance office will monitor ongoing conformity with the SMSVP Standard (FAA, 2015a)

These voluntary participants such as collegiate programs are expected to make steady progress towards full SMS implementation and continual improvement. The entire process is coordinated by a Certificate Maintenance Team (CMT) which is responsible for validating the certificate holder's management system applications during both the implementation process and after full implementation (FAA, 2015a; FAA, 2015b). The CMT also gets guidance from the SMS Program Office (SMSPO) whose primary objective is to assist CMTs in validating SMS development and certificate holders maintain their "active conformance" status. The SMSPO also has sole authority to authorize or withdraw recognition of a certificate holder's SMS (FAA, 2015b).

The following categories denote the progress expected from the SMSVP participants and the implementation phase is different from certificate holders under the SMS Part 5 Rule. The implementation stages for the voluntary programs are as follows:

1. The first level of *SMSVP Active Applicant* is when the certificate holder and CMT have committed to sufficiently support the SMS implementation and validation processes.
2. The second phase of *SMSVP Active Participant* is the actual level, where the certificate holder officially begins and maintains its implementation efforts.
3. The third level of *SMSVP Active Conformance* is attained when the CMT and SMSPO acknowledge full implementation of the certificate holder's SMS. By this stage, the certificate holder is expected to use and continually improve its safety management processes.

When a certificate holder fails to meet SMSVP standards, it becomes an *SMSVP Non Active Participant*. One of the important phases of the preliminary implementation process is the use of *Job Aids* by the CMT to track progress. Some of the important *Job Aids* are the *Design Job Aids* which will be used to evaluate certificate holder's documentation describing its SMS applications. The *Design Job Aids* encompass the operational SMSVP conformance requirements. These *Job Aids* are considered the minimum performance validation activities to be used during the design validation phase (FAA, 2015b). Figure 6 shows the SMSVP implementation levels.

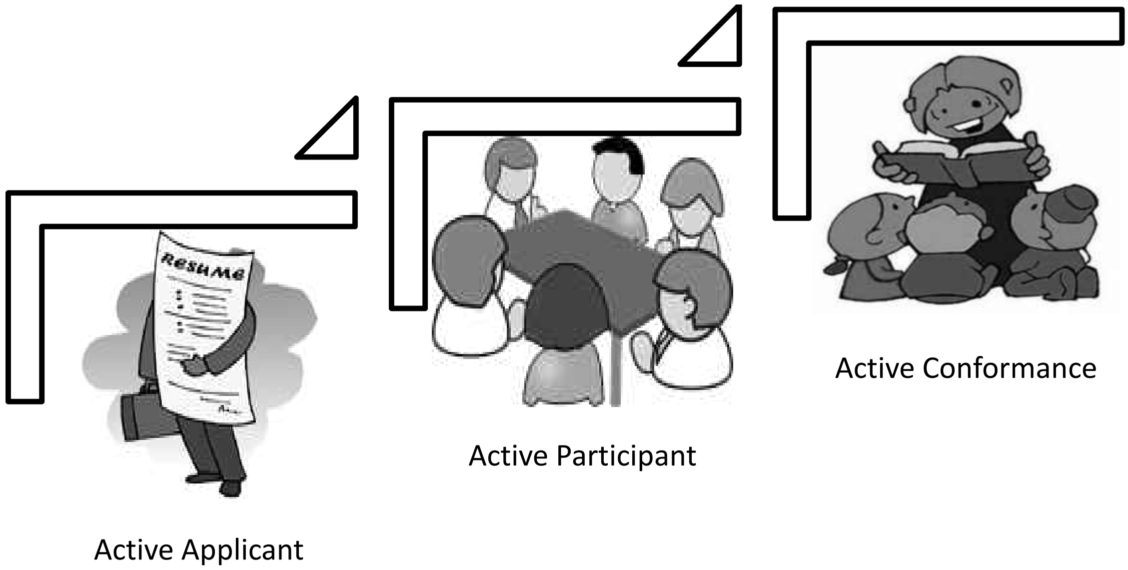

Figure 6. SMSVP Levels of Implementation (Based on FAA, 2015b).

Another very important requirement in SMSVP is the use of *Performance Job Aid* which is used to evaluate the certificate holder's safety management performance. Where actual field performance cannot be assessed (e.g., emergency response plans), the CMT is permitted to use simulated processes (sometimes called "table top exercises") allowing CMT to evaluate the certificate holder's capabilities without an actual performance demonstration. Once a certificate holder has satisfied all the requirements for validation and implementation and SMS has been integrated into every facet of operations of the certificate holder, the CMT manager would request for recognition of the SMS by the SMSPO.

The SMSPO would conduct a review of the request and upon satisfactory review; the SMSPO will change the certificate holder's status from "SMSVP Active Participant" to "SMSVP Active Conformance" and issue the certificate holder a current status letter. The SMSPO will post a record of the certificate holder's "SMSVP Active Compliance Status" on the internal FAA SharePoint® site. This will constitute evidence of "state recognition" of the certificate holders SMS (FAA, 2015b).

The challenge for the certificate holder is the Continuous Operational Safety (COS) phase. This stage is basically continuous monitoring and surveillance of the certificate holder's technical processes and the responsibility now falls on the CMT to broaden the scope of its normal surveillance activities to include safety management assessment (FAA, 2015b; ICAO, 2013).

Collegiate Aviation Programs and Safety Management System (SMS) Implementation

An important facet of a positive safety culture is geared toward the nurturing of good safety behavior and practices (von Thaden, 2008). A strong positive safety culture is also essential to a collegiate aviation program because it is one of the most effective and systematic ways to reduce accidents and incidents within the flight training organization (ICAO, 2009). There has been an imperative need to control risk through an assessment of the prevalent safety culture inherent in such collegiate flight programs (Patankar, 2003). Evans, Glendon & Creed (2007) suggested that a safety culture assessment could also provide the needed data and feedback to build a predictive model aimed at continuously improving safety and ensuring an integrated system wide safety net for training organizations.

In trying to generate an organizational framework to effectively manage safety and serves as the structure that generates a positive safety culture (von Thaden, 2008), the Federal Aviation Administration (FAA) and the International Civil Aviation Organization (ICAO) has recommended that aviation service providers should adopt Safety Management Systems (SMS). Safety Management System is a structured and systematic quality based management approach to aviation safety (FAA, 2008; ICAO, 2009). Safety Management Systems would provide an organized approach to safety procedures, processes and performance management (von Thaden & Gibbons, 2008). Safety Management System has the potential to reduce the safety risk of flight operations to a level that is tolerable for sustainable and productive operations (ICAO, 2009).

Safety Management System frameworks has been effective when adopted as part of a core business function by aviation service providers (FAA, 2008). Even though presently Safety Management System (SMS) and SMS components such as safety culture assessment are not a regulatory requirement in the United States for collegiate aviation programs (Part 141) and Part 61 flight training schools (FAA, 2015a), a number of SMS voluntary programs are being run by some proactive university aviation departments due to the immense positive benefits it has provided (UND, 2012; FAA, 2015a).

Benefits of SMS Implementation in Collegiate Aviation Programs

Some of the benefits of SMS have been the enhancement of a good safety culture and collection of real time safety information. The collection of safety information has been through non-punitive safety reporting mechanisms, voluntary safety reporting system and flight data monitoring system (FDM). The safety information system has identified risky operational trends and helped to proactively mitigate the risk due to such unsafe conditions and actions to a level acceptable for operation (UND, 2012; Adjekum, 2014a).

Other benefits have included students' confidence in the operational safety of the flight program. A Safety Management System and a positive safety culture would be advantageous to collegiate aviation because they perform standardized activities towards established goals (FAA, 2013). Finally, proactive and corrective measures have saved flight schools the detrimental cost of accidents that can result in, loss of students, aircraft and reputation (Adjekum, 2014a; CBS, 2014).

Evaluation of the effectiveness of SMS Initiative in Collegiate Aviation Programs

With the adoption of Safety Management System by collegiate aviation programs, it would be important to evaluate how effective the espoused benefits have been to personnel.

That will fall within the level four of the implementation hierarchy recommended by the FAA. One of the means for evaluation is through perceptions on the merits of this safety initiatives and how it has influenced the safety attitudes and behavior of personnel. Studies on the perceptions of operational personnel of collegiate aviation related to the safety culture within their programs would provide an end users perspective on the effectiveness of the organizational management of safety (von Thaden, Kessel & Ruengvisesh, 2008; Adjekum, 2014b; Adjekum et al., 2015).

Previous safety culture assessment studies carried out by Patanker (2003) and the Australian Transportation Safety Bureau (2004) on aviation maintenance organizations suggested that a good indicator for organizational safety culture required the identification, analysis, and prioritization of information to mitigate hazards and risks. As aviation organizations like collegiate aviation become diversified to include contract training for foreign airlines and international students (Patankar, 2003; Australian Transportation Safety Bureau, 2004) safety initiatives assessments should become routine and consistent.

The increased risk of safety occurrences in an environment of high tempo flight training of domestic US students and international flight student in US collegiate aviation programs, has made it imperative to find the effect of how SMS and variables such as ethical leadership, self-efficacy, and safety motivation interact to influenced the safety behaviors of these students.

Challenges and Perceptual Gaps in SMS Implementation in Collegiate Aviation

When promoting SMS, in collegiate aviation programs, the critical issues that may emerge are how senior-level policy makers would identify with, and provide support for the key components of the SMS. Other thorny areas are how inter-mediate and supervisory level managers weigh the importance of its various dimensions and steps, and how front-line employees are taught to evaluate the effects of their safety behaviors and practices (Adjekum, 2014; Freiwald, Lenz-Anderson & Baker, 2013; Chen, 2014).

Previous studies have indicated that occasionally, there exist perceptual gaps in regards to the successful implementation of the SMS initiative and safety culture between top level managers and operational personnel in the aviation industry (Patankar, 2003; von Thaden, 2008; Chen & Chen, 2011; Adjekum, 2014a; Adjekum et al., 2015). It is therefore very important to continuously evaluate and monitor any SMS initiative for gaps and provide the necessary controls to close those gaps especially within collegiate aviation programs that are currently part of the FAA voluntary SMS initiative (Patankar, 2003; FAA, 2015b).

Another challenge that collegiate aviation programs may face is the constant balancing act between resources for training/operational activities and safety initiative implementations (ICAO, 2009). Most collegiate aviation programs are expected to comply with regulatory operational safety standards (14CFR Part 141 and other relevant Federal Aviation Regulations). These standards are the safety baseline/threshold and are mandatory. Any form of non-compliance by these collegiate programs may result in enforcement actions such the revocation of operational certificates or punitive fines by the FAA.

Safety initiatives such as SMS aim at ensuring that the certificate holder meets and exceeds the minimum regulatory safety compliance requirements (FAA, 2015b). The aim is to keep operational activities within the safety risk tolerability region, where hazards have been identified and associated risk to flight operations have been subjected to effective mitigations and controls (Stolzer, Halford & Goglia, 2011; ICAO, 2013). The residual risk is deemed tolerable and as low as reasonably practical (ALARP) for operations (ICAO, 2013).

Another important aspect of the SMS initiative in collegiate aviation program is the need for continuous monitoring when the active compliance level is attained. There may be periods when the Perceived Level of Safety (PLoS) as depicted in safety policies and proposals may differ from the Actual Level of Safety (ALoS), within the program. The use of safety assurance tools for periodic evaluation of safety performance can reveal these perceptual gaps (SMS performance gaps). Remedial tools such as policy reviews, changes in procedures, process control managements, and training can be used to align and bridge the gap (Patankar, 2003).

There may also be periods, when the congruence of high tempo flight operational demands and limited resources may adversely constrain investments in safety. Allocation of resources for sustaining proactive safety measures and defenses may stagnate or even decline. This management level decision can easily lower the safety margins by creating latent unsafe conditions that pre-disposes the program to potential safety occurrences (Reason, 1997).

The latent conditions can increase the probability of more active failures of front -line operational personnel such as flight students and instructors through the promotion of errors and violations. The active failures of frontline personnel are able to create gaps through existing safety defenses such as Standard Operating Procedures (SOPs). The latent conditions can also aggravate the severity of the unsafe act by the adverse effects on the already weakened system defenses, barriers and safeguards (Reason, 1997; Dekker, 2014).

When a collegiate aviation program determines that there are increases in safety non-compliances and violations, it may be a signal that there is operational safety slack and the accident potential is high (Adjekum, 2014b). It may also indicate that the program is in the safety risk vulnerability region. Figure 7 shows a plot of safety initiative and operational activities interaction.

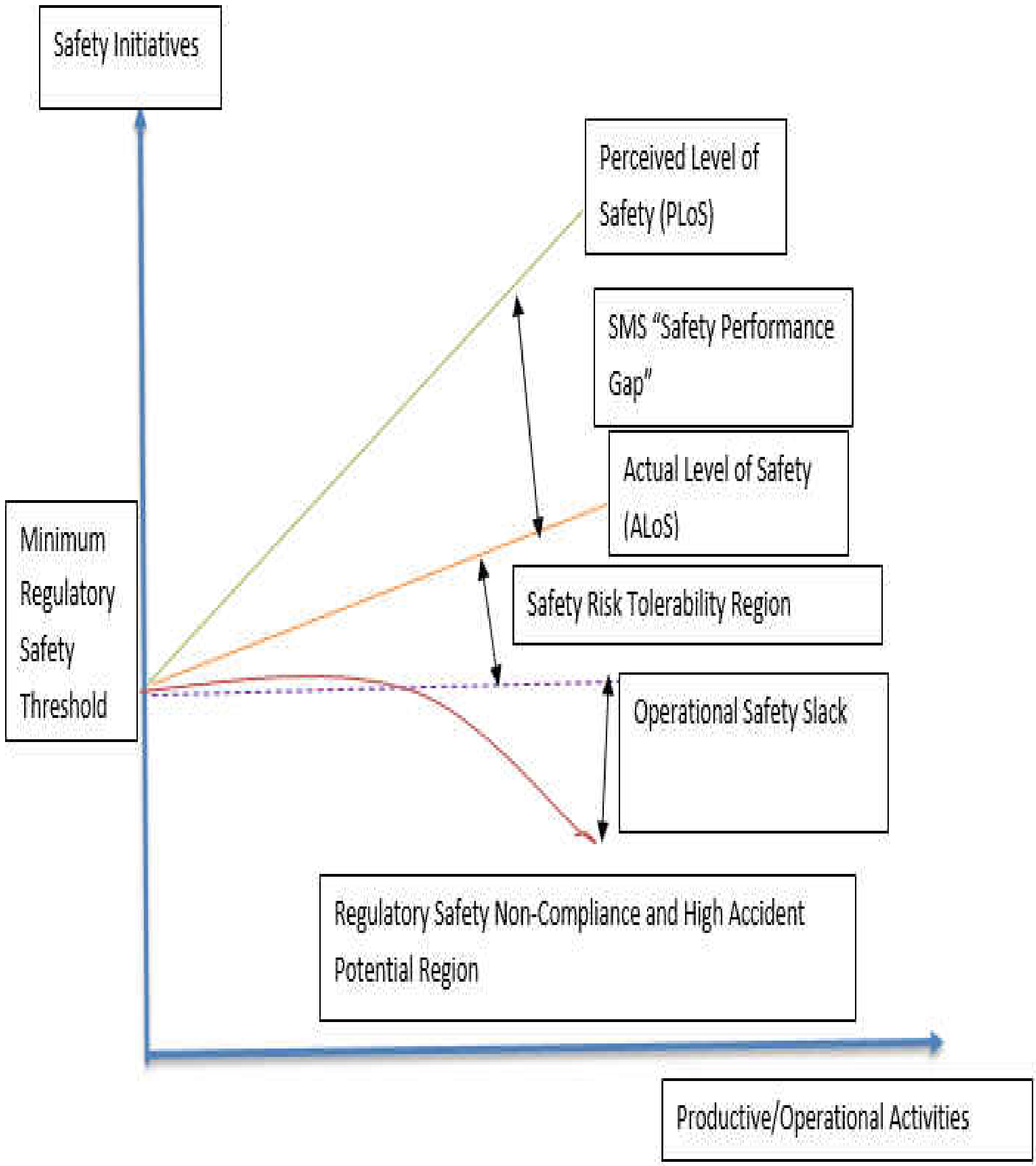

Figure 7. Interaction between Safety Initiatives and Productive/Operational Activities (Self designed from ideas adopted from ICAO, 2013).

CHAPTER III

LITERATURE REVIEW

This chapter describes the review of literature related to the study, including SMS initiatives, the effects of transformational safety leadership on safety behavior, self-efficacy, safety motivation, safety compliance, and safety participation. The chapter also explores the literature that grounds how these constructs are related to self-reported safety events. The theoretical construct presented in *Figure* 1 shows the relationships between transformational safety leadership, perceptions of SMS initiative, self-efficacy, safety motivation, safety behavior, and safety events. These relationships in collegiate aviation operations have not been explored in existing literature. The mediating role of safety motivation and the other endogenous variables such as SMS perceptions and self-efficacy on safety behavior are of particular interest in the construction of a model for the evaluation of the effects of the perceptions of SMS constructs on safety behavior and events.

Theoretical Foundation

Safety Management System Initiatives, Implementation and Practices

Safety Management System initiative, implementation, and practices are the policies, strategies, procedures and activities implemented or followed by the management of an organization targeting safety of their personnel (ICAO, 2013). These practices are the essential elements permitting an effective management of safety in organizations and are designed to comply with the existing legislations applicable to the organization. Nominally safety management has focused on prescription- based regulation compliance, and accordingly the main tool used for safety improvement is guaranteeing compliance with prescriptive regulations (ICAO, 2009; FAA, 2013).

This mode of safety management approach using prescriptive regulations can be defined as the “regulatory compliance-based approach”. Prescriptive regulations undoubtedly play an important role in improving aviation safety and normally mandate controls in response to hazards in the aviation system (Stolzer, Halford & Goglia, 2008). They are important since they ensure that a fundamental set of hazards is addressed. On the other hand, prescriptive regulations are general tools that cover all relevant service providers at the national, regional and international level (ICAO, 2013). Consequently, prescriptive regulation may not address all the specific hazards that are likely to exist in different aviation organizations and contexts, and may not be effective enough against certain specific hazards and risks that may arise specific to a context in organizations, each of which may be considered a socio-technical system (Reason, 1997; Stolzer, Halford & Goglia, 2008; Dekker, 2011).

Therefore, although regulatory compliance is achieved, organizational and contextual factors may cause people to make errors and thereby imperil organizational safety (Reason, 1997). Reflecting on this approach, it may suffice that personnel within a normatively well-designed system can always carry out operational duties required within the organization safely under all contextual conditions (Reason, 1997).

Performance -Based Safety Management System Approach

There has also been a contemporary advocacy by ICAO, for a shift from prescription - based safety management to a performance- based management of safety, where the goal is to achieve safety performance metrics, such as higher frequency of personnel safety training and awareness will exceed the requirements of existing regulations (FAA, 2012; Remawi, Bates & Dix, 2011; ICAO, 2013). The extent to which these practices are implemented in an organization will be manifested through various actions and programs of the management and will be clearly visible to an insider like an employee. Safety Management System (and its practices) can be regarded as an antecedent of an organization's safety culture (Stolzer, Halford & Goglia, 2008; FAA, 2012; Adjekum, 2014b).

A performance-based approach combines prescribed standards with performance standards. What is essentially expected from companies is a continuous improvement in safety performance, as well as compliance with regulations (ICAO, 2013). Companies use proactive tools such as hazard identification and risk analysis, safety measurement, safety performance monitoring and prediction in order to fulfill these expectations. Aviation organizations demonstrate that they know and manage their own customized hazards and risks in a contextual dynamic environment, and the regulatory authority oversees the effectiveness of the service provider's SMS (FAA, 2012; ICAO, 2013).

Performance-based safety approach is predicated on the notion that regulations should focus on the achievement of regulatory objectives and that regulated entities should be left to determine how best to achieve them. The performance-based approach may bring about organizational, as well as effective context-specific solutions, for hazard identification and safety risk mitigation (May, 2010).

In furtherance of the performance -based safety approach, currently in the U.S, a final rule on SMS implementation (Part 5) requires air carriers operating under 14 Code of Federal Regulations (CFR) Part 121 to develop and implement a safety management system (SMS) to improve the safety of their aviation-related activities (U.S Federal Register, 2015). Air carriers authorized to conduct operations under Part 121 must develop and implement an SMS within three years of the effective date of the final rule.

To demonstrate that the air carrier's SMS will be fully implemented by the end of this three-year period, the air carrier will be required to submit an implementation plan within 6 months of the effective date of the final rule. The implementation plan should include any existing programs, policies or procedures the air carrier intends to include in its SMS, such as continuing analysis and surveillance systems, aspects of quality management systems, and employee reporting systems. As part of the new rule, this implementation plan must be approved by the FAA within 12 months of the effective date of the final rule (U.S Federal Register, 2015; FAA, 2015a).

SMS Implementation Cost Concerns

One of the principal concerns among aviation service providers about the implementation of SMS in the US is the cost related to initiating and implementing SMS even though the FAA suggests through cost-benefit analysis that one of the expectations of the requirements of the rule is to help airlines identify safety problems (FAA, 2015b). It has also been suggested that if airlines take steps to mitigate these safety problems, there could be estimated benefits from that mitigation ranging from $205.0 and $472.3 million over 10 years ($104.9 to $241.9 million present value at 7 percent discount rate) (US. Federal Register, 2015). However, the costs of the rule's provisions (excluding any mitigation costs, which have not been estimated) are estimated to be $224.3 million ($135.1 million present value at 7 percent discount rate) over 10 years (U.S Federal Register, 2015).

Global Application of SMS in other Allied Industries

Interestingly, SMS has not only been limited to the aviation industry. SMS has also found wider acceptance in a variety of industries, such as the chemical, oil, construction, occupational health, food, highway, electrical, fire protection, and other industries to improve safety (Fernández-Muñiz, Montes-Peón, Vázquez-Ordás, 2007; Remawi, Bates & Dix, 2011; Stolzer, Halford & Goglia, 2011, Dekker, 2014). SMS has been a key tool used for the management of safety by high reliability organization (HROs), where the consequences of accidents and incidents can lead to high fatality rates (Stolzer, Halford & Goglia, 2011).

Review of some SMS related Studies

Within the collegiate aviation operational environment in the United States, the number of studies related to the SMS is relatively limited (Adjekum, 2014b) and most of the reviews would be on the broader perspective of SMS in high reliability organizations, inclusive of aviation. McDonald et al. (2000) proposed a self-regulatory model to examine how different organizations manage safety. However, their study was aimed mainly at exploring the relationship between different aspects of safety culture and safety management systems, not exploring the critical success factors of the SMS or the problems related to its implementation.

Gill and Shergill (2004) studied employee perceptions of safety management and safety culture in New Zealand's aviation industry and tried to develop a scale to assess the management of safety. Their study also focuses on safety culture. Furthermore, rather than define what the components and elements of a successful safety management system are, the scale took into consideration the organizations' current approach to safety management in a general manner.

Fernández-Muñiz, Montes-Peón, Vázquez-Ordás (2007) found out that there have been various studies that emphasized the importance of Safety Management Systems (SMS), and how to implement them, but there are very few works providing a specific tool to measure the degree of implementation of the policies and practices making up this management system in organizations. The authors conceptualized SMS, followed by a risk management process that described the essential elements making up the SMS. This management process provided the basis for identifying, in turn, a set of variables that would be used to develop an instrument to measure the degree of implementation of such a process.

Fernández-Muñiz, Montes-Peón, Vázquez-Ordás (2007) constructed a scale made up of 29 items structured in eight first-order factors; policy, incentives, training, communication, preventive planning, emergency planning, internal control and benchmarking techniques. A second-order Confirmatory Factor Analysis (CFA) confirmed that the dimensions preventive planning and emergency planning, internal control and benchmarking and converged on two factors, labelled planning and control, respectively.

Finally, a third-order CFA confirmed that the measurement dimensions: policy, incentives, training, communication, planning and control do indeed underlie a single major dimension: The Safety Management System. The results of the study suggest that SMS, apart from improving the working conditions of personnel, has a positive impact on their safety behavior. The results also suggested that the organization's accident rate is reduced, both directly and indirectly, through the reduction in unsafe worker behavior, minimizing the human and material losses associated with accidents.

In a study on the effect of employee perceptions on six SMS practices and self-reported safety knowledge, safety motivation, safety compliance and safety participation, Vinodkumara and Bhasib (2010) conducted a survey using questionnaire among 1566 employees belonging to eight major accident hazard process industrial units in Kerala, a state in southern part of India. The researchers found out that the reliability and unidimesionality of all the scales were acceptable.

In that particular study, path analysis using AMOS-4® software showed that some of the SMS practices had direct and indirect relations with the safety performance components, namely, safety compliance and safety participation. Safety knowledge and safety motivation were found to be the key mediators in explaining these relationships. Safety training was identified as the most important safety management practice that predicted safety knowledge, safety motivation, safety compliance and safety participation.

Within a framework of assessing the impact of SMS implementation in aviation, Remawi, Bates and Dix (2011) measured the extent to which the introduction of SMS at an international airport in the Middle-East would influence the safety attitude and culture of employees. A Safety Culture Survey was used as the pre and post-test measure over a 12-month period to determine the extent of influence of the introduction of the SMS at Sharjah Airport, United Arab Emirates. The average score reported by participants at Sharjah Airport increased significantly from pre-test measure to post-test measure in relation to communication, safety rules, supportive environment, personnel risk appreciation, work environment, and involvement.

The results from the study indicated that participants at Sharjah Airport recorded a significant positive shift in attitude to the safety factors covered in the Safety Culture Survey, whilst at the same time responses from a second airport (control without SMS) showed no such shift in attitude. The second airport showed neither decline nor improvement in responses and the results suggested that the introduction of an SMS at Sharjah Airport has effected positive changes not observed at the second airport.

There have also been several academic studies aimed at identifying the critical components and elements of the SMS, such as Liou and Chuang (2010) who mapped out structural relationships among diverse components of SMS and identified key factors in their model. A similar study was conducted by Hsu, Li and Chen (2010) to develop an analytical framework for defining the key components and dimensions of an airline SMS and their interaction.

Chen and Chen (2012) developed a customized SMS evaluation scale for the airline industry based on the perceptions of aviation experts and airline managers, since their earlier exploratory qualitative research (Chen & Chen, 2011) showed that there is a clear perception gap regarding the implementation of the SMS between managers and hands-on employees in the airline industry.

One of the keys to achieving successful implementation of an SMS is to ensure that every employee participates in the system and fulfills their designated roles, as Galotti et al. (2006) noted that such a ‘‘system’’ represents the concept of an integrated set of processes which manage safety across intra-departmental boundaries. When promoting SMS, especially in the collegiate aviation environment, some of the critical issues are how program policy-makers can identify the key components of the system, how managers weigh the importance of its various dimensions and steps, and how personnel are taught to evaluate the effects of these safety practices.

Pilots' evaluations of their collegiate program SMS initiatives may thus be interpreted as their perceptions of how greatly the program values safety and the effects of adopting such a proactive safety model at an organizational level. This study will investigate the effects of a collegiate aviation actual SMS initiative on pilots' safety behaviors for two reasons. The first is that even though SMS is gradually becoming an industry accepted benchmark for safety and reliability and is getting a lot of advocacy from both the FAA, industry and, ICAO), there is still limited research examining SMS related issues (Adjekum, 2014b; Chen, 2014).

The second reason is that the success of any SMS initiative depends on a continuous action of improvement and a better understanding of personnel perceptions regarding the particular system their organization adopts. Previous studies verify the relationship between the implementation of an SMS and the attitudes of employees toward safety behaviors in aviation (Remawi, Bates & Dix, 2011).

It will also be insightful to have a comprehensive understanding of the implementation framework as outlined for service providers by regulatory agencies such as the FAA. This understanding of the implementation framework will provide organizations and service providers such as collegiate aviation programs, who are voluntary participants in SMS initiatives, the necessary tools and resources for successful SMS implementation as outlined in the revised Safety Management System for aviation service provider's manual *AC 120-92B* and Safety Management System Voluntary Program Guide (AFS-900-002-G201) (FAA, 2015).

Paucity of Literature in Collegiate Aviation SMS Initiatives

Generally, there has been a paucity of literature and studies on SMS in collegiate aviation, due to only few programs implementing the voluntary FAA SMS initiative, since it is not a mandatory regulatory requirement in the US (FAA, 2015a; FAA, 2015b; UND, 2012). Some of the indirect studies on SMS in collegiate aviation have been targeted at safety climate/culture assessments (Dillman, Voges & Robertson, 2010; Adjekum, 2014b; Adjekum et al., 2015; Freiwald, Lenz-Anderson & Baker, 2013).

In terms of validated survey instruments to conduct evaluations of SMS within the aviation industry and specifically airlines, Chen and Chen, (2012) developed an SMS measurement scale from the perspective of aviation experts and airline managers to evaluate the performance of airline's safety management system. The results revealed a five-factor structure consisting of 23 items. The five factors included documentation and commands, safety promotion and training, executive management commitment, emergency preparedness and response plan, and safety management policy.

Chen (2014) examined the effects of pilots' perceptions of Safety Management System (SMS) practices, fleet managers' morality leadership and pilots' self-efficacy on flight crews' safety behaviors through the mediation of safety motivation. Using a sample of 239 Taiwanese commercial pilot participants, and Structural Equation Modeling (SEM) technique, the results indicated that both perceptions of SMS practices and self-efficacy have direct, positive effects on pilots' safety behaviors (safety participation and safety compliance), while the effect of fleet managers' morality leadership on such behavior was fully mediated by pilots' safety motivation.

Leadership and Organizational Safety Performance

A substantial number of studies has investigated leadership, both as a construct and as a concept, which plays an important role in successful organizational change and is one of the key driving forces for improving safety performance (Zohar, 2002; Kelloway, Mullen, & Francis, 2006; Kapp, 2012; Fernández-Muñiz, Montes-Peón & Vázquez-Ordás, 2014; Pilbeam, Doherty, Davidson & Denyer, 2016). It can rather be a challenge to define leadership out of context, and there have been many definitions based on varying fields of studies. Greenberg (2013) defines leadership as "A process whereby one individual influences other group members in a non-coercive manner towards the defined group or organizational goals, pg. 335).

Burns (1978) notes that although leadership concepts and theories richly abound in extant literature, no central concept of leadership has emerged, because scholars are working in separate disciplines to answer specific questions unique to their specialty. Burns asserts that due to the influence of research conducted in the field of humanistic psychology, it may be possible to make generalizations about leadership across cultures and time. According to Burns (1978), the concept of leadership must be aligned with a collective purpose and effective leaders must be judged by their ability to make social changes.

Burns further suggests that the role of the leader and follower be united conceptually and that the process of leadership is the interplay of conflict and power. Burns delineates two basic types of leadership: transactional and transformational. Transactional leaders approach followers with the intent to exchange one thing for another, for example, the leaders may reward the hard-working employees with an increase in budget allowance. On the other hand, "The Transforming leader looks for potential motives in followers, seeks to satisfy higher needs, and engages the full person of the follower" (p. 4).

The result of this leadership is a mutual relationship that converts followers to leaders and leaders into moral agents. The concept of moral leadership is proposed as a means for leaders to take responsibility for their leadership and to aspire to satisfy the needs of the followers. Finally, Burns posits that leaders are neither born nor made but rather evolve from a structure of motivation, values, and goals. Martínez-Córcoles, Gracia, Tomás and Peiró (2011) conducted a review of the definitions of leadership and concluded that ‘‘a common element is present in all of them, namely, that the leader does by means of others or induces others to perform activities that they would not carry to completion if this influence were not present in the first place’’.

Eid, Mearns, Larsson, Laberg and Johnsen (2012) suggest that existing safety leadership studies published in a variety of academic journals, books and policy documents have focused on either transformational–transactional leadership or leader–member exchange (LMX). Most of these safety leadership behaviors have been inferred from the reports given by subordinates through quantitative survey instruments and both transformational and transactional leadership styles are often assessed by completing the MLQ survey developed by Avolio and Bass (2004).

The MLQ measures a broad range of leadership types from passive leaders, to leaders who give contingent rewards to followers, to leaders who transform their followers into becoming leaders themselves and has been adapted to focus on safety by researchers such as Barling, Loughlin, & Kelloway (2002). Studies by Kelloway, Mullen, & Francis (2006) and Christian, Bradley, Wallace & Burke (2009) examined the relationship between leadership and safety and suggested that safe behavior had an effect on reducing organizational accidents. These studies also suggest that leader and sub-ordinate relations has a vital effect on the personnel actions.

Christian, Bradley, Wallace & Burke (2009) further suggest that generally, front line personnel who have high-quality relationships with their leaders are more likely to have more positive safety behaviors because the leader and the personnel would have connected to solve problems together. They also suggest that personnel who have positive interactions with their leaders are more likely to respond to their leaders positively than their colleagues who do not have such positive interactions.

Within the earlier concepts of systems safety and accident prevention strategies, there has been a focus on shared leadership. Shared Leadership is another management strategy that reflects the change from a top-down management approach to a shared leadership. Normally in the regular top-down setting, the individual at the top of an organization or an organization unit is the leader and plans, organizes, and directs. The idea of shared leadership invites other members in a group to contribute ideas for safety improvement within an organization and to take responsibility for leading the rest of the group in certain aspects of the productive activities (Brauer, 2006).

As a result, the roles of people in the group vary, depending on who is leading a particular activity. In one activity, a person may have a leadership responsibility and in the next be a participant. Leadership is not limited to only one person. This however may be at variance with much more modern concepts, where there is shared responsibility and accountability for safety at various levels in the organization but ultimately within the organization, there would have to be an accountable executive, who will be the final authority when it comes to responsibility and accountability for extremely high risk decision making within the organizational hierarchy (ICAO, 2013).

Effects of Transformational and Transactional Leadership on Safety Performance

There has been several studies and disparate discourse over which style of leadership is best suited for safety performance in organizations (Kirkpatrick & Locke, 1996; Lowe, Kroeck, & Sivasubramaniam, 1996; DeGroot, Kiker & Cross, 2000; Dvir, Eden, Avolio, & Shamir, 2002; Zohar, 2002; Kelloway, Mullen, & Francis, 2006; Avolio, Walumbwa & Weber, 2009; Inness, Turner, Barling & Stride, 2010; Kapp, 2012; Fernández-Muñiz, Montes-Peón, Vázquez-Ordás, 2014).

Bass and Avolio (1994) suggest that transformational leadership motivates followers to improve performance by transforming followers' attitudes, beliefs, and values as opposed to simply gaining compliance. Other the contrary Zohar (2000) suggests that transactional leadership helps organizations achieve their current objectives more efficiently by linking job performance to valued rewards and by ensuring that employees have the resources they need to carry out their work.

