Examining Principle Core Competencies for Aviation-Safety Professionals

Dissertation

Submitted to Northcentral University

Graduate Faculty of the School of Business and Technology Management

in Partial Fulfillment of the

Requirements for the Degree of

DOCTOR OF PHILOSOPHY


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April 2014

Approval Page

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## Abstract

In comparison with other natural or fabricated disasters, unacceptable accidents in commercial airlines gain attention at the national and global level, despite the fact thatnaturalor fabricated catastrophes may lead to greater casualties and higher financial burden. Current aviation industry standards for the assignment of personnel to aviation-safety departments vary from company to company. A person is placed into a safety position by a director of safety or human resources or by a manager of authority. The problem is the lack of governmental and industry requirements and qualifications for aviation-safety professionals to control risk and prevent accidents. Aviation-safety professionals have no mandated regulatory requirements based on education level, professional licensing andcertification, and competencies. The purpose of this study was to examine the comparative relationship of core competencies, education, and professional licensing and certification of aviation-safety professionals in commercial and transportation aviation industries. The non-experimental mixed methods comparative study focused on the criterion variable of core competencies and the predictors of education, professional certification, professional licensing, and the skills and abilities necessary to function as an aviation-safety professional. The target audience for this study was a sample size of 524 aviation-safety professionals in U.S.-based aviation companies. These aviation-safety professionals acted as the competency generators to examine the necessary core safety professional competencies required to manage commercial and transportation aviation-safety programs. With three statistical tests for reliability, the conclusions and resultsrevealed a high degree of reliability in support of the core safety competencies ofeducation, professional licensing, and

certification of aviation safety professionals in commercial and transportation aviation industries. The results suggest future research by other researchers or professionals in the areas of aviation safety orfor possible dissertation topics by new doctoral studentsfor study with different survey populations such as government, industry, and/or academia.Future research can also focus on differences in competencies according to the level of responsibility (entry, middle, or senior level).

Table of Contents

**List of Tables**

# Chapter 1: Introduction

In comparison with other natural or human error disasters, unacceptable accidents involving commercial airlines gain attention at the national and global level (Haruta & Hallahan, 2004), despite thatnatural or human error catastrophes may lead to greater casualties and higher financial burden. Such attention is evident from the amount of airtime used by 24-hour news channels to present updates regarding anaccident (Cobb & Primo, 2003). The National Transportation Safety Board (NTSB, 2005) response efforts and incident details collaboratewith local and national news media.Thesepress releases and media statements from the NTSB include daily updates regarding a plane crash, injury andcasualty status, identification of the cause of the incident, and development of necessary measures to ensure the prevention of such incidents in the future (Cobb & Primo, 2003).

In a Joint Flight Standards Project report by the Federal Aviation Association (FAA) the agency identified several factors in relation to the probable causes of aircraft incidents, including pilot competence, maintenance quality, financial stability, and management attitude (Cobb & Primo, 2003). To address the aspect of corporate safety management programs and attitudes, officials from the FAA conceptualized a large-scale, decade-long project with the objective of reducing the rate of aircraft accidents and incidents (Cobb & Primo, 2003). Components of the FAA report involved the formulation and concept of the FAA's Joint Flight Standards Handbook Bulletin for Air Transportation (HBAT) and for Airworthiness (Cobb & Primo, 2003). The Joint Flight Standards Project findings outlined strategies that would help decrease commercial airline incidents through the collaboration of experts from academia, manufacturing industry, government agencies, and commercial airlines (Cobb & Primo, 2003). Relying on the accumulation of aviation-safety expertise gained from years of experience, the professionals from the Joint Flight Standards Project conducted a safety management study. The aim was to probe and clarify fundamental problems in the aviation industry although studies have indicated that the FAA generallyhas surpassed its aviation safety goals (FAA Exceeds General Aviation Safety Goals, 2008).

One significant objective, however, was not addressed in the resulting report:the identification of requisite core safety skills and knowledge that aviation-safety professionals should possess tomanage and promote a proactive safety environment (Cobb & Primo, 2003). Taking into account the regulatory nature of aviation and the specific federal requisites enforced on pilots and mechanics, the researcher found that the recommendations of specific core aviation-safety competencies for safety professionals are weak in definition (J. Oyler, personal communication, July1, 2012). The following is an example of these deficiencies: the only qualification for the Director of Safety for an air carrier is employment in a full-time capacity in that position (FAA, 2005).

**Background**

Current aviation industry standards for the assignment of personnel to aviation-safety departments vary from company to company (Shao, 2012). A director of safety or human resources, management of authority, or a combination of these personnelmay determine the capacity or experience by the selector place personnel into a safety position (J. Oyler, personal communication, July 1, 2012). With no core competencies identified by governmental requirements, these hiring officials and company directives or policies determined the core requirements for safety positions (Cobb & Primo, 2003).

The identification of the core requirements had become the responsibility of these aviation managers usually uninformed on the subject of the requisite skill requirements (Cobb & Primo, 2003). No uniform and standard qualifications existed among air carriers, similarities in size and fleet composition of such carriers notwithstanding (Cobb & Primo, 2003). Aviation flight safety management studies were deficient and too broad in focus even though other industries had conducted safety management studies in other industries (Glendon, Clarke, &McKenna, 2006). Air carriers did not even have uniform and standard qualifications for safety personnel (FAA, 2005). Safety management studies existed in other industries (Jovanis & Gross, 2006) although safety management studies in aviation did not identify adequately the safety competencies (Wood, 2003).

The proposed quantitative comparatives study focused on the examination of core competencies and their relationship to education, professional certification, professional licensing, and the skills and abilities necessary to function in the capacity of an aviation-safety professional (Danylchuk, 2012). Safety professionals consider these core competencies necessary to ensure successful and proactive management of safety procedures and processes within the commercial aviation industry (J. Oyler, personal communication, July 1, 2012). Setting boundaries by identifying necessary core competencies would contribute to the profession of safety in the aviation industry (Pantankar, 2008). The contribution of examining core competencies from this study may become significant to managers and the aviation industry as a guide for the selection, qualification, and hiring of aviation-safety positions (Keshavarzi, 2011).

The government body regulating the United States aviation industry, the FAA (2012), does not list any specific requirements or qualifications for aviation-safety professionals. The authority contained in Federal Aviation Regulations (FAR) Part 119, Certification: Air Carriers and Commercial Operators (Title 14 Code of Federal Regulations Part 119) outlines the minimum qualifications and requirements for management personnel. FAR Part 119, Section 119.65, identifiesfive mandatory management positions for FAR Part 121--Operating Requirements: Domestic, Flag, and Supplemental Operations. The purpose and intent disclosed in FAR 119 states,

> Each certificate holder must have sufficient qualified management and technical personnel to ensure the highest degree of safety in its operations. The certificate holder must have qualified personnel serving full-time in the following or equivalent positions: Director of Safety, Director of Operations, Chief Pilot, Director of Maintenance, and Chief Inspector. (FAA, 2012, Section 119.65)

In the midst of the continual evolution of aviation technology, the interaction between man and machine had engulfed the human operational environment and had become a main focus in risk management and aviation safety (Tjorhom, 2010).

Moreover, areas of aviation safety concern should have been addressed to alleviate the predicaments arising not only during normal flight but also during abnormal flights. A clear comprehension of the specific skills thataviation-safety professionals should possess may contribute to the body of safety knowledge. This knowledge has been accumulated since the first flight of the Wright brothers at Kitty Hawk, NC (Murdock, 2000).

**Problem Statement**

The problem this study addressed was the lack of governmental and industry requirements and qualifications for aviation-safety professionalsto control risk and prevent accidents (Brantley, 2008). Government agencies had not mandated any regulatory requirements for aviation-safety professionals based on the fundamentals of education level, professional licensing, certification, and competencies. This absence of requirements for aviation-safety professionals posed a negative image and effect, not only for the industry but also for the safety of the public (Keshavarzi, 2011). The regulations governing aviation safety mandated its presence but did not place the proper controls or qualified aviation-safety professionals in place as an enforcement or authority figures. Currently, persons with no knowledge in the field of safety can fill these aviation-safety professional positions.