Several studies have found relationships between safety-specific transformational leadership (i.e. Transformational leadership specifically focused on enhancing individual and organizational safety) and safety-related outcomes, including perceived safety climate, safety events, safety consciousness (Kelloway, Mullen, & Francis, 2006), and safety citizenship behavior (Conchie & Donald, 2009). Empirical evidence suggests that transformational leadership predicts positive performance outcomes in field experiments, field studies, laboratory studies, and meta-analytic studies (Hater & Bass, 1988; Keller, 1992; Howell & Avolio, 1993; Barling, Weber, & Kelloway, 1996; Fuller, Patterson, Hester & Stringer, 1996; Kirkpatrick & Locke, 1996; Lowe, Kroeck, & Sivasubramaniam, 1996; DeGroot, Kiker & Cross, 2000; Dvir, Eden, Avolio, & Shamir, 2002).

According to Judge and Piccolo (2004), more than 87 studies report positive relationships among transformational leadership and organizational outcomes such as safety behaviors. Transformational leadership has received considerable conceptual and empirical attention in recent times. In focusing on the scope of this research, transformational leadership is defined as "leader behaviors that transform and inspire followers to perform beyond expectations while transcending self-interest for the good of the organization" (Avolio, Walumbwa & Weber, 2009, pg. 243).

According to Pilbeam, Doherty, Davidson and Denyer (2016) citing earlier works of Bass and Riggio (2006), transformational leadership comprises of four leader behaviors. *Idealized influence* is when leaders demonstrate high standards of moral conduct in their own behavior. *Inspirational motivation* occurs when leaders communicate a positive, value-based vision for the future state of the organization and its employees. *Intellectual stimulation* is when leaders encourage employees to challenge organizational norms and think creatively. Lastly, *individual consideration* is when leaders recognize the unique needs of followers.

In contrast, Zohar (2002) suggested that transactional leadership is based on non-individualized hierarchical relationships and comprises three dimensions (constructive leadership, corrective leadership and laissez-faire leadership). *Constructive leadership* offers material rewards (e.g. increased salary, promotion, job security) contingent upon satisfactory performance and requires clear communication between leader and follower.

Zohar further stated that some understanding of the individual needs and abilities is needed in order to offer motivationally relevant rewards. *Corrective leadership* (or active management by exception) monitors individual performance against standards, detecting errors and correcting them. *Laissez-faire leadership* (passive management by exceptions) disowns all leadership responsibility and only engages with subordinates in an emergency.

In adopting a transactional leadership style for safety, leaders typically establish appropriate safety goals, monitor performance towards these goals and reward behaviors that sustain or improve safety practices (Zohar, 2002; Kapp, 2012). In contrast, leaders adopting a transformational leadership style for safety demonstrate these actions, as outlined in the Kelloway et al. (2006) study. These include: expressing satisfaction when jobs are performed safely; rewarding achievement of safety targets; continuous encouragement for safe working;

maintaining a safe working environment; suggesting new ways of working more safely; encouraging employees to openly discuss safety at work; talking about personal value and beliefs in the importance of safety; behaving in a way that demonstrates commitment to safety; spending time to demonstrate how to work safely; and, listening to safety concerns.

Bass and Avolio (1994) had earlier suggested that transformational leaders, by strongly promoting leader–member exchange, make their followers aware of the importance of the results obtained, improve their employees' innovative and creative behaviors, seek new ways of working, seek opportunities in the face of risk, prefer effective answers to efficient answers, and are less likely to support the status quo. Transformational leaders generate trust and respect among their followers, who are motivated to achieve more than was originally expected and move their followers beyond their own self-interests for the sake of the group, organization or society (Kapp, 2012).

The transformational style tends to be considered broader and more effective than the transactional style (Avolio and Bass, 2002; Bass and Riggio, 2006). But Stewart (2006) in a review of the works of Burns, Bass and Avolio argues that transformational leadership is likely to be ineffective in the total absence of a transactional relationship between a leader and subordinate. Stewart further advocates that both styles can be combined to achieve the desired aims and so can be seen as complementary rather than polar constructs in order to achieve their organization's objectives and goals.

Transformational leadership can motivate superior employee task and extra role performance by creating a positive vision of the organization's future, empowering employees, and placing importance on their needs (Conger & Kanungo, 1998; Avolio and Bass, 2002; Bass and Riggio, 2006). Zohar (2002) found out that personnel in a factory who were exposed to transformational safety leadership had higher levels of safety compliance (as measured by earplug use) when compared with a control group.

Clarke and Ward (2006) also found out that transformational leadership was positively related to employee safety participation. Transformational safety leadership exerts the same effects on safety-specific performance, such as following rules and helping improve sub-ordinates safety behavior, by generating motivation to achieve positive change and prioritizing employee well-being (Judge & Piccolo, 2004).

Challenges of Transformational Safety -Specific Leadership

However, several issues remain with transformational safety-specific leadership. First, the salience of safety as an important outcome in the presence of safety-focused leaders is understandable; there has been long standing research (Cohen, 1977; Zohar, 1980) showing that organizations in which leaders take an active role in promoting safety enjoy better organizational safety records. Transformational safety-specific leadership, when used as the sole predictor of safety outcomes may confound safety performance and transformational leadership. The possibility remains that a safety climate (Wallace & Chen, 2006; Zohar, 2002) rather than transformational leadership behaviors per se explains variance in employee safety performance.

Secondly, item content is shared across measures of transformational safety-specific leadership (e.g., Barling, Loughlin, & Kelloway, 2002) and employee safety performance (Neal, Griffin, & Hart, 2000) when predictor and criterion variables are collected from the same source (i.e., employees), all of the scales contain derivatives of the word safety in every item potentially inflating the relationship between predictor and criterion.

Empirical strength of Transformational Safety-Specific Leadership

In the Barling, Loughlin and Kelloway, 2002 study, the authors developed, tested, and replicated a model in which transformational safety-specific leadership predicted occupational injuries in 2 separate studies. Data from 174 restaurant workers (M age=26.75 years, range=15-64) were analyzed using structural equation modeling and provided strong support for a model whereby transformational safety-specific leadership predicted occupational injuries through the effects of perceived safety climate, safety consciousness, and safety-related events.

A second study replicated and extended this model with data from 164 young workers from diverse jobs (Mean age=19.54 years, Range=14-24). Transformational safety-specific leadership and role overload were related to occupational injuries through the effects of perceived safety climate, safety consciousness, and safety-related events. Another study (Mullen & Kelloway, 2009) tested the relative effects of safety specific and generalized transformational leadership training on employee safety performance, and found an increase in transformational safety-specific leadership behaviors in the safety-focused training group. However, it was less clear whether there was an increase in generalized transformational leadership in either training group, and the relationship between generalized transformational leadership and employee safety outcomes was not reported.

Using focus groups, factor analysis, and validation instruments, Edwards, Knight, Broome and Flynn (2010) developed and established psychometrics for the Survey of Transformational Leadership (STL). Their study evaluated clinical directors on leadership practices by using 214 counselors within 57 programs in four U.S. regions. Nine themes emerged: integrity, sensible risk, demonstrates innovation, encourages innovation, inspirational motivation, supports others, develops others, delegates tasks, and expects excellence. Reliability for all first-order confirmatory factor analysis STL factors met or exceeded Nunally's (1978) recommendation of (α =.70) for newly developed scales. The alpha coefficient (internal consistency) scores ranged from (α =.78, for Supports Others) to (α =.97, for Inspirational Motivation). The criterion validity showed Cronbach alphas for the validated factors ranged between (α =. 88) and (α =.94).

Freiwald (2013) did a comprehensive investigation of the effects of leadership (ethical aspect) on measurable safety outcomes such as safety behavior and work place related injuries among aviation and healthcare organizations. Freiwald suggested that as the adoption of safety management systems becomes mandatory in more areas of aviation, safety outcomes will be measured and reported to regulatory agencies for organizations of all sizes and types for the first time. Friewald further suggested a strong positive relationship between ethical leadership and sub-ordinate safety behavior.

Fernández-Muñiz, Montes-Peón, Vázquez-Ordás (2014) in an extensive study on Safety leadership, risk management and safety performance in Spanish Firms, found out that transformational safety leadership directly influenced employee satisfaction. The results of the study suggested that transformational leadership transmits to the employees the idea that their managers are really concerned about their safety and well-being in the workplace and that leads to a reduction in workers' complaints about working conditions, greater employee satisfaction, and consequently, lower turnover in the organization.

Fernández-Muñiz, Montes-Peón, Vázquez-Ordás (2014) also found out that, transformational safety leadership indirectly affected safety behavior via the proactive risk management and safety outcomes via safety compliance. This result was in line with Zohar (2002), who, using the transformational leadership model to examine safety management, showed that leadership predicts the injury rate through the mediation of safety climate.

The Fernández-Muñiz, Montes-Peón, Vázquez-Ordás (2014), in contrast, suggested that the transactional leadership style did not have a direct effect on safety performance even though it had a direct effect on the proactive risk management. The findings also suggest that transactional leadership can affect safety outcomes and employee satisfaction, but this effect is mediated by the proactive risk management which has an influence on safety participation and safety compliance.

Fernández-Muñiz, Montes-Peón, Vázquez-Ordás (2014) finally suggest that although both styles are not incompatible, the study suggested that the most effective leadership style for reducing accidents and injuries and improving employee satisfaction is transformational leadership, because this leadership style has a direct effect on safety behavior and employee satisfaction. Interestingly, these findings of Fernández-Muñiz, Montes-Peón, Vázquez-Ordás is starkly at variance with an earlier study by Inness, Turner, Barling and Stride (2010) which suggested that transformational leadership was not related to safety compliance and suggested that transactional leadership may encourage safety compliance more among personnel.

In terms of the existing methodologies for assessing leadership styles in organizations, Pilbeam, Doherty, Davidson and Denyer (2016) in an extensive review of different safety leadership styles from existing literature found out that the majority of studies investigating safety leadership utilized scales that provided a quantitative assessment of the leaders' behavior from the perspective of the follower (in this case the employee). Pilbeam et al. suggest that this is a clear limitation in understanding of safety leadership. Pilbeam et al. argue that such methods rely on both a pre-determined articulation of leader behaviors which may not be applicable always and rather provides a retrospective, and necessarily subjective, perception of employees to describe leader behaviors, which is often de-contextualized.

Pilbeam et al. suggest that new research should focus directly rather than indirectly on the leader and their actions and understanding of leadership, examine leadership 'in the moment' and take account of context, including relationships with others. They argue that may provide deeper insights into the important role of leadership in enhancing organizational safety performance indicators, such as safety compliance and safety participation. This position of Pilbeam et al. echoes similar suggestions by Eid, Mearns, Larsson, Laberg, & Johnsen (2012).

Based on the existing literature and the premise that there has to be a choice of leadership type a researcher needs to measure within the scope of a study, transformational leadership may suffice for this research in collegiate aviation operations. Empirical findings support the relationship between transformational leadership and enhanced task performance and safety behavior (Howell & Avolio, 1993; Barling, Weber, & Kelloway, 1996; Zohar, 2002; Inness, Turner, Barling & Stride, 2010; Fernández-Muñiz, Montes-Peón, Vázquez-Ordás, 2014; Pilbeam, Doherty, Davidson & Denyer, 2016).

These studies provide ample support of the rationale to determine the effect of transformational leadership on the level of safety compliance and safety participation of operations personnel such as flight students and instructors, within the collegiate aviation environment. Safety leadership can potentially influence proactive and cost- effective intervention in aviation operations, resulting in positive safety outcomes. It is would therefore be insightful to explore the relationship between transformational safety leadership as demonstrated by both senior level management and supervisory level managers in collegiate aviation programs and the resultant safety behavior of operational personnel.

Senior Leadership Attitudes to Safety and Safety Culture Perceptions of Personnel

Within an organization, an individual’s perception of senior managers’ attitudes toward safety has been proposed as an important predictor of the organization’s safety culture (Zohar, 1980; Seo, Torabi, Blair & Ellis, 2004; Hall, 2006; Fogarty & Shaw, 2009). Hence, safety culture studies have highlighted the importance of top management’s attitudes and leadership commitment toward safety. In an empirical study, Helmreich and Merritt (2001) surveyed pilots working at two airline companies to observe the variance in perceptions of leadership attitudes toward safety. While 84% of pilots working at one company were confident that top-level leadership never compromised safety, only 12% of pilots working at the other company believed in the leadership's commitment to safety (Helmreich & Merritt, 2001).

The authors emphasized that leadership attitudes influenced pilots ‘attitudes regarding safety practices and norms. Indeed, 68% of pilots working at the first company believed that management would seriously consider their safety suggestions, compared with 19% of the pilots working at the second company (Helmreich & Merritt, 2001). The study found out that the causal mechanism of management attitudes influence on pilot behavior could be explained by the second company's environment.

The study also found out that up to 88% of pilots working at the second company believed that the management compromised safety for the sake of profit. Moreover, they believed that high level management ignored their suggestions to improve the organization's safety processes. The study suggested that demoralized and cynical pilots are more likely to deviate from safety procedures and norms (Helmreich & Merritt, 2001). In other words, pilots develop an attitude favoring low safety standards, because it is difficult to maintain high safety standards when perceiving high level management to have low standards.

A key indicator of senior management's commitment to safety is the adequacy of resources, including financial support and active involvement in safety initiatives by senior management (Simon, 2009). Schiff (2006) suggests that a bottom-up support and participation from operational level personnel is equally critical for the success of any safety program. Adjekum (2014b) also posits that senior level management commitment to safety is normally reflected in three major areas: Safety Values (SV) which are attitudes and values regarding safety expressed, in words and actions, by senior level leadership; Safety Fundamentals (SF) which deals with the compliance with regulated aspects of safety such as training requirements, manuals, etc.; and Going Beyond Compliance (GBC) wherein priority is given to safety in the allocation of company resources (e.g., equipment, personnel time) even though they are not required by regulations.

In a study of challenges to the success of the Safety Management System (SMS) in aircraft maintenance organizations in Turkey, Gerede (2014) found out that SMS experts and managers in rating the success of implementation of SMS initiatives underscored the importance of senior management support for the SMS and a real commitment by senior management to enhance safety. Qualitative data were collected from thirty participants through an open-ended questionnaire. Both inductive and deductive methods were used for the data analysis.

The study suggested that the SMS entails a cultural transformation and is likely to bring about certain challenges because of its new and different characteristics. The study suggested that senior management holds the major responsibility in safety assurance and are authorized to decide on goals and objectives, and the allocation of resources in the organization. The results also buttressed the assertion that senior management leadership capabilities and commitment to safety play a major role in the reinforcement of a positive safety culture.

While senior management plays a role in the emergence of problems related to a "Just Culture", the same senior management holds the power and resources to solve these problems. Senior level management is also responsible for promotion of the safety initiative in an organization, since a "visible" safety program helps to set the stage for improved employee attitude (Transport Canada, 2008). Periodic safety related training and inspections by top management help to convince personnel that the program is not merely administrative program of the month, but is an item of real concern.

When personnel participate in safety initiatives, the safety program evolves into an active force in the organization (Patankar, 2003) and these employees subconsciously develop the habit of planning ahead and examining the safety, production, quality, and cost aspects of the task before them (Roughton, 2002). Although the physical safe-guarding of the workplace is a real factor in safety, the mental attitude of the employee is the ultimate key to avoiding incidents (Roughton, 2002).

The quality of leadership provided by senior level management personnel within collegiate aviation programs is believed to have a significant influence on flight students and instructors' behaviors, as there is considerable evidence to support the causal relationship between the leadership styles or types and the performance of subordinates (Barling & Kelloway, 2002; Jong & Hartog, 2007).

Within collegiate aviation operations, the flight operational leadership consists of the director of flight operations, chief flight instructors and assistant chief flight instructors. These are the senior level management leadership that provides operational control. Therefore, examining whether these program managers' transformational leadership style enhances pilots' motivation to acceptable levels of safety behaviors may provide crucial insights into the underlying factors linking leadership and employee behaviors.

Underlying Theories- Safety Motivation, Safety Behavior and Safety Performance

Research has shown that people's perceptions affect their behavior. More specifically, perception of risk affects the likelihood to exhibit certain behaviors (Cooper, 2000; Hunter, 2006; Forgaty & Shaw, 2009; Dillard, Ferrer, Ubel, & Fagerlin, 2012). Some safety professionals strongly advocate for a focus on safety behavior modification and behavior – based safety (BBS) within organizations implementing SMS (Brauer, 2006; Cooper, 2009). BBS is defined as "A process that creates a safety partnership between management and employees that continually focuses people's attentions and actions on theirs, and others, daily safety behavior and focuses on what people do, analyzes why they do it, and then applies a research-supported intervention strategy to improve what people do" (Geller, 2004; Cooper, 2009).

In general, behavior-based safety techniques focus on work processes. In analyzing work processes, the workgroup identifies behaviors that are critical to safe process performance. They measure how well the group completes safe behaviors. Measurement typically requires observation. Analysis of performance provides feedback to the participants. Participants also identify and resolve other process elements that impact the ability to perform safely as part of the continuous improvement process (Brauer, 2006).

To be effective, those in the workgroup need training on hazard recognition, evaluation, and control as well as learning how behaviors that are part of the process can contribute to the safety of the work. The participants may need to change their approach to how safety is handled in the process. It requires a shift from a top-down management style. It requires broad participation and collaboration among members of a work group (Brauer, 2006; Yates, 2015).

The aim of this organizational behavior modification approach is to ensure that a proactive safety initiative such as SMS is based upon the hierarchy of hazard identification, and safety risk mitigation strategies. However, such behavioral modification approach should not be used in preference to the implementation of reasonably practicable safety measures further up the organizational hierarchy (Krause, 2005; Cooper, 2009). Generally, interventions and strategies that aim at positively influencing the safety behavior of personnel within an organization should also have some strong theoretical bedrock of safety motivation that will ensure that personnel’s safety performance will meet set safety goals and objectives (Yates, 2015).

Maslow's Hierarchy of Needs Theory

Theoretically there are competing schools of thought on the effects of safety behavior and motivations on safety outcomes and performance. Abraham Maslow introduced the *Hierarchy of Needs Theory* (Maslow, 1970) to explain human motivations and needs. In this theory, Maslow proposed that all human beings are motivated by unsatisfied needs and that certain lower factors need to be satisfied before higher needs can be satisfied. Maslow theorized that the lower needs have to be satisfied before the next need level serves as a motivator. Furthermore, once the lower level need has been satisfied, it no longer serves as a motivator.

Maslow's *Hierarchy Theory* underpins the essence of identifying those underlying potential motivational factors that can enhance proactive safety behavior in collegiate aviation programs (McLeod, 2014). Collegiate flight student's cognitive needs, which affect their decision making process and largely safety behavior, can be enhanced if their basic physiological needs are met.

For example, a fatigued and hungry flight student may find it difficult to focus on flight activities, which could be a precursor to an unsafe act. Flight students need to feel emotionally and physically safe and accepted within their programs to progress and reach their full potential. Maslow suggests that flight students must be shown that they are valued and respected by their instructors and flight managers in order to create a supportive and safe flight training environment.

McGregor's Theory X and Theory Y

Douglas McGregor postulated two theories of organization management and employee motivation, calling them *Theory X and Theory Y* (McGregor, 1960). Under *Theory X,* McGregor states that leadership assumes the following: Motivation occurs only at the physiological and security levels of Maslow's *Hierarchy of Needs*. Most people are self-centered and as a result, they must be closely controlled and often coerced to achieve organizational objectives. To summarize *Theory X*, McGregor believed that the main source of most employee motivation is monetary, with security as a strong second and leaders can manage safety behavior by coercion, threats, or micromanagement (Stewarts, 2010; Sorenson, 2015).

In *Theory Y*, McGregor theorizes that employees are motivated primarily at the esteem and self-actualization levels. Almost in contrast to *Theory X*, leadership in *Theory Y* makes the following general assumptions that personnel will be self-directed and creative to meet their work and organizational safety objectives if they are committed to them. Personnel will be committed to their safety and productivity objectives if rewards that address higher needs such as self-fulfillment are in place. This particular aspect of the *Theory Y* has profound implications for personnel to have "buy-in" and participate in safety programs initiated in collegiate aviation program.

Under *Theory Y*, the capacity for creativity spreads throughout organizations and most personnel can handle responsibility because creativity and ingenuity are common in the population. Under these conditions outlined by *Theory Y*, personnel will seek out responsibility and an organization can decentralize control and reduce the number of management levels required to operate safely.

Under *Theory Y*, the scope of work by personnel can be broadened, which adds variety and opportunities, while engaging employees in the decision-making process. Personnel are allowed to set performance objectives and participate in the process of evaluating how well they were met (Sorenson, 2015). However, the drawback in these two theories is that neither of these approaches are optimal and the best management method in terms of safety motivation and behavior, may lie somewhere between the two approaches (Sorenson, 2015).

Frederick Herzberg's Motivational Theory (Two-Factor Theory)

Another important theory that underpins safety motivation and safety behavior is the Frederick Herzberg's *Motivational Theory (Two-Factor Theory)*. In this theory, Herzberg attempted to explain factors that motivate individuals through identifying and satisfying their individual needs, desires, and the aims pursued to satisfy these desires (Hines, 1973; Neil, 2007; Greenberg, 2013). Herzberg stated that motivation can be split into two major categories: hygiene factors and motivation factors. The *Hygiene factors* affect the level of dissatisfaction but are rarely noted as creators of job satisfaction. However, if these factors are not present or satisfied, they can demotivate a person.

Herzberg's *Hygiene factors* include the following: supervision, interpersonal relationships, physical working conditions and salary. Job dissatisfaction, under normal circumstances, is not normally attributed to motivation factors. However, when they are present, they serve as motivational factors. Motivation factors include achievement, advancement, recognition and responsibility.

The drawback of this theory and implication on safety behavior is that whenever there is shortage of motivation factors present in the work environment, personnel may focus on other factors, such as the hygiene factors and when there are unfavorable working conditions and production pressures under limited resources resulting in job dissatisfaction, that could be a recipe for unsafe behaviors and possible accidents (Schultz & Schultz, 2010).

Another limitation of the two-factor theory is the relatively explicit assumption that well motivated and satisfied personnel will exhibit better safety behavior. This assumption might not always be the case as an individual's expectancy that a given behavior will bring a valued outcome may determine their choice of means and the effort they will devote to these means (Neil, 2007; Mazur, 2013; Greenberg, 2013).

Skinner’s Operant Learning Theory

According to the *Operant Learning Theory*, behavior is a function of the person's environment and can be modified by rearranging the consequences of the behavior (Skinner, 1953). According to Skinner, behavior with positively reinforcing consequences (e.g., increased earnings or reductions in amount of effort required to do a task) tends to increase in frequency, whereas behavior with punishing consequences (e.g., disciplinary actions) tends to diminish in frequency.

The implications of this theory for operational safety, especially in a flight training environment is that personnel may have a tendency to act safely, and follow training guidelines and safety instructions since the outcomes are positive as compared to unsafe acts, which may have adverse consequences. In reality this assertion may not always hold true, since personnel may not know the outcome of certain actions, especially in novel situations and would only get to know of the outcome in hindsight. Some personnel may also engage in some operational activities in an unsafe manner, but due to the absence of other vital pre-cursors of accident causation, such as unsafe conditions or just plain luck, nothing adverse happen, creating an illusion of invulnerability (Reason, 2008).

Thorndike's Reinforcement Theory

The Thorndike's *Reinforcement Theory* states that behavioral responses to stimuli that are followed by a satisfactory response will be strengthened, but responses that are followed by discomfort will be weakened (Nevin, 1999). The theory essentially postulates that behaviors that are rewarded are often repeated, and those behaviors that are not rewarded are less likely to occur in the future. The *Reinforcement Theory* looks at the relationship between behavior and its consequences. The defining factor of reinforcement theory is, of course, reinforcement, which can be either positive or negative.

The first component, *Positive reinforcement* uses favorable consequences that reinforce the desired behavior as the correct behavior. In terms of safety behavior, when personnel in an organization meet safety performance targets, such as incident free production over a period of time (a desired behavior), safety awards and recognition are given (positive reinforcement), making it more likely for personnel to repeat that same behavior that resulted in the positive reinforcement (Nevin, 1999; Mazur, 2013). Other examples of positive reinforcement may include pay raises and bonuses for flight instructors who undertake incident –free training over a period of time, promotions, safety awards and public recognition. In collegiate aviation, leadership can give free training hours to flight students for exemplary safety operations and behavior. The use of positive reinforcement could increase operational productivity and improve students and department morale.

Evidence suggest that the use of rewards such special parking slots and inexpensive household items and special recognition for safe behavior of personnel can enhance operational productivity and safety. In a polystyrene production company, personnel earned safety points for accident-free productive activities within a time frame and were recognized and rewarded. This action on the part of management actually raised the productivity of that company by 16.5 percent, lowered error rates by 40percent and lowered accident rates by 43.7 percent (Greenberg, 2013).

The other component of the theory, *Negative reinforcement*, also referred to as avoidance, rewards a behavior by removing negative or undesirable consequences, which strengthens the probability of the behavior being repeated. Negative reinforcement, or avoidance, is used by managers to show personnel what the consequences of unacceptable behavior will be (Nevin, 1999; Neil, 2007). The goal of *Negative reinforcement* is to get the employee to avoid the unacceptable behavior. If an employee does not engage in the unacceptable behavior, then he or she will not experience the consequence. Both positive and negative reinforcement have the ability to increase the likelihood of a desired behavior being repeated. However, in reality, both positive and negative reinforcement do not always work, and create the path for the use of two other reinforcement strategies such as punishment and extinction (Nevin, 1999; Mazur, 2013; Greenberg, 2013).

However, it may not be reasonable to assume that generally rewards and reinforcements may correlate with desired safety performance. Generally, not all organizations have had success with such behavior modification programs, since there may be other confounding variables that could influence accident causation, such as unsafe working environment and operational and productive pressures in a resource constrained environment (Reason, 1998; Greenberg, 2013). Such reinforcements may prove ineffective, as in the case of a worker who is pushed by production pressures or inflexible technology to take risks or exhibit unsafe behaviors (ICAO, 2009).

These reinforcement theories could also create a situation where personnel may feel reluctant or may simply not report near-misses, unsafe actions and hazards perceived to be attributable to them, due to the fear of losing out on rewards or smearing a determined unblemished safety performance record. That state of affairs in any organization could adversely affect a proactive safety risk management process in an SMS.

Vroom's Expectancy Theory

Whereas Maslow and Herzberg look at the relationship between internal needs and the resulting effort expended to fulfil them, Vroom's *Expectancy Theory* separates effort (which arises from motivation), performance, and outcomes and assumes that behavior results from conscious choices among alternatives whose purpose it is to maximize pleasure and to minimize pain (Vroom, 1964; Bandura, 1986; Greenberg, 2013). Vroom realized that an employee's performance is based on individual factors such as personality, skills, knowledge, experience and abilities.

The *Expectancy Theory* states that effort, performance and motivation are linked in a person's motivation and the variables Expectancy, Instrumentality and Valence are used to account for this (Greenberg, 2013; Yates, 2015). While Maslow's Theory and other theories do not allow for the same degree of individuality between people. This model takes into account individual perceptions and thus personal histories, allowing a richness of response not obvious in Maslow, who assume that people are essentially all the same.

The *Expectancy Theory* has implication for both personnel and leadership in an organization in terms of safety motivation and behavior. Personnel would change their level of effort according to the value they place on the bonus they receive from a process and on their perception of the strength of the links between effort and outcome (Bandura, 1986; Greenberg, 2013). Organizational leadership should use systems that tie rewards very closely to safety performance and leaders should ensure that the rewards provided are deserved and wanted by the deserving personnel (Greenberg, 2013). In order to improve the effort-performance tie, leaders should engage in training to improve their capabilities and improve their belief that added effort will in fact lead to better performance.

Theory of Planned Behavior (TPB)

Another theoretical foundation to human behavior has been proposed by Ajzen (1991; 2005) in the *Theory of Planned Behavior (TPB).* The theory explains the psychological aspects of employee behavior and the principal assumption of the TPB has to do with the intentions behind any human action. Ajzen posits that intentions to perform any kind of behavior are guided by different considerations: attitude toward behavior, subjective norm, and perceived behavioral control. The theory postulates that individuals' intentions regarding any kind of behavior can be predicted with a high degree of accuracy by their attitudes toward behavior, subjective norms, and perceived behavioral control constructs. Second, the predicted intentions, together with perceived behavioral control, can explain variances in actual behavior

According to Fogarty and Shaw (2009), Ajzen introduced the intention variable to strengthen the relation between attitudes and behavior, because attitudes sometimes fail to become behavior due to many other factors preventing individuals from converting their attitudes into behaviors. In other words, an individual’s own attitude toward behavior, subjective norms, and perceived behavioral control can be used to predict intentions regarding any safety issue. Intention can in this way be used to predict actual safety behavior

Error Management, Behavior-Based Safety and Safety Compliance Enforcement

There has been an ongoing debate among safety theorist and safety professionals on the merits and demerits of using safety behavior modifiers inclusive of disciplinary actions and other forms of punitive actions in error managements and other forms of non-compliance with safety procedures and regulations (Reason, 2008; Cooper, 2009; Dekker, 2014; Yates, 2015). Within an SMS, the aim of enhancing a desired safety behavior among personnel is to build a proactive safety culture, which has one of it tenets a *Just Culture* that balances accountability with learning (Dekker, 2007).

Within the framework of safety behavior modification, proponents, such as Geller (2004; 2005), Cooper (2009), and Goetsch (2010) advocates for a Behavior Based Safety (BBS) model that consists of seven principles, namely: intervention; identification; identification of internal factors; motivation to behave in the desired manner; focus on the positive consequences of appropriate behavior; application of the scientific method, integration of information; and planned interventions to control individual behavior in an organization.

Even though BBS interventions have been quite effective in certain organizations in modifying safety behaviors (Cooper, 2009), advances in BBS should not lead one to forget that behavior is only one factor in an interrelated web of safety and accident causation and that engineering solution rather than punitive- based compliance strategies are sometimes the most effective (Holden, 2009). Violations, work-arounds, shortcuts, and non-compliant behaviors are real –time challenges and important topics in modern performance –based safety management initiatives such as SMS (Stolzer, Halford & Goglia, 2011; ICAO, 2013).

However, some organizational theorist and safety professionals believe that punitive actions for errors and safety infractions are justified to ensure organizational safety compliance (Cooper, 2009; Greenberg, 2013). Inness et al. (2010) even suggest that in order to achieve safety compliance, formal control through rewards and punishments may be more appropriate. These proponents place the burden of causality for errors and unsafe behaviors in organizations on human traits and actions. Proponents of the *Person-Centered Safety Theory* argue that if rewards can be used to systematically encourage desirable and precisely safe operational behavior, then punishment can be used to discourage undesirable and unsafe behavior (Cooper, 2009).

Person-Centered Safety Theory

An early proponent of the *Person-Centered Safety Theory* was Heinrich and his *Domino Theory of Accident Causation*, which postulates that an accident occurs only as a result of a personal or mechanical hazard (Hollnagel, 2009; Goetsch, 2010; Yates, 2015). The theory emphasizes, that personal and mechanical hazards exist only through the fault of careless persons or poorly designed or improperly maintained equipment. Faults of persons are inherited or acquired as a result of their social environment or acquired by ancestry and that the environment is where and how a person was raised and educated. Heinrich advocated that the unsafe behavior of personnel or the mechanical or physical hazard should receive the most attention. These attentions may include the use of enforcement measures such as punishment (Holden, 2009; Inness et al., 2010; Goetsch, 2010).

Greenberg (2013) argues that an organization should have a systematic administration of punishment and that the unpleasant outcome of the punishment in response to an unsafe behavior would send a signal to the personnel involved in the safety non-compliant behavior and other personnel that such behavior will not be tolerated and will curtail future incidents. The challenges with these practice is how an organization uses punishment to moderate behavior and how to effectively administer punishment.

Greenberg (2013) further recommends that levels of punishment should be graduated and commensurate with the severity of the outcome of the actions, punishments should focus on the personnel's actions and not on the personality of the personnel, punishment should be consistently applied to all personnel without any form of partiality and finally the reason for punishments should be explicitly communicated to personnel, since that help to strengthen the previewed connection between the undesired behavior and the consequences of the actions.

Organizational and Systems-Centered Theory

On the other extreme are those who dismiss the *Person –Centered Theory* in favor of the *Organizational* and *Systems-Centered Theory* (Reason, 2008; Holden, 2009; Hollnagel, 2009). These advocates opine that accidents are caused by multiple factors and occur due to the complex interactions of numerous work system elements, human and non-human. Some of these advocates against the *Person-Centered Theory* include Reason (1998; 2000; 2008) and Dekker (2003a; 2007; 2011; 2014), who argue strongly against the unbridled use of punishment as a safety behavior modification tool especially in high reliability organizations such as aviation and healthcare.

Dekker (2007; 2011) posits that punitive actions and other attempts to keep people accountable for human errors and unsafe behaviors are predicated upon person-centered causality, reminiscent of fellow servant and contributory negligence rules of the not-sodistant past. Dekker strongly makes a case that blame and punishment comes from social cognition research on accountability and that person-centered causal attribution of work place accidents need not involve blame. Even though quite unconventional, Dekker advocates that punishing of personnel for unsafe behavior protects false beliefs about basically safe systems where humans are the least reliable components. Punishment emphasizes that failures are deviant, that they do not naturally belong in the system and rather conditions others to not get caught next time.

Bad Apple Theory

The *Bad Apple Theory* of safety management "identifies bad apples (unreliable human components) somewhere in an organization, and gets rid of them or somehow constrains their activities" and this is what safety scholars such as Dekker (2014), Reason (2008) and Hollnagel (2009) describe as belonging to the "old view" of human error, which states that the system in which people work is basically safe and success is intrinsic. The "old view" of human error according to Dekker (2014) sees the major threat to safety as the inherent unreliability of people and that progress on safety can be made by protecting the system from unreliable humans through selection, proceduralization, automation, training and discipline.

Person Attribution Theory

Reason (2000; 2008) posits that the *Person Attribution Theory* that has blame and punishments as some of its components and is directed mainly at reducing unwanted variability in human behavior may have associated counter-benefits. The methods under this *Theory* advocates for appealing to people's sense of fear, writing another procedure (or adding to existing ones), disciplinary measures, threat of litigation, retraining, naming, blaming, and shaming.

Human Factors Theory

The *Human Factors Theory* posits that accidents are entirely the result of human error (Goetsch, 2010; Yates, 2015). These errors are categorized broadly as overload resulting from a task being beyond the capability of the worker, environmental factors (noise, distractions, etc.), internal factors (personal problems, emotional stress) and situational factors (unclear instructions, risk level). The theory posits that human error can be the result of inappropriate and unsafe behavior and oftentimes, undertaking a task without the requisite training can lead to accidents and injuries. The *Human Factors Theory* finally propounds that unfamiliarity with equipment and procedures and misjudging the degree of risk associated with the task are examples of unsafe activities.