The qualifications of management personnel identified in Section 119.65 were listed in FAR Part 119, Section 119.67 Management Personnel: Qualifications for Operations Conducted under Part 121. Of these five minimal positions, the FAA only addressed the requirements for the Director of Operations, Chief Pilot, Director of Maintenance, and Chief Inspector (FAA, 2005). The Director of Safety position, normally identified as a safety professional in aviation, had no minimum qualification requirements identified by the FAA in Section 119.67 (FAA, 2012). From this section, the director andchief positions had identified the following pre-qualifications that the person must hold: a rated FAA pilot's or mechanic's certificate for the capacity of that position, prior supervisory or managerial experience within a given time frame, and a minimum time frame for holding these certifications (FAA, 2012).

**Purpose Statement**

The purpose of this non-experimental mixed methods study was to examine the comparative relationship of the criterionvariable core competencies and the predictor variables of experience, managerial level, area of work, education, and certification of aviation-safety professionals in United States commercial and transportation aviation industries (Jovanis & Gross, 2006). Based upon *a priori* sample size estimates, this study useda sample of up to 524 respondents. To ensure that this sample size would be achieved, the researcher solicited responses from more than 3,000 aviation-safety professionals from airlines, government, academia, and business/commercial sectors. Current governmental regulations did not identify the core competency requirements, the education requirements, or the professional licensing and certification requirements of aviation-safety professionals (FAA, 2012).

With none of these attributes regulated for aviation-safety professionals, this study produced a baseline to align with the justification statement by the American Society of Safety Engineers (ASSE, 1999). Representatives of the ASSE asserted there was a need for certification of safety professionals and recommended minimum standards and criteria for safety professionals, safety practitioners, and technicians (Carvazos & Rutherford, 2011). The comparative relationship of competencies, education, professional licensing, and certification of aviation-safety professionals may serve as aninstrument in the assessment of identifying training standards, certification, and training of aviation-safety professionals for academia, industry, professional societies andassociations, and government agencies (Waikar, 1997). The foundation of this comparative study was the assessment of core competencies, education, and professional licensing and certification by experts in aviation safety (ASSE, 1999).

**Theoretical Framework**

Safety in aviation continues to increase with new technology and the regulatory drive in requirements for the *components* of the following: operators, manufacturers, infrastructure, facilities, and service providers. The current drive from the 2007 FAA Safety Management Systems (SMS) pilot program for airports and international requirements by ICAO had gained momentum to the release of a noticeof proposed rulemaking (ANPRM). The ANPRM released by the FAA (2012) established the groundwork for requiring aviation operators and businesses to implement an SMS program.

The International Civil Aviation Organization (ICAO) established a January 2009 deadline for nations to adopt an SMS mandate, to which the FAA replied with a statement of noncompliance or difference while the agency progressed towardcompliance. This implementation and integration of the SMS framework into these componentscreated obstacles and controversies in the incorporation of current safety and training programs. As these aviation components expanded their safety programs under the SMS framework, the criteria for employee and position placement played a critical role in its success (Kolesár & Petruf, 2012). Thus, the dilemmas and obstacles of SMS implementation still needed definitionsand mandates. Several questions arose for each aviation *component* regarding the necessary qualifications and skill set required or that must coexistfor the placement of employees, management positions, and programs.

**Research Questions**

To address the principal question, the researcher investigated the following specific research questions:

RQ1: To what extent, if any, did the competency ratings reported by respondents differ by levels of education?

RQ2: To what extent, if any, did the competency ratings reported by respondents differ by the major field of their study?

RQ3: To what extent, if any, did the competency ratings reported by respondents differ by professional certification and licensure?

RQ4: To what extent, if any, did the reported competency ratings differ byrespondents' membership in their respective departmental safety teams?

The primary goal to be addressed in this research was the examination of the direct relationship among professional endorsements, education, experience, and competencies required to be an effective aviation-safety professional tomanage safety programs for commercial and transport aviation companies. Regulatory compliance requirements did not define the requirements for aviation-safety professionals. The principal question to be addressed in this research was as follows: did the rating of competencies deemed required for aviation-safety professionals to possess have a direct relationship to experience, managerial level, area of work, education level, professional licensing, and professional certification? The researcher collected data from four work groups within the industry:

**Academia**. An aviation safety professional working for a college or university.

**Airline.** An aviation safety professional working for an airline.

**Business/Commercial Aviation.** An aviation safety professional working for corporate or business aviation.

**Government.** An aviation safety professional working for a government regulatory or investigative authority.

**Hypotheses**

The primary goal in this research was to translate the direct relationship among professional endorsements, education, and competencies required to be an effective aviation-safety professional. To manage safety programs for commercial and transport aviation companies, the writers of regulatory compliance requirements did not define the requirements for aviation-safety professionals. The principal question to be addressed in this research was: What competencies should aviation-safety professionals possess, and wasthere a direct relationship to experience, managerial level, area of work, education level, professional licensing, and professional certification associated with each competency?

Using analyses and tests of reliability, the researcher was able to identify which aviation industry best predicts core competencies measured on the study survey. Statistical significance wasset at the .05 confidence level.Opinions were based on the longevity of the experiences of the officials in the industries. The hypotheses were also revised to reflect the IRB Approved Survey Instrument. The revised hypotheses were:

H1o: There is no relationship between core competency and educational attainment of respondents.

H1a: There is a positive relationship between core competency and educational attainment of respondents.

H2o: There is no relationship regarding core competencies and respondents' major field of study.

H2a: There is a positive relationship regarding core competencies and respondents' major fields of study.

H3o: There is no relationship regarding difference in opinions regarding core competencies among respondents with a professional safety certification (license) from the FAA or training in a major field of study.

H3a: There is a difference regarding difference in opinions regarding core competencies among respondents with a professional safety certification (license) from the FAA or training in a major field of study.

H4o: There is no relationship between opinions of respondents regarding core competencies and respondents' membership in their respective departmental safety committees.

H4a: There is a relationship between opinions of respondents regarding core competencies and respondents' membership in their respective departmental safety committees.

The researcher examined mean differences among groups. Appropriate *post-hoc* analyses and reliability tests were employedto determine accuratelywhere mean differences lie and to reduce probability of Type I error. Statistical significance was determined at the .05 confidence level.

**Nature of the Study**

The researcher used the proposed study to examine the comparative relationship of competencies, level of experience, managerial level, area of work, education, professional licensing, and professional certification deemed necessary for aviation-safety professionals. The primary goal to be addressed in this research was to translate the direct relationship among professional endorsements, education, and competencies required to be an effective aviation-safety professional.

The research methodologies and analytical tools used in this study followed mixed methods principles and constructs. To aid the examination and investigation of the study, the researcher proposed research questions and several constructs. These constructs included the rating and evaluation of competencies important for an aviation-safety professional to possess.

The variables for this study focused on the six predictor variables and one criterion variable. The first predictor variable focused on the rating of competencies. The second variable with respect to competency rating was the educational level attained by the aviation-safety professional. The third variable was the professional license variable, and the fourth variable was the examination of the professional certification. The criterion variable for these hypothesis statements was competency rating. The researcher completed the individual evaluation of competencies using of a 7-pointLikert scale. The instrument used for data collection supporting the scope of this study was a survey questionnaire.

**Significance of the Study**

The key factor of public safety in the commercial aviation community was to ensure the public and company employees worked in a safe environment (Wood, 2003).

The values and fundamentals of safety in commercial aviation have a direct effect on public perception and trust (Wood, 2003). To complement the fundamental issue of trust, people placed in safety positions had to be competent and knowledgeable in their area of expertise (Wood, 2003). The issue of trust was complemented further by the role of the aviation-safety professional with a diverse background in basic safety management, the fields of flight safety, system safety analysis, ground andequipment safety, environmental safety training, and human factors (Wood, 2003). According to Sabatini (2004), aside from the management tasks of safety professionals, responsibilities also included investigation, program and policy development, and examination of flights.

According to the NTSB (2010), commercial airline travel is one of the safest methods among all means of transportation in terms of the number of mishaps per million miles operated. Given the number of fatalities and/orserious injuries and the number of commercial aircraft enplanements from 1986 to 2005, the chance of being gravely wounded or killed in a commercial aviation accident was only 0.00003% (NTSB, 2005). This figure was significantly less than the rate of fatalities or injuries in any other means of transportation.

The negative effect of commercial air travel's strong reputation for safety, however, was that most airline customers and airline staff simply viewedthe industry's safety status as standard (Wood, 2003). In most cases, examination ofaviation-safety procedures only became important when a major aircraft accident happened (Wood, 2003). Furthermore, when such an accident occurred, the media had a tendency to sensationalize and overstate the event--a reaction that served to promote a concentrated focus of public concern and awareness with respect to safe commercial air travel (Sabatini, 2004).

An example of this concern was the incident involving Southwest Airlines Flight 1248 in 2005, which occurred when a Boeing 737 overshot the end of the runway at Chicago Midway International Airport (AirSafe, 2005). The accident was a disaster for Southwest Airlines, which had never experienced a fatal accident during the 35 years of its corporate existence (AirSafe, 2005). Led by the NTSB, officials investigated this accident for approximately oneyear. The investigation necessitated both public and government queries on the subject of the various protocols and procedures that Southwest Airlines, Midway Airport, and various federal agencies had implemented (AirSafe, 2005).

Safety-related issues in air travel and investigative inquiries had signified the imperative need to guarantee that those individuals holding positions in aviation safety were competent and expert in their areas of responsibility (Wood, 2003). The researcher intended to identify the competencies required to warrant that employees, equipment, and facilities are in compliance with safety regulations.The researcher also intended to ensure that aviation personnel transport passengers in a safe, efficient, and seamless manner from their point of origin to their ultimate destination (Wood, 2003).

**Definitions**

The following definitions identify key terms used in this research study in the field of aviation safety.

**Air Transport Association of North America (ATA).** The ATA is a trade association for the airline industry in the United States and seeks to operate within several areas of concern and withemphasis on safety, service, and efficiency (ATA, 2009).

**American Society of Safety Engineers (ASSE).** The ASSE (2006) is the largest safety-related organization in the United States consisting of more than 30,000 active members. ASSE membership consists of professionals from industry, government, andeducation with expertise in the area of environment, safety, and health (ASSE, 2006).

**Board of Certified Safety Professionals (BCSP).** The BCSP is a board whose sole purpose is to certify the competency of practitioners in the safety profession (BCSP, 2006).

**Certificate holder.** A certificate holder is an airline company that has satisfactorily met the required standards set by the FAA to transport passengers, cargo, or a combination of the two (FAA, 2006). Depending on the result of the certification process, the certificate may restrict the certificate holder to domestic or international routes or a combination of the two (FAA, 2006).

**Civil aviation.** Civil aviation is one of two major classifications of flying, representing all nonmilitary operations, both private and commercial (Stolzer, Halford, & Goglia, 2008). According to Stolzer et al.(2008), “Civil aviation has two major categories: (a) the scheduled air transport that are passenger or cargo flights operating on regularly-scheduled routes and (b) general aviation that includes all other flights, whether private or commercial” (p. 21).

**Commercial flight safety manager.** A commercial flight safety manager is an individual responsible for aviation-specific safety management, training, investigation, compliance, and regulatory programs at a commercial aviation company (Wood, 2003).

**Department of Transportation (DOT).** The DOT is an executive department at a cabinet level of the U.S. government that formulates and implements policies and programs to ensure an efficiently and economically sound national transportation system (DOT, 2006). The DOT consists of 13 agencies that specialize in different aspects of the U.S. transportation system (DOT, 2006).

**Director of Safety (DOS).** The DOS is a member of the airline management team which the Federal Aviation Regulation (FAR) 119.65 requires for operations conducted under FAR Part 121 (FAA, 1999). According to FAR Part 121, one requirement that an airline company must satisfy for certification is the involvement of adequately qualified management and technical personnel, including the DOS, to guarantee the maximum level of safety in its operations (FAA, 1999).

**FAR Part 121 Flag Operation.** This FAR procedure is a scheduled operation used by any individual operating any turbojet-powered airplane that contains more than nine passenger seats, excluding each crewmember seat. The operation is also used for any airplane containing a payload capacity in excess of 7,500 pounds at the location between any points within the U.S. or any territory or possession of the United States (FAA, 2006).

**FAR Part 135 Commuter Operation.** A FAR Part 135 Commuter Operation is a scheduled operation conducted by any person controlling any air transport vehicle, with the exception of turbojet powered airplanes with a maximum passenger-seat configuration of nine seats or less. A commuter operation has a payload capacity of 7,500 pounds or less, or rotorcraft, with a frequency of operation of at least five round trips per week on at least one route between two or more points according to the published flight schedules (FAA, 2006).

**Federal Aviation Administration (FAA).** The FAA (2006) is a division of the DOT with the main responsibility of ensuring the safety in the civil aviation system.

**Federal Aviation Regulations (FARs).** The FARs are a set of rules and regulations stipulated by the FAA, which oversees all operations pertaining to aviation in the United States (FAA, 1999).

**Flight Safety Foundation (FSF).** The FSF is an international, nonprofit organization engaged in research, auditing, education, and advocacy committed to the attainment of aviation safety (FSF, 2009).

**International Air Transport Association (IATA).** The IATA is a global trade organization for the domestic and international airline industries (IATA, 2007)

**International Civil Aviation Organization (ICAO).** The ICAO is a United Nations agency that administrates international air navigation through proposal formulation and international air transport and safety development (ICAO, 2006).

**International Society of Air Safety Investigators (ISASI).** The ISASI is an organization that endorses safety in air transportation through the exchange of ideas, experiences, and information about aircraft accident investigations; assists in the enhancement of flight safety; promotes technical advancement by providing professional education; and facilitates the exchange of information for mutual development and improved investigations (ISASI, 2006).

**National Transportation Safety Board (NTSB).** The NTSB is an independent U.S. governmental organization instituted by the Congress, which serves as an investigative body that deals with aviation, highway, marine, pipeline, and railroad accidents in the United States (NTSB, 2006).

**Transportation Security Administration (TSA).** Congress established the TSA in accordance with the Aviation and Transportation Security Act of 2001, which was enacted into law by President G. W. Bush on November 19, 2001 (TSA, 2006). The TSA was initially a division of the U.S. Department of Transportation but was transferred to the U.S. Department of Homeland Security on March 1, 2003 (TSA, 2006). Its main responsibility is to protect the security of passengers and baggage going through U.S. airports (TSA, 2006).

**Summary**

Historical data provided evidence that commercial air travel is the safest mode of transportation; however, the issue of safety in the aviation system should not be taken for granted. Regardless of the lower rate of casualties and injuries caused by air travel accidents, the safety situations in the air transportation industry must improve. The industry must enhance increased safety even before occurrences of unacceptable incidents or accidents involving air transportation have drawn attention of the public both locally and internationally.

Because aviation safety was a shared responsibility, federal agencies in the United States had collaborated to work toward the goal of ensuring a safe and efficient air transportation system. Among the agencies actively involved were the DOT, FAA, NTSB, and TSA (DOT, 2011; FAA, 2011, NTSB, 2011; TSA, 2011). However, the responsibility of maintaining a safe aviation system did not remain solely within the purview of the listed agencies. The ASSE and the Board of Certified Safety Professionals (BCSP) played an integrated element of ensuring and researching critical safety initiatives within the aviation industries. Aviation companies and organizations also had a significant role to play in enhancing a safe aviation environment.

Every aviation company and organization had an aviation-safety function responsible for guaranteeing the safety of its passengers and staff. The researcher investigated the need for definitive standards that an individual should possess to serve as an aviation-safety professional.The most prominent notion that this study analyzed was the necessity of identifying the core competencies safety professionals should possess to manage commercial and transportation aviation-safety programs to prevent or decrease airlines accidents. Upon the review and assessment of the components of the aviation-safety program, the researcher asserted that the results of this study may reveal a direct link for the introduction of a consistent set of aviation-safety professional core competencies to provide for better aviation safety with the reduction of accidents.

## Chapter 2: Literature Review

Given the primary purpose of the study, which is to identify the core competencies required for aviation-safety professionals to manage commercial and transportation aviation-safety programs, it is necessary to provide a background of related concepts. Currently, governmental regulations do not identify the core competency requirements, education, or experience of aviation-safety professionals to control risk and prevent accidents (Brantley, 2008; FAA, 2005). With no core competencies regulated for aviation-safety professionals, the findings of this study should allow the researcher to identify a baseline to align with the justification statement by the American Society of Safety Engineers (ASSE, 1999) for the certification of aviation-safety professionals. Representatives of the ASSE asserted there was a need for certification of safety professionals and recommended minimum standards and criteria for safety professionals, safety practitioners, and technicians.