Petersen's Theory (Accident/ Incident Theory)

The *Petersen's Theory (Accident/ Incident Theory)* is basically an extension of the *Human Factors* accident causation model with additional elements such as ergonomic traps, the decision to err, and system failures (Goetsch, 2010; Yates, 2015). Petersen stated that a decision to err by an employee may be an unconscious and based on logic, or it could be a conscious decision. Factors such as deadlines, peer pressure, and budget factors could make a person decide to behave in an unsafe manner. One important factor in the *Petersen Model* that causes a person to make a logical decision to disregard procedures is the "*Superman Syndrome*." The *Superman Syndrome* leads the person to believe that he is invincible or bulletproof, simply because "it won't happen to me or accidents happen to others who don't pay attention."

The addition of system failure to the *Petersen Model* is an important step in identifying the potential for causal relationship between management decisions or management behaviors regarding safety. System failure helps establish and solidify management's role in the accident prevention process. It also helps identify the avenues in which the system can fail, such as clearly defining areas of responsibility, inspections, measurements, training, and orientation of employees.

In the *Petersen Model*, management's role is multilayered and responsible for setting policies, placing responsibility, training employees, following up on training and enforcement of policies with inspections to ensure compliance. Management is also charged with enforcing standards with corrective actions.

Challenges of Behavior-Based Safety Approach and Error Management in SMS

Other safety scholars such as Van den Hoven (2001) suggest that personnel sometimes engage in unsafe behavior because they lack the authority to make risk-based decisions during productive activities that they are responsible for, especially when constrained by goals other than safety. Klien (1998) also suggests that personnel may sometimes engage in unsafe behavior because time and other resources for making sense of a situation are lacking, information may not be at hand or may be ambiguous, and there may be no neutral or additional expertise to draw on.

Helander (2006), in arguing for a systems approach to errors and unsafe behaviors, writes "the notion that the operator should be punished or personally made responsible is unwarranted, unless of course there is a clear violation of regulations" (p.340). Woods and Cook (1999) also argue that undesired safety behaviors and violations are sometimes adaptive and not irrational. When seen through the lens of local rationality i.e., given what the worker knew at the time, what was the mindset, and what were the goals, most violations appear to be reasonable or at least understandable.

Organizational leadership is faced with two major choices in dealing with violations and non-compliant safety behaviors. Non-compliant safety behavior can be treated as the behaviors of bad people, and mitigated with person-centered solutions, such as enforcement and subsequent punishments or treat such behaviors as an indicator for better design of the system properties that necessitate violations (DeJoy, 2005; Reason, 2008). System design should also include support systems that keep personnel safe when they have to go outside of protocol or work around a flawed system (Dekker, 2011; 2014).

Although many safety professionals advocate for the latter approach, the former person-centered approach appears to dominate in organizational set-ups, including some aviation organizations (Dekker, 2007; 2011). Some companies will fire or demote employees who are involved in accidents due to failure to follow safety procedures in an effort to show their commitment to safety (DeJoy, 2005).

The downside of using this type of punishment is that it creates an adversarial relationship between personnel and management and may also stifle personnel proactivity in participating in safety initiatives or under-report safety occurrences and near-misses for fear of punitive action. Such a safety climate can adversely affect the implementation of an SMS initiative by stifling both safety participation and safety compliance (Neal, Griffin, & Hart, 2000; Stolzer, Halford & Goglia, 2011).

Relationship between Pilots' Self-Efficacy, Safety Motivation and Safety Behavior

Research suggests that people with high levels of self-efficacy have greater beliefs in their own capabilities to achieve certain goals and that pilots with higher perceived self-efficacy are likely to better resist pressure and devote more efforts to improving their work-related and management performance (Schwarzer & Jerusalem, 1995). Individual self-efficacy has been applied as the observed predictor in the number of studies that investigate pilots' work-related behaviors (Parasuraman, Molloy & Singh, 1993; Prinzel, 2002).

Prior research demonstrates that self-efficacy has effects on the level of motivation, learning and performance (Schunk and Pajares, 2001). Graham and Weiner (1995), for example, stated that self-efficacy is a consistent predictor of behavior and behavioral change. However, self-efficacy has been noted to be a double-edged sword which may lead to the concern that pilots with high self-efficacy may be more likely to take dangerous short-cuts because of overconfidence (Prinzel, 2002). Within the collegiate aviation environment, that may be worrisome.

As part of the SMS initiatives, some of the collegiate programs have implemented proactive data monitoring systems such as flight data monitoring (FDM) on their fleet (UND, 2012). The aim of these proactive safety tools is to capture exceedances and excursions outside the normal flight envelopes during flight training. The data accrued are monitored and analyzed for trends that depict exceedances. Corrective actions in terms of changes in procedures and gaps in training methods closed. Therefore, within practical limits, overconfidence on the parts of either students or flight instructors which may creep in due to high self-efficacy resulting in safe flight parameters exceedances can be picked up early and controlled.

Relationship between Safety Behavior and Safety- Related Events (SRE)

Transformational safety leadership and the resultant commitment by senior level management to safety may enhance operational safety performance. However, there is also a relationship between personnel safety performance indicators such as compliance with safety regulations, and safety related events (Zohar, 2002). Safety performance involves behaviors that directly contribute to developing a safe work environment. Therefore, behaviors that are characteristic of safety compliance will lead to fewer safety- related events in the workplace (Griffin & Neal, 2000). For example, personnel who comply with established safety regulations are less likely to experience safety- related events than those who do not comply with established safety regulations.

The relationship between safety participation and safety related events is also examined in this study. Studies on the effect of individual risk perceptions on participation in health and safety programs illustrate that perceived risk directly predicts participation (Cree

& Kelloway, 1997; Goldberg, Dar-el, & Rubin, 1991). Individuals who experience close calls or safety related events, display higher levels of safety participation (Mullen, 2004). Cree and Kelloway (1997) suggest that exposure to workplace accidents or safety related events strongly influence an individual's own perception of risk so that their perceived risk increases as exposure to the events increases.

Mullen (2004) found that perceived risks associated with a job tended to be heightened when an individual vicariously experienced or learned about an injury that occurs within the workplace. In such cases, an individual is at risk of becoming injured while performing the job. In fact, workers report that a shock or close call raises safety awareness and helps them realize the potential consequences of unsafe behavior (Mullen, 2004).

Self-reported safety behavior and safety attitudes can be an alternative to relying on mishaps data to evaluate the effectiveness of an organization's safety program. For example, Thompson et al. (1998) suggested that minor workplace accidents often go unreported, yet these events may be the best indicators of improving (or worsening) safety conditions that might eventually lead to serious injury or safety related events.

On the flip-side, safety- related events, or close calls, resulting in the realization of the importance of safety in the workplace can increase the likelihood that individuals would voluntarily perform their work safely (Mullen, 2004; Zohar, 2002). These safety- related events are a direct function of the safety climate, within the organization. The call for increased research focused on identifying factors that are associated with safety compliance and participation has also come from Neal and Griffin's (2002) review of the safety climate and safety events literature.

Findings from Neal and Griffin (2002) support the relationship between safety climate, safety events and safety behavior. Neal and Griffin (2002) also hypothesized that safety behavior could be defined by the underlying construct measures of safety compliance and safety participation. While Neal and Griffin (2002) suggested that safety climate is one of the potential predictors of safety behavior, they further identified other potential predictors of safety behavior as supportive leadership and conscientiousness. In a previous study, Griffin and Neal (2000) suggested that conscientiousness predicted safety motivation, safety compliance, and safety participation. Other studies have suggested that a key component of conscientiousness is self-efficacy (Scwazzer & Jerusalem, 1995; Chen, 2014).

In other studies, Neal and Griffin (2006) found that perceptions of knowledge about safety and motivation to perform work functions safely significantly influenced self-report of task and contextual safety performance, namely safety compliance and safety participation. For these reasons, the authors suggest that an enhanced safety climate, through SMS implementation could be a viable predictor of safety compliance and safety participation. The authors also suggest that safety behavior may be intrinsically associated with safety events.

Summary and Conclusions

After an extensive synthesis of literature on SMS initiatives, implementation in aviation, transformational safety leadership, safety motivation and self-efficacy and their potential inter-relationships, there is ample evidence that there exists some level of paucity of literature on the inter-relationships of these variables within collegiate aviation programs in the US. While most research has focused on the airline, maintenance and air -traffic organizations, there have been minimal studies focused on SMS implementation in collegiate aviation.

This apparent minimal focus may be attributed to the fact that there is presently no regulatory requirement for aviation training organizations (ATOs) such as collegiate aviation programs in the US to implement SMS in their operations (FAA, 2012). However most of the existing SMS programs running in collegiate programs are basically voluntary and fledgling in nature, and have not reached a matured point for a systematic evaluation of the processes and system.

The success of any SMS initiative depends on a continuous improvement and a better understanding of front-line operational personnel's perceptions regarding the particular safety system their organization adopts. Previous studies verified the relationship between the implementation of SMS and the attitudes of employees towards safety in airport operations (Remawi, Bates & Dix, 2011). It was important to replicate such studies in collegiate aviation operations. Finally, it was insightful to have a comprehensive understanding through structural equation models of the relationship between SMS initiatives, self-efficacy, transformational safety leadership on safety behavior, when safety motivation was used as a mediating variable in collegiate aviation programs.

CHAPTER IV

RESEARCH METHOD

The intent of this concurrent triangulation mixed-methods study was to evaluate the inter-relationships between SMS initiatives, safety leadership, safety climate, self-efficacy, safety motivation and safety behavior in a collegiate aviation program in the US. The study aimed at filling a gap in research on SMS initiatives in collegiate aviation programs, add to existing literature, and establish a coherent relationship between these variables through the use of a comprehensive concurrent triangulation approach. Another aim of this study was to establish a proactive operational safety change and benchmark for continuous monitoring and improvements in SMS implementations within collegiate aviation programs.

In this study, a quantitative survey instrument was used to examine the relationship between the perceptions of collegiate aviation flight personnel, i.e., flight students including those with certified flight instructor ratings and employed in the program on Safety Management System (SMS) initiatives, Transformational Safety Leadership (TSL), Self-Efficacy (SE), and Self-Reported Safety Behaviors (SB) while mediating with Safety Motivation (SM). Safety behavior was measured by Safety Compliance (SC) and Safety Participation (SP). The various dimensions were measured using the validated scales outlined in chapter one and Appendix A.

A hypothesized measurement model was evaluated using the data from the responses of the sample of collegiate aviation personnel. The results were analyzed using both first – order and second-order Confirmatory Factor Analysis (CFA) and Structural Equation Modeling (SEM) to determine the strengths of relationship among the variables while iteratively determining the quality of both the hypothesized and final measurement models for the interactions. The relationship between these indicators of safety and safety outcomes (self -reported safety events) was also be explored.

Concurrently, selected senior level management personnel/process owners (Assistant Dean, Director of Academic Research, Director of Aviation Safety, and the Director of Flight Operation) perspective on the state of SMS initiative and implementation in the program was assessed through semi-structured interviews (Maxwell, 2005; Glesne, 2011). The rationale for this assessment was to provide an insight into the strategic perspective of the operational safety state in the aviation program. Another reason for the interview was to determine if there existed real-time perceptual safety gaps in the SMS initiative and the inter-relationship with the other research variables from the findings of the artifact/document analysis and students'/instructors perceptions.

The final triangulation process was to integrate the quantitative data from the survey of respondents' perceptions on research variables, over-arching themes emerging from coding/nodes of semi-structured interview transcripts of selected senior management personnel, forensic analysis of safety artifacts/documents containing aggregate data of safety performance indicators. Some of the safety performance indicators used was the number of confidential safety reports filed by personnel and closed reports/feedback from safety office, attendance to safety meetings, and number of students and instructors formally trained in SMS between the *active applicant* period to the *active conformance* stage (2012-2016) of the SMS initiative.

Research Design

Concurrent Triangulation Mixed Method Approach

A concurrent- triangulation strategy of mixed-methods design was used to collects both quantitative, qualitative and documented aggregate safety data concurrently. The three databases were compared to determine if there existed convergence, divergence, or some combinations. This approach has been found to help in comparing and cross-validating the multi-sourced findings. This approach generally uses separate quantitative and qualitative methods as a means to offset the inherent weaknesses in one method with the strength of the other (Creswell, 2009; Glesne, 2011).

The results from all the analyses were integrated during the discussion /data interpretation phase. A side- by- side integration had the quantitative analysis done first followed by the qualitative analysis and then the document analysis to either support or disconfirm the quantitative results. Figure 8 shows a two-dimensional overview of the concurrent triangulation mixed-method approach.

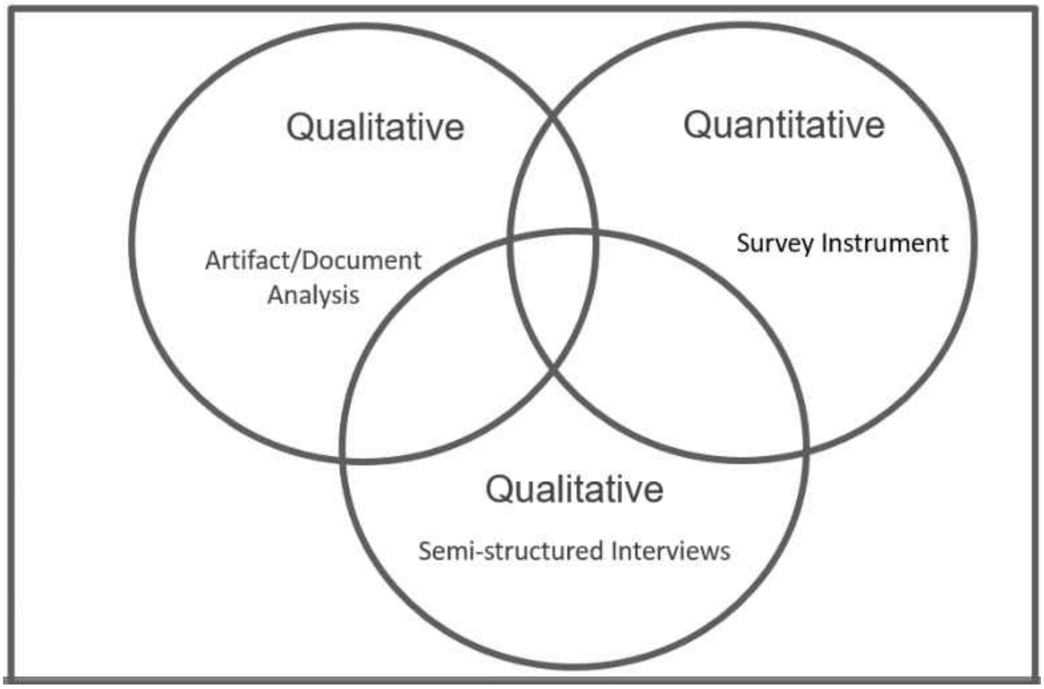

Figure 8. An overview of the concurrent triangulation mixed-method approach.

Methodology

Population

The study focused on the responses to a survey instruments from a random sample of respondents enrolled in flight-related courses within a population of flight students and flight instructors in an accredited four-year undergraduate degree awarding collegiate aviation program (49 CFR Part 141) of a public owned university in the Mid-Western United States (N= 800). The aviation program also offers graduate level degrees in aviation and aerospace sciences. The aviation program in the university has been recognized by the FAA as an *active conformant* in the implementation of the voluntary SMS program. The concurrent qualitative phase of the study involved a semi-structured interview with a purposive sample of four senior level management personnel of the collegiate aviation program.

Sampling Procedures

Power Analysis and Sample Size Selection

Several arguments have been proposed regarding the necessary sample size of a covariance structure model (Stevens, 2002). Boomsma and Hoogland (2001) claimed that 200 cases constitute a reliable sample size for a correct model; one in which any problem related to power analysis is less likely to occur. On the other hand, smaller samples have also been used in the literature, while Kline (2005) suggests that sample size estimation should be made based on the number of parameters.

While a ratio of 10 respondents per parameter is reasonable, a ratio of 20 respondents per parameter ensures adequate power for the analysis (Kline, 2005). Since in this study there were 14 parameters, using the criteria outlined by Kline, an estimated sample size of 280 was determined to suffice. Normally for SEM and CFA, it is highly recommended that a sample size of more than 200 will ensure a more reliable model (Stevens, 2002). The sample size was estimated at any value greater than 280 (n >280).

Even though the survey instrument would ensure adequate coverage and random chance for all the respondents, a purposive sampling strategy limited the quantitative portion of the study to only respondents who were either enrolled in flight related courses or employed as CFIs (exclusion criteria) in both the collegiate aviation program and contract program. Non-flight students, graduate students, management pilots, faculty and staff were excluded from the survey instrument phase of this study. Data collection was purposefully limited to a three-week period in the fall 2016 academic semester.

Procedures for Recruitment, Participation, and Data Collection

An Institutional Review Board (IRB) approval from the university was sought before the study commenced, since the study involved human subjects. Permission was sought from the chair of the aviation program to facilitate the emails of all flight students and flight instructors at the university. A confidential Qualtrics® generated online survey instrument was sent to respondent's university issued email address.

Faculty members were also requested to post the anonymous link to the survey on their class sites for easy access by their students. The respondents accessed the survey through a sign -in into their university email, using their username and password. After accessing the link to the Qualtrics® online survey, the respondents were required to digitally agree to and sign a consent form that explained all the rights of the respondent in the study.

A respondent who agreed to the consent proceeded to answer questions in the survey. A respondent who did not agree with the consent was logged out. Respondents who proceeded with the survey after consent could at any time quit the survey at their own choice, without any adverse repercussions. The completed responses were stored in a secure online database in accordance with the security protocols required by the university and the Institutional Review Board (IRB).

The semi-structured interviews were done face-to- face with the top-level management personnel and audio-recorded. The interviewees were given ample notice (Two weeks) and the questionnaire for the interview and IRB consent forms were sent to them prior to the interview. The audio recordings were transcribed and the transcript sent to the interviewees for authentication and validation of contents. The validated contents were then coded for emergent themes and classifications. The coding and classifications were done using a combination of manual means and computer –assisted qualitative soft wares such as the Atlasti 7®, and NVivo 11®.

Even though the ultimate value existed in the relationship between the self-reporting of events and individual respondents' perception of SMS, self-efficacy, transformational safety leadership, safety motivation, and safety behavior, the safety artifacts and records of the collegiate program assisted in the triangulation of data provided by respondents. A formal request was made to the relevant management personnel authorized to grant access for the release of factual aggregate safety performance data and existing safety survey results within the program.

A forensic analysis of safety documents containing aggregate data of safety performance indicators i.e., number of confidential safety reports filed by personnel and closed reports/feedback from safety office, attendance to safety meetings, and SMS training of students and instructors within the *active applicant* period to the *active conformance* stage of the SMS initiative formed the basis of the third component of the triangulation process (Creswell, 2009; Patankar, Brown, Sabin & Bigda-Peyton, 2012).

Demographic Details

Demographic details such as age, gender, international students' status, flight certificate, year group, and SMS training status was sought from respondents. The rationale for these demographic data was to facilitate analysis and helped to understand how demographic variables also influenced the phenomena under investigations. However, such data was collected in accordance with the requirements of the IRB and as much as possible no personal identifying data was collected. Due to the anonymous nature of the quantitative survey, it was difficult to have any form of follow -up or corroborations of submitted responses.

Instrumentation and Operationalization of Constructs

The scales used to obtain the measures of the variables are described below. All scales were measured using a five-point Likert scale (1 = strongly disagree; 5=strongly agree) or (1= very rarely; 5 = very frequent). To assess the reliability of scales, which refers to a variable or a set of indicators of a latent construct being internally consistent in their measurements (Fields, 2009), Cronbach's coefficient was applied with a minimum alpha value (α= 0 .70) being considered adequate for all the results in line with social science research (Nunally, 1978; Stevens, 2002; Fields, 2009).

Perceptions on SMS Initiative

Perceptions on the SMS initiative were measured by twenty-two items derived from the SMS evaluation scale developed from Chen and Chen (2012), Chen (2014), and the Transport Canada SMS assessment guide (2005). The Chen (2014) SMS scale is designed to identify the important aspects and items for airlines to develop an effective SMS and has a reported reliability (α = 0.95). The items were modified to reflect the scale and operational adaptability of a collegiate aviation program.

Due to the modifications, another set of Factor Analysis (Principal Axis Factoring) was conducted on the items. An example of an item in the scale is "The safety policy is signed and approved by the Dean, who demonstrates a strong commitment to safety through active and visible participation in the safety management system". The entire survey is attached in the Appendix A. The various dimensions that measured the multi-dimensional construct of SMS initiative was evaluated using first-order confirmatory factor Analysis (CFA) and a path analyses (PA)/structural equation modeling (SEM) to evolve a final measurement model that had a good fit of the data.

Transformational Safety Leadership

Transformational Safety Leadership (TSL) at the group level of the collegiate aviation program measured the quality of leadership provided by supervisory flight managers such as Chief /Assistant Chief Flight Instructors. The construct was measured by six items derived from the Survey of Transformational Leadership (STL) developed by Edwards, Knight, Broome and Flynn (2010). The STL is a comprehensive assessment and non-commercial instrument for transformational leadership that can be used to inform organizational self-monitoring and training efforts that reflects approaches to the conceptualization and measurement of transformational practices.

The STL is available free of charge (Public Domain), reliable, valid, and examines five core components. These include four that are traditionally conceptualized as transformational domains (i.e., idealized influence, intellectual stimulation, inspirational motivation, and individualized consideration), plus one that is measured less frequently (empowerment). The instrument was validated using focus groups, factor analysis, and validation instruments. The Survey of Transformational Leadership (STL) utilizes a thorough and comprehensive approach, eliciting detailed information about specific leadership behaviors.

The strength of the STL lies in the fact that it addresses adequately, some important components (such as empowerment), which are not routinely assessed. Additionally, most existing instruments include scales with only one or two marker items that reflect important themes within a core component. This approach works well when assessing a global construct of core transformational components, but is inadequate when examining components in greater detail for self-assessment and training purposes. Furthermore, the most commonly used and most comprehensive measures of transformational leadership (such as the Multifactor Leadership Questionnaire; Bass & Avolio, 1995) are only available for a fee.

Reliability for all first-order STL factors met or exceeded Nunally's (1978) recommendation of 0.70 for newly developed scales. The alpha coefficient to measure the internal consistency of the scale had scores ranging from 0.78 (Supports others) to 0.97 (Inspirational Motivation). The criterion validity showed Cronbach alphas for the validation factors ranged between 0.94 and 0.88. A five-point frequency scale ranging from (1= very rare to 5= very frequent) was used for the assessment. An example of an item in the scale was "The Chief Flight Instructor clearly defines the steps to reach training program goals". The requisite citations and acknowledgement was done.

Self-Efficacy

Self-efficacy was measured by the Generalized Self-Efficacy Scale developed by Schwarzer and Jerusalem (1995) to assess pilots' self-beliefs with regard to coping with a variety of challenges. Four items in the scale were used and sample items are ''I can solve most problems if I invest the necessary effort,'' and ''It is easy for me to stick to my aims and accomplish my goals.'' The reported coefficient alpha was 0.86.

Safety Motivation

Safety motivation was measured with three items from Neal and Griffin (2006) which measures the degree to which respondents regard safety as an essential part of their flight training and professional development. Examples of items in this scale are: ''I feel it is important to maintain safety at all times,'' and ''I believe that it is important to reduce the risk of accidents and incidents in flight operations.'' The reported coefficient alpha for this scale was 0.90.

Safety Behavior

Safety behavior consisting of two components i.e., safety compliance (3 items) and safety participation (3 items) was adopted from Neal, Griffin and Hart (2000) and Neal and Griffin (2006). Safety compliance evaluates the core tasks that pilots have to accomplish to maintain flight safety. An example of an item in the safety compliance scale is ‘‘I pay full attention to the pre-flight briefing to collect sufficient data for every flight.’’ Safety participation assesses the extent to which pilots help develop an environment that supports safety.

Some slight adjustments were made to the items to better match the characteristics of flight students/flight instructors and the main focus of collegiate aviation programs. An example of an item was ‘‘I attend aviation safety programs organized in the school.’’ The reported coefficient alpha values for safety compliance and safety participation are 0.91 and 0.84, respectively.

Safety –Related Events

Safety Events is a measure of the knowledge of respondents on the frequency of safety occurrences in the aviation program. This was used as a gauge of the safety performance level within the program and was corroborated with verifiable data that was acquired during the artifact collection stage of the study and interviews with senior-level management personnel.

A relationship was also established between respondent’s knowledge about safety-related events and their safety behavior. The five items for this scale was derived from the Collegiate Aviation Perception of Safety Culture Assessment Scale (CAPSCAS) (Adjekum, 2014b). An example of an item in the scale is “Collision of aircraft with fixed ground objects while taxing”. The reported reliability for the CAPSCAS was an alpha of 0.92.

Construct Validity of Survey Instrument and Pilot Study

A pilot study to validate the modified survey (combination of scales into a single survey) and establish preliminary reliability was done using a convenience sample of flight students inclusive of those who are certified flight instructors at the university. Preliminary draft copies of the modified survey were given to a panel of three SMS subject matter experts

(SMEs) on faculty and at the safety department to peruse and make recommendations on construct validity and suitability for collegiate aviation safety assessment.

After the review and comments by the SMEs, the requisite amendments were done and a target sample of fifty students and flight instructors who were enrolled in the Crew Resources Management (CRM) course in the program beta -tested the survey online. The rationale for using these participants from this course was due to the copious mixture of both initial and advanced flight students, some of whom were certified flight instructors. A paper copy of the survey was given to ten international students volunteers (South-East Asians and Middle Eastern/Arabic) for identification of areas that may pose comprehensibility problems. That strategy helped to identify the cultural sensitivity and adaptability of the survey instrument.

After a period of two weeks, all the surveys were collected and descriptive statistics (mean, standard deviations and normality) were conducted. Factor analysis was used to cluster and determine items that loaded strongly on factors and measure the underlying latent constructs. Reliability checks were conducted and the retained items were used in the new survey instrument for the actual online survey for this study.

CHAPTER V

DATA ANALYSIS AND RESULTS

Quantitative Data Analysis and Validation

Quantitative survey data was imported from the Qualtrics ® data collection software into the SPSS ® software and analyzed. Significant statistical values were set at the 0.05 alpha levels (2-tailed) for most of the analyses unless otherwise specified. The responses from the items in the survey were reduced using factor analysis approach and the resulting items that loaded strongly on factors were tested for content validity and reliability of scale.

Descriptive and inferential analyses were conducted using IBM SPSS 23® and IBM AMOS Graphics 23® soft wares. The descriptive analysis included mean, standard deviation, standard error of the mean, normality test (kurtosis and skewness) and physical inspections of the resultant normal distribution curves. The inferential analysis included bivariate correlations, T-test of mean, analysis of variances (ANOVA) and testing of hypotheses using CFA and SEM-PA.

Qualitative Data Analysis and Validation

The qualitative portion of the study was analyzed by first validating the contents of the interviews by sending a copy of the audio files and transcribed interviews to the interviewees for their perusal and validation of the contents. Once the interviewees had validated the transcripts, preliminary manual coding to identify keywords, phrases and classifications that aligned significantly with the over-arching objective of answering the research questions and hypotheses was done. After the manual coding, qualitative coding soft wares Atlasti 7® and Nvivo 11® were used to code the interview transcripts into themes and identify common trends. The results of both manual and computer aided analysis were then compared, validated and analyzed for relationships.

Demographic Information

At the end of the response three-week period, two hundred and eighty-two (*n* =282) responses were completed beyond the consent page and used for analysis. Two hundred and forty-seven- male (*n*= 247) representing 87.6% and thirty -five female (*n*=35) representing 12.4% of the total respondents' submitted useable data for analysis. The overall online survey response rate was about 35 % which is adequate for most internal online surveys (Tse-Hua & Xitao, 2009). Twenty-five responses (n=25) were deleted because the respondents did not go beyond the consent page and that made the data unusable.

In terms of the international students' enrollment status, there were two-hundred and fifty-one respondents (89.0%) identified as domestic US students as compared to thirty -one who were international students (11.0%). One hundred and eighty-three respondents (64.9%) stated that they have undergone formal SMS training while ninety-nine (35.1%) responded in the negative. In terms of year groups there were thirty -two freshmen (11.3%), forty-nine sophomores (17.4%), fifty-six juniors (19.9%) and one -hundred and forty-five seniors (51.4%). The respondents comprised of four flight certification groupings of forty-two pre-private respondents (13.9%), seventy-two private pilot certificate respondents (25.5%), eighty-two commercial certificate respondents (29.1%) and eighty-six certified flight instructors (31.5%). Table 1 and Table 2 show the demographic distribution.

Table 1. Demographic variables of Gender, Enrollment Status, and Educational Level Group.

Variable	Value	Percentages (%)
Gender		
Male	247	87.6
Female	35	12.4
Total	282	100.0
Enrolment Status		
Domestic	251	89.0
International	31	11.0
Total	282	100.0
Educational Level		
Freshmen	32	11.4
Sophomore	49	17.4
Junior	56	19.8
Senior	145	51.4
Total	282	100.0

Note. Percentages are approximate values.

Table 2. Demographic Variables of Flight Certificates, Age Groups and SMS Training.

Variables	Values	Percentages (100%)
Flight Certificate		
Pre-Private	42	13.9
Private	72	25.5
Commercial	82	29.1
Certified Flight Instructor	86	31.5
Total	282	100.0
Age Group		
17-21	106	37.6
22-26	143	50.7
27-31	19	6.7
Others	14	5.0
Total	282	100.0
SMS Training		
Yes	183	64.9
No	99	35.1
Total	282	100.0

Note. Percentages are approximate values.

Question One

What are the factors that measure the latent construct of SMS initiative?

An Exploratory Factor Analysis (EFA) (Principal Axis Factoring) was conducted on the SMS initiative scale using a varimax rotation. An EFA is a statistical method used to find a small set of unobserved variables (also called latent variables, or factors) which may account for the covariance among a larger set of observed variables (Steven, 2002). A factor is an unobservable variable that is assumed to influence observed variables. Items with strong loading on factors were extracted from each set of items in the subscales.

Strongly loaded items on the factors were identified after the rotation and two factors emerged out of SMS Initiative data. The two factors were identified using the factor loadings and the scree plot of the SPSS® output. The scree plot helped to visually verify and confirm the number of factors. The two factors that loaded separately were re-designated as SMS policy implementation (SMSPol.Imp) and SMS process engagement (SMSPro.Eng). Seventeen items loaded to SMSPol.Imp and five items loaded to SMSPro.Eng. Five items were dropped due to low loadings and most of those items were related to emergency response planning. The cut-off thresholds for the identified factors were any value greater than 0.5 and Eigen values greater than 1 was adopted to avoid ambiguity.

The two factors SMSPol.Imp and SMSPro.Eng explained about 46% percent of the variance in the initial Eigen values determined and are shown in Table 4. The SMSPol.Imp denotes the actual implementation practices and strategies by the organizational leadership to ensure the effectiveness of the SMS initiative while the SMSPro.Eng specifies the degree of involvement and acceptance of organizational personnel towards the SMS initiative processes.

The rotated factor loadings, scree plot and factor loading matrix in three dimensions are shown in Appendix C. Internal consistency and reliability of the scales were determined with the Cronbach's Alpha test in the SPSS 23® software package and pre-determined internal consistency baseline of an alpha (α) of .70 and above was used as a benchmark for high internal consistency as recommended by both Stevens (2002) and Fields (2009).

All the items in the various scales showed good reliability above the .70 threshold and the descriptive statistics on the summed items in each scale were conducted. The results were determined to be consistent with the assumptions of normally distributed data. The assumption of normality was confirmed based on histograms with normality plot. The kurtosis and skewness values of the descriptive statistics tables were in the acceptable range of -1 to +1. The results indicate that safety compliance had the highest mean scores on a five point Likert-scale (M= 4.25, SD= .589) and the lowest score was awareness of involvement in a safety-related events (M= 2.57, SD = 1.007). The neutral point was 3 and any value above that was considered desirable. Details of the sample size, mean, Standard Deviation (SD), reliability and variances explained are shown in Table 3 and Figure 9.

Table 3. Details of Descriptive Statistics of all the Study Variables

	Variables							
	SMS Policy Implementation	SMS Process Engagement	SE	SM	SC	SP	TSL	SEV
N	282	282	282	282	282	282	282	282
Mean	4.01	3.15	4.06	3.31	4.25	3.73	3.21	2.57
Std. Deviation	.648	.942	.666	.474	.589	.836	1.259	1.007
Skewness	-1.123	.066	-1.045	-1.371	-.887	-.475	.254	.254
Std. Error of Skewness	.145	.145	.145	.145	.145	.145	.145	.145
Kurtosis	2.472	-.665	2.736	3.267	2.953	-.022	-.708	-.708
Std. Error of Kurtosis	.289	.289	.289	.289	.289	.289	.289	.289
Percentage variance explained (FA)	38.2	10.8	-	-	-	-	-	-
Cronbach's Alpha (α)	0.93	0.75	0.84	0.76	0.80	0.80	0.83	0.87
Number of Items in Scale	17	4	4	4	3	3	4	5

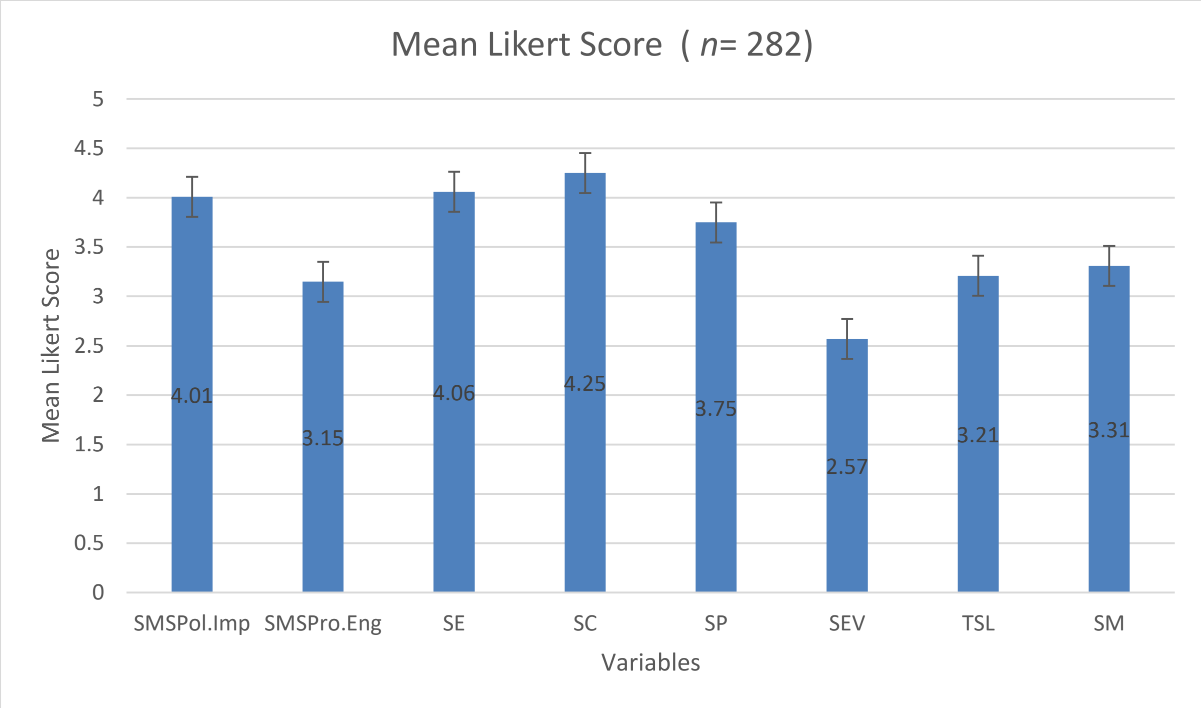

Figure 9. Mean Likert Scores for all the Research Variables.