The identified core safety competencies can be used by government, industry, professional societies and associations, and educational institutions for the assessment, standards, certification, and training of aviation-safety professionals. The foundation of this study will be the identification of these competencies by experts in aviation safety, with an eventual introduction of an industry standard. This overview of the history of aviation safety begins with the first human flight and continues through the contemporary period. The researcher will use this overview of scholarly studies with a focus on safety competencies and management skill sets to identify significant boundaries and concepts for aviation-safety professionals. Industry implementations such as SMS, education foundations, and safety processes are reviewed to complement the principles of aviation-safety professionals.

**History of Aviation Safety**

The first engineered human flight experience is attributed toda Vinci in the 1480s, followed by the Montgolfier brothers, who flew the first hot air balloon in 1783 (Millbrooke, 2000). However, the official period of flight and the onset of modern aviation began when the Wright brothers used a 12 horsepower engine to lift their 605-pound *Flyer* off the ground (Millbrooke, 2000). The Wright brothers were successful in 1903 in flying theirmachine for a distance of 120 feet for 12 seconds (Millbrooke, 2000). This successful air travel experience by the Wright brothers was followed by the first two-passenger flights in an aircraft, the flight piloted by Delagrange and the flight taken on by Furnas who was with the Wright brothers at Kitty Hawk (Murdock, 2000).

Although the realization of the true possibility of man's capability to fly began with the Wright brothers, U.S. Army Lieutenant Foulois introduced the concept of aviation safety through the development of the first set of flying rules in 1911 (Millbrooke, 2000). In the Provisional Regulations, Lieutenant Foulois allocated two pages to the discussion of flight safety (Murdock, 2000). Among the rules included in these provisions were learning to know when the engine sounds right, never attempting sensational or dangerous evolutions with the machine while in flight, and never landing with the wind blowing from behind the machine, as this action might create an underestimation of additional aircraft speed (Millbrooke, 2000; Murdock, 2000). From these rules, the adaption determined that flight safety was already a matter of some concern even from the earliest inception of the U.S. Army's aviation program.

Aviation safety in civilian flight programs did not gain formal attention during the early years of aviation (Del Gandio, 2004). On May 20, 1927, Lindbergh requested that Lederer, the designated head of safety for the U.S. Air Mail Service, perform a safety check and inspection of the aircraft, the Spirit of St. Louisat Roosevelt Field in New York City (Del Gandio, 2004). Having found no safety problems with the aircraft, Lederer allowed Lindbergh to make the historic nonstop flight from New York to Paris (Millbrooke, 2000). Lederer would later become the father of aviation safety (Sabatini, 2004).

Since that time, flight safety has developed into a vitally important component of the aviation industry and has become a determinant of the success or failure of the industry (Lin, 2010). Along with the advent of formal aviation-safety measures, there has also been a corresponding response to issues concerning the competency and training of safety program managers (Wood, 2003). As a result, the total rate of incidents per miles flown has decreased since the inception of commercial flight (Wood, 2003). However, when aviation-related accidents do occur, casualties may often involve the deaths of many people and total devastation of the aircraft (NTSB, 2011).

**Research Studies**

To manage a myriad of tasks, aviation-safety professionals must equip themselves with much expertise, including knowledge of flight safety, system safety analysis, human factors, ground and equipment safety, and environmental safety training (Sabatini, 2004). Aviation-safety professionals must be able to analyze any potential threats to determine possible scenarios that may occur or the probability of occurrence and the extent of the cost and severity (J. Darbo, personal communication, 2012). Upon assessment of the hazards, aviation-safety professionals must ascertain, execute, and manage the appropriate cost-effective controls (Sabatini, 2004).

A number of studies have focused on different areas of aviation safety, but no significant study has focused specifically on the identification of core competencies required for managing safety programs in the aviation industry. Based on the literature reviewed, the study with a scope and focus closest to this proposal is one conducted in 1995 during a summit convened by Secretary of Transportation Pena, which led to the conceptualization of the original FAR 119.65 regulation for Air Carrier Director of Safety (DOS; FAA, 1999). The participants in this summit included representatives from the FAA, academia, various airlines, and the aircraft manufacturing industry (FAA, 1999). From the commencement until the completion of this FAR, a representative of the American Airlines Flight Safety Department and the committee chair actively participated in its development (FAA, 1999). The DOT and FAA eventually implemented the new regulation with the support of airline industry representatives (FAA, 1999).

In the beginning of the summit, there was no established set of skill requirements for the position of DOS (FAA, 1999). However, after two years of hard work and lobbying efforts, the airline industry's recommendation that candidates for the DOS position must possess specific skill sets was approved by the FAA through the ATA Flight Safety Committee (FAA, 1999). Rather than being a federal regulation, the required skill set was integrated into the HBAT (FAA, 1999). Despite the FAA's endorsement, failure to implement the specific skill sets into the FAR frustrated achievement of the industry's goal of establishing appropriate regulatory language as a requirement for airline carriers (FAA, 1999).

**Roles and Contributions of Researchers**

The roles of researchers and their contributions to science perform a vital role in the continuation of research. In the scope of safety as a profession, the needs and demands of industry continue to grow for safety professionals. Reviewing each source of literature performs an important role in the identification of aviation-safety professional core competencies. The context of this research study includes several case studies. Studies conducted by researchers contributed to the theory and focus of identifying core competencies for an aviation-safety professional. The experience, credentials, publications, and education of these researchers reflect characteristics and traits of safety professionals.

E.H. Blair (Indiana University, 2009) is Associate Professor and Program Director for Safety Management at Indiana University in Bloomington. With 25 years of experience in occupational safety and health, industry, academia, and consultation, Blair is a Certified Safety Professional (CSP; Indiana University, 2009). Prior to earning a doctorate in Vocational Education, Blair earned degrees in psychology and safety management (Indiana University, 2009). Blair served in safety positions with numerous Fortune 500 companies and led two U.S. industrial sites into Occupational Safety and Health Administration (OSHA; 2006) Voluntary Protection Programs (VPP) as the earliest *STAR* rated sites in the 1980s. Blair's research interests include ways to improve safety performance through leadership, safety culture, training, behavior, and measurement (Indiana University, 2009). Blair conducted safety training and educated safety professionals across the United States and around the world in the leadership and performance aspects of safety (Indiana University, 2009).

E.H. Blair is a keynote speaker and an award-winning author (Indiana University, 2009). Blair has conducted seminars that include the Psychology of Safety for the American Society of Safety Engineers (ASSE) and Managing Employee Safety and Health for Tel-A-Train (Indiana University, 2009). Blair was a keynote or session speaker at the Michigan Safety Conference, the Kentucky Safety & Health Conference, and NASA's Super Safety & Health Day at the Kennedy Space Center, and for the KNOWLEDGE Group in Kuala Lumpur and Singapore. Blair has written numerous articles on safety and is the recipient for the best technical safety article in 1996 as awarded by the ASSE (Indiana University, 2009).

J.F. Montgomery is an Environmental Safety & Health professional and has knowledge of state and federal OSHA, DOT, EPA, and Workers' Compensation Administration. Currently, Montgomery is the Vice President of Safety for Air Serv Corporation, a growing aviation service company with headquarters in Atlanta, Georgia. Montgomery's responsibilities include more than 20 domestic and international stations (Air Serv Corporation, 2009). Prior to joining Air Serv Corporation, Montgomery served as the Corporate Manager of Ground Safety, Corporate Manager/Acting Managing Director of the Environmental Department and most recently as the Manager of the Noise and Emissions Regulatory Program with American Airlines for 16 years (Air Serv Corporation, 2009).

J.F. Montgomery holds a Doctor of Philosophy degree from Texas A&M University as well as two more advanced degrees (Air Serv Corporation, 2009).

Montgomery's certifications include professional certifications such as Certified Safety Professional (Safety) and Certified Hazardous Material Manager (Environmental) (Air Serv Corporation, 2009). Montgomery served as an Assistant Professor/Lecturer at several universities, including Texas A&M University, Embry-Riddle Aeronautical University, Central Missouri State University, Central Oklahoma University, and Lamar University. Montgomery is a frequent speaker at industry meetings, conferences, and seminars and served as the editorial advisor to *Safety and Health Magazine*. Montgomery served as the editor-in-chief both in 1996 and 2000of the two-volume *Accident Prevention Manual for Industry and Business* (Air Serv Corporation, 2009). Montgomery's research contributions have appeared in business management, safety, security, and climate change (Air Serv Corporation, 2009).

W.T. DeLeo served as an Army First Lieutenant from 1964 to 1966 as a platoon leader for the 64th Engineer Battalion 2nd Army Corps of Engineers (Zoominfo, 2009). DeLeo's educational background includes a Doctorate in Technology Education from North Carolina State University.DeLeo holds a Master's of Science degree in Industrial Technology with an emphasis in Safety from East Carolina University and a Bachelor of Science degree in Civil Engineering from the Virginia Military Institute (Zoominfo, 2009).

After retirement, DeLeo served in Iraq with the U.S. Army Corps of Engineers and was in the Baghdad International Zone Resident Office, where he managed construction projects in western Baghdad (Zoominfo, 2009). As a builder and developer, DeLeo served as the Head of Construction and Development of Star Development Corporation in Greenville, North Carolina, and oversaw the construction and development of many residential complexes throughout Pitt County, North Carolina, including land acquisition, road landsite development, model and town home construction, and sales and marketing (Zoominfo, 2009).

F. Gross is a highway safety engineer employed at Vanasse Hangen Brustlin (Gross & Yunk, 2009). Gross has seven years of experience in research in transportation and engineering as well as in the design of highways, traffic operations, and construction inspection (Gross & Yunk, 2009). His specialties include re-analysis of data, highway safety evaluations, and audits of road safety. He played a significant role in a study with a Transportation Research Board task force to identify core competencies for the highway safety professional workforce (Gross & Yunk, 2009). Gross has participated in several transportation and safety research studies throughout his career. Gross specialized in transportation safety and earned a Ph.D. in civil engineering from The Pennsylvania State University (Gross & Yunk, 2009). Gross also earned a graduate minor in statistics.

With more than 30 years of experience in road safety research and education, P. Jovanis has studied what statistical methods are best for analyzing crash data (Iowa State University [ISU], 2009). For more than 20 years, he has been a pioneer in the use of survival analysis and logistic regression for the analysis of such problems as truck driver fatigue (ISU, 2009). Jovanis was one of the first researchers to use Poisson regression methods for the analysis of road segment crash and traffic data. His research has included the application of case-control and cohort models to statistical estimation of crash modification factors and the use of Full Bayes models to study relationships between network characteristics and safety performance functions (ISU, 2009). His research consistently has added to the knowledge base on road safety. Additional contributions from Jovanis include working with people like Gross to develop competencies for professional education and training with the Transportation Research Board (TRB; ISU, 2009) publishing his research.Jovanis participates in safety conferences for the TRB safety conferences and is TRB reports reviewer. His commitment to safety education is obvious in his teaching of graduate classes in transportation safety analysis for more than 20 years (ISU, 2009). Jovanis has a doctorate in civil engineering with a major in transportation engineering from the University of California, Berkley (ISU, 2009).

**Safety Research Studies**

A relevant research study is the dissertation conducted by J.L. Morris (1989) pertaining to minimal competencies by safety educators at trade and industrial (T&I) schools. In this study, the researcher conducted tests to identify the differences in perceptions of safety competencies between T&I instructors and various other safety and health experts. In a similar study, Blair (2001) examined the competencies that safety, health, and environmental (SH&E) managers ought to have as well as the training and development necessary for them to become efficient in fulfilling their responsibilities. DeLeo (2002) identified the competencies that should be a requirement of an occupational safety and environmental health doctoral degree student. Another similar study conducted by Montgomery (1983) aimed to identify the entering competencies of transportation safety professionals, specifically those in the trucking industry.

To identify their competencies, these researchers employed several techniques and methodologies. Blair (2001) made use of Quinn's *Becoming a Master Manager: A Competency Framework* to formulate his competency survey, which was forwarded to 400 randomly selected Certified Safety Professionals (CSPs) and 100 educators. The

Likert scale rated the level of competencies. DeLeo (2002) used the Delphi Technique in devising a questionnaire to gain the consensual agreement of expert safety professionals in identifying the most important competencies. The Rand Corporation developed the Delphi Technique and is commonly employed when conducting studies in safety management, particularly for extrapolation of trends in future years (Adams, 2001). Similar to Blair (2000), DeLeo (2002) and Montgomery (1983) also used a Likert scale in rating the competencies on their questionnaires. Morris (1989) selected a group of 10 safety and health experts and enlisted the help of a trained facilitator to develop his list of safety and health competencies, which was submitted to four groups for verification.

By and through the facilitation of the U.S. Government, researchers recognized the need to identify specific criteria for aviation-related education, qualification, and currency for federal aviators as well as to set minimum requirements for pilot certification. The government program known as Aviation Training 2000 (1999) instituted a set of aviation training standards for its Natural Resource Agency personnel. This program, in accordance with the Aviation Management Council, used both cultural and institutional knowledge as its foundation for competency identification.

To ensure the aviation safety for its airborne and airframe systems, National Aeronautics and Space Administration's (NASA) Langley Research Center (2003) developed a safety operations manual that set forth the general guidelines, instructions, and competencies for the management and operation of NASA aircraft. Aviation-safety experts identified these competencies. This work will be one of the fundamental references for the identification and validation of competencies in the proposed research.

An article concerning an American Airlines crash in Little Rock, Arkansas underscored the significance of safety competency, certification, and expertise of those involved in the airline industry (Origel, 2000). Despite the fact that American Airlines had competent aviation-safety professionals, aggressive training, and professional pilots, the NTSB report made85 recommendations aimed to prevent future aviation-related accidents and to ensure aviation safety in the future. This proposed study used the NTSB recommendations to ascertain if they were relative to the final listing of the airline-safety competencies.

To summarize, DeLeo (2002), Morris (1989), and Montgomery (1983) conducted pertinent research studies concerning the competency of safety professionals. These three studies evaluated many different segments of safety professions, such as educators, safety managers, and doctoral degree candidates. The research contributions from the DeLeo (2002), Morris (1989), and Montgomery (1983) studies will aid the proposed study in the presentation of a thorough illustration of the skill sets necessary for an aviation-safety professional.

**Related Studies on Competencies in Safety Management**

Similar to the proposed study, Morris (1989), Montgomery (1983), and Blair (2001) conducted studies highlighting occupational competencies in safety management. Morris completed a comparative analysis of the perceptions of minimal safety competencies necessary among various components of the safety and health profession. With the help of 10 safety and health experts, a trained facilitator, and the *developing a curriculum* (DACUM) method, Morris developed a list of 96 competencies. Professionals from the following four groups reviewed these competencies: trade and industrial education instructors, safety and health experts, vocational supervisors, and state supervisors of trade and industrial education (Morris, 1989).

Montgomery (1983) investigated the competencies required for entry-level professionals from the transportation sector, using data obtained from safety professionals who were also active members of the transportation industry workforce. Montgomery's study was more comprehensive as he examined several variables using multiple tests on factor analysis and employing the Duncan Multi-range. Montgomery's study differed from the methodology employed by Morris (1989) who analyzed the expert listings of competencies by use of a statistical mean average.

Both Morris (1989) and Montgomery (1983) used the Analysis of Variance (ANOVA) statistical test from respondent data. Morris tested the data rankings with a relationship toward the importance of competency and the need for training in each duty area (Morris, 1989). Montgomery, however, used ANOVA to rate the five most important and the five least important competencies. Grouping for each of these studies differed with variables subject to test, such as age, education level, affiliation, gender, experience, and training background.

In contrast to the Morris and Montgomery studies, Blair used a *t*-test to test the null hypothesis that no difference exists in the perceptions of competencies between the Safety Educators and the CSPs. Blair also tested the null hypothesis--that no difference exists between the perceptions of respondents with more than 20 years of experience and those of respondents with 20 or fewer years of experience.