Confirmatory Factor Analysis (CFA)

A first-order confirmatory factor analysis (CFA) was conducted on all the items describing the constructs SE, SM, SC, SP, TSL and SEV. Additionally, the CFA was used to analyse the validity of these scales using a structural equation model -path analysis (SEM-PA) techniques. A CFA allows researchers to test hypotheses about a particular factor structure (e.g., factor loading between the first factor and first observed variable is zero). Unlike an EFA, a CFA produces several goodness-of-fit measures to evaluate the model but do not calculate factor scores (Brown, 2006). SPSS AMOS 23® software was used to evaluate the measurement models and determine the factor loadings. Details of the estimates for MLE, S.E., C.R., p-value and standardized regression weights (β) are shown in Table 4.

Table 4. Maximum Likelihood Estimates of Study Variables using CFA.

			Estimate	S.E.	C.R.	P	β
SE 1	<---	Self-Efficacy	.720	.057	12.664	***	.67
SE 2	<---	Self-Efficacy	.667	.055	12.173	***	.85
SE 3	<---	Self-Efficacy	.641	.050	12.747	***	.83
SM 1	<---	Safety Motivation	.610	.045	13.484	***	.81
SM 2	<---	Safety Motivation	.720	.046	15.672	***	.90
SM 3	<---	Safety Motivation	.647	.047	13.868	***	.83
SC 1	<---	Safety Compliance	.648	.045	14.388	***	.85
SC 2	<---	Safety Compliance	.642	.046	13.848	***	.83
SC 3	<---	Safety Compliance	.654	.045	14.606	***	.86
SP 1	<---	Safe Part.	.673	.060	11.191	***	.74
SP 3	<---	Safe Part.	.734	.074	9.918	***	.94
SP 2	<---	Safe Part.	.922	.063	14.593	***	.66
TSL1	<---	Trans.SafetyLeader.	.799	.059	13.488	***	.81
TSL4	<---	Trans.SafetyLeader.	.770	.052	14.828	***	.80
TSL3	<---	Trans.SafetyLeader.	.782	.059	13.190	***	.86
TSL5	<---	Trans.SafetyLeader.	.751	.056	13.381	***	.80
SEV1	<---	SafetyRelatedEvents	.950	.078	12.193	***	.75
SEV3	<---	SafetyRelatedEvents	1.021	.073	14.080	***	.89
SEV2	<---	SafetyRelatedEvents	1.027	.065	15.785	***	.83
SEV4	<---	SafetyRelatedEvents	.816	.063	12.986	***	.78
SEV5	<---	SafetyRelatedEvents	1.100	.089	12.290	***	.75

Question Two

What are the strengths of the relationship between SMS initiative, transformational safety leadership, self-efficacy, safety motivation and the outcome variable safety behavior measured by safety compliance and safety participation?

A Pearson's bivariate test of correlations was used to establish the strengths of relationship between SMS initiative (SMS policy implementation and SMS process engagement), transformational safety leadership, self-efficacy, safety motivation and the outcome variable safety behavior measured by safety compliance and safety participation. This analysis was conducted, to find out variables that were linearly related, and could potentially become viable predictors in the subsequent confirmatory factor analysis and SEM.

The results indicate that the highest statistically significant correlation existed between SMS policy implementation and self-efficacy [r (282) = .56, $p < .01$ (2T)] and safety participation and safety compliance [r (282) = .56, $p < .01$ (2T)]. SMS policy implementation and safety compliance had significant correlation [r (282) = .50, $p < .01$ (2T)] and self-efficacy and safety compliance had significant correlations [r (282) = .49, $p < .01$ (2T)].

The results suggested that safety motivation and SMS policy implementation had significant correlation [r (282) = .45, $p < .01$ (2T)] and self-efficacy and safety participation were also statistically correlated [r (282) = .38, $p < .01$ (2T)]. SMS process engagement and safety participation were significantly correlated [r (282) = .36, $p < .01$ (2T)] and SMS policy implementation and safety participation were also significantly correlated [r (282) = .35, $p < .01$ (2T)].

Safety participation and safety motivation also had significant correlation [r (282) = .34, $p < .01$ (2T)] and self-efficacy and safety motivation were significantly correlated [r (282) = .34, $p < .01$ (2T)]. SMS process engagement and safety motivation had significant correlation [r (282) = .12, $p < .05$ (2T)] and SMS process engagement and safety compliance were significantly correlated [r (282) = .12, p < .05 (2T)]. Finally, there was a significant negative correlation between transformational safety leadership and safety motivation [r (282) = -.17, p < .01 (2T)]. Details of results are shown in Table 5.

Table 5. Bivariate Correlation of all the Research Variables.

	Transformational Safety Leadership	Safety Participation	Safety Motivation	SMSPolicy Implementation	SMS Process Engagement	Self-Efficacy	Safety Compliance
Transformational Safety Leadership	1	.029	-.168**	-.088	-.069	-.046	-.101
Safety Participation	.029	1	.336**	.353**	.358**	.384**	.563**
Safety Motivation	-.168**	.336**	1	.450**	.123*	.344**	.471**
SMSPolicyImplementation	-.088	.353**	.450**	1	.192**	.562**	.504**
SMSProcessEngagement	-.069	.358**	.123*	.192**	1	.184**	.123*
Self-Efficacy	-.046	.384**	.344**	.562**	.184**	1	.493**
Safety Compliance	-.101	.563**	.471**	.504**	.123*	.493**	1

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Question Three

What is the effectiveness of a proposed measurement model as compared to that of a final measurement model that assesses 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?

The use of exploratory factor analysis increased the number of constructs for the initial proposed measurement model from the initial seven to eight accounting for the splitting of SMS Initiative into two factors namely SMS policy implementation (SMSPol.Imp) and SMS process engagement (SMSPro.Eng). In order to assess the proposed measurement models, the covariance matrix of the variables served as the input to the maximum likelihood estimation procedures of IBM SPSS® Amos version 23.

A large class of omnibus tests exists for assessing how well a model matches an observed data, and the chi-squared (χ^2) is a classic goodness-of-fit measure to determine overall model fit. However, the chi-squared is sensitive to sample size, and it becomes difficult to retain the null hypothesis as the number of cases increases (Kline, 2005). The χ^2 test may also be invalid when distributional assumptions are violated, leading to the rejection of good models or the retention of bad ones (Steven, 2002; Brown, 2006).

Another commonly reported statistic is the Root Mean Square Error of Approximation (RMSEA). A recommended value of 0.05 or less indicates a close fit of the model in relation to the degrees of freedom (Brown, 2006). Another test statistics is the Comparative Fit Index (CFI) that evaluates the fit of a user-specified solution in relation to a more restricted, nested baseline model, in which the covariance among all input indicators are fixed to zero or no relationship among variables is posited (Brown, 2006, p.86). The fit index CFI ranges from 0, for a poor fit, to 1 for a good fit. Finally, the Tucker-Lewis Index (TLI) is another index for comparative fit that "includes a penalty function for adding freely estimated parameters" (Brown, 2006, p. 85). According to Brown (2006), TLI may be interpreted in a similar fashion as CFI, but can have a value outside of the range of 0 to 1.

Hu and Bentler (1999) provided rules of thumb for deciding which statistics to report and choosing cut-off values for declaring significance. When RMSEA values are .05 or below, and CFI and TLI are .95 or greater, the model may have a reasonably good fit. Therefore, it is recommended to not only report χ^2 but RMSEA and CFI/TLI. In the case of the chi-squared goodness of fit, if the appropriate distributional assumptions are met and the specified model is correct, then the values of the p-values is the approximate probability of a chi-square statistic. The proposed measurement (fully mediated) model for the research and SEM-PA analysis is shown in Figure 10.

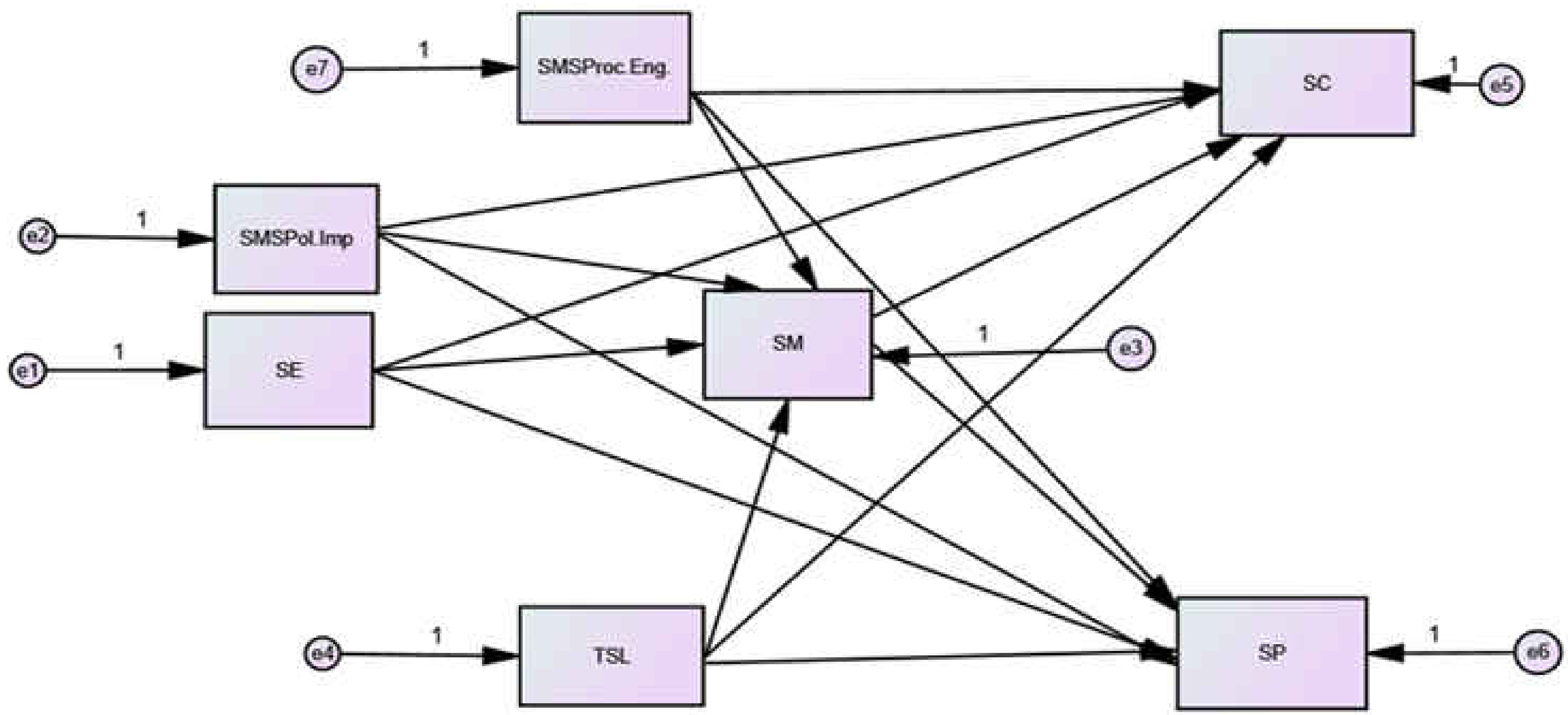

Figure 10. Fully Mediated Measurement Model for SMS Proc.Eng, SMS Pol.Imp, TSL, SE, SM, SC and SP interactions.

After the preliminary analysis was done using AMOS, the fully mediated model failed to produce any good or acceptable fit, as evidenced by the fit indices: CMIN = 376.458; df = 14; P = .000; TLI = .137; CFI = .425; PNFI = .281; RMSEA = .304. The Modification indices (MI) in AMOS suggested major modifications produce a more adequate fit for the model. The substantial changes that were recommended to ensure an adequate fit were done in incremental steps and are as follows:

a) Direct path between TSL and SMSPol.Imp.
b) Covariant path from SMSPol.Imp and SE.
c) Covariant path from SMSPro.Eng to SMSPol.Imp.
d) Removal of direct path from SMSPol.Imp and SP.

However, when the analysis was re-run the direct path from TSL to SMSPol.Imp was found to produce additional modifications and a non-significant path coefficient. The direct path was then removed and a new analysis was re-run based on the first model and adding of covariant path from SMSPol.Imp and TSL. The resulting model was better than the initial model but did not produce good fit as shown by the fit indices: CMIN = 62.681; P= .000; df = 4; TLI = .336; CFI = .873; PNFI =.125; RMSEA = .228. Figure 11 shows the new model after the iteration.

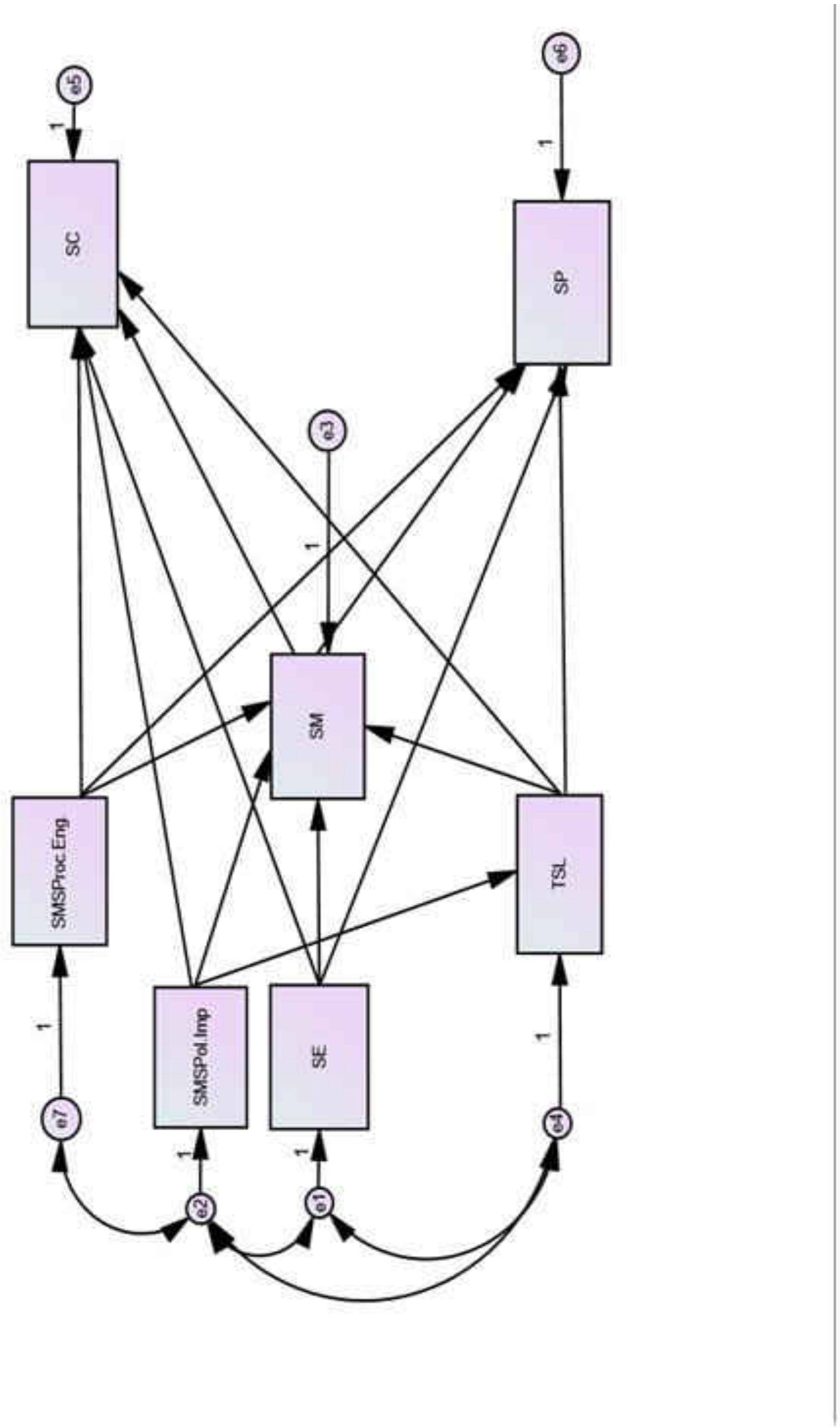

Figure 11. Modified Measurement Model 2 (Partially Mediated).

The next set of iteration to the model was done based on the recommendations from the MI and the theoretical consideration of getting a model that will address the research questions. Another covariant path was added between SMSPro.Eng and SE; SC and SP. The

MI also recommended the removal of the direct path from TSL to SC to improve the fit. The analysis was re-run and the new fit indices showed good fit: CMIN = 3.829; df = 3; P = .28; TLI = .987; CFI = .998; PNFI = .143; RMSEA = .031. Figure 12 shows the emergent measurement model.

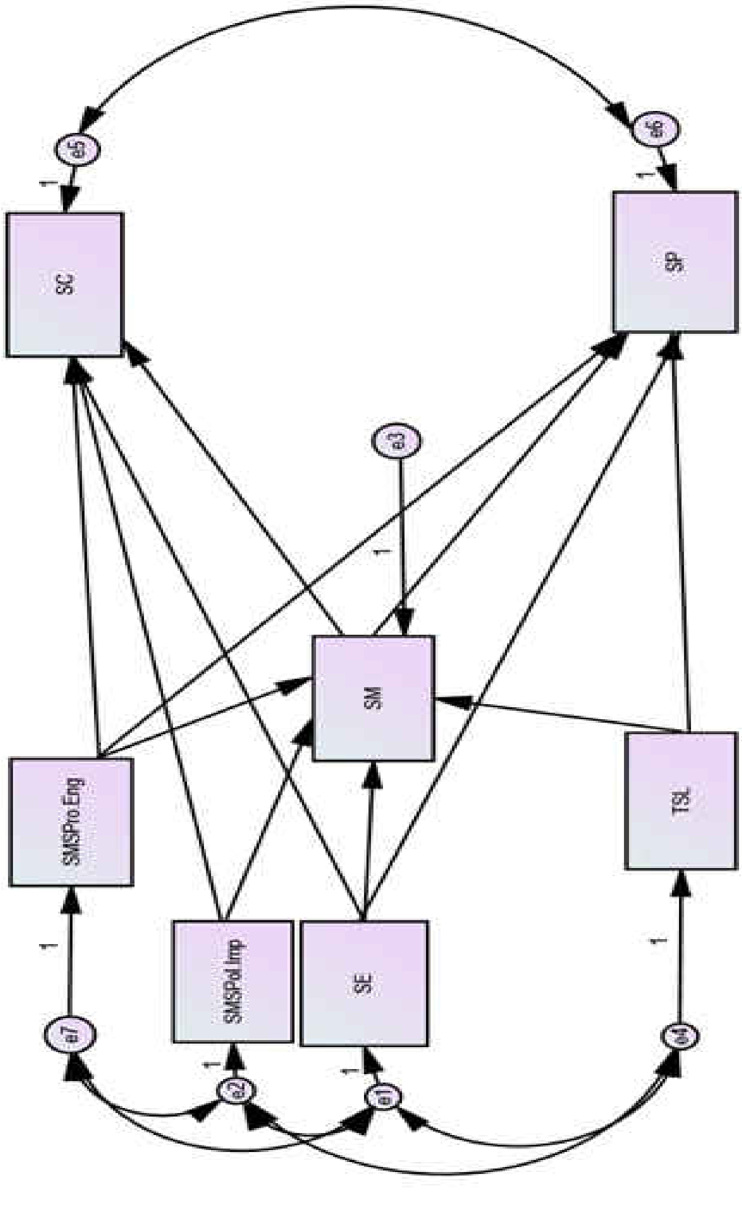

Figure 12. Modified Measurement Model 3 (Partially Mediated).

The measurement model was further improved by a recommendation from the MI for a covariant path between TSL and SMSPro.Eng. The covariant path was added between TSL and SMSPro.Eng and the sum of these modifications yielded the highest incremental improvement to the model fit. The details of the fit index are: CMIN = 2.473; df = 2; P = .290; TLI = .999; CFI = .989; PNFI = .095; RMSEA = .029. Figure 13 shows the final measurement model with the best fit for the data and Figure 14 shows the standardized regression weights and significance levels. Details of all the goodness-of-fit indices are shown in Table 6 and Table 7 provides a summary of the maximum likelihood estimate (MLE), standard error (SE), critical ratios (CR), p-values, estimated of effect sizes and hypotheses of the final measurement model with best goodness-of-fit.

Table 6. Goodness-of-fit Estimates for various Measurement Models

Model	Chi-square (X^2)	df	P	TLI	CFI	PNFI	RMSEA	LO 90	HI 90
Fully Mediated Model 1	376.459	14	.000	.137	.425	.281	.304	.277	.330
Partially Mediated Model 2	62.681	4	.000	.336	.876	.166	.228	.181	.280
Partially Mediated Model 3	3.829	3	.280	.987	.998	.143	.031	.000	.110
Final Best-fit Model 4	1.141	1	.285	.998	.991	.067	.026	.000	.189

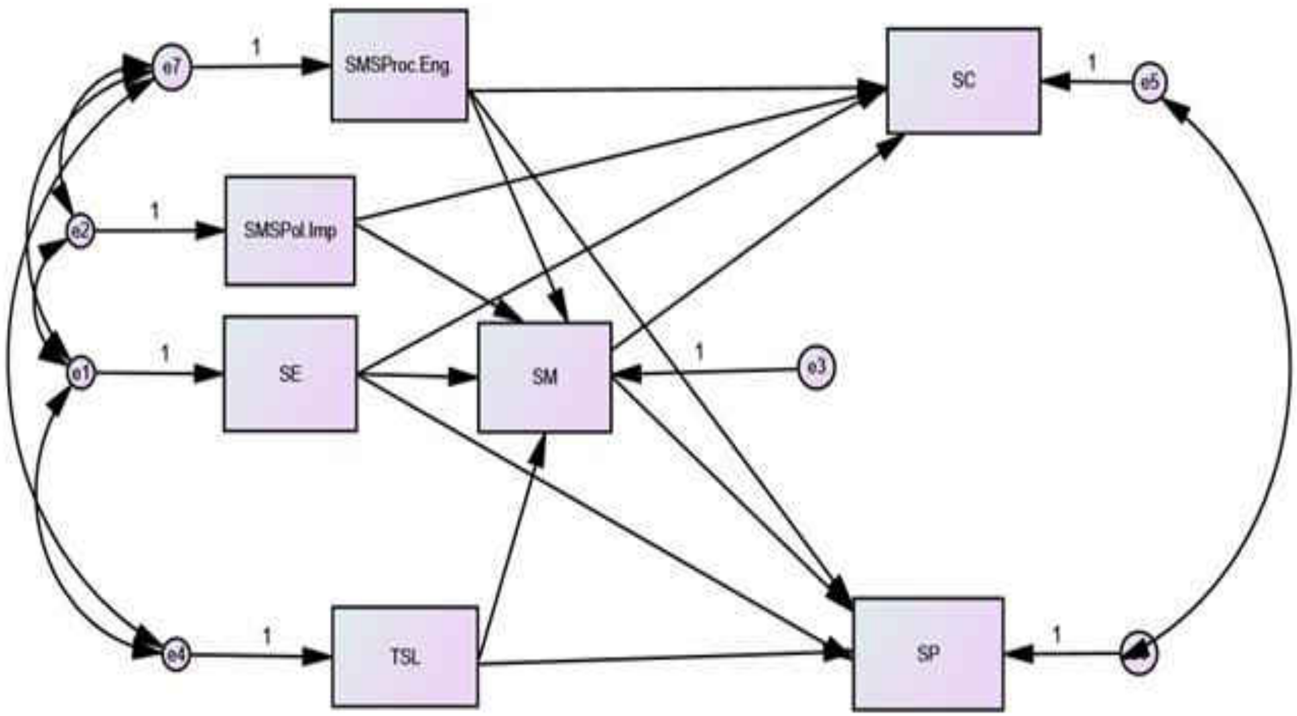

Figure 13. Final Measurement Model with Best -fit Indices.

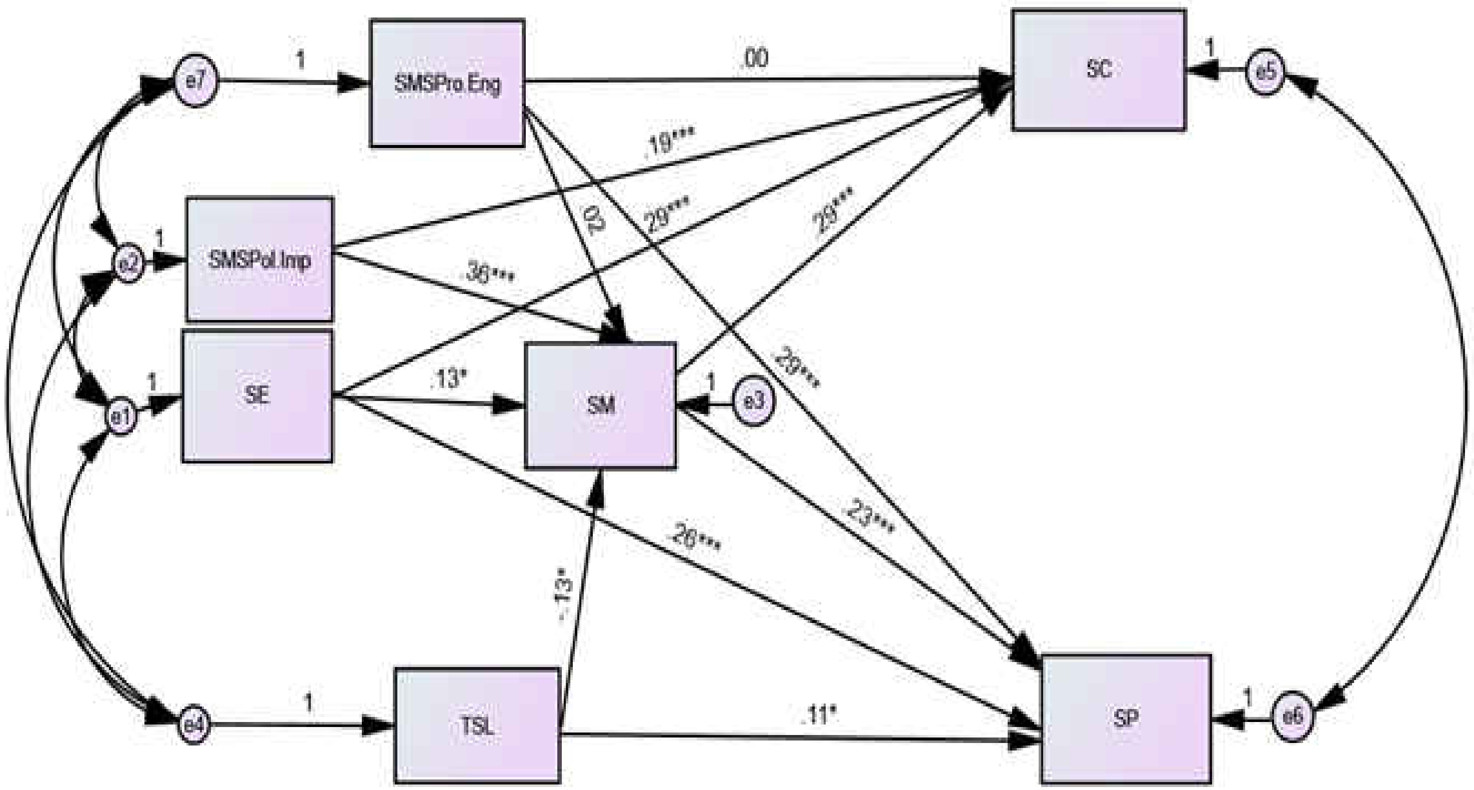

Figure 14. Final Measurement Model with Standardized Regression Weights.

Table.7 Estimates of Final Measurement Model of the relationship between SMS Initiative, SE, TSL, SM. SP and SC

		Interactions	Estimate	S.E.	C.R.	P	β	Direct Effect	Indirect Effect	Total Effect	Hypothesis Testing
SM	<---	SMSPol.Imp	.263	.047	5.644	***	.360	.360	.000	.360	**Supported**
SM	<---	SE	.094	.045	2.087	.037	.133	.133	.000	.133	**Supported**
SM	<---	TSL	-.049	.020	-2.457	.014	-.129	-.129	.000	-.129	**Supported**
SM	<---	SMSPro.Eng.	.010	.027	.377	.706	.020	.020	.000	.020	Not Supported
SP	<---	SM	.407	.096	4.236	***	.231	.231	.000	.231	**Supported**
SC	<---	SM	.356	.065	5.449	***	.288	.288	.000	.288	**Supported**
SC	<---	SMSPol.Imp	.173	.050	3.486	***	.191	.191	.103	.294	**Supported**
SP	<---	TSL	.073	.031	2.385	.017	.110	.110	-.030	.080	**Supported**
SC	<---	SMSPro.Eng.	-.001	.030	-.030	.976	-.001	-.001	.005	.004	Not Supported
SC	<---	SE	.255	.050	5.109	***	.289	.289	.130	.410	**Supported**
SP	<---	SMSPro.Eng.	.258	.046	5.631	***	.290	.290	.005	.295	**Supported**
SP	<---	SE	.322	.068	4.704	***	.256	.256	.031	.287	**Supported**

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

Hypothesis Testing

The study hypothesized that there existed a relationship between SMS initiative and safety behavior (safety compliance and safety participation). This study hypothesized that safety motivation will mediate the relationship between SMS initiative and pilots' safety behaviors (safety compliance and safety participation). The construct Safety Management System initiative was further split in to two underlying factors (SMS policy implementation and SMS process engagement) using factor analysis. Hypotheses 1 to 16 were tested using the final measurement model obtained from the SEM-PA.

Hypothesis 1. The first hypothesis tested the relationship between respondents' perceptions of their collegiate aviation program SMS initiative and safety motivation. The results indicated that the relationship between SMS policy implementation and safety motivation was statistically significant (β= .360; SE = .047; C.R. = 5.644; p = .000), and supported the hypothesis. The coefficient of the direct path was .360 and indicates a medium to large effect. There was no coefficient for the mediated path.

However, the results indicated that the relationship between SMS process engagement and safety motivation was not statistically significant (β= .020; SE = .027; C.R. = .377; p = .706). The final measurement model only supported the path that connects SMS policy and safety motivation. There was no path for SMS process engagement and safety motivation in the final measurement model. The overall results indicated that the relationship between SMS Initiative and safety motivation was partially supported within the study population.

Hypothesis 2. The hypothesis tested the relationship between respondents' perceptions on SMS initiative and their safety compliance. The results indicated that the relationship between the SMS policy implementation and safety compliance was statistically significant (β= .191; SE = .050; C.R. = 3.486; *p* = .000). The coefficients of the direct path were .191 and the mediated path was .103 yielding a total effect of .294.

The relationship between SMS process engagement and safety compliance was not statistically significant (β= -.001; SE = .030; C.R. = -.030; p = .976). The results suggested that the model only supported the relational pathway between SMS policy implementation and safety compliance within the study population. The overall results indicated that the relationship between SMS initiative and safety compliance was partially supported within the study population.

Hypothesis 3. The hypothesis tested the relationship between respondents' perceptions on SMS initiative and their safety participation. The results indicated that the relationship between the SMS process engagement and safety participation was statistically significant (β= .290; SE = .046; C.R. = 5.631; p = .000). The coefficients of the direct path were .290 and the mediated path was .005 yielding a total effect of .295.

The results support the hypothesis that there exist a positive relationship between SMS process engagement and safety participation and the total effect was small to medium. The model however did not support any relational path between SMS policy implementation and safety participation. The net effect was that the hypothesis about the relationship between SMS initiative and safety participation was partially supported.

Hypothesis 4. The hypothesis stated that respondents' safety motivation mediated the relationship between perceptions of their collegiate SMS initiative and safety compliance. The results indicated safety motivation significantly mediated the path between SMS policy implementation and safety compliance even though the effect coefficient was relatively small (.103). There was no significant relationship between SMS process engagement and safety compliance when mediated by safety motivation. The overall effect was that the hypothesis was partially supported.

Hypothesis 5. The hypothesis tested how respondents' safety motivation mediated the relationship between the perceptions of their collegiate SMS initiative and safety participation. The results suggested that safety motivation significantly mediated the relationships between SMS process engagement and safety participation with a negligible effect (.005) while there was no mediational pathway between SMS policy implementation and safety participation by safety motivation. The results suggest that the hypothesis was weakly supported.

Hypothesis 6. The hypothesis stated that transformational safety leadership was related to safety motivation and the results indicated that there was a significant relationship between transformational safety leadership and safety motivation at the .05 significant level (β= -.129; SE = .020; C.R. = -2.457; p = .014). The results suggested a small negative effect (-.129) in the relationship. The hypothesis was supported among the study population.

Hypothesis 7. The hypothesis stated that transformational safety leadership was related to safety compliance. The final model did not have any relational pathway between the two variables and the hypothesis was not supported among the study population.

Hypothesis 8. The hypothesis stated that transformational safety leadership was related to safety participation. The results suggested that there was a significant relationship between transformational safety leadership and safety participation (β= .110; SE = .031; C.R. = 2.385; p = .000). The direct effect coefficient was .080 and the overall effect was .110. The hypothesis was supported within the study population.

Hypothesis 9. The hypothesis stated that transformational safety leadership was related to safety compliance when mediated by safety motivation. The results suggested that there was no relational path in the final model and the hypothesis was not supported within the study population.

Hypothesis10. The hypothesis stated that transformational safety leadership was related to safety participation when mediated by safety motivation. The results suggested that there was a significant relationship between transformational safety leadership and safety participation (β= .110; SE = .031; C.R. = 2.385; *p* = .000) when mediated by safety motivation. The mediated effect coefficient was -.030 and the overall effect was .110. The hypothesis was supported within the study population.