The sample from the Blair study consisted of two groups made up of 100 Safety Educators and 400 Certified Safety Professionals (CSP). Conversely, a study by Weijia

(2005) divided theparticipants into four groups from the ranks of upper management, project management and staff, and labor. Weijia, like Blair, used a *t*-test for the measurement of these four groups and in comparison to their involvement with an accident. An ANOVA test determined the safety climate score and the rankings of high, medium, and low for jobsite safety. The focus of the study by Weijia was the safety culture and its relationship with safety performance in the construction industry.

In the literature on competencies and safety, the Soule (1993) study was the only one that used the Chi-square test; otherwise, it was similar to the DeLeo (2002) and Morris (1989) studies. Soule concentrated on the perception of an occupational safety curriculum by surveying previous graduates, their employers, and university faculty with relationship to students' ability to perform in safety positions. The Soule questionnaire allowed respondents to rank job duties and scope to what degree these were vital or not vital (Soule, 1993). The rankings also identified group similarities and differences, as did the Morris (1989), Montgomery (1983), Blair (2001), and Weijia (2005) studies.

While the DeLeo study was similar to the Morris and Soule studies in regard to curriculum, DeLeo's main area of concern was the identification of core competencies for a doctoral degree in occupational safety. DeLeo used 16 identified safety experts from the American Society of Safety Engineers (ASSE) to create an initial list of 138 degree competencies. A panel reviewed and evaluated the competencies utilizing a Likert scale rating on three different occurrences and producing a final list of 15 competencies required for the degree program.

**Core Competencies: Adaptation through the Transportation Discipline**

The study by Jovanis and Gross (2006) identified core competencies for highway safety professionals and is the most thorough of all the studies. They conducted the study over a two-year period with input from industry professionals, universities, educators, and departments of the government (Jovanis & Gross, 2006). The core competencies for safety professionals identified in their study are excellent support forthe safety education of professionals, no matter the industry. For the proposed study, the competencies related to the aviation industry will be identified. The competencies of this study establish a baseline for the minimum set of core knowledge, skills, and abilities needed for efficient work for highway safety (Jovanis & Gross, 2006). These competencies that summarize the combinations of applied knowledge, skills, and behaviors are useful in the profession.

Jovanis and Gross (2006) reported that the competencies from their study are comprehensive, multidisciplinary, systematic, adaptable across different industries, and applicable to individuals with professional responsibilities within an organization (e.g., engineer, planner, safety manager or administrator, and other professional staff positions). The competencies cover the domains of public health, injury prevention, and behavioral science concepts along with components from engineering and education. The competencies treat safety as a set of interrelated components that interact and result in incidents/accidents. The simplicity of the competencies allowed different industries to use these competencies (O'Neil, 2011). The competencies were created to follow a systematic approach to treating safety as a set of interrelated components that interact for a holistic approach (Jovanis & Gross, 2006). The competencies, however, did not represent all safety knowledge that a safety professional should know, but they were the foundation of what an individual must know (Jovanis &Gross, 2006). The core competencies defined knowledge in a way similar to many disciplines and skills currently practiced in the field and support the development of the science of safety (Jovanis & Gross, 2006).

The study by Jovanis and Gross (2009) identified five core competencies that complemented learning objectives within each discipline. Adapting these competencies to the aviation-safety professional quantified the following competencies from their study. The aviation-safety professional defines the learning objectives by being able to describe, recognize, explain, identify, and understand safety management principles.

The first core competency was the multidisciplinary nature of safety. It provided a broad understanding of aviation-safety management as a complex multidisciplinary system. For example, anaviation-safety professional should be able to:

1. Explain aviation safety as a complex and interdisciplinary discipline that may help in avoiding fatalities, injuries, and crashes;

2. Comprehend, value, and use safety research, based on science, which will aid further safety improvements;

3. List the demographic trends underlying the need for comprehensive and integrated aviation-safety management (e.g., social, cultural, age, gender);

4. Identify how crash contributing factors interact;

5. Explain the *Four E's* of safety: engineering, education, enforcement, and emergency services (Jovanis & Gross, 2006).

The secondcore competency required the aviation-safety professional to know the history of aviation safety and the institutional settings for management decisions. For the second core competency, the learning objectives stated that an aviation-safety professional should be able to (a) understand the historic figures, benchmarks, and decisions underlying aviation safety and (b) identify safety aspects of major transportation legislation and interest groups with a stake in policy and investment decisions (Jovanis & Gross, 2006).

The third core competency was the understanding of the origins and characteristics of aviation-safety data and information systems to support decisions using a data driven approach in the managing aviation safety. The learning objectives included the ability to describe state and local information systems and data elements for safety management. The objectives also focused on the ability to describe specialized national databases available and the process of data collection including constraints of accurate, reliable field data and strengths and weaknesses of various systems.

The fourth core competency focused on the demonstration of knowledge and skills to assess factors contributing to aviation crashes, injuries andfatalities, identifying potential countermeasures linking contributing factors, applying countermeasures to groups for incident reduction, and implementing andevaluating the effectiveness of the countermeasures. The learning objectives for the fourth core competency stated that an aviation-safety professional should be able to:

1. Identify current and potential aviation-safety problems using suitable scientific methods (e.g., those controlling for regression to the mean);

2. Identify the linkages among human factors and behavior, aircraft and equipment design, and the environment and their interactions with respect to identified crash problems and effective countermeasures that address specific crash factors;

3. Establish priorities for alternative interventions and countermeasures based upon their expected cost and effectiveness and select countermeasures to implement (e.g., utilizing current science-based research methods);

4.Evaluate the effectiveness of the implemented intervention and countermeasure using appropriate statistical techniques in safety management;

5. Understand the importance of computing the expected safety benefit/cost daily directly associated with implementing a countermeasure as the difference between the crashes, fatalities, and injuries likely to occur with the countermeasure in place and the number of crashes, fatalities, and injuries expected to occur if the countermeasure were not implemented (Jovanis & Gross, 2006).

The fifth core competency focused on the ability to develop, implement, and manage an aviation-safety management program (Jovanis & Gross, 2006). The learning objectives for the final core competency included that an aviation-safety professional should be able to identify and utilize the following: (1) strategies to integrate and amplify safety in the transportation planning processes, opportunities for internal and external coalition-building and strategic communications for aviation-safety initiatives, and sources of current research that support effective aviation-safety management; (2) scientific management techniques in planning, implementing, and evaluating aviation-safety programs; and(3) the ability to explain the need to provide leadership and funding for ongoing service/support enhancements such as professional development, staff education andtraining, upgraded computer hardware and software (Jovanis& Gross, 2006).

In general, the core competencies includedthe abilities to (a) assess individual abilities relative to a list of standard competencies; (b) identify the knowledge, skills, and abilities an organization requires; (c) determine workforce requirements; (d) identify prerequisite skills for employees, instructors, faculty, or researchers; (e) develop or modify job descriptions; (f) assess the skill level of a team; (g) develop course curricula, assess course materials, decide education activities to undertake, and use results as the basis for credentials certificates, or degree programs (Jovanis & Gross, 2006).

**Education Foundations for Safety Professionals**

To understand competencies required of a safety professional, a broad characterization must be defined. DeSiervo (2004), a Certified Safety Professional (CSP), described and defined the role of safety professionals as individuals engaged in the prevention of events that harm people, property, or the environment. Occupational safety professionals help organizations in the prevention of injuries, illnesses, and property damage (DeSiervo, 2004). These professionals must acquire knowledge of safety sciences through education and experience so that others can rely on their judgment and recommendations (DeSiervo, 2004). A safety professional will use qualitative and quantitative analysis of simple and complex products, data, systems, operations, and other activities in the identification of hazards. DeSiervo (2004) determined that safety professionals will evaluate the hazards to identify what events can occur, the likelihood of occurrence, severity of results, risks (a combination of probability and severity), and cost. Safety professionals identified what controls were appropriate and their cost and effectiveness and made recommendations and provide consultation to managers, directors, designers, employers, government agencies, and others (Pourdehnad, 2012). Hazard controls may involve administrative controls such as plans, policies, procedures, training and engineering controls that may incorporate safety features and systems, fail-safe features, barriers, and other forms of protection. Safety professionals may manage and provide help to implement controls.