Hypothesis11. The hypothesis tested how respondents' perceived self-efficacy was related with safety motivation. The results suggest that there existed a statistically significant relationship between self-efficacy and safety motivation at the .05 significant level (β= .133; SE = .045; C.R. = 2.087; *p* = .037). The total effect coefficient was .133 and the hypothesis was supported within the study population.

Hypothesis12. The hypothesis tested how respondents' perceived self-efficacy was related with safety compliance. The results suggest that there existed a statistically significant relationship between self-efficacy and safety compliance (β= .289; SE = .050; C.R. = 5.109; *p* = .000). The direct effect coefficient was .289 and the total effect was .410. The hypothesis was supported within the study population.

Hypothesis13. The hypothesis tested how respondents' perceived self-efficacy was related with safety participation. The results suggest that there existed a statistically significant relationship between self-efficacy and safety participation (β= .256; SE = .068; C.R. = 4.704; *p* = .000). The direct effect coefficient was .287 and the hypothesis was supported within the study population.

Hypothesis14. The hypothesis tested how respondents' perceived self-efficacy was related with safety compliance when mediated by safety motivation. The results suggest that there existed a statistically significant relationship between self-efficacy and safety compliance (β= .289; SE = .050; C.R. = 5.109; *p* = .000) at indirect (mediated) effect coefficient was .13. The hypothesis was supported within the study population.

Hypothesis15. The hypothesis stated that self-efficacy was related to safety participation when mediated by safety motivation. The results suggested that there was a significant relationship between self-efficacy and safety participation (β= .256; SE = .068; C.R. = 4.704; *p* = .000) and the mediated (indirect) effect coefficient was .031. The hypothesis was supported within the study population.

Hypothesis16. The hypothesis tested how respondents' safety motivation was related to safety participation. The results suggest that there existed a statistically significant relationship between self-efficacy and safety participation (β= .231; SE = .096; C.R. = 4.236; *p* = .000). The total effect coefficient was .231 and the hypothesis was supported within the study population.

Hypothesis17. The hypothesis stated that safety motivation was related to safety compliance. The results suggested that there was a significant relationship between safety motivation and safety compliance (β= .288; SE = .065; C.R. = 5.449; *p* = .000) and direct effect coefficient was .288. The hypothesis was supported within the study population.

Question Four

What are the strengths of the relationship between Safety behavior (Safety participation and Safety compliance) and Safety-related events?

A mediation analysis was performed using the Baron and Kenny (1986) causal-step approach and the Preacher and Hayes (2008) bootstrapped confidence interval for *ab* indirect effect procedure using the SPSS AMOS® 23 software package. The path analysis helped to establish predictive causal path and relationships between safety behavior and safety-related events. The null hypothesis was that safety- related events will not have an effect on safety participation when mediated by safety compliance within the SMS initiative of a collegiate aviation program.

The path models also helped to determine the causal path coefficients for the variables under investigations. The maximum likelihood estimates, standardized regression weights, critical ratios, total, direct and indirect effects were determined. Finally, the *p*-value was also determined to find out whether the hypothesis under examination was supported. A preliminary data screening suggested that there were no serious violations of the assumptions of linearity or normality. All the coefficients reported are standardized and the statistical significance criterion was .05 (two-tailed). The results from this analysis were used to test hypothesis 18, 19 and 20.

Hypothesis18. The hypothesis tested how respondents' safety compliance was related with safety participation. The results suggest that there existed a statistically significant relationship between safety compliance and safety participation within the study population (β= .83; SE = .041; C.R. = 20.209; p = .000). The direct effect of safety compliance on safety participation was 0.83 which suggest a large effect. The result indicated a failure to accept the null hypothesis in favor of the alternate hypothesis.

Hypothesis19. The hypothesis tested how respondents' safety compliance was related with safety participation when mediated by an awareness of safety -related events. The results suggest that there was no statistically significant mediational path between safety compliance and safety participation when mediated by an awareness of safety-related events (β= .20; SE = .042; C.R. = .167 p = .867). The results indicate a failure to reject the null hypothesis in favor of an alternate.

Hypothesis20. The hypothesis tested how respondents' safety compliance when there is an awareness of safety -related events. The results suggest that there existed a statistically significant relationship between safety compliance and safety-related events (β= .32; SE = .068; C.R. = 4.847; p = .000). The direct effect was 0.32 and the results suggest a small to medium effect. Details of the path estimates for the interactions between SC, SP and SEV and the causal model are shown in Table 8 and Figure 15 respectively. A summary of all the result of research hypotheses tested in questions three and four are shown in Table 9.

Table 8. Path Estimates for Interactions between SC,SP and SEV.

Interactions		MLE	S.E.	C.R.	β	Direct Effect	Indirect Effect	Total Effect	P	Null Hypothesis
SC	<--- SEV	.329	.068	4.847	.32	.320	-	.320	***	Reject
SP	<--- SEV	.007	.042	.167	.20	.007	.265	.272	.867	Accept
SP	<--- SC	.825	.041	20.209	.83	.828	-	.828	***	Reject

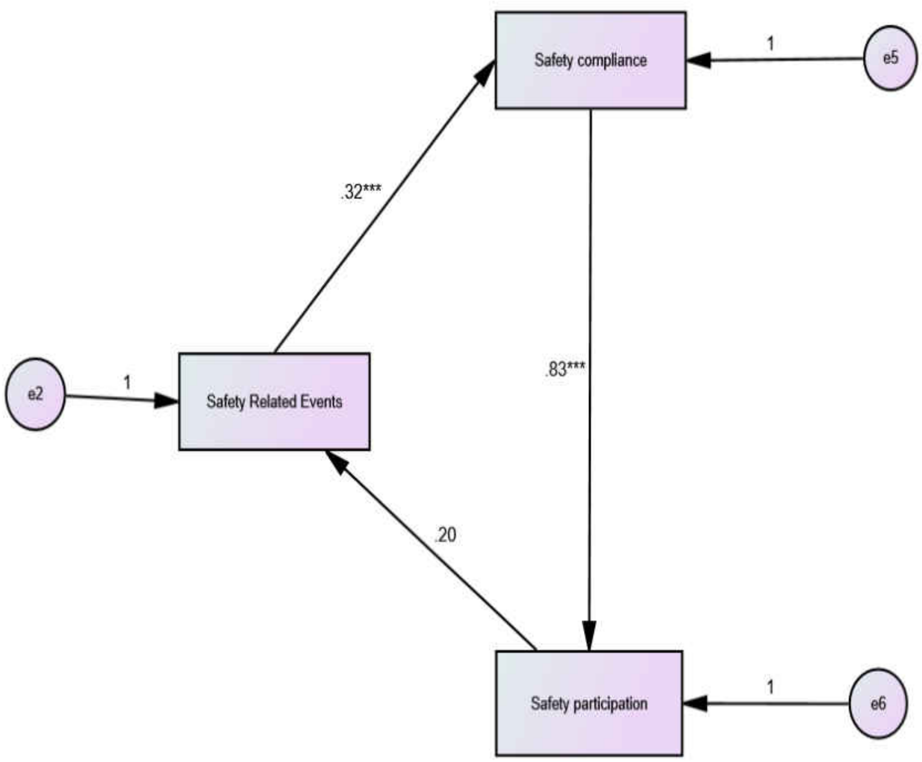

Figure 15. SEM-PA of relationship between SP, SC and SEV.

Table 9. A summary of all the result of research hypotheses tested.

Hypothesis	Results
H_{1A}: Pilots' perceptions of their collegiate aviation program SMS policy implementation are related to their safety motivation.	Supported
H_{1B}: Pilots' perceptions of their collegiate aviation program SMS process engagement are related to their safety motivation.	Not Supported
H_{2A}: Pilots' perceptions of their collegiate aviation SMS policy implementation are related with to safety compliance.	Supported
H_{2B}: Pilots' perceptions of their collegiate aviation SMS process engagement are related with to safety compliance.	Not Supported
H_{3A}: Pilots' perceptions of their collegiate aviation SMS policy implementation are related with to safety participation.	Not Supported
H_{3B}: Pilots' perceptions of their collegiate aviation SMS process engagement are related with to safety participation.	Supported
H_{4A}: Pilots' safety motivation mediates the relationship between their perceptions of their collegiate SMS policy implementation and safety compliance.	Supported
H_{4B}: Pilots' safety motivation mediates the relationship between their perceptions of their collegiate SMS process engagement and safety compliance.	Not Supported
H_{5A}: Pilots' safety motivation mediates the relationship between their perceptions of their collegiate SMS policy implementation and safety participation.	Supported
H_{5B}: Pilots' safety motivation mediates the relationship between their perceptions of their collegiate SMS process engagement and safety participation.	Not Supported
H_6: Collegiate aviation program transformational safety leadership style is related to pilot's safety motivation.	Supported
H_7. Collegiate aviation program transformational safety leadership style is related to pilot's safety compliance.	Not Supported
H_8. Collegiate aviation program transformational safety leadership style is related to pilot's safety participation.	Supported

Table 9. Cont.

Hypothesis	**Results**
H9. Collegiate aviation program transformational safety leadership style is related to pilot's safety compliance when mediated by safety motivation.	Not Supported
H10. Collegiate aviation program transformational safety leadership style is related to pilot's safety participation when mediated by safety motivation.	Supported
H11: Collegiate aviation pilots' perceived self-efficacy is related with their safety motivation.	Supported
H12: Collegiate aviation pilots' perceived self-efficacy is related to their safety compliance.	Supported
H13: Collegiate aviation pilots' perceived self-efficacy is related to their safety participation.	Supported
H14: Collegiate aviation pilots' safety motivation mediates the relationship between perceived self-efficacy and safety compliance.	Supported
H15: Collegiate aviation pilots' safety motivation mediates the relationship between perceived self-efficacy and safety participation.	Supported
H16: Collegiate aviation pilot's safety motivation is related to safety participation.	Supported
H17: Collegiate aviation pilot's motivation is related to safety compliance.	Supported
H18: Collegiate aviation pilot's safety compliance is related to safety participation.	Supported
H19: Collegiate aviation pilot's safety compliance is related to safety participation when mediated by safety –related events.	Not Supported
H20: Collegiate aviation pilot's safety compliance is related to safety –related events.	Supported

Question Five

What are the differences in perceptions among the demographic variables (years in program, age group, SMS training status, and flight certification) on safety behavior and self-reported safety events?

A one-way between-S ANOVA was done to compare the mean scores on perceptions on safety compliance among age brackets in the flight program. An examination of a histogram of scores of respondent on safety compliance was approximately normally distributed with no extreme outliers. Prior to the analysis, the *Levene test* for homogeneity of variance was used to examine whether there were serious violations of the homogeneity of variance assumption across groups, but no significant violation was found: F (3, 278) = .112, p = .953. The overall *F-value for* the one-way ANOVA was not statistically significant, F (3, 278) = 1.740, p =. 159. There were also no significant differences in the mean scores on safety participation among the age brackets, F (3, 278) = 2.379, p =.070 and the differences in the mean scores on safety -related events among the age groups, F (3, 278) = 2.216, p =.087.

There were also no significant differences in mean scores on safety- related event among flight certification groups, F (3, 278) = 1.504, p = .214. However, there was significant statistical differences among the flight certificate groups in terms of mean scores on safety compliance, F (3, 278) = 4.965, p = .002 (2T). A Bonferroni-Tukey *post-hoc* test revealed significant differences between the mean scores of pre-private students (*M*=4.05, *S.D* =.578) and certified flight instructors (CFI) who had a mean value of (*M*= 4.44, *S.D* = .479).

The results suggest the CFI group had a slightly higher level of safety compliance than the pre-private /student pilot certificate holders. There were also significant differences in the mean scores on safety participation in terms of flight certification, F (3, 278) = 4.911, p

=. 002 (2-Tail). A Bonferroni-Tukey *post-hoc* test revealed significant differences between the mean scores of pre-private students (*M*=3.61, *S.D* =.807) and CFI who had a mean value of (*M*= 4.03, *S.D* = .695).

In terms of the academic year groups, there was significant differences in mean scores of safety compliance, *F* (3, 278) = 3.047, *p* =. 029 (2-Tail). The differences in scores were between the seniors (*M*=4.32, *S.D* =.593) and the freshmen (*M*=4.0, *S.D* =.598) and shows that relatively seniors had higher safety compliance than freshmen. There was statistical significance in the differences in mean score on safety participation *F* (3, 278) = 3.114, *p* =. 027 (2-Tail).

A Bonferroni-Tukey *post-hoc* test showed that seniors (*M*=3.86, *S.D* =.762) significantly had a relatively higher participation in safety activities than juniors (*M*=3.56, *S.D* =.869). Finally, there was statistical significance in terms of mean scores on awareness and involvement in safety-related events F (3, 278) = 3.273, *p* =. 022 (2-Tail). A Bonferroni-Tukey *post-hoc* test showed that seniors (*M*=2.70, *S.D* =1.050) significantly were more aware or involved in safety -related events than juniors (*M*=2.18, *S.D* =.947).

An independent *t-test* of mean was done to determine if there were any differences in the mean scores on safety compliance, safety participation and safety -related event between respondents who had been formally trained in SMS and those who had not. The results showed there were no statistically significant differences in mean scores on safety compliance [*t* (280) =1.63, *p* = .097, two-tail] among those trained in SMS and those who have not. The results also indicate no statistical significance in mean scores on safety participation [*t* (280) =1.45, *p* = .149, two-tail] and safety-related events [*t* (280) = .392, *p* = .695, two-tail].

Semi –Structured Interviews

The over-arching purpose of questions posed to the selected senior management personnel during the semi-structured interview were to find out the leadership perspective on the level of implementation of the SMS initiative and current safety performance of the collegiate aviation program. The following themes with underlying codes emerged after the qualitative analysis using both manual and computer –aided methods. Some direct quotes from the interviewees are also added to corroborate the results which suggest the following:

Leadership

There was unanimous agreement among the top level management personnel interviewed that leadership at the highest level (The Dean), who happens to be the accountable executive for the SMS initiative was and continues to be very instrumental in getting the initiative on a very strong pedestal. The results suggest that the Dean has provided the vision, resources and transformational leadership to both start and sustain the SMS initiative.

Commitment and Acceptance. The results also suggest that leadership at all levels within the organization (Top-level and Supervisory) "bought –in" completely to the initiative and continue to fully support the initiative. The acceptance of the SMS at all levels of leadership has also evolved a higher level of commitment to the objectives and goals of the SMS initiative. One of the top level management personnel, who is also a process owners intimated that at the initial stages of the SMS implementation, some of the top leadership could not fully understand the concept due to the technical nature of SMS and lack of literature.

One of the top management personnel interviewed who was a major player in the SMS initiative stated that even though there was acceptance among the top level management, some did not fully make it a priority and were a bit reluctant to accept the change from the status quo that SMS presented. The top level manager further stated that these process owners and managers wanted the benefits of SMS, however, they continued to be content with the status quo at times so getting them to buy in to the SMS concepts was sometimes a little bit more difficult than would have been expected. Below is a direct quote from this top level management person:

As far as the process managers go, they accepted the SMS process; however, most of them were happy to let a small core people do all of the work. And it turned out to be a situation where about 10 percent of the people did 90 percent of the work on the SMS development. So to kind of summarize that first question, I think everyone was very, very supportive.

However, not everyone made it a priority; not everyone was involved. And again, at times, I think there are still process owners and managers that sometimes appear to be happy with the status quo of how things were done in the past, relative to how things should be done as it relates to SMS.

The opinions of the above mentioned top level management personnel was however divergent from that of another top level management personnel who intimated that most process owners and managers accepted the challenge and fully supported the Dean's effort to implement the SMS initiative by using effective communication and cooperation to rally support. One of the direct quotes from this top level management personnel/ process owner clearly throws light on the level of commitment and acceptance from the top:

The top level leadership bought in very early to the SMS program. However, I do think that a lot of people, leadership included, didn't quite understand what an SMS program's all about and how involved it was. But from the beginning, the higher-ups, the Dean, the accountable executive for the program; you know, it was very clear that this was the direction they wanted to go. And they did go through, the FAA came in *and did several days of training with them, and they sat through all that. So leadership played a big role, because without them this would have never gotten off the ground. It would have just been another science project that didn't amount to much.*

Resource Provision. The results suggest that top level management; specifically, the accountable executive provided resources at every phase of the SMS initiative and continues to resource the program. A process owner stated that SMS like any organizational initiative that aims to transform safety can be a costly process in terms of financial, material and human capital during the implementation phases and it was refreshing that the accountable executive fully provided adequate resources necessary to get the program running.

Another process owner directly involved with the SMS initiative intimated that the SMS required comprehensive organizational adjustments in operational processes and systems in an effort to align actual performance with desired safety performance benchmarks. The process owner suggested that due to these adjustments, there were some hesitancy among some process owners to allocate human resources from their departments to be part of the initial implementation team because that might affect their productive capabilities. The process owner however alluded to the fact that because there was a strong backing from the accountable executive, it served as a leverage to get these process owners to allocate the require human resources from their departments to be part of the initial implementing team.

The results show that top level management provided initial indoctrination training for management personnel through the use of subject matter experts (SME) from the SMS program office of the FAA. The top level management also allocated funding for two faculty members and one process owner to be trained as subject matter experts. These indigenous SMS subsequently worked full time implementing the SMS initiative. These SME performed the preliminary and detailed GAP analysis as part of the active applicant phase.

Another top level leadership personnel /process owner interviewed intimated that even though the SMS initiative has been extensive, expensive and time consuming there has been constant provision of adequate resources to sustain the initiative. Finally, one of the top level management personnel/process owners was of the opinion that the proactive safety resource such as the flight data monitoring (FDM) program established has provided a data-driven approach to the SMS initiative. An active quote from the top level management personnel succinctly provides clarity on the support from top level leadership:

> *We talked about it at some of our leadership meetings. And the Dean was always 100 percent, let's do this. We'll find the money if it's going to cost extra money. This is something that we'll ensure that what we say, our safety is number one, and generally all organizations say that; but this is putting our effort and our money behind it. And so I know that was – from the Dean's office, I know it was a high priority and never hesitated at all to get it going. And gave all the support necessary for those that are working on it day to day – day by day, to – have the full green light. Financially, materially, personnel wise, everything was provided.*

Responsibility and Accountability. Two of the top level management personnel interviewed agreed that the SMS initiative has ensured an active awareness among leadership at all levels (Top and supervisory) of their responsibilities and accountabilities for safety in their process domains as compared to the pre-SMS initiative period. These top level management personnel further emphasized that safety benchmarks were clearly outlined and documented in a safety policy and safety management system manual signed and approved by the accountable executive (The Dean). A process owner stated that the safety policy required leadership at all levels to ensure that operational processes and activities under their management are conducted safely and meet the safety performance benchmarks of the organization.

The statement by the process manager was further corroborated by other top level management personnel, who stated that the safety policy in the SMS initiative gives clarity on safety accountability as a metric in the performance evaluation of leadership at all levels within the flight program. Another process owner also stated that the safety policy clearly requires leadership at all levels to be responsible for hazard identification and safety risk management within their operational processes. The process owner also stated that the safety policy requires the process owners and their supervisory leadership to use safety risk assessment on identified flight operational hazards and apply control strategies outlined as part of the SMS to minimize these safety risks to levels tolerable for flight training and operations.

Operational Performance Impact

There was general agreement among all the top level management personnel interviewed that the SMS initiative has and continue to have a positive operational performance impact on the flight program. The notable areas that came up during the interviews were safety risk management, efficiency of flight operations and safety risk behavior among students and flight instructors.

Safety Risk Management. Two of the top level management personnel who were actively involved in the formulation of safety risk management strategies as part of the initiative shed light on the entire process. The consensus among these two top level management personnel consolidated the opinions that the organization's knowledge of what actually goes on in flight operations had greatly increased due to the SMS initiative. One of them who double as a process owner stated that prior to initiating SMS and establishing proactive flight data collection strategies, the flight program's safety management was very reactionary and only acted when there was a safety occurrence.

One of the top level management personnel who doubles as a faculty and was part of the initial SMS initiative team strongly supported the earlier opinion by a process manager that the SMS initiative had provided the capability for all flight activities and operational processes to be tracked and analyzed for abnormal trends so that pre-emptive remedial actions can be taken before any safety occurrence takes place. When asked for specifics to corroborate the assertion, the top level management person said:

> *These are things we do track, in one way or another. And one of the cases, the unstable approaches, I can talk a little bit about our Phoenix op. When we were first sort of looking at the high-low, fast-slow tools, which is kind of the way we loosely defined stabilized approach in Phoenix. I mean, there were a lot more things that go into a stabilized approach, but at its core, we thought high-low fast-slow would be a good one. And so we started looking at that and we found a number of flights that were landing early, because these are really long runways, and the VASIS were displaced, you know, like two or three thousand feet down.*
>
> *And so people weren't following the VASIS; they were just kind of landing. And so we made everyone aware, we showed them the data and we said, look what's going on. And then it helped a little bit, and then we had a couple of safety meetings down there; and we were able to largely mitigate on most of the runways. There was one runway we were never able to solve. But that was an example of how we were able to specifically use the program to achieve a desired result.*

A top level management person interviewed who was directly involved in the SMS initiative stated that the flight program had all the essential components of an SMS in place prior to the formal *active applicant* level. This top level management person stated that safety reporting system, flight data monitoring, safety meetings, safety training and a safety council were already in existence but did not meet the FAA specifications and guidelines. The top level management person stated that the SMS initiative has brought these components into conformance with FAA specifications and guidelines.

The top level management personnel also stated that performance metrics such as safety reporting has remained fairly constant over the past five years since the SMS initiative started. However, the top level management person was of the view that the introduction of SMS in the academic syllabus was a positive one even though it was elective and not a core requirement for flight students. This top level management person was of the opinion that SMS should be made a co-requisite or pre-requisite for other mandatory flight courses to increase the level of training in SMS.

Safety Risk Behavior. In terms of safety risk behavior among students and flight instructors, the general consensus among all the top level management personnel interviewed was that the SMS initiative was positively having an impact on safety risk behavior. One of the top level management personnel who also double as a faculty member was of the opinion that the SMS initiative has helped to track and remedy mitigation decay and specifically organization safety behavior over time. The faculty member stated that:

> *We corrected the organization's behavior; I also could track over time, the return of the organization back to the old behavior which was the pre-mitigation behavior. And demonstrated that many cases, after – it was roughly, give or take, depending on the situation, it was around six months. If we didn't continue to remind, they returned to their unsafe and old behavior.*
>
> *And so – I'm sorry, it was more like eight months. So my recommendation was, every six months, sit down and review this data again and reset everything. So it was kind of – it was a very data driven, very interesting way to manage your safety. The old fashion way would have been to wait for someone to go off the end of the runway.*

One of the top level management personnel who is also a process owner with a lot of experience in flight operations stated that effective communication and cooperation has helped to ensure that safety risk to flight operations are discussed in a candid and constructive manner with all stakeholders. The process owner stated that there was good liaison between safety department staff and operational department staff in in promoting a cultural change in safety reporting behavior and the great benefits of safety reporting among students and flight instructors. The process owner was of the opinion that safety reporting among flight students and instructors had relatively improved due to the safety communication process and these improved safety reporting has enabled proactive analysis for high accident potential conditions and attitudes. A statement from the process owner sums up the point:

> *The safety reports, I read all those; and I find them interesting. And everything that happens, it seems like that is – becomes certainly a single occurrence, or if they see some trends – they, meaning the flight operations people, get that out as quickly as possible. One of them just came out last night about a somewhat near miss on an approach. Two planes coming in. And that could be something just to – no, that's not good so let's not talk about it. But no, they're right up front with everything. And everything that needs to be talked about seems like it is, and presented very, very well.*

Another top level management personnel who is directly involved in students' administrative issues and a member of the review committee on drugs and alcohol violations within the program stated that there were relatively lower cases of drugs and alcohol violations among flight students and instructors as compared to previous years and attributed it to the enhanced safety awareness created by the SMS initiative. The top level management personnel also reiterated the effectiveness of the proactive data-driven approach to managing safety within the program that effectively identify hazards and used safety risk management techniques to mitigate and control these risks before safety occurrences hamper flight operations. Finally, to affirm the robustness of the drug and alcohol policy, the top level management personnel stated:

> *Again, my role on the review board for alcohol and drug and behavioral issues, we take that very seriously. And we work very closely with the students when the – in fact, we had one yesterday at review board and I – just sitting through the process, I'm going – you know – it's amazing how much – how the organization takes this so seriously. And we just don't pay lip service to it.*

Efficiency. A process owner who has extensive oversight of flight operational activities stated that even though the initial investment into the SMS initiative may have been high, the impact on efficiency of flight operations has been positive. The fact that flight hazards can be identified early and risk mitigated and controlled through an effective data monitoring system has reduced the potential "down- time" an accident or incident could have on both personnel and equipment.

The process owner also intimated that the SMS initiative had brought about a relatively high level of standardization in procedures and documentation of all processes, which even though may seem cumbersome, was very good at ensuring that losses and inefficient operational procedures and practices are tracked and mitigated. Another process owner with in-depth experience in flight training and operations was of the opinion that due to the collegiate program's SMS initiative, there has been greater investments in modern training aircraft fleet with enhanced safety technology such as digital navigational and flight deck displays, automated dependence surveillance-broadcast (ADS-B) and global position systems (GPS).

The process owner stated that though these technologies had greatly improved safety and efficiency of flight training, the investments had relatively also increased the direct operational cost for flight training and opined that there should be a good cost -benefit analysis between extensive investments in latest safety technology and cost over-runs and transfer to flight students who eventually pay for these safety enhancements.

Implementation Challenges

The SMS initiative obviously has not had it all smooth and there have been some challenges during the implementation and sustenance. Some of the challenges identified during the interviews were operational productivity and safety balance, technicality of SMS training and technical expertise and guidance from the FAA.

Operational Productivity and Safety Balance. Two process owners were of the opinion that one of the biggest challenges faced in the SMS initiative is a collaborative agreement on the acceptance of a tolerable level for safety in flight operations among stakeholders involved in making safety risk decisions relating to flight. A process owner stated that on some occasions there have been disagreements with the aviation safety department over safety risk assessments and remedial measures recommended by the department.

The process owner was of the opinion that even though the personnel at the aviation safety department did a good job most of the time, they also had to balance their safety recommendations with operational productivity that commensurate with the needs and reality of the flight operations business. Another process owner interviewed was of the opinion that sometimes risk control measures recommended by the aviation safety department required costly and unrealistic financial input that was counterproductive in respect to a good return on investment for flight training as a business.

The process owner was of the opinion that disagreements over safety risk assessments, control strategies and cost implications have sometimes resulted in a perception that some of these leaders do not fully support the SMS initiative. The process owner also felt that at times personnel of the aviation safety department tries to encroach into the domain of other process owners by attempting to implement risk mitigation and control measures recommend by the same aviation safety department, when in actual fact that should be the preserve of the respective process owner. These actions sometimes result in friction between the process owners and the aviation safety department. A top level management person who doubles as a process owner had the following comments:

> *I also have to worry about the business side. I have to balance production with safety. When all you look at is safety, it's easy. But when you have to balance the two, and that's where the challenge comes in. But myself and safety will at times struggle together because I feel, not necessary. Example, we're currently – we're having a meeting on hangar occurrences; we call it hangar rush. Where lining pulls out an aircraft and they might hit a wingtip; okay. And it happens.*
>
> *We do thousands of aircraft moves a day, okay. And we go through and we calculate X amount of damage a year. So example, say we do $10,000 to $15,000 of damage a year to aircraft by moving them in or out. Safety says this is a problem, we have to address it. And we look at the safety risk assessment; we look at it and I'll go through and they make all the recommendations to me, and their recommendations will be you must hire more line personnel so we have wing-walkers on every wing, when we move an airplane in or out. So I say, okay I have to hire four additional people. You pay them $30,000 a year plus fringe, so that's $45,000 a year. I hire four people, that's $200,000 a year it's going to cost me to stop $15,000 of damage. So when do you accept such assessments?*

Another process owner with extensive flight training responsibility was of the opinion that the structured nature of the SMS initiative and the need to document every process sometimes inhibited initiative and flexibility in safety risk decisions as supervisors and mid-level managers have to periodically resort to either their bosses or the safety department for clearances on operational issues with safety implications that could have been easily dealt with at their level. The process owner stated that:

> *At some point, you have to trust your managers to make decisions, and they have to do things. But when some people lean fully on this SMS program, everything they feel has to go back to the Safety Management System. And I feel sometimes that takes away the ability of your managers to make decisions to work within your organization.*

Technicality of SMS Training. Two of the top level management personnel interviewed were of the opinion that due to the technical and sometimes complex structure of the SMS initiative, there was a lot of apprehension and lack of understanding of the entire process among some management personnel. Even though the accountable executive (The Dean) arranged for experts from the FAA regional offices and headquarters to conduct orientation training for most of the leadership, some of these management personnel still struggled with the entire SMS concept. A top level management person also stated that even though SMS training has been implemented as part of the training course outline in the flight program, there were still some training gaps in terms of making it a compulsory requirement for all flight students as compared to the present state where it is an elective course.

The top level management personnel however noted that most of the flight instructors in the flight program had been extensively trained in the SMS concepts as part of the flight instructors' standardization program. The top level management person however stated that areas with least SMS training were the line and maintenance departments where most of the personnel are not graduates from the collegiate aviation program of the university.

In the opinion of the top level management personnel, a lot of work has to be done to simplify the technical verbiage of SMS manuals and processes and make it comprehensible to the various personnel within the program who may not have extensive technical background.

The top level management personnel reiterated the need for concepts under the SMS initiative to be simplified and correlated with real-time operational activities so that it will be effectively utilized by flight students, flight instructors, faculty and other personnel. A quote from the top level management personnel sum up the points:

The second thing, of course, was the time and the effort. I also think that a lot of people didn't understand what an SMS was or what it entailed; so a lot of people kind of saw this like, I don't really want to participate in that or don't know about it. So there was a little bit of that too. Those are probably the biggest challenges.

Technical Expertise and Guidance from FAA. There were some conflicting views among three of the top level management personnel interviewed on the role of the regulator (FAA) in the SMS initiative. One of the top level management personnel was of the opinion that the FAA was very active and instrumental in the initial training and technical assistance provision during the active applicant through to the active conformance levels, while two top level management personnel (One is a process owner and the other doubles as a faculty member) were of the opinion that the certification maintenance team (CMT) out of the Fargo Flight Safety District Office (FSDO) which locally oversees the SMS implementation program was not well resourced with SMS technical experts. These top level management personnel were of the opinion that this factor delayed and stifled the initial efforts and subsequent oversight of the SMS initiative in the flight program. A quote from one of the top level management personnel gives insight to the point:

Yeah, there were definitely challenges. I mean, both in the implementation and presently. I personally believe the biggest challenge has been the governmental or the policy side; because the folks that oversee our SMS, they're down in Fargo, the Fargo [FSDO.] And they probably were not properly resourced. And so they ended up kind of not really being trained for SMS, and it was difficult because they had to sign off on *our SMS and we had to surveil it and everything. And so to me that was one of the biggest things.*

The sentiments shared by the top level management personnel was further re-echoed by another process owner and top level management personnel who stated that the documentation required for the SMS initiative was cumbersome, some of the processes were changed mid-stream and some of the principal inspectors from the local FAA who were supposed to ensure oversight over the SMS initiative were not trained nor technically capable of the oversight resulting in implementation delays. A quote from the process owner highlights the point:

> *The FAA documents were very cumbersome; they were hard to understand; they changed halfway through – the FAA changed the whole process halfway through. With all due respect to our local flight standards district office; they weren't involved; they had nobody there that had training. So that again, created a lot of challenges. We weren't able to deal with our local FAA office in Fargo for example. When we had questions we had to deal with a regional office, and it was sometimes hard to get feedback or get them involved or schedule them to come to meetings.*
>
> *We had a couple of meetings with the FAA's SMS experts from regional and national offices. But there were times where it would take six or seven or eight weeks to get them to respond to an e-mail, for example. So yeah, there were a lot of challenges internally in our organization and we had challenges outside the organization, primarily with our FAA office. None of those inspectors were trained in the SMS concept. They knew what it meant, but they couldn't answer any questions for us.*

Sustainability

Within the backdrop that the flight program has been recognized by the FAA as a fully-fledged voluntary collegiate SMS program with all the components functional (Active conformance level) there is a need to sustain that level through evaluation, monitoring and continuous improvement. The top level leaders interviewed were asked to share their opinions on strategies adopted to ensure the sustainability of the SMS Initiative. Some of the key areas that emerged were evaluation and monitoring, data-driven analysis and improvements and active personnel involvement and process ownership.

Evaluation and Monitoring. There was a general agreement among all the top level management personnel interviewed that some positive effort has gone into the area of actively monitoring the SMS initiative and the processes aligned with it. One process owner was of the opinion that there had been a constant awareness of safety risk assessment in every facet of operational processes and also the effectiveness of the confidential and non-punitive reporting systems put in place to identify hazards and risk to safety.

However, the process owner was of the opinion that there were only few people with the expertise and normally within the safety office who were actively doing the evaluation and monitoring. Two of the top level management personnel were of the opinion that the implementation mistakes, disagreements and set-backs have provided a lot of organizational learning that has further improved the SMS initiative. Below is a quote by one of the top level management personnel:

> *There was a team doing an SRA on congested airspace. And we actually weren't following the process, and it upset me in the fact this group was meeting and making decisions and implementing without my approval as a process owner. They wanted me to park airplanes to reduce congested airspace. And I said, do you realize every airplane out there costs $330,000 and you're going to tell me to park them? I refuse*

to do it; I will not do it. We will look for other ways to mitigate the safety, or you guys are going to have to go above me to my boss, and he's going to tell me to park them, or I will not.

So that was a very good learning process for us as an organization. I knew I was going to upset some people and I was going to ruffle some feathers; but I went in there and said, as the process owner I don't agree to this. You're taking this one and this one off the list; you're dealing with the rest. And it was a good thing for us to go through.

Data-driven Analysis and Improvements. Another process owner was of the opinion that the investment in a flight -data monitoring system (FDM) for flight operations has helped to increase the acquisition of real-time flight data and the use of empirical means to determine trends that have the potential to degrade flight operational efficiency and safety. The top level management personnel who has a lot of experience in safety data analysis stated that the data-driven analysis of risk in the flight program has helped leadership to make smart safety risk decision and to put in place cost effective control strategies that has substantially improved both the business and operational safety ends of the program. This was a quote from the top level management personnel:

Now the way we're doing it, which I think is acceptable; is we're identifying risks, and we're doing SRAs on those. And there is now a list of them that we keep track of, and we keep track of the SRA activities. It is based on perceived threats and hazards or what the data might be indicating to us. But I do think there might be a better way to maybe more formalize that; and to maybe use the data to actually point to what your biggest problems may be. So when you do a risk assessment – and I mean, I think we do a pretty good job. I don't know that there's anything that's wrong with what we do.