DeSiervo (2004) identified that the knowledge and skills one must acquire through education and experience for this profession were extensive. Requirements for the basic knowledge of sciences include: biology, chemistry, mathematics, physics, and behavioral sciences like psychology. This skill set also requires experience in business operations, training and education, strong communication skills, and engineering theory. As the profession spans from industry to industry, a basic knowledge and understanding of different types of operations are necessary such as healthcare, construction, manufacturing, and transportation.

The knowledge and skills acquired by safety professionals through formal education become refined and useful through internships and other work experience, enabling them to identify hazards and the appropriate level of control to prevent problematic events (DeSiervo, 2004). Their experience gained under supervision by experienced safety professionals will also enhance their safety knowledge and skills, especially for recent entrants into the discipline.

DeSiervo (2004) also identified the diversity of the safety profession to be like no other recognized professions in that individuals entering the safety profession need to be extremely heterogeneous. DeSiervo (2004) clarified their didactic experience as having an educational background as diverse as anyone can imagine from the arts to zoology and everything in between. Frequently, business and liberal arts majors as well as applied science and engineering students become engaged in safety. DeSiervo (2004) suggested the formal education of these individuals needs to be appreciated and, to a large degree, their diversity and backgrounds should be celebrated. The knowledge gained in each area of study iswithin the realm of an accomplished safety professional, from the basic and applied sciences to the liberal artsand business studies fields. These individuals may not be experts in all areas of safety; however, they have a basic, fundamental understanding andappreciation of safety sciences that enable them to identify hazards and provide the appropriate controls (DeSiervo, 2004). With any profession, a generalist or even a specialist should know when to call in others to help with an unfamiliar problem or one not in a specific area of competency (DeSiervo, 2004).

According to the Board of Certified Safety Professionals (BCSP) (2012), one of the most reputable certifications sought after in the industry is that of a Certified Safety Professional (CSP). The requirements to become a CSP stipulate that one must have at least an accredited two-year degree in health or safety or a bachelor's degree in any field. Applicants for the CSP must also possessfull-time professional experience managing the safety and protection of people, property, and the environment. This experience must encompass experience with hazard control and prevention and development and implementation of the same. In addition, the CSP applicants must also pass the Safety Fundamentals and Comprehensive Practice examinations to obtain certification (BCSP, 2012). An applicant must pay an annual fee to the BCSP and meet certification requirements every fiveyears.

Blair (2001) surveyed CSPs andeducators and concluded that safety professionals needed to be more than simple technicians. These safety professionals also need to have a high level of comprehension of business operations and be excellent communicators, possessing superior management skills and experience. In nontechnical terms, safety professionals need to be a total package of disciplines to be successful.

At the undergraduate level, universities have the opportunity to provide much of the formal knowledge and safety foundation these future safety professionals will need to have gained and assimilated (DeSiervo, 2004). Like many other professions, at the undergraduate level, it is currently inconceivable to saturate learners with all the safety courses needed to hit the ground running as complete safety professionals. DeSiervo (2004) recommended some period of *apprenticeship* or work under the guidance of a veteran safety professional (formal, educational internships) with additional lifelongstudy.

Universities at the graduate level needed to be attentive to a learner's undergraduate course workand work experiences so they could facilitate an educational experience that would prepare students for a profession with the scope necessary to practice at a professional level. In summary, in the reality of the formal education process, there needed to be a process for providing the information and skills. These required skills should prepare graduates for applying safety sciences with trust on their judgment and recommendations to prevent injury, illness, and property damage (DeSiervo, 2004).

**Safety Management Systems: The Safety Professional Movement**

In the history of aviation with the aircraft accident rate expressed in losses per 100,000 departures, which had been improving continually since the end of World War II, the rate has leveled off and is stable (Wood, 2003). Therefore, as the industry grows and departures increase, the number of accidents will also increase. Although the current rate of accidents is at an all-time low, the industry also assumes that any appreciable increase in the numberof accidents would be unacceptable to the public. To avoid this situation, the industry will need to reduce the accident rate even further.

Considerably, the steady improvement in the accident rate has been attributed to improvements to technology, such as the introduction of more reliable power plants, automation, and navigational systems (Wood, 2003). However, the majority of current accidents can still be attributed to human or organizational factors (errors). With a few notable exceptions, there is little opportunity for a technology-based solution to these types of accidents. A Safety Management System (SMS), on the other hand, offered the most promising means of preventing these types of accidents (Glendon et al., 2006).

As air traffic activity continues to grow, accident prevention becomes increasingly important as air traffic activity continues to grow, especially for the flying public concerned with safety issues. Detecting and preventing safety problems from occurring require the application of consistent aviation-safety principles that meet individual airport needs and conditions. As an example, the FAA decided to include a pilot program designed to evaluate the application of unified Safety Management Systems (SMS) at U.S. airports. These SMS programs should match individual airport needs with consideration of the new SMS protocols that had been set down for international airports. This program has the potential to affect the aviation industry, especially aviation organizations and professionals.

The November 2005 amendment to Annex 14 by the International Civil Aviation Organization (ICAO, 2005), which set SMS as a regulatory standard for all international airports, led the FAA to anticipate SMS soon becoming a regulatory requirement for U.S. airports. A new focus addressed the issue of aviation safety because of ever-increasing industry growth and expansion and the related increase in air traffic. Detection and prevention of problems became a matter of importance, especially as sensational media coverage of aviation incidents brought about increased public scrutiny of airline safety practices and procedures.

A consistent approach to aviation safety was necessary, but the FAA (2007) established that new rules be tailored to support specifically U.S. safety regulations already in place rather than copying new international standards. Hence, the FAA (2007) chose to use a small number of airports that varied in size to participate in the development of an SMS Manual. Airportoperators were to draw SMS principles from all currently available industry guidance documents during this process. The SPM Manual would determine if there were significant discrepancies between the current Airport Certification Program and the developing SMS program (FAA, 2007).

As the safety movement toward SMS began to develop, there would be an increased demand for operational safety in the aviation community. The aviation industry would be experiencing more concern over safety practices through current conditions of regulatory demands, public perception, economic impact, and security measures (Wasson, 2006). Employees face different kinds of everyday decisions ranging from the go-no-go decisions confronting frontline inspectors to conceptual policy decisions. Thus, Safety Risk Management (SRM) was not an alternative to the use of delegated authority. When personnel break rules and regulations, inspectors must exercise their delegated authorities(Wasson, 2006).

The best approach to developing safety policies, procedures, and practices was a systematic approach that required considerable planning, organization, and communication (Wasson, 2006). This approach is central to creating an effective aviation industry safety culture such as SMS. Effective safety cultures have defined procedures, are a well-understood hierarchy of responsibilities at all levels, and have clear reporting protocols to facilitate effective and useful communication regarding safety issues. Establishing an effective aviation-safety culture was a main goal of the SMS program. SMS benefitted the industry by improving safety while increasing the likelihood that safety problems can be handled before an accident can occur (FAA, 2007). Implementation of the pilot program had allowed airports and the FAA (2007) to gain experience establishing airport-specific SMS tailored for the individual airport. This information will provide FAA information on SMS best practices and lessons learned that will be helpful as FAA issues a Notice of Proposed Rulemaking to incorporate SMS into *14 C.F.R. Part 139, Certification of Airports.*

The existence of a positive safety culture will strengthen success in an organization's safety performance. Safety culture in an organization is a core fundamental value in daily business practices and in the management of safety (FAA, 2007). Safety culture begins with the communication principles of top management and results in all staff exhibiting a safety philosophy that transcends departmental boundaries.

Informal or formal staff surveys or observations conducted in safety related work areas can measure this safety culture. Safety culture is essential and must be actively managed from the top levels of management down to the entry-level positions of the company (Wasson, 2006). This safety management process is an integral strategic aspect of business management, recognizing the high priority commitment by the company to safety (Wasson, 2006). To that end, a demonstrable broad-level commitment to an effective formal SMS must also exist. Emphasis is necessary, and the contribution that all staff can make to the effectiveness of an organization's SMS program determines its success.