Active Personnel Involvement and Process Ownership. Three of the top level management personnel interviewed suggested that in order for the SMS initiative to be sustainable and continuously improve there should be active personnel involvement in the processes under the initiative and not have the perception that SMS only belongs to the aviation safety department.

One of these top level management personnel was of the opinion that some students, flight instructors and personnel were not knowledgeable about the components and structure of the SMS and the role expected of them. The top level management person was of the opinion that it may have been a reason for some apathy towards issues related to SMS during the initial phases and presently. The top management personnel opined that a continuous engagement between the aviation safety department and other departments and sensitization outreach could bridge the SMS knowledge gap.

A process owner also stated that personal interaction with supervisory managers and personnel within the department highlighted a perception that the aviation safety department had an adversarial attitude of fault finding with their operations and activities and that has resulted in some resentment towards the safety personnel resulting in a need to avoid them.

The top level management personnel recommended that mid-level and low- level personnel should be included in safety risk decision making, especially ones related to hazards these personnel have identified or filed in safety reports. The top level management personnel further agreed that the sense of involvement could potentially bring in acceptance and process ownership of the SMS initiative. This was a quote from one of the top level management personnel to buttress those points:

> *Get the buy-in and involve everybody through the implementation process. That's the important part. Don't let one or two individuals take it and do everything, and then at the end say, here it is. Yeah, don't shove it down our throats – involve.*

Performance Review and Recommendations

The four top level management personnel interviewed were finally asked to review the performance of the SMS initiative and also make recommendations for other collegiate programs that intends to or are in the process of implementing SMS. The themes that emerged were top level leadership active commitment, effective communication and cooperation, scaled implementation and progressive metrics and tenacity and resilience.

Top level Leadership Active Involvement. There was a unanimous declaration from all the leaders interviewed that based on the experiences and review of the SMS initiative from the initial implementation to the present level, a key element for a successful SMS program is the active involvement of top level leadership. Almost all the leaders interviewed affirmed that the transformational leadership and personal involvement of the Dean in the SMS initiative motivated them to actively get involved in the process. The leaders stated that provision of financial, material and human resources is a function of top level leadership and they as leaders set the tone for the students, instructors, faculty and other personnel to "buy-in" the entire concept of SMS.

The leaders further reiterated that it was very important for them to "walk the talk". They recommended that any collegiate aviation program that intends to start an SMS program must have a progressive and proactive top level leadership ready to provide moral, financial and physical support for the SMS initiative. A quote from one of the top level leadership provides clarity on the point:

> *If someone asked me; if another program asked me what would be – I'd say, you'd have to have the buy-in of your senior management team, and they have to be sincere about it. Because if they are not – if they're not directing, let's do this, and this isn't just an exercise, no work committed to this; that makes it – that's going to trickle all the way down.*

Effective Communication and Cooperation. A top level management personnel and process manager stated that there was an important need for effective communication among top level leadership and between leadership, students, flight instructors, faculty and personnel for any successful SMS initiative. The top level management personnel intimated that the vision and objectives of the SMS initiative needs to be clearly stated and outlined in a policy statement and documented.

One of the top level management person stated that due to the technical nature of some of the concepts of SMS, there needs to be effective communication through formalized SMS training and information network. Two top level management personnel also reiterated the point about cooperation among top level leadership in the area of safety risk mitigation and control strategies. They were of the opinion that communication and cooperation will minimize over-stretch into other process owners' areas of responsibilities when safety mitigations are required.

In the opinion of these top level management personnel that will also reduce duplicity of effort and inefficiency in flight operations. Overall the leaders were of the opinion that a culture of candor and openness will foster cordial exchange of ideas on how to optimize positive benefits out of the SMS initiative. One of the leaders summed up the point succinctly:

> *I believe in SMS, I really do. I think it's great for organizations to have it. I just think it's important again that you continuously educate, and as an organization, sit down and evaluate how you're using that program. So do your homework, visit operations that have it, take it back to your staff, get the buy-in and involve everybody through the implementation process.*

Scaled Implementation and Progressive Metrics. There was agreement among two of the top level management personnel interviewed on the need for a step-wise or scaled implementation process for the SMS initiative. One of the top level leaders stated that due to the size and complexity of each organization, there may be difficulties in comparing SMS initiatives across board. The top level management personnel and faculty member who was part of the initial team trained to implement the SMS initiative recommended that aviation collegiate programs aspiring to implement SMS must use both internal and external resources such as the FAA and other aviation colleges with robust and recognized SMS.

The top level management personnel further stated that aspiring collegiate aviation programs should adopt strategies that will align with the scale of their operations. The top level management personnel also recommended that metrics should be progressive, clearly outlined and not lumped together since that could result in frustration within the organization due to un-attainable metrics. Below is a quote from the top level leader to buttress the points:

> *But my advice would be to take a longer term view of everything. So yes, we have to always worry about tomorrow or the next day, but we also need to worry about one year from now or two years from now. And so make sure they stay focused on the longer term too. What are you trying to do for your organization? And if the goal is – is one year from now, we want to have a safer organization than we have today; I think that's a really good way to – to that. So then that would be my recommendation; my advice.*

Tenacity and Resilience. There was agreement among all the top level management personnel interviewed that key characteristics principal to initiating and sustaining any SMS initiative are tenacity and resilience. A top-level leader and process owner stated that any time there are organizational changes that could result in paradigm shift of institutional cultures, systems and processes there are normally a lot of resistance from people who may be accustomed to doing things the old way.

The top level management personnel intimated that implementing an SMS initiative requires some tenacious, tactful and strong-willed safety champions. Another top level leader and a process owner also pointed out that when implementing SMS, things will not always go as expected or planned. The process owner stated that during non-normal and novel situations that could adversely affect flight operations and organizational cohesion there needs to be structures in place to restore the organization back to normalcy. This was a quote from the top level management personnel:

> *The other recommendation I'd have is not to be – to another program – I mean, not to be fearful of the whole process. I mean, it takes a while but it's the right thing to do. It's going to improve the program, and it's the paradigm that students are going to have to learn to operate under anyway, so program shouldn't have the fear of going through it.*
>
> *And if it takes them a little bit longer, that's fine; at least you're making progress towards it. Yeah, and it kind of goes back to – one of the things I was just saying is, don't be fearful of starting. But then also once you've started, see it through. And it does take probably some strong personalities to kind of push it through.*

A qualitative conceptual tree (hierarchical structure) of the codes and themes is shown below as Figure 16 and the conceptual map and word cloud of the computer assisted qualitative analysis can be found in Appendix C.

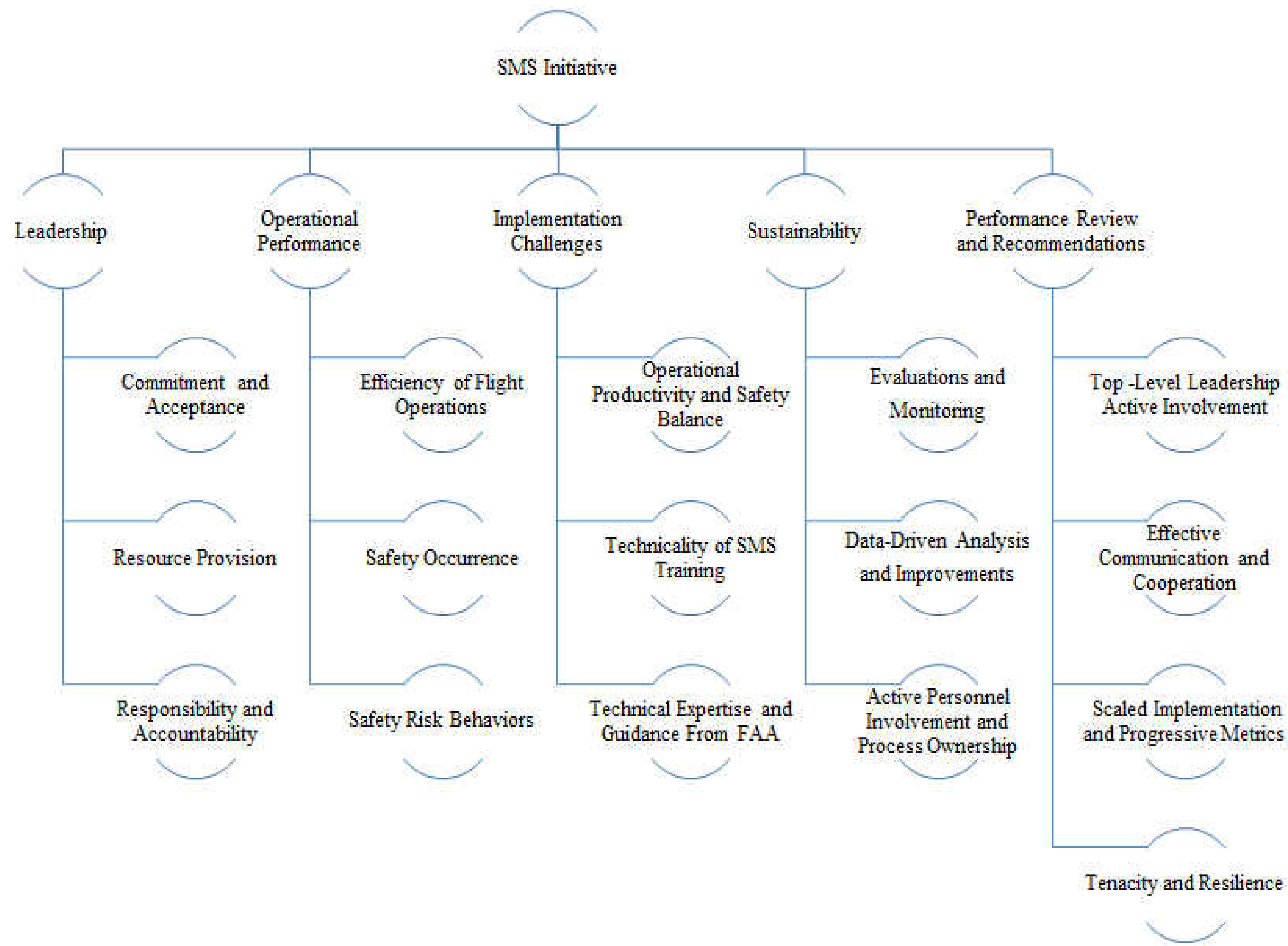

Figure 16. A Conceptual Tree of Codes and Themes of SMS Initiatives in Collegiate Aviation.

Factual Operational Performance Data

An analysis of safety documents containing aggregate data of both historic and real-time safety performance indicators i.e., number of confidential safety reports filed by personnel and closed reports/feedback from safety office, attendance to safety meetings, and SMS training conducted for students and instructors between the *active applicant* period (2012) to the *active conformance* stage (2016) of the SMS initiative was done for Grand Forks flight program (GFK) and Mesa Programs. The results show that the six –year average was 495 reports per Flying Year (FY) for GFK and 28 reports per FY for the Mesa flight operations.

Factual Safety Reporting (GFK and Mesa)

Analyzing the overall safety performance in terms of safety reporting, the results suggest that in FY 2014 (451 safety reports) there was a 9% increment in safety reporting as compared to the six-year mean safety reporting. In 2015 (556 safety reports) there was about 12 % increase in safety reporting and then the trend dipped in 2016 (352 safety reports as at September 30) with a 28% reduction. The two year forecasted trend suggests a slight increase in safety reporting in 2017 (~ 410 safety reports) and a level trend in 2018 (~ 400 safety reports). Figure 17 shows the trend pattern of safety reports submitted from 2011-2016 and the forecast.

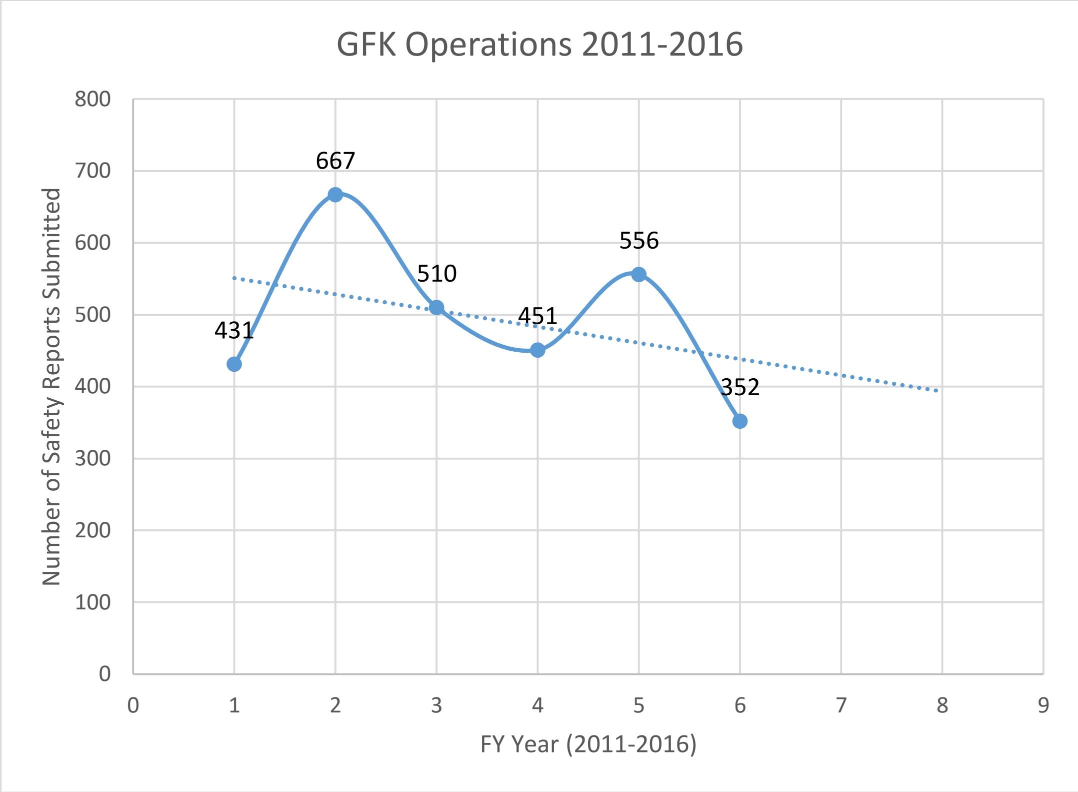

Figure 17. GFK Operations Safety Reports Submitted (2011-2016).

An audit of the respective annual and six-year mean performance in terms of safety reporting for the Mesa flight operations showed that the six- year mean for safety reports processed by the aviation safety office was 28. Comparing the yearly safety reports processed to the mean value, there was a 25% reduction in safety reporting in 2014. In 2015 there was about 67 % increase in safety reporting. The trend increased substantially in 2016 (Third Quarter) with a 100% increase. A two year forecasted trend suggests a significant increase in safety reporting in 2017 (~ 63 safety reports) and 2018 (~ 72 safety reports). Figure 20 shows the trend pattern of safety reports submitted from 2011-2016 and the forecast.

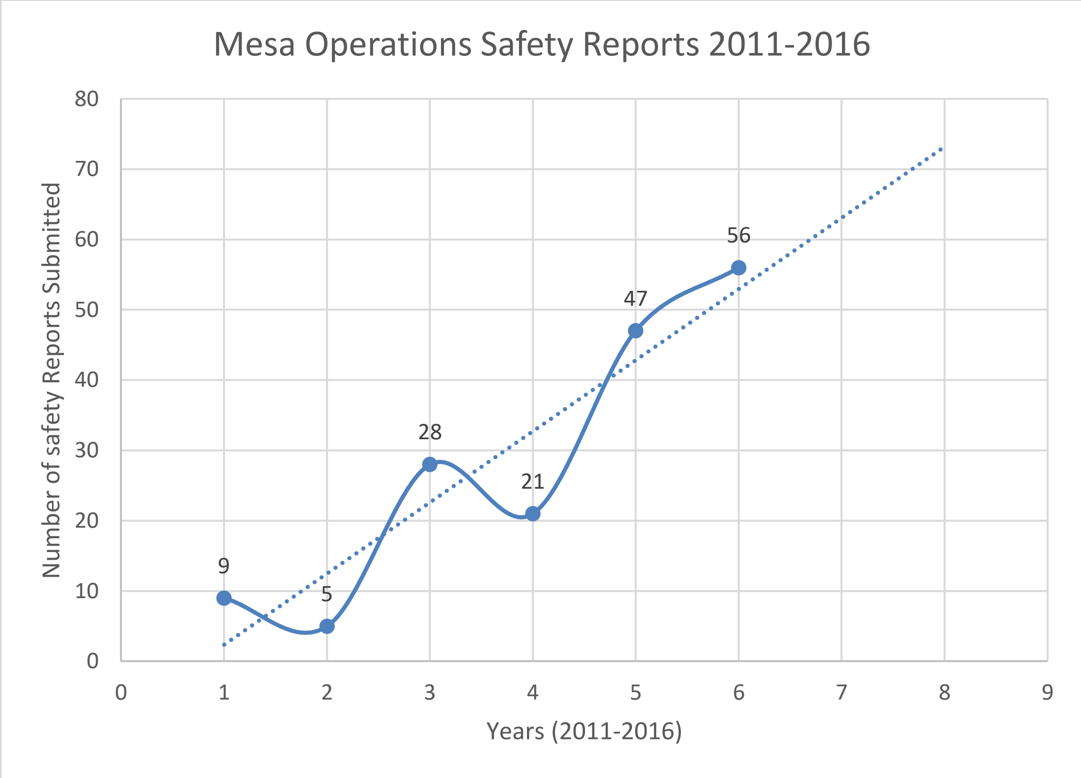

Figure 18. Mesa Operations Safety Reports Submitted (2011-2016).

The breakdown of safety reporting for the various departments in GFK such as flight operation, line operations, maintenance, supervisor of flight (SOF) and others suggest that flight operations had the highest reporting within the periods (2011-2016) with a mean safety reporting of 398 and SOF having the lowest of 4. At the Mesa program, the results show that operations had the highest mean safety reporting value of 26 as compared to line and maintenance with 1 each.

A two- year forecast suggests that there will be a slight increase in safety reporting in 2017 and a level trend in 2018 for flight operations at GFK. A two year forecasted trend for Mesa suggests that there will be a substantial increase in safety reporting within the flight operations department. Figures 19 and 20 show the departmental safety reporting trends at GFK and Mesa respectively.

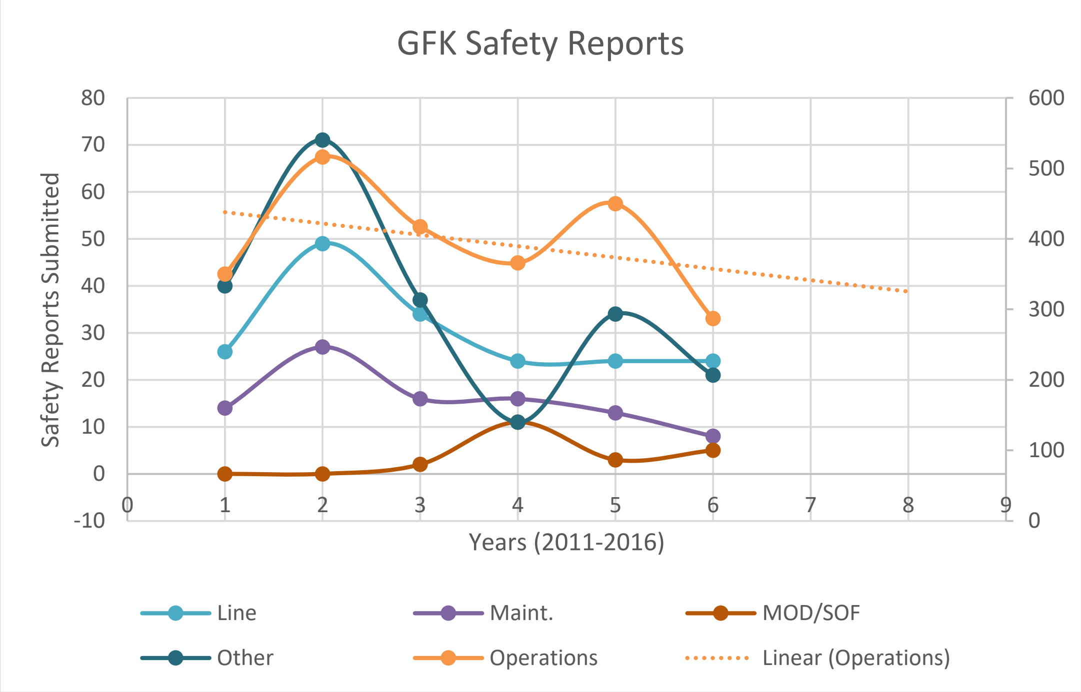

Figure 19. GFK Operations Safety Reports Submitted by Departments (2011-2016).

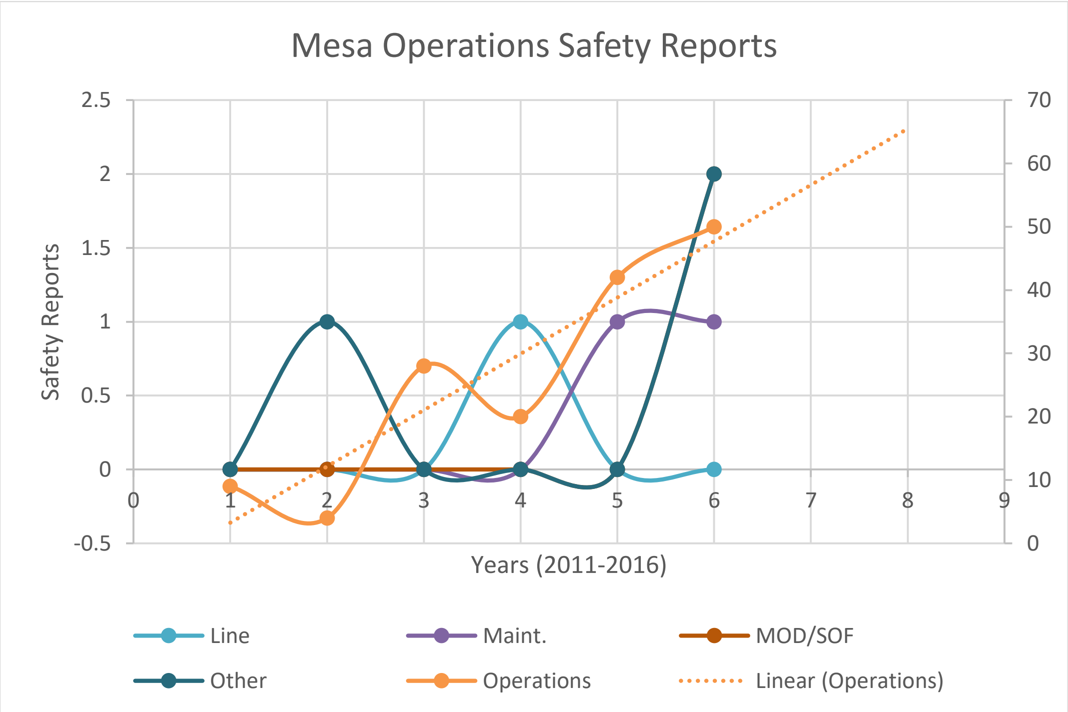

Figure 20. Mesa Operations Safety Reports Submitted by Departments (2011-2016).

In order to understand the safety reporting performance at the granular level, the number of reports per month for the period 2012-2016 was analyzed. The mean safety reporting per month within the specified period was 47 for GFK operations. The results show that the month of September had the highest safety reporting of 69 and compared to the mean value shows a 47% increase in safety reporting.

The other months with high safety reporting were March (51reports) and October (52 reports) showing an 11% increase compared to the mean value. The month with the lowest safety reports was December (22 reports) which corresponds to a 53% decrease when compared to the mean value. The Figure 21 shows the monthly safety reporting for the periods 2012-2016 and the forecasted trend suggesting a decrease in safety reporting for January and February 2017 compared to the five-year mean values for January (36 reports) and February (46 reports).

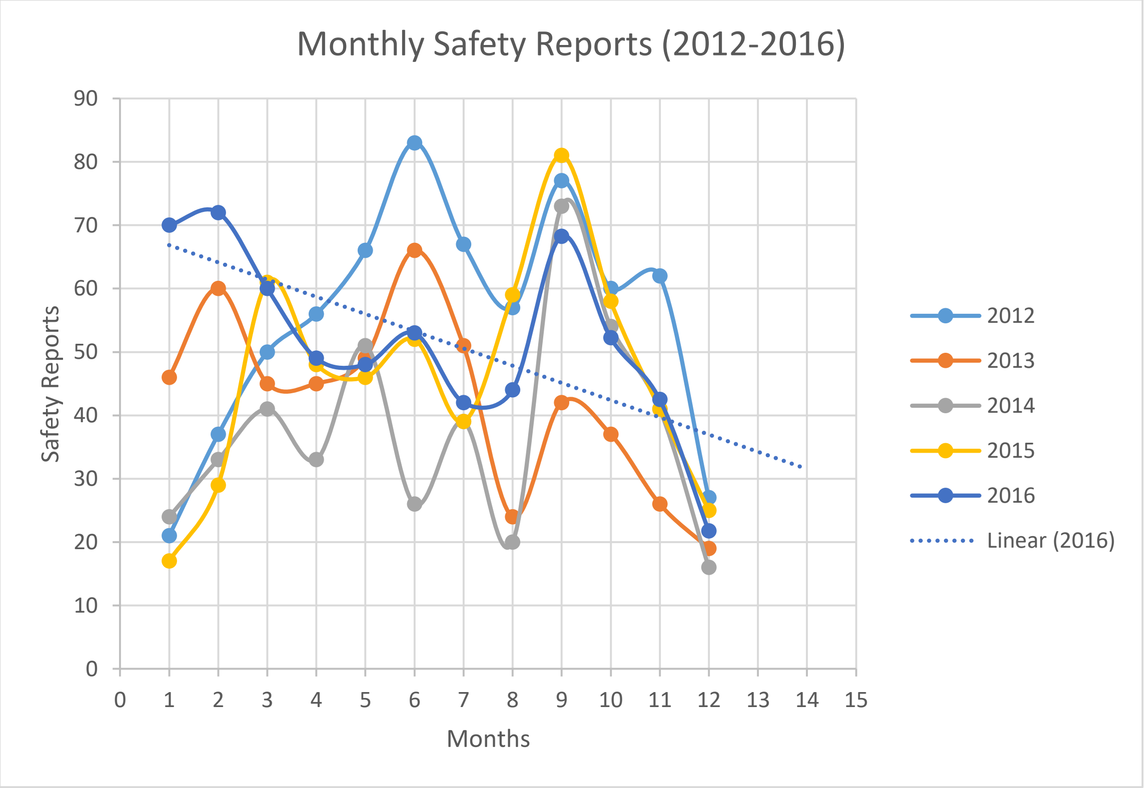

Figure 21. GFK Operations Monthly Safety Reports Submitted (2011-2016).

The number of safety reports submitted was compared to flight activities (safety reports/1000 hours flown) to determine the rate and identify trends both at GFK and Mesa. The results show that GFK program had a six-year mean rate of 0.006 (6 reports per 1000 hours) and the mean rate in Mesa was 0.003 (3 reports per 1000 hours). The results show that Flying Year (FY) 2016 had the highest rate of 0.008 (8 reports per 1000 hours) as compared to the lowest rate of 0.005 (5 reports per 1000 hours) for FY2013 and FY2014 in GFK.

The results suggest a 33% improvement of the FY 2016 reporting rate over the six-year average in GFK. The results from Mesa indicates that the highest rate was in FY2015 (5 reports per 1000 flight hours) as compared to the lowest rate of 0.001 (1 report per 1000 flight hours) in FY2012. The results suggest a 67% increase in reporting rate compared to the six-year mean value. The forecasted trends suggest a decrease in reporting rates in GFK (~ 7 reports) in 2017 and a relatively stable rate in Mesa (~ 5 reports). The safety reports per 1000 flight hours for the period 2012-2016 in GFK and Mesa are shown in Table 10, Figures 22, Table 11 and Figure 23 respectively.

Table 10. Safety Reports per 1000 Flight Hours at GFK.

Years	Flight Hours Flown (1000)	Safety Reports	Safety Reports/ Flight hours	Rate x 1000
2012	87.80	667	0.007	7
2013	102.00	510	0.005	5
2014	90.20	451	0.005	5
2015	86.70	556	0.006	6
2016	42.80	352	0.008	8

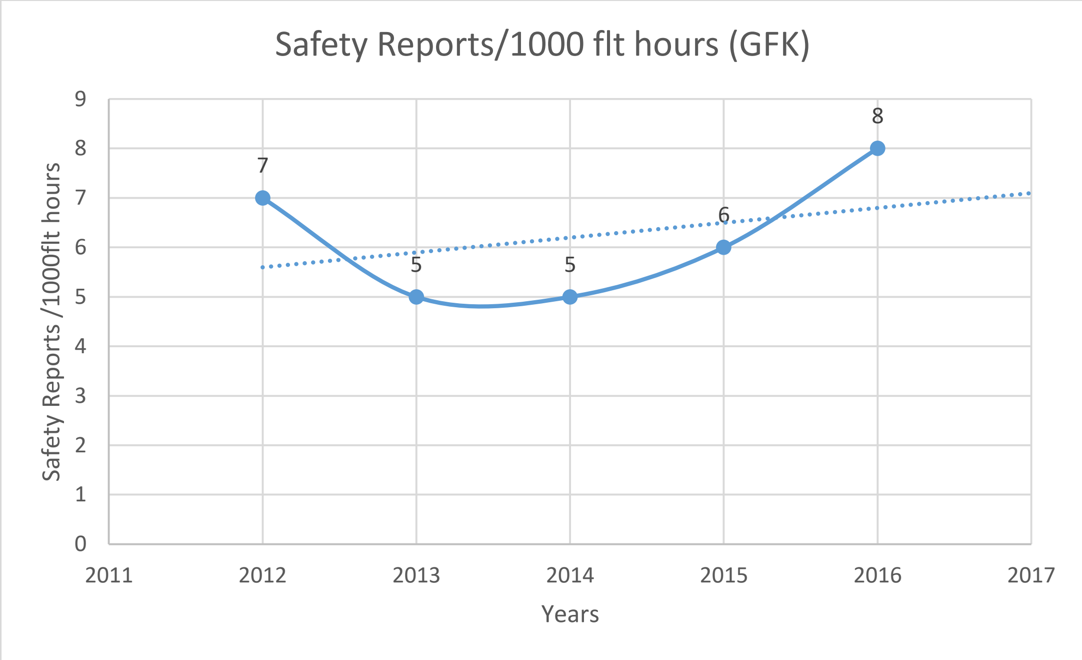

Figure 22. GFK Operations Safety Reports per 1000 flight hours (2012-2016).

Table 11. Safety reports per 1000 flight hours at Mesa.

Years	Flight hours Flown (1000)	Safety Reports	Safety Reports/Flight Hours	Rate x1000
2012	4.893	5	0.001	1
2013	6.722	28	0.004	4
2014	11.61	21	0.002	2
2015	19.931	47	0.002	2
2016	12.025	56	0.005	5

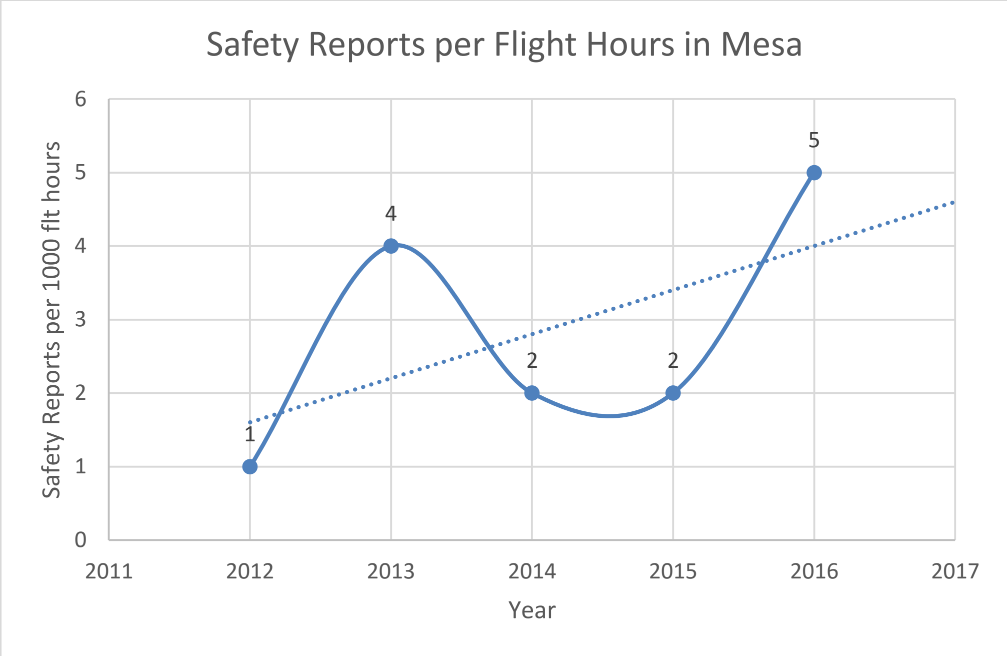

Figure 23. Mesa Operations Safety Reports per 1000 flight hours (2012-2016).

Safety Meetings (Factual Data)

A safety performance analysis of attendance to safety meetings for the periods fall 2014 – spring 2016 suggest a mean attendance of 1047 students and other personnel. The highest attendance value over the four-year period was in fall 2015 (1094) as compared to the lowest in spring 2015 (990). The findings suggest that the value in fall 2015 was a 4.5% improvement over the four-year mean and the value for spring 2015 was 5.4 % reduction compared to the mean value. However, the forecasted trend indicates an improvement in safety meeting attendance in the next two reporting periods of fall 2016 and spring 2017. The GFK operations safety meetings attendance is shown in Figure 24.

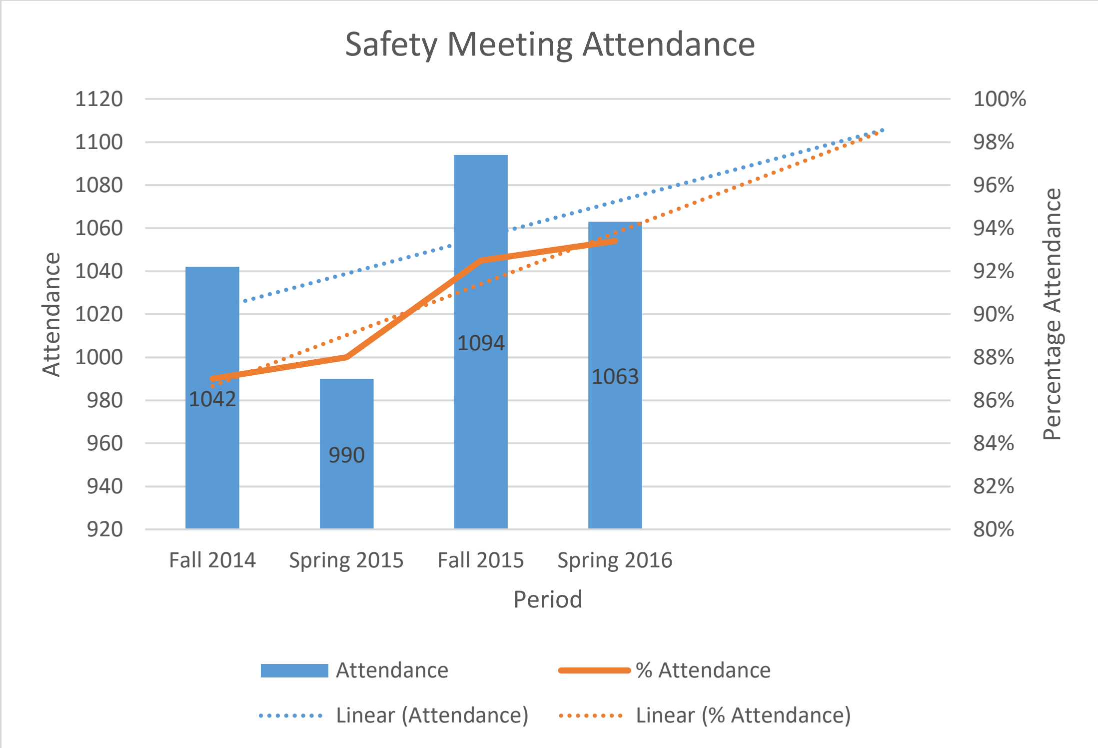

Figure 24. GFK Operations Safety Meeting Attendance (2014-2016).

SMS Training (Factual Data)

A safety performance analysis of number of students and instructors formally trained in SMS was also evaluated for the spring 2012 – spring 2016 academic semesters in both GFK and Mesa. The findings suggest a mean number of 157 students and 131 instructors were trained each semester within the stated period. The highest number of students trained per semester was 259 in fall 2015 (65% improvement over the mean value).

The lowest number of students trained was 90 in spring 2012 and spring 2013 (43% decrease compared to mean value). The highest number of instructors was 375 in fall 2015 and the lowest number was zero in spring 2012 and spring 2013. The forecasted trends suggest that there will be an increase in SMS training for students (~230) and instructor/staff (~ 345) in fall 2016 and spring 2017 academic years when compared to the mean number of personnel who receive SMS training. The values for the number of students and instructors trained in SMS are shown in Figure 25.

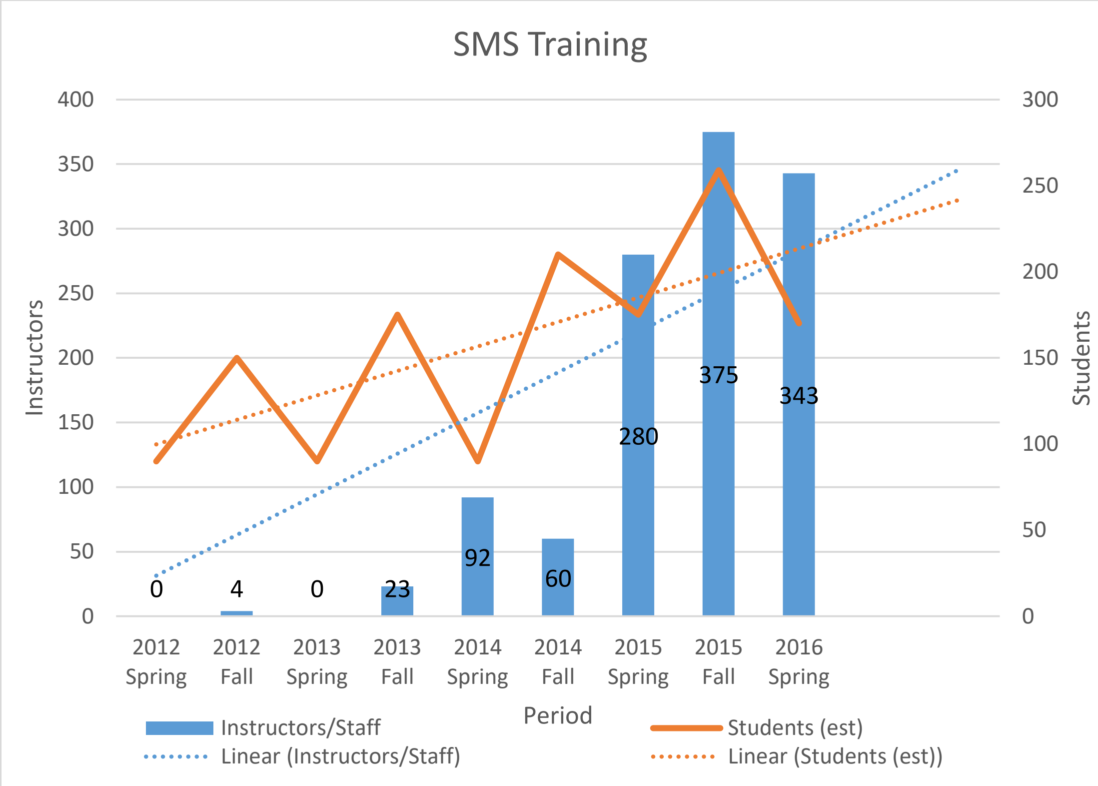

Figure 25. Number of Students, Instructors and Staff Trained in SMS (2012-2016).

CHAPTER VI

DISCUSSION, IMPLICATIONS, CONCLUSION

SMS Initiative Construct Validation

The results and findings from the research suggest that in attempting to measure the latent construct of SMS initiative using factor analysis, two underlying factors emerged namely SMS process engagement and SMS policy implementation. The SMS policy implementation ($\alpha = .93$) explained about 38.2% of the total variance for the SMS Initiative construct as compared to SMS process engagement ($\alpha = .75$) which explained about 10.8% of SMS Initiative construct. It was however very interesting most items on an important component of SMS initiative, Emergency Response Planning (ERP) had poor loadings and had to be dropped. These may indicate that respondents were not familiar with policies and processes related to ERP.

The two factor obtained corroborates earlier findings by Chen (2014) who also found had two underlying factors measuring SMS among airline pilots in Taiwan. Chen (2014) designated the two underlying scales as SMS policy ($\alpha = .95$) and SMS practices ($\alpha = .95$). While Chen (2014) had the underlying factors explain about 71% of total variance for the SMS evaluation scale, the present study had about 46% explanation of total variances in the construct SMS.

The higher level of experience and professionalism of airline pilots and the depth of knowledge about their organization's policy implementation, practices and process engagement relating to SMS initiatives may have a higher effect on the perceptions of these professional pilots as compared to pilot trainees and flight instructors in a collegiate aviation program implementing an SMS Initiative. These factors could possibly be a reason for the relatively high variance in Chen (2014) as compared to this study.

The two factors identified in this study was also different from factors identified in an earlier study by Fernández-Muñiz, Montes-Peón, Vázquez-Ordás (2007) in which a scale made up of 29 items turned out eight first-order factors; policy, incentives, training, communication, preventive planning, emergency planning, internal control and benchmarking techniques.

This study also differs from the number of factors identified by Chen and Chen, (2012) who developed an SMS measurement scale from the perspective of aviation experts and airline managers to evaluate the performance of airline's SMS. The results revealed a five-factor structure consisting of 23 items. A reason for these differences may be the type of respondents used. Both the current study and Chen (2014) used front-line operational personnel such line pilots and flight students and flight instructors instead of senior line managers who may have a different perspective on SMS.

This research also adds to existing literature on SMS construct validations in aviation such as Liou and Chuang (2010) who mapped out structural relationships among diverse components of SMS and identified key factors in their model and another study by Hsu, Li and Chen (2010) that developed an analytical framework for defining the key components and dimensions of an airline SMS and their interaction.

SMS Policy Implementation

A common thread in all of these studies and the current study reveals that the factor "*SMS policy*" as a key component and under pins the importance of a coherent SMS policy in any organization that wants to implement an SMS initiative. The findings in this study also highlights SMS policy implementation as essential in explicitly describing core responsibility, authority, lines of accountability and pursuable targets. The findings from both the survey instruments and the semi-structured interviews suggest that roles, responsibility and relationship outlined in safety policies of collegiate aviation programs can have a positive effect on the sustenance of high operational safety standards and these roles must be clearly defined for an effective SMS policy implementation (ICAO, 2009).

The results also support extant literature that SMS policy implementation must originate from the highest echelon of authority in an organization and must have ample evidence of top leadership initiatives, commitment and support for the implementation drive (FAA, 2015b). The safety policy implementation must be documented and enshrined in the core mission and vision statement. The safety policy implementation strategies must be visible and communicated wide across the structures of the organization and must be widely known and accepted by all employees as a bona-fide safety policy (Wood, 2003; IATA, 2012).

SMS Process Engagement

The results also suggest that sometimes safety policy implementation does not always result in effective SMS process engagement which is the reciprocal gesture or acceptance of the key tenets of the SMS policy by front-line operational personnel such as flight students and flight instructors. The study suggest that top level leadership must use ingenuity and smart promotion strategies to get the necessary "buy-ins" and acceptance from these "sharp-end" operational personnel to get some level of parity between SMS policy implementation and SMS process engagement.

The interviews with some of the top level management personnel and process owners revealed that the SMS policy implementation was very effective which was corroborated by the survey among the students and flight instructors. However, the SMS process engagement component seems weak and may be attributed to the fact that realistically most students and flight instructors are actually distal from implementation strategies and are only beneficiaries of the windfalls of any of these SMS polices. Three of the top level management personnel interviewed suggested that in order for the SMS initiative to be sustainable and continuously improve there should be active personnel involvement in the processes under the initiative and not have the perception that SMS only belongs to the aviation safety department.

A top level management person interviewed was of the opinion that some flight students, flight instructors and personnel were not knowledgeable about the processes and structure of the SMS and the role expected of them and that may be a reason for some apathy towards issues related to SMS during the initial phases and presently. The top management personnel opined that a proactive and ingenious outreach and engagement between the aviation safety department and other departments could bridge the SMS knowledge gap and may reduce the perception among students and instructors of “they and us” while actively promoting process ownership and engagement.

The results suggest that collegiate aviation programs with SMS initiatives must engage individual student, student organizations and flight instructors during the SMS implementation process and also in the subsequent continuous improvement processes. The challenges to these recommendations may be the reality of constraints due to time and academic activities for most collegiate aviation students, which may restrict a greater role and engagement in the SMS initiative. Another challenge will be the level of expertise and knowledge that may be required to execute the SMS policy implementation within a collegiate aviation program. However, it may be still beneficial to reach out to these students and flight instructors through SMS initial and recurrent training.

An analysis of factual safety performance data suggested that in terms of SMS process engagement strategies such SMS initial and recurrent training for flight students and instructors, some effort has been put in place by the top level management but more needed to be done and the forecasted trends suggested that there will be an increase in SMS training for students (~230) and instructor/staff (~ 345) in fall 2016 and spring 2017 academic years.

Triangulated Results on SMS Initiative

The results suggest that collegiate aviation programs could use in-house resources and external resources such as the FAA SMS program office to assist in policy implementation. However, sometimes the local FAA offices may not have SMS experts and that may stifle the SMS initiatives' progress since the local FAA traditionally has oversight over the certification process. The results suggest that such aviation collegiate programs may need to establish a healthy rapport and liaison with their local FAA offices and possibly get external expertise from the FAA SMS office at the regional or national level to assist in the drafting of initial SMS policies, Gap Analysis, training, Job Aids and actual process integrations.

The results from the factual data corroborates the findings from the survey and the semi-structured interviews that the SMS policy implementation has provided the flight program with the necessary benchmarks and tracking mechanism for safety performance. A critical assessment of the six-year performance data from the flight programs operations at both GFK and Mesa showed a substantial increase in safety occurrence reporting and safety meeting attendance among students and flight instructors, which may be attributed to enhanced safety promotion efforts outlined in the SMS policy implementation. These trends may be some of the data-driven behavioral benchmarks that need to be tracked in an SMS initiative. It was quite difficult to gauge the level of process engagement in Mesa but at least the results seem to indicate an effective SMS policy implementation.

Theoretical Implications

The theoretical implications of this study are that an attempt has been made to measure the dimensionality of SMS Initiative in a collegiate aviation program. The findings of this study may serve as a foundation and road-map for future research by further refining the dimensions through the use of a larger sample and participation of more collegiate aviation programs with functional SMS Initiatives. Finally, the results corroborate extant literature that any SMS policy should outline the key safety goals and objectives, which must be attainable, pragmatic, must be included in the overall corporate strategic plan (Stolzer, Halford & Goglia, 2008).

Relationships between SMS Initiative and Other Study Variables

One of the key rational for this study was to evaluate the relationship between SMS initiative, self-efficacy, transformational, safety leadership, safety motivation, safety participation, safety compliance and safety -related occurrences. The results from the structural equation model and path analysis indicate that respondents' perceptions about the SMS policy implementation had a positive and significant effect on their safety motivation, safety compliance and safety participation. The results indicate that an investment in SMS initiative may enhance the perceptions of flight students and instructors on the collegiate programs operations and safety culture.

This result corroborates findings in earlier studies on SMS and safety culture (Dillman, Voges & Robertson, 2010; Adjekum, 2014b; Adjekum et al., 2015; Freiwald, Lenz-Anderson & Baker, 2013, Chen, 2014) which highlighted the positive benefits of SMS in improving organizational safety culture and specifically safety behavior in aviation. The results also validate findings in previous studies that indicated a positive trend in attitudes and behavior of employees towards safety after SMS implementation in airport operations (Remawi, Bates & Dix, 2011).

Safety Policy Implementation and Safety Participation

The results indicate that organizational indicators such as perceptions on SMS process engagement have a higher predictive power with regards to respondents' safety participation than SMS policy implementation which did not have any significant direct path to safety participation. The only significant pathway from SMS policy implementation to safety participation was when mediated by safety motivation. The results indicate that although SMS policy implementation may not directly have a positive effect on safety participation, the indirect effect through safety motivation may positively improve safety participation.

The results also validate the suggestion by Neal and Griffin (2006) that SMS implementation could be a viable predictor of safety compliance and safety participation. The results further indicate that when respondents understand and associate with the SMS policies and how it is implemented, it may motivate them to get involved in safety related activities. This finding is very important since a well-defined SMS policy is very essential to drive the entire SMS initiative and improve the safety culture of the organization as recommended by Stolzer, Halford & Goglia (2008), (ICAO, 2013) and FAA (2015).

SMS Process Engagement and Safety Participation

The results from the final structural model supported the hypothesis that SMS process engagement has a significant positive direct effect on safety participation. The finding is supported by Mc Gregor's *Theory Y* which has a profound implication for respondents to have "buy-in" and participate in SMS initiated in a collegiate aviation program. Under the conditions outlined by *Theory Y*, this finding may encourage flight students and instructors to seek out responsibility within the SMS process engagement factor and collegiate aviation programs can decentralize the SMS policy implementation and ensure operational level participation under the process owners.

Policy Implication. Under *Theory Y*, the scope of SMS process engagement by flight instructors can be broadened, which may add variety and opportunities, while engaging them in the decision-making process. In ensuring SMS process engagement, students and flight instructors may be allowed to set performance objectives that meet or even exceed FAA requirement and participate in the process of evaluating how well they were met as recommended by Sorenson (2015).

SMS Process Engagement and Safety Motivation

The path way from SMS process engagement to safety motivation was not significant, indicating that safety motivation alone may not influence personnel to actively engage in safety actives if they feel that they are not part of SMS process or have been sidelined in the SMS process implementation. The results therefore implore collegiate aviation programs to actively reach out and engage the students and flight instructors in the processes of SMS such as safety promotion, safety risk management and very importantly emergency response planning (ERP) which is one area that there were lots of non-responses from respondents. Flight instructors may be included in safety promotion councils and flight students may be included in flight data monitoring or event review team (ERT) memberships.

Safety Process Engagement and Safety Compliance

The results did not support the hypothesis that there existed a relationship between SMS process engagement and safety compliance. This finding was very interesting and suggests that getting respondents to be part of SMS process may not affect their safety compliance. A reason for this finding could be the idea that in collegiate aviation program, most of the task and operations are heavily regulated and higher compliance is required by the FAA in order to maintain certification status. Non-compliance with the requirements of regulations may elicit disciplinary actions and sanctions, hence the need to comply whether actively engaged in the SMS initiative processes or not.

Self-Efficacy and Safety Compliance

The results from the final structural model supported the hypothesis that self-efficacy has a strong direct effect on safety compliance and an even stronger total effect on safety compliance when mediated by safety motivation. This result strongly corroborates findings in earlier research Schwarzer & Jerusalem (1995) which suggested that respondents with higher perceived self-efficacy are likely to better resist pressure and devote more efforts to improving their work-related and management performance. This result also supports findings in earlier research (Parasuraman, Molloy & Singh, 1993; Prinzel, 2002) that applied as the self-efficacy as an observed predictor in the number of studies that investigate pilots' work-related behaviors.

Self- Efficacy and Safety Motivation

The results support prior research in the field of teaching and learning in collegiate environment that demonstrated that self-efficacy has effects on the level of motivation, learning and performance and a consistent predictor of behavior and behavioral change (Graham and Weiner, 1995; Schunk and Pajares, 2001). This finding suggests a positive trend among respondents and for attaining the performance objectives of the SMS initiative.

Self-Efficacy and Safety Participation

The results indicate a positive direct effect of self-efficacy on safety participation and a positive total effect when mediated by safety motivation. This may be good news for leadership in the collegiate aviation program as it may offset the rather non-direct effect of SMS policy implementation on safety participation in the model. Although self-efficacy may be a function of an individual inherent character it may be improved by formal training which can ensure massive participation from flight students (Schunk and Pajares, 2001; Chen, 2014).

Policy Implication. The inclusion of self-efficacy in flight course or SMS training programs can be adopted as a policy in the collegiate aviation program. Since the flight program already has a robust SMS training program as corroborated by findings of the factual safety data it may be intuitive to team up with the psychology department and include modules on self-efficacy to both initial and recurrent SMS training classes. However, it is important to state that like all self-reported surveys, there may be issues of social desirability bias in terms of respondents' perceptions on their level of self-efficacy.

Self- Efficacy and Safety Compliance

There was a significant positive relationship between self-efficacy and safety compliance and that is nominally very good, however some researchers have expressed concern that it could be a two-edged sword and that people with high self-efficacy may be extremely goal –oriented at the expense of safety (Prinzel, 2002). Under deadlines, peer pressure, and budget factors, some flight students and instructors with high self-efficacy may decide to logically disregard procedures. This behavior is termed the "*Superman Syndrome*" by the *Petersen Accident Theory*. That is why the active engagement of students groups and flight instructors in the SMS initiative could equip them with a sense of process ownership and peer review of this undesired safety behavior.

Transformational Safety Leadership, Safety Participation and Safety Compliance

The results from the final measurement model indicates that there was a significant direct effect of transformational safety leadership on safety participation and no direct path or effect on safety compliance. There was a positive indirect effect of transformational safety leadership on safety compliance through the mediation of safety motivation. However, even with a small negative direct effect of transformational safety leadership on safety motivation, the total effect on safety participation and safety compliance were significant and positive.

The results were contrary to earlier findings by Chen (2014) who found out that at the group aspect level ethical or morality leadership did show a significant direct effect on airline pilots' safety compliance. Chen (2014) suggested that pilots by virtue of their level of professionalism normally have their behavior dictated by their training and since most airline pilots actually work as a team with other crew members, sharing information and learning from each other, their safety behaviors may not be influenced by a single fleet manager or chief pilot and recommends that the influence of leadership on pilots' safety compliance may need to be interpreted from a different perspective.

However, the result was similar to empirical findings from extant literature that suggest a positive relationship between transformational leadership and enhanced task performance and safety behavior (Howell & Avolio, 1993; Barling, Weber, & Kelloway, 1996; Zohar, 2002; Inness, Turner, Barling & Stride, 2010; Fernández-Muñiz, Montes-Peón, Vázquez-Ordás, 2014; Pilbeam, Doherty, Davidson & Denyer, 2016).

A reason that could be adduced by the counter-intuitive finding of the negative direct relationship between transformational safety leadership and safety motivation may be the idea that when chief flight instructors and other senior flight supervisory staff exhibit high levels of transformational safety leadership traits in a flight program with a matured and functional SMS initiative, flight students and flight instructors become complacent and less motivated to pursue safety objectives because in their opinion the system is inherently safe and dependable with such transformational leadership in place.

That may create a spurious "*Dependency Syndrome*" that leadership will always ensure a safe operational environment even without the input of these respondents. This trend could potentially be detrimental to continuous improvement and sustenance of any SMS and could lead to operational drift and mitigation decay. It was rather interesting that the interview with one of the top level leadership and a faculty member with very close association to flight student organizations re-iterated similar sentiments about waning safety motivation among flight students over time.

The top level management person was of the view that even though top leadership has provided transformational leadership in safety and resourced the SMS initiative, there have been periods of behavioral mitigation decays over time. The top leader emphasized that recommendations have been made to consistently use data-driven strategies to track behavioral and attitudinal trends within the flight program for indicators such as lack of safety motivation, safety compliance and safety participation among flight students and instructors to pro-actively mitigate such hazardous attitudes before the flight program slips back to a pre-mitigation period of unsafe attitudes and behaviors.

Another reason that may explain this result is that although top level flight supervisory staff may be exhibiting transformational leadership traits, they may be missing out on some underlying potential motivational factors that can enhance proactive safety behavior in collegiate aviation programs (McLeod, 2014). Two of the four elements of transformational safety leadership are *individualized consideration* and *inspirational motivation* (Bass & Riggio, 2006) and when respondents observe the other components of TSL such as *idealized influence* and *intellectual stimulation* but not the first two, the net effect may be negative perception of TSL, which could wane safety motivation.

Sometimes respondents may not directly come into contact with some of these supervisory flight leaders, but will hear negative things about them from third-party sources and that may skew their perceptions about TSL within the organization. On the contrary there may be real issues of poor traits of TSL in these supervisory flight leaders but due to the over-arching proactive safety culture within the organization and the personal expectations and goals of these respondents to place higher value on safety outcomes, they may be self-motivated to ensure safety behavior as grounded in the Vroom's Expectancy Theory.

Realistically, these supervisory flight leaders have to ensure some level of transactional leadership based on non-individualized hierarchical relationships and specifically *Corrective leadership* (or active management by exception) that monitors individual performance against standards, detecting errors and correcting them (Zohar, 2002). Therefore, if these supervisory flight leaders exhibit transformational safety leadership traits most of the time, there may be periods where they could become overwhelmed balancing relationship maintenance and attaining operational goals. This becomes more challenging during times of high flight training periods and operational exigencies. Zohar's Corrective *Leadership* may create a perception that these supervisory flight leaders do not identify with the cognitive and physiological needs of flight students and instructors such as fatigue and stress. These factors may adversely affect safety motivation. These observations are also theoretically grounded in the Maslow's *Hierarchy Theory.*

These flight students and instructors need to feel emotionally and physically safe and accepted within the flight program to progress and reach their full potential. These flight students and instructors must be shown that they are valued and their opinions respected by their supervisory flight leadership in order to create an environment that ensures high safety participation and safety compliance as recommended by Maslow.

It was however interesting to note that the factual safety data analysis revealed that safety behavioral markers such as safety occurrence reporting and safety meeting attendance had increased among respondents over the six-year reporting period and the projected trends also indicated an increase in reports and attendance in Mesa and GFK respectively. These trends may suggest that overall the impact of transformational safety leadership provided at the highest level in resourcing and actively supporting the SMS initiative may be yielding benefits.

Safety Motivation, Safety Participation and Safety Compliance

The result supported the hypothesis that safety motivation has a direct positive effect on both safety participation and safety compliance. This finding supports extant theories that examined the effects of safety motivation on safety behavior such as the Frederick Herzberg's *Motivational Theory (Two-Factor Theory)* which theoretically explains why safety motivational factors such as achievement, advancement, recognition and responsibility encourage desired and proactive safety behavior in an organization (Hines, 1973; Neil, 2007;

Greenberg, 2013). The results also confirm previous findings by Chen (2014) and Friewald (2013) that suggested that safety motivation positively influenced airline pilots and flight students respectively to exhibit proactive safety behavior.

Theoretical Implication. The theoretical implications of this finding for a collegiate aviation program with a functional SMS is that policies, processes and procedures may improve the safety motivation of flight students that can positively affect operational practices such as the tendency to act safely, and follow training guidelines and safety instructions. Safety motivation may create an awareness and incentives that operational outcomes are positive as compared to unsafe acts, which may have adverse consequences. This invariably may improve safety compliance and is well grounded in the *Skinner's Operant Theory*. Another theoretical implication of this finding is that when respondents are motivated as a result of positive reinforcement from safety award programs, they may be more apt to engage in safety compliant behavior and participate in safety activities supported by the *Thorndike's Reinforcement Theory*.

Policy Implication. Based on this finding, it may be beneficial for collegiate aviation programs with SMS to use some form of positive reinforcement such as bonuses for flight instructors who undertake occurrence –free training over a period of time. Other incentives such as safety awards and public recognition may improve the level of safety motivation. Top level leadership may also award "free" training hours to flight students for exemplary safety operations and behavior.

The use of safety motivational strategies such as positive reinforcement could improve flight students and instructors' safety behavior as suggested by the positive direct effect of the causal path in this study. However, top level leadership should be guided by the limitations of incentives and reinforcement especially in times of high flight training regime in resource constrained environment, where the potential for unsafe working conditions could derail gains made from safety motivations and adversely affects safety behavior (Reason, 1998; Greenberg, 2013).

Safety Compliance, Safety Participation and Safety -Related Events

The result supported the hypothesis that safety compliance was related to safety participation. However, the hypothesis that safety- related events mediated the causal path between safety participation and safety compliance was not supported. There was a significant positive causal path between safety -related events and safety compliance. The finding suggests that there exists a strong correlation between safety compliance and safety participation due to the fact that they are both factors that explain safety behavior (Griffin and Neal, 2000).

The result supports earlier findings by Zohar (2002) that suggested a causal relationship between personnel safety performance indicators such as compliance with safety regulations, and safety- related events. The result also buttresses earlier findings by Griffin and Neal (2000) that suggested that behaviors that are characteristic of safety compliance will lead to fewer safety- related events in the workplace. For example, personnel who comply with established safety regulations are less likely to experience safety- related events than those who do not comply with established safety regulations. The findings also support previous findings from studies by Mullen (2004).

The result did not support earlier findings on the relationship between safety participation and safety -related events. Earlier studies by Cree and Kelloway (1997) had suggested that that individuals who experience close calls or safety related events, display higher levels of safety participation. More current research findings by Mullen (2004) found that perceived risks associated with a job tended to be heightened when an individual vicariously experienced or learned about an injury that occurs within the workplace and these safety -related events raised their safety awareness and increased their participation in safety activities.

Even though the hypothesis that safety -related event mediated safety participation and safety compliance was not fully supported, the relationship between safety-related events and safety compliance was supported by the causal path model and corroborates findings by Neal and Griffin (2006) that knowledge about the safety climate and safety-related events significantly influenced self-report of task and contextual safety performance, namely safety compliance and safety participation.

Factual data on safety -related events could not be obtained for this study but the findings from the other factual safety performance indicators suggest that the SMS initiative had greatly improved the safety participation levels of respondents and one of the top level leadership personnel interviewed stated that even with a generally high level of safety compliance and participation there were still occasional cases of safety -related events such as aircraft in close proximity in airspace (air-prox) that required remedial and corrective action as part of the safety risk management program of the SMS.

The top level management personnel also indicated that there have been some recent cases of safety risk behavioral issues involving alcohol that have been dealt with by a safety review team. It may be difficult to determine within the context of this study if the knowledge and awareness of such safety -related events by respondents may have significantly improved safety participation.

Effects of Demographic Variables on Safety Behavior and Safety-Related Events

One of the essential elements of any SMS initiative is to improve the safety culture within the organization and especially among the various demography that make up collegiate aviation programs (von Thaden, 2008; Adjekum, 2014b; Adjekum et al., 2015). The findings from an ANOVA conducted suggested that there were significant differences in terms of safety compliance between certified flight instructors (CFI) and pre-private and student pilots.

This result may not be surprising since most CFI have relatively extensive experience with standard operating procedures (SOPs), aircraft systems and limitations and airspace compared to pre-private and student pilots. Another factor could be the motivation factor and incentives. Most CFI have worked assiduously to obtain their ratings and certificates as instructors and they know the repercussions of non-compliance with safety regulations and violations. That may serve as a motivation to ensure that they operate under full compliance with standards and federal regulations. The CFI may also be held to higher standards in case of non-compliance as compared to the student pilot or pre-private student who may not have any certificate to lose.

The findings also indicate that the CFI group had a significantly higher safety participation than the pre-private and student pilots group. This finding may also not be surprising considering the fact that most of these CFI have been well adapted to the safety culture and SMS initiative and may be even active in the process engagement. Another reason may be that CFI are required as part of their standardization to attend safety meetings and meets specific institutional safety requirements that are mandatory as part of their roles as CFI. The pre-private group may not have such roles and responsibility to actively participate in safety activities since some of them may not even know about the components of the SMS initiative nor be well adapted to the institutional safety culture.

It was also interesting finding that in terms of academic year groupings and safety compliance, there was a significant difference. The seniors had a significantly higher level of mean scores on safety compliance as compared to the freshmen. This was also not very surprising considering that facts that most of the seniors were enrolled in higher level flight course and actively engaged in more training flights, relatively experienced, had better institutional knowledge on safety procedures and SOPs, and most likely CFI who were more at risk to substantially lose if their flight certifications were revoked or they face sanctions for non-compliance with regulations.

These listed factors may pre-dispose the seniors to be more compliant than the freshmen who may not have much, institutional knowledge on safety, SOP, aircraft systems and above all may have not much to lose in case of violations and non-compliance. Some of these freshmen in pre-private and student pilot courses may defer to their CFI who may be seniors to comply with procedures and standards since they deem them to be more experienced and responsible for the overall safety of flights during training. Another factor could be negative transfer of safety risk attitudes and behaviors from other domains that can pre-dispose these freshmen to be less compliant with safety procedures and regulations.

In terms of the safety participation the results suggested that there were significant differences between the seniors and juniors. The seniors had a higher mean score on safety participation compared to the juniors and that may be due to the fact that relatively the seniors may be in a phase of their flight training where there be some flexibility in terms of flight schedules and academic intensity to allow them to be more involved in safety activities as part of the SMS initiative.

Some of the seniors may also be CFI who as earlier adduced have to participate in SMS training and other safety activities as part of their certificate requirements and institutional standardization. On the other hand, these juniors may be at the most intensive phases of their flight training such as CFI training, multi-engine training and even instrument phase and that may not allow them the flexibility to participate in a lot of non- mandatory safety activities. The seniors may also be gearing up as part of their professional development into industry and the knowledge and participation in safety activities may enhance their personal safety culture while boosting their resume.

There were significant differences in terms of knowledge and involvement in safety -related-events among the academic year groups. A *post-hoc* test revealed that there were significant differences in the mean score on safety-related events among the seniors and the juniors. The seniors had a relatively higher exposure to safety -related events as compared to the juniors. This finding could also be adduced to the notion that a sizable sample of the seniors were CFI and that meant they had more flight activities relative to the juniors and more experiences with the risk of flight training. The higher level of flight operational engagement may account for the higher scores.

These seniors may also be more active in safety activities such as SMS training and safety meetings where information on safety occurrences may be shared. These seniors as CFI may have better inter -phase with activities at the flight lines and safety reports from the flight students assigned to them and that may pre-dispose them to know more about safety-related occurrences than the juniors.

SMS Training Effects on Demography

A *T-test* of mean was conducted to determine if SMS training had any effect on various demography within the flight program. The results indicate that there was no significant effect of SMS training on mean scores on safety participation, safety compliance or safety-related events. This finding was quite interesting and fascinating since extant literature on safety culture and SMS such as Vinodkumara and Bhasib (2010) suggested that SMS training was identified as the most important safety management practice that predicted safety knowledge, safety motivation, safety compliance and safety participation.

However, triangulating this result with the factual safety performance data analyzed revealed that though there has been an aggressive action by top level management to increase the level of initial and recurrent training SMS among flight students, there were still training gaps. The analysis from the factual safety performance data suggest a forecasted increase in SMS training for 2017 academic year.

Policy Implication. The finding identifies a training gap and need and suggests that training in the concepts and principles of the SMS should be expanded to cover all flight students and flight instructors. The findings from both the factual data and interviews suggest a policy change of making SMS mandatory in the academic curriculum in the flight program so that every flight student will have some form of initial SMS training.

Conclusions and Future Research Direction

The focus of this research was to establish a coherent causal relationship between SMS Initiative, Transformational Safety Leadership, Self-Efficacy, Safety Participation, Safety Compliance, and Safety-Related Events when Safety Motivation is used as a mediation variable the use of a comprehensive triangulation approach in a collegiate aviation program in the US. The study also sought to establishes a proactive operational safety benchmarks for continuous monitoring and improvements in SMS implementation within collegiate aviation programs.

Overall the findings from the triangulation of various data sources showed a positive perception of respondents on the SMS initiative in the collegiate program and that was corroborated by factual safety performance data and interviews with top level management personnel. The study conceptualized the causal relationships and effects of Safety Management System (SMS) initiative, self-efficacy, and transformational safety leadership as constructs with safety behavior (measured by safety compliance and safety participation) when mediated by safety motivation using a concurrent-triangulation approach. The study also evaluated the relationship between safety behavior and safety -related events.

Structural Equation modeling techniques and Path Analysis (SEM –PA) were used to derive a final measurement model that fit the empirical data after four iterations of the initial conceptual model using both modification indices and theoretical considerations. The model iterations allowed for the improvement of the data fit; the best-fit model accounted for the data and was used to test the study hypotheses and validate the conclusions.

Utilizing a sample of 282 collegiate flight students and instructors from a collegiate aviation program in a large public university in the United States with a fully functional SMS program that has been recognized by the FAA as attaining the active *conformance* level, a 46-item survey was conducted to measure respondent's perceptions on the study variables. Concurrently, semi- structured Interviews were also conducted with 4 top-level management personnel to sample their opinions on the effectiveness of the SMS initiative. Finally, factual safety performance data on the flight program over a six-year period was analyzed to complete a concurrent -triangulation approach.