The complexity and uniqueness of the aviation industry allow for legislation and perceptions to place demands on employees; however, the demands are often not communicated accurately to upper management (Wasson, 2006). Because of major airline disasters, passengers andregulators have demanded there be an increase in safety but withthe unwilling acceptance to the cost of safety. Legislative requirements emphasize requirements for airlines to implement a systematic approach to safety management or SMS (FAA, 2007). The core requirement for an SMS is to have an effective method of identifying and controlling risk. This described concept from ICAO (2005) reads as:

> Therisks and costs inherent in commercial aviation necessitate a rational process for decision-making. Daily, operators andmanagers make decisions in real time, weighing the probability and severity of any adverse consequences implied by the risk against the expected gain of taking the risk. This process is known as risk management. (p. 5)

**Safety Management Systems: The Process**

An effective SMS helps enhanced safety performance while meeting or exceeding the basic compliance with the regulatory requirements associated with safety and quality (FAA, 2007). Enhanced safety performance in a proactive safety culture is important in the organization's safety-related activities (FAA, 2007). This foundation is achieved through effective executive management in association with a means of oversight, both of which are the ultimate responsibility of the organization's Chief Executive Officer (CEO; FAA, 2007).

An *SMS* is a systematic and continual management process built on identifying hazards and analyzing potential risks (Alexander & Sheedy, 2004). The FAA refers to this safety system process as the four pillars of safety, consisting of Policy, Safety Risk Management, Safety Assurance and Internal Evaluation, and Safety Promotion (FAA, 2007). These linked components create a culture that promotes safety. These components set policies, identify and reduce risks utilizing the SRM process, provide a means for continuous assessment of the system through internal and external audits, and promote safety through various methods and mediums (FAA, 2007).

**Elements of SMS**

With accepted industry standards, the FAA (2007) and ICAO (2005) defined four main elements as being crucial to SMS. For an effective SMS program, the safety policy and objectives must include a formal safety policy signed by senior management. This policy must contain commitments from top-level management so that SMS implementation has the highest priority. The program must provide resources to ensure improved safety practices and to include an outline of responsibility and accountability. The SMS program must also establish clear reporting protocols and create a safety manager who reports to the highest level of management.

Safety Risk Management (SRM) procedures help in identifying hazards and potential risks while encouraging the development of risk mitigation strategies (FAA, 2007). The SRM process contains five separate phases. The first phase is a description of the system. The second phase is the identification of hazards. The third phase is the determination of a known risk. The fourth phase is the assessment and analysis of risk identified. The fifth phase is the treatment (mitigation, monitoring, and tracking) of the risk (FAA, 2007).

Safety assurance policies help establish consistent organizational systems and provide a systematic approach to auditing, oversight, and correction of discrepancies (Alexander & Sheedy, 2004). These policies also allow solicitation of input and systematic review of available feedback from multiple sources. Safety promotion includes all aspects and levels of safety-related education and communication within the organization and directs resources toward the goal of continuous improvement outlined in the formal safety policy (Alexander & Sheedy, 2004).

Safety management is at the forefront of making aviation, already a safe form of travel, even safer (Kossiakoff & Sweet, 2003). The primary difference in the SMS approach is movement away from the traditional reactionary systems to those that can predict areas of exposure to risk through assessment of any observable risk areas in airworthiness and operations and supplementing them with operational knowledge and professional judgment (Kossiakoff & Sweet, 2003).

According to Stephans (2004), *system safety*is the application of engineering and management principles, criteria, and techniques to have an acceptable level of safety throughout the entire system. Thus, the primary objective of SMS is to achieve system safety. A well-structured SMS program is a systematic, explicit, and comprehensive process for managing risks (Alexander & Sheedy, 2004). Also included in the process is the setting of goals, planning, documentation, and regular evaluation of performance. SMS is a businesslike approach to safety that will provide for goal setting, planning, and measuring performance as it is embedded into the organization's core and becomes part of the culture: the way people do their jobs (Adams, 2007).

The SMS organizational structures and activities are found throughout an organization with every employee's contributing to the safety and health of the organization. Larger organizations must ensure that safety management activities permeate the operations throughout the establishment even though these activities may be more visible in some departments (Adams, 2007). Achievement of safety practices through implementation and continuing support of a coherent safety policy leads to well-designed procedures (Adams, 2007).

Because aviation is a dynamic industry, conditions are constantly changing (Cavazos, 2007). To inform management that something has changed or a new hazard is emerging, organizations need input from all various levels. Thus, employees must have a means of management to report hazards and safety concerns (Adams, 2007). In general, when an employee reports a concern or hazard, the report needs to be acknowledged and evaluated. When management responds to employee safety concerns, employee confidence in the system will increase. On the other hand, if the system is not maintained, employees will no longer use it. Some regulations required organizations to institute a reporting system. A system that employees do not trust or use will not fulfill the requirements of the concept (Alexander & Sheedy, 2004).

The report submitted must be analyzed to determine if there is a genuine threat to safety. When the issue required action, the manager with authority must take action. This process preserved the accountability of the SMS. The credibility of the system is preserved when the outcome of the issue reaches the reporter. If no action is appropriate, that information and the reasons for that decision should also be communicated to the person (ICAO, 2005). The goal of this process was that all staff members know how to report safety concerns and that their reports are acknowledged, analyzed, and resolved in a timely manner (Ringle, Sarsedt, & Zimmerman, 2011).

Once the problem had been defined, the next step was a preliminary analysis that must define the risk associated with it. The preliminary analysis entailed an initial identification and analysis of potential risk to determine if immediate action were required. Other options included whether further study is advised or if no further action is needed because the problem was not an issue (Alexander & Sheedy, 2004).

The next procedure was to evaluate and estimate risk. The probability and consequences of various risk and uncertainties will always exist, no matter how reliable the information is about risk (Alexander & Sheedy, 2004). Consultation with stakeholders should continue so their perceptions about the risk(s) involved are accurate and understood.

The next process was risk control. Various risk mitigation options exist. As part of risk control, a contingency plan should be implemented for handling any residual risk that cannot be mitigated to the satisfaction of all concerned. The company should evaluate the feasibility of financing these plans (Alexander & Sheedy, 2004). All stakeholders should be aware of the decision and should be given the opportunity to provide comments and feedback.

Once the risk control phase was complete, the take action process occurred. In this step, the decision is implemented, and the strategy for communicating began. Controls on the implementation plan must occur to be certain target dates before various components are met.

The last process of SRM was to monitor the effect of the risk. After the monitoring process, the researcher must establish an agreement for measuring the effectiveness of the decision over time. This monitoring phase is a key step in the process and provides an opportunity to identify new risks or to assess the impact of changes in known risks (Alexander & Sheedy, 2004). As with all steps of SRM, documentation of the impact of all actions taken would provide confirmation of the appropriateness of the decision(s) taken.

**Summary**

In recent years, businesses have devoted effort to understanding how accidents happen in aviation and other industries. The perception that most accidents result from human error is generally accepted as fact (Alexander & Sheedy, 2004). While this generalization would not be an accurate moral assumption, it would be easy to conclude that these human errors indicate carelessness or incompetence on the job. Research and investigators are finding that the human is the last link in a chain of events that lead to an accident, incident, or occurrence. While the human is a direct link in the process, the element of changing people will not prevent accidents, but the addressing of underlying causal factors will have a greater impact on accident prevention (Alexander & Sheedy, 2004).

As Blair (2001) indicated, the safety professional was no longer a one-discipline technician. Safety professionals were now multi-tasked and multi-occupational practitioners. With that point in mind, the safety professional needed to be knowledgeable and experienced in multiple disciplines such as education, safety, human factors, and engineering. According to Sabatini (2004), aviation-safety professionals must be able to manage a myriad of tasks and possess considerable expertise, including knowledge of flight safety, system safety analysis, human factors, ground and equipment safety, and environmental safety training.

A number of studies have focused on different areas of aviation safety, but there has been no significant study conducted with a specific focus on the identification of core competencies required for managing safety programs in the aviation industry. The research of Montgomery (1983) was similar, but he focused on the investigation of the competencies required for entry-level professionals from the transportation sector. Montgomery used data from safety professionals who were also active members of the transportation industry workforce. Morris (1989) focused his research on testing the data rankings with a relationship toward the importance of competency and the need for training in each duty area.

With the current movement to incorporate SMS before FAA regulations mandate as a requirement of operation, the aviation community and its safety