The results indicated that perceptions of SMS policy implementation had direct, positive effect on safety compliance and SMS process engagement had direct, positive effect on safety participation. Self-efficacy and safety motivation had direct, positive effect on both safety compliance and safety participation. Safety motivation fully mediated the positive effect of transformational safety leadership on safety participation.

However, the best- fit measurement model indicated that there was no direct effect of transformational safety leadership on safety compliance. Safety –related events did not fully mediate the effect between safety compliance and safety participation. Most of the survey items related to Emergency Response Planning (ERP) had poor loadings during the factor analysis and had to be dropped. That may indicate that respondents were not familiar with policies and processes related to ERP.

An ANOVA suggested that certified flight instructors significantly had better safety participation and safety compliance than pre-private pilots. The ANOVA further revealed that *senior* students significantly had better safety participation than *junior* students. The

ANOVA finally revealed that senior students were significantly more exposed and aware of safety –related events more than junior students.

A *T-test* of mean did not reveal any significant differences in safety participation and safety compliance between respondents who had formal SMS training and those who did not. A review of factual safety data suggests a positive effect on the safety reporting and safety meeting attendance among respondents due to the SMS initiative. Interviews revealed that top level management support, resource provision and resilience are key elements in the success of any SMS initiative. SMS process ownership by respondents was also identified as essential for a sustainable SMS initiative. Technical expertise was identified as a major SMS implementation challenge.

Overall, this study was timely and provided additional insight and literature on SMS to help collegiate aviation management, regulators and policy makers to establish a data driven approach in formulating policies for SMS implementation and continuous improvement on safety, while reducing safety events and accidents. This study also investigated the effects of a collegiate aviation SMS initiative on pilots' safety behaviors for two reasons. Even though SMS is gradually becoming an industry accepted benchmark for safety and reliability and is getting a lot of advocacy from both the FAA, industry and, ICAO, there is still limited research examining SMS initiative in collegiate aviation (Adjekum, 2014b, Chen, 2014).

Limitations

Some of the limitations of this study were the fact that the survey was about individual's attitudes and perceptions and that inherently renders such responses to response bias and social desirability bias. It was assumed that the responses reflected the actual perceptions of these respondents within that time and moment. Some of the respondents were freshmen and pre-private students who were still getting used to the institutional safety culture and that may have an effect on their perception on the SMS initiative.

The conceptual measurement model for this study was subjected to iterative modification to get a good- fit to estimate the strengths of relationships among the constructs, resulting in a final measurement model that aimed at adequately representing the constructs under study. The use of factor analysis (Exploratory and Confirmatory) as a data reduction tool resulted in a series of modifications of the final model compared to the proposed model.

The concepts of transformational safety leadership and self-efficacy are highly subjective and were measured as the perceptions of the respondents. Neither the instrument nor the study differentiated among flight level supervisory management relative to the respondents, as they may come into various contacts with diverse people, whose leadership traits at any particular time may represent operational safety leadership.

The concurrent –triangulation method was also limited to a snapshot of perceptions of SMS initiative implementation within the study period and may not have reflected the general trend over a long period. The dynamic nature of flight operations and the real-time occurrence of a safety –related event during the study period have a potential to affect the perceptions of respondents.

Future Directions

This particular study has established a benchmark for assessing SMS at within the collegiate aviation environments and provides a template for evaluation of the effectiveness of an SMS program with established safety performance metrics using a concurrent-triangulation method which provide a holistic and thorough audit of the safety initiative.

Future studies may concentrate on a longitudinal study that will assess how the predictive capabilities of the exogenous variables such as SMS initiative, self –efficacy, safety motivation and transformational safety leadership affects safety behavior and safety-related events over time by sampling a cohort of flight students from the freshman year to the senior year. Other studies may involve an inter-collegiate triangulation studies to include other US collegiate aviation programs with and without functional SMS programs. Another research area could be a comparative assessment of collegiate aviation programs in the US at the various levels of the FAA voluntary SMS program implementation level to gain insight into some of the trends and predictive relationship that may exist between the exogenous variables, safety behavior and safety-related events.

APPENDICES

APPENDIX A

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Title: Scale development of safety management system evaluation for the airline industry
Author: Ching-Fu Chen,Shu-Chuan Chen
Publication: Accident Analysis & Prevention
Publisher: Elsevier
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Schwarzer, R., & Jerusalem, M. (1995). Generalized Self-Efficacy scale. In J. Weinman, S. Wright, & M. Johnston, *Measures in health psychology: A user's portfolio. Causal and control beliefs* (pp.35-37). Windsor, UK: NFER-NELSON.

Professor Dr. Ralf Schwarzer
www.ralfschwarzer.de

Permission for Safety Behavior (Safety Participation and Safety Compliance) Scale

Title: The impact of organizational climate on safety climate and individual behavior

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August 29, 2016

Principal Investigator:	Daniel Kwasi Adjekum
Project Title:	An Evaluation of the Relationships between Safety Management System Initiatives, Transformational Safety Leadership, Self-Efficacy, Safety Behavior, and Safety-Related Events Mediated by Safety Motivation in Collegiate Aviation
IRB Project Number:	IRB-201608-044
Project Review Level:	Expedited 6, 7
Date of IRB Approval:	08/26/2016
Expiration Date of This Approval:	08/25/2017
Consent Form Approval Date:	08/26/2016

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 L. Bowles

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

Invitation Letter for Semi-Structured Interviews

Daniel Kwasi Adjekum

Graduate Teaching Assistant/Ph.D. Candidate

Department of Aviation.

University of North Dakota.

Phone: 701-630-9743.

Email: kadjekum@yahoo.com.

Associate Dean/Assistant Dean/Process Managers.

Invitation to Participate in Research on Aviation Safety Management System (SMS) Initiative

I respectfully request your strategic leadership perspectives on the [redacted] initiative and its effect on students/personnel safety behavior and safety-related events through a semi-structured interview. I am under the supervision of Dr. Warren Jensen of the Aviation Department and a dissertation committee.

Your input is required because you are a senior management personnel and process manager in the SMS initiative. The interview is envisaged to last not more than 45 minutes and the questions and IRB approved consent forms are attached for your perusal. I would be available to arrange a schedule and location convenient to you for the recorded interview. The interview time line is the last week in September 2016. Please feel free to revert to me if there are any questions.

Thank you.

Sincerely.

Daniel Kwasi Adjekum

Ph.D. Candidate

Aerospace Sciences

Invitation Letter for Anonymous E-mail Surveys

INVITATION TO PARTICIPATE IN AN AVIATION SAFETY MANAGEMENT SYSTEM (SMS) SURVEY

My name is Daniel Kwasi Adjekum and I am a doctoral candidate (Aerospace Sciences) at the UND Odegard School of Aerospace Sciences. I am currently working on my dissertation, which is in the area of evaluating the perceptions of flight students and certificated flight instructors (CFI) on the relationships between SMS, transformational safety leadership, self-efficacy, safety behavior, and safety –related events mediated by safety motivation in the [redacted] flight program. I respectfully request your response to an on- line survey (Maximum response time of about 15 minutes), which is strictly voluntary and anonymous. All information and data would be secured in line with [redacted] IRB policy on handling of data.

Please find below the **Anonymous Survey Link:**

https://[redacted].qualtrics.com/SE/?SID=SV_3PhW917KfJ95sPj

Your candid opinion will help me to evaluate the relationships that exist within the research variables, in order to make recommendations for continuous improvement of aviation safety at [redacted]. This study will also enhance the effectiveness of our Safety Management System (SMS).

For any further clarification and information please feel free to send me an email at kadjekum@ yahoo.com/ Daniel.adjekum@NDUS.edu or Dr. Warren Jensen @wjensen@aero.und.edu.

Thanks for your participation.

Daniel Kwasi Adjekum

Ph.D. Candidate (Aerospace Sciences)

APPENDIX B

SMS Initiative Dissertation Survey 2016 (Used for Quantitative Part of Research)

<u>Demographic Details</u>

Q1 Year Group

- ❍ Freshman
- ❍ Sophomore
- ❍ Junior
- ❍ Senior

Q2 Flight Certificate Held

- ❍ Pre-Private/Student
- ❍ Private
- ❍ Commercial
- ❍ Certified Flight Instructor (CFI, CFII, MEI)

Q3 Age Group

- ❍ 17-21
- ❍ 22-26
- ❍ 27-31
- ❍ 32-36
- ❍ Other

Q4 Gender

- ❍ Male
- ❍ Female

Q5 Are you an International Contract Student?

- ❍ Yes
- ❍ No

Q6 Have you had any formal initial training in Safety Management System (SMS) in your program?

- ❍ Yes
- ❍ No

Q7. Please provide your degree of agreement regarding the following statements about the Safety Management System (SMS) in your flight program

	Strongly disagree (1)	Disagree (2)	Neither disagree or agree (3)	Agree (4)	Strongly agree (5)
SMS1. The safety policy is documented and includes a commitment to involve all students/personnel at all levels in the maintenance of SMS	❍	❍	❍	❍	❍
SMS 2.The safety policy is communicated to all students/personnel to make them aware of their individual safety obligations.	❍	❍	❍	❍	❍
SMS3.The safety policy is signed and approved by the Dean, who demonstrates a commitment to safety through active and visible participation in the SMS	❍	❍	❍	❍	❍
SMS4.Conditions under which punitive disciplinary action would be considered (e.g. illegal activity, negligence or willful misconduct) are not clearly defined.	❍	❍	❍	❍	❍

Q8. Please provide your degree of agreement regarding the following statements about the SMS in your flight program

	Strongly disagree (1)	Disagree (2)	Neither agree nor disagree (3)	Agree (4)	Strongly agree (5)
SMS5.There is an established means of spreading information on SMS related matters to students/personnel.	❍	❍	❍	❍	❍
SMS6.Safety objectives and goals are publicized.	❍	❍	❍	❍	❍
SMS7.Students/personnel are not informed on the primary contacts for aviation safety related matters.	❍	❍	❍	❍	❍
SMS8.Top level management allocates resources for achieving the safety objectives and goals of the school.	❍	❍	❍	❍	❍

Q9. Please provide your degree of agreement regarding the following statements about the SMS in your flight program

	Strongly disagree (1)	Disagree (2)	Neither agree nor disagree (3)	Agree (4)	Strongly agree (5)
SMS9.Students/personnel are aware of procedures that measure safety performance on a regular basis, with the purpose of improving safety.	❍	❍	❍	❍	❍
SMS10.The results of safety performance reviews are used by the program leadership as input for safety improvement processes.	❍	❍	❍	❍	❍
SMS11.There is a process that provides for the capture of information on hazards, incidents, accidents and other data relevant to SMS.	❍	❍	❍	❍	❍

Q10. Please provide your degree of agreement regarding the following statements about the SMS in your flight program

	Strongly disagree (1)	disagree (2)	Neither agree nor disagree (3)	agree (4)	Strongly agree (5)
SMS12.There is a feedback process to notify contributors that their safety reports have been received and the results of the analysis shared.	❍	❍	❍	❍	❍
SMS13.Students/personnel know the criteria for evaluating the tolerable level of risk the flight program is willing to accept.	❍	❍	❍	❍	❍
SMS14.The scope of safety related hazards that must be reported are not explained to students/personnel.	❍	❍	❍	❍	❍
SMS15.There is a constant awareness of the Emergency Response Plan (ERP) in the flight program.	❍	❍	❍	❍	❍
SMS16.Students/personnel are not familiar with their role in the Emergency Response Plan (ERP) of the flight program.	❍	❍	❍	❍	❍
SMS17.Student/personnel are part of periodic drills to test the effectiveness of the ERP.	❍	❍	❍	❍	❍

Q11. Please provide your degree of agreement regarding the following statements about the SMS in your flight program

	Strongly disagree (1)	Disagree (2)	Neither agree nor disagree (3)	Agree (4)	Strongly agree (5)
SMS18.There is a process for the systematic investigation of operational conditions that have been identified as potentially hazardous	❍	❍	❍	❍	❍
SMS19.Corrective and preventative actions are generated in response to event investigation and analysis	❍	❍	❍	❍	❍
SMS20.Safety professionals with appropriate skills, knowledge and experience conduct SMS training	❍	❍	❍	❍	❍

Q11.Cont. Please provide your degree of agreement regarding the following statements about the SMS in your flight program.

	Strongly disagree (1)	Disagree (2)	Neither agree nor disagree (3)	Agree (4)	Strongly agree (5)
SMS21.SMS training is part of indoctrination training upon enrollment or employment.	❍	❍	❍	❍	❍
SMS22.SMS training is kept current to reflect new techniques, results of investigations and corrective actions.	❍	❍	❍	❍	❍

Q12 Please provide your degree of agreement regarding the following statements about yourself

	Strongly disagree (1)	Disagree (2)	Neither agree nor disagree (3)	Agree (4)	Strongly agree (5)
SMS23.I can always manage to solve difficult problems if I try hard enough	❍	❍	❍	❍	❍
SMS24.It is easy for me to stick to my aims and accomplish my goals	❍	❍	❍	❍	❍
SMS25.I am confident that I can deal efficiently with unexpected events	❍	❍	❍	❍	❍
SMS26.I can remain calm when facing difficulties because I can rely on my coping abilities	❍	❍	❍	❍	❍

Q13 Please provide your degree of agreement regarding the following statements about yourself

	Strongly disagree (1)	Disagree (2)	Neither agree nor disagree (3)	Agree (4)	Strongly agree (5)
SMS26.It's worthwhile to improve personal safety	❍	❍	❍	❍	❍
SMS27.It's important to maintain safety at all times	❍	❍	❍	❍	❍
SMS28.It's important to reduce risk of safety events in flight operations	❍	❍	❍	❍	❍

Q14 Please provide your degree of agreement regarding the following statements about yourself

	Strongly disagree (1)	Disagree (2)	Neither agree nor disagree (3)	Agree (4)	Strongly agree (5)
SMS29.I pay full attention to pre-flight briefing during flight operations	❍	❍	❍	❍	❍
SMS30.I follow correct safety procedures in flight operations	❍	❍	❍	❍	❍
SMS31.I ensure the highest level of safety in flight operations	❍	❍	❍	❍	❍
SMS32.I promote the safety program within the flight program	❍	❍	❍	❍	❍
SMS33.I put in extra effort to improve the flight safety program	❍	❍	❍	❍	❍
SMS34.I volunteer for safety related task in the flight program	❍	❍	❍	❍	❍

Q15 Please provide your degree of agreement regarding the following statements about the quality of leadership provided in your flight program by these supervisory managers (Chief Flight Instructor/Assistant Chief Flight Instructor)

	Strongly disagree (1)	Disagree (2)	Neither agree nor disagree (3)	Agree (4)	Strongly agree (5)
SMS35.Look out for the interest of the flight program over personal interest	❍	❍	❍	❍	❍
SMS36.Does not listen to students concerns	❍	❍	❍	❍	❍
SMS37. Can be trusted to overcome every obstacle	❍	❍	❍	❍	❍
SMS38. Clearly defines the steps needed to reach training goals	❍	❍	❍	❍	❍
SMS39. Considers the ethical consequences of decisions	❍	❍	❍	❍	❍
SMS40. Is disrespectful in handling students errors	❍	❍	❍	❍	❍

Q16 Please state to the best of your knowledge, frequency of safety events that have occurred in the program this academic year

	Very Rare (Has never occurred)	Rare (Has occurred only once)	Occasional (2-3 times)	Frequent (4-5 times)	Very frequent (more than 5 times)
SMS41. Deviation from ATC instructions under normal flight conditions	❍	❍	❍	❍	❍
SMS42. Runway incursions	❍	❍	❍	❍	❍
SMS43. Close proximity to another aircraft requiring evasive action	❍	❍	❍	❍	❍
SMS45. Collision with ground object while taxiing	❍	❍	❍	❍	❍
SMS46. Loss of flight privilege/Flight hold due to alcohol or controlled substance use.	❍	❍	❍	❍	❍

Q17 what are your opinions on the safety performance of the aviation program with the implementation of the SMS initiative?

Q18 How can the aviation program improve the SMS initiative?

Q19 Thanks for taking part in this study.

APPENDIX C

SPSS® Outputs and Nvivo® Screen Shots

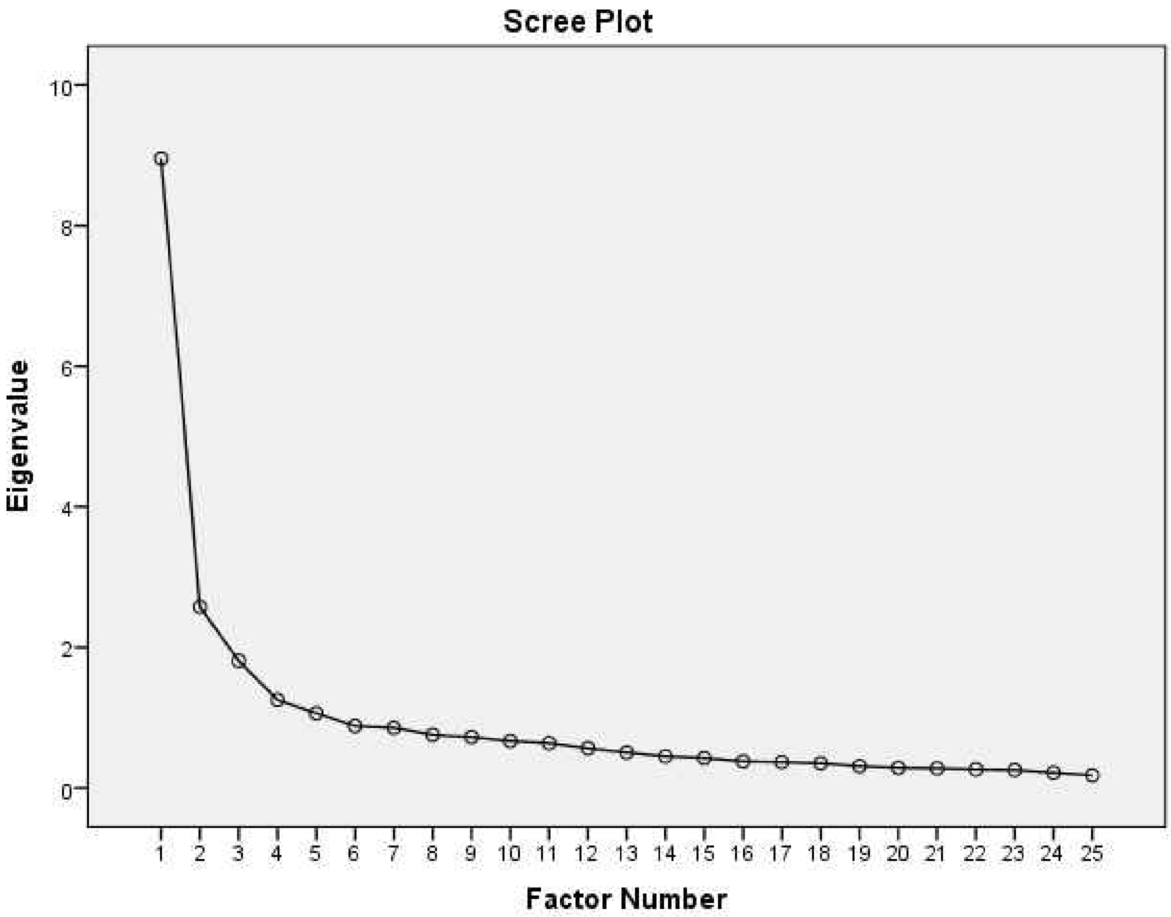

Figure 1C. Scree Plot of factors obtained in SMS initiative.

Table 1C. Rotated Factor Matrix of SMS Initiative.

Items	Factor SMSPol.Imp.	SMSPro.Eng.
SMS3 - The safety policy is signed and approved by the Dean, who demonstrates a c...	.752	
SMS23- Safety professionals with appropriate skills, knowledge and experience conduct...	.746	
SMS14 -There is a process that provides for the capture of information on hazards...	.729	
SMS13 -The results of safety performance reviews are used by the program leadership...	.718	
SMS25- SMS training is kept current to reflect new techniques, results of investigations...	.700	
SMS2 -The safety policy is communicated to all students/personnel to make them aw...	.694	
SMS24- SMS training is incorporated into indoctrination training upon enrollment o...	.677	
SMS6 -Top level management clearly articulate the importance of safety when addressing...	.660	
SMS12- Students/personnel are aware of procedures that measure safety performance...	.659	
SMS16 -Students/personnel know the criteria for evaluating the tolerable level of...	.646	
SMS1- The safety policy is documented and includes a commitment to involve all students and personnel.	.642	
SMS4- There is a policy in place that provides immunity from disciplinary action...	.631	
SMS22- Corrective and preventative actions are generated in response to event investigations.	.629	

Table. 1C. Cont.

Items	SMS Pol.Imp.	SMS Proc.Eng.
SMS11- Top level management declares a strong commitment to SMS, even when SMS goa...	.568	
SMS8 Safety objectives and goals are publicized.	.561	
SMS15- There is a feedback process to notify contributors that their safety report...	.552	
SMS7- There is an established means of spreading information on SMS related matte...	.546	
SMS10 -Top level management allocate resources for achieving the safety objectives...	.518	
SMS21- There is a process for the systematic investigation of operational condition...		Low Loading
SMS9- Students/personnel are not informed on the primary contacts for aviation s...		.790
SMS17- The scope of safety related hazards that must be reported are not explained...		.723
SMS20- Student/personnel are part of periodic drills to test the effectiveness of...		.569
SMS5- Conditions under which punitive disciplinary action would be considered (e....		.537
SMS18 -There is a constant awareness of the Emergency Response Plan (ERP) in the...		Low Loading
SMS19 - Students/personnel are not familiar with their role in the Emergency Response...		Low Loading

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

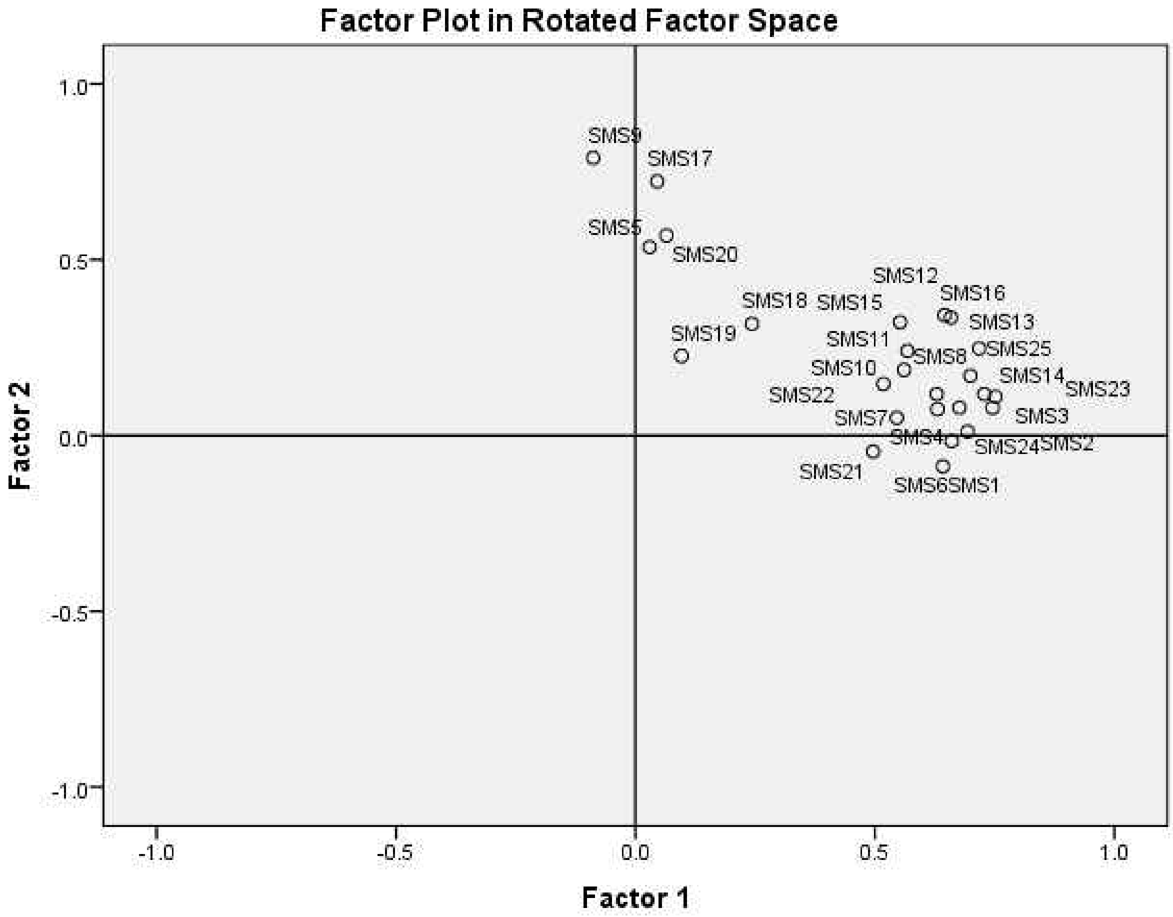

Figure 2C. Factor Plot in Rotated Space for SMS Initiative.

Table 2C. Estimates of Variables using CFA.

			Estimate	S.E.	C.R.	P	β
SE 1	<---	Self-Efficacy	.720	.057	12.664	***	.67
SE 2	<---	SelfEfficacy	.667	.055	12.173	***	.85
SE 3	<---	SelfEfficacy	.641	.050	12.747	***	.83
SM 1	<---	SafetyMotivation	.610	.045	13.484	***	.81
SM 2	<---	SafetyMotivation	.720	.046	15.672	***	.90
SM 3	<---	SafetyMotivation	.647	.047	13.868	***	.83
SC 1	<---	SafetyCompliance	.648	.045	14.388	***	.85
SC 2	<---	SafetyCompliance	.642	.046	13.848	***	.83

Table 2C. Cont.

			Estimate	S.E.	C.R.	P	β
SC 3	<---	Safety Compliance	.654	.045	14.606	***	.86
SP 1	<---	SAFEPART	.673	.060	11.191	***	.74
SP 3	<---	SAFEPART	.734	.074	9.918	***	.94
SP 2	<---	SAFEPART	.922	.063	14.593	***	.66
TSL1	<---	TransformationalSafety Leadership	.799	.059	13.488	***	.81
TSL4	<---	TransformationalSafety Leadership	.770	.052	14.828	***	.80
TSL3	<---	TransformationalSafety Leadership	.782	.059	13.190	***	.86
TSL5	<---	TransformationalSafety Leadership	.751	.056	13.381	***	.80
SEV1	<---	SafetyRelatedEvents	.950	.078	12.193	***	.75
SEV3	<---	SafetyRelatedEvents	1.021	.073	14.080	***	.89
SEV2	<---	SafetyRelatedEvents	1.027	.065	15.785	***	.83
SEV4	<---	SafetyRelatedEvents	.816	.063	12.986	***	.78
SEV5	<---	SafetyRelatedEvents	1.100	.089	12.290	***	.75

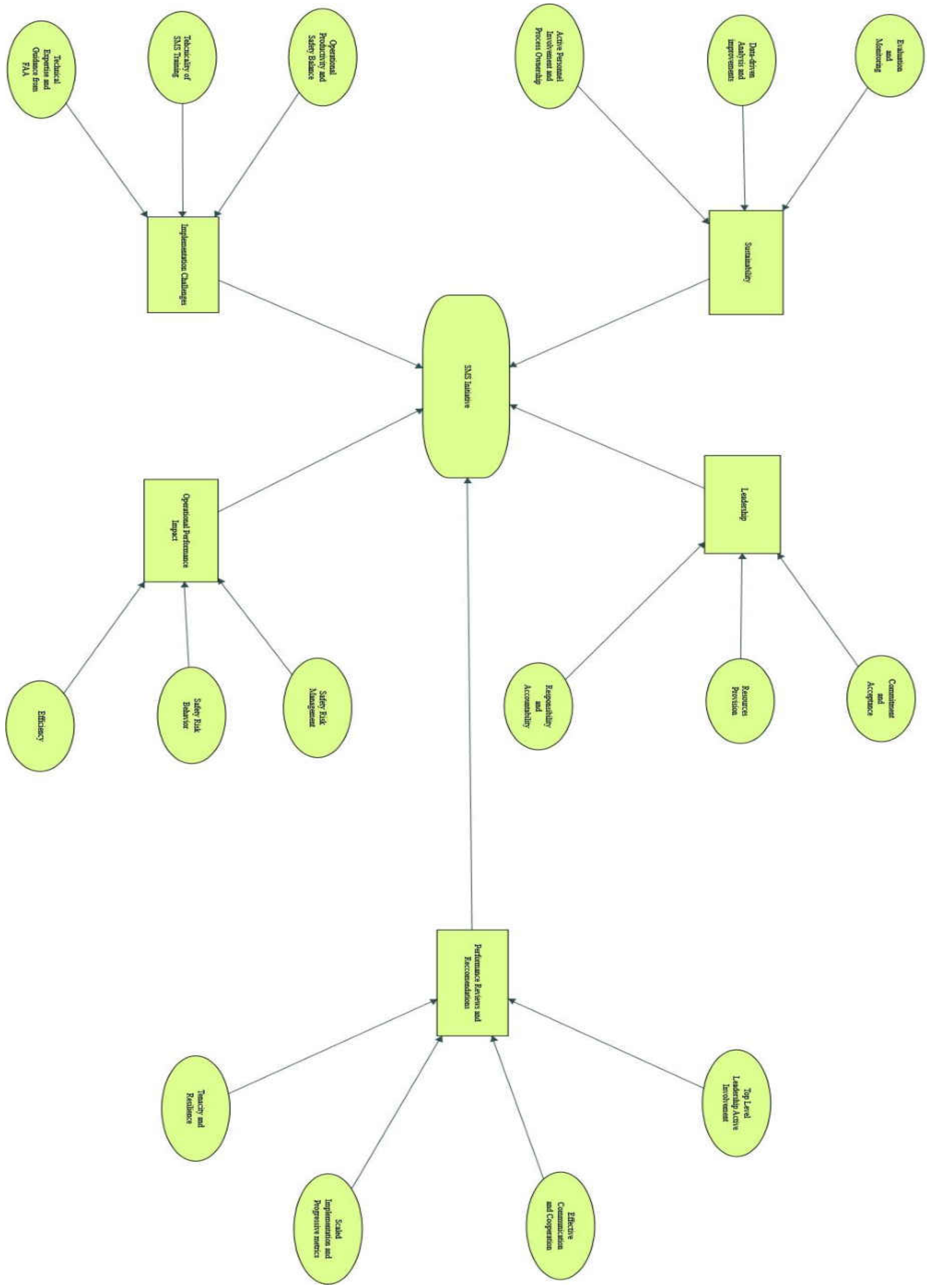

Figure 3C. Conceptual Qualitative Coding Tree (Using NVivo 11®).

Figure 4C. Screen shot of Qualitative Coding Word Cloud (Using NVivo 11®).

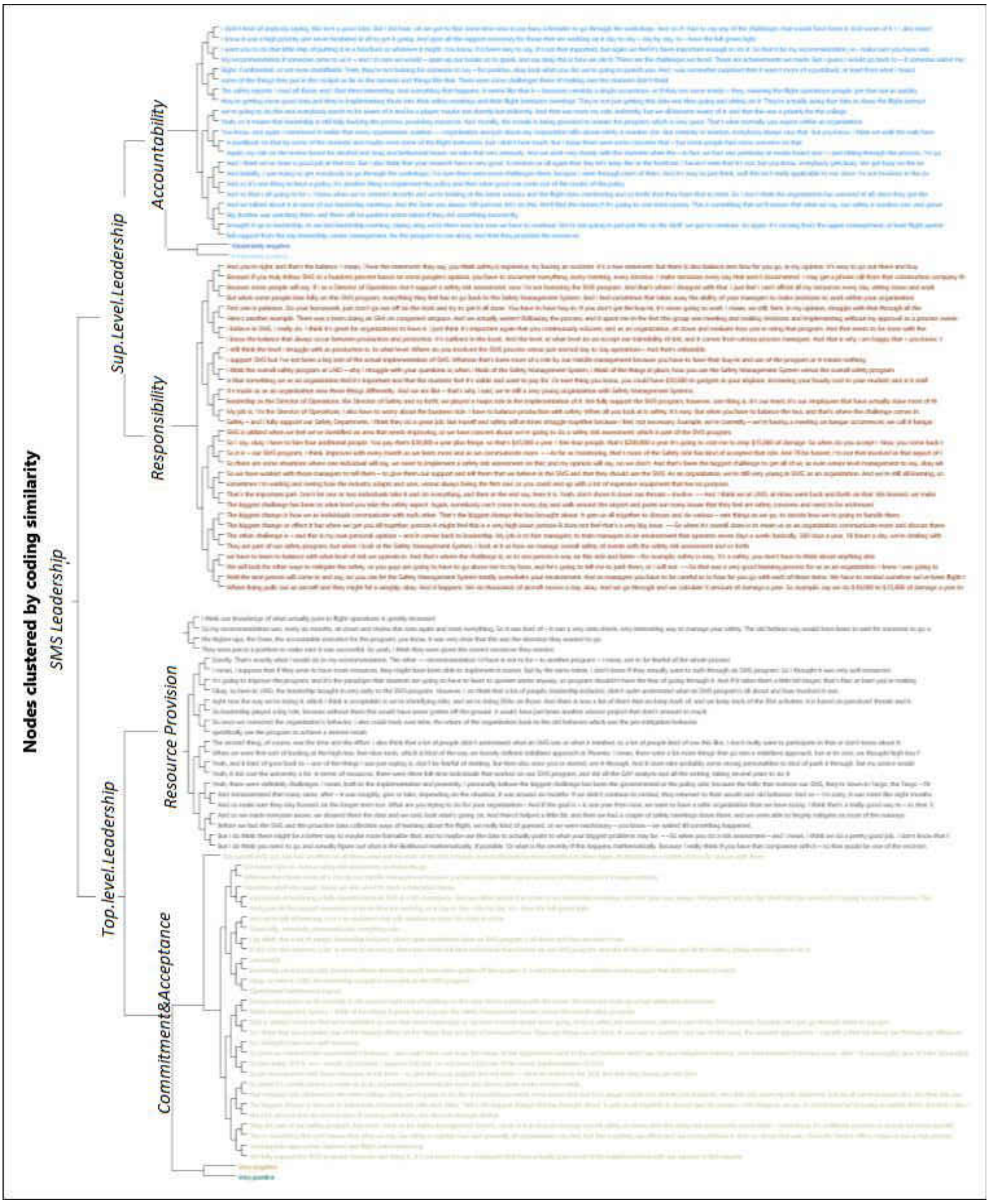

Figure 5C. Screenshot of Nodes Clustered by Coding Similarities (Using Nvivo 11®).

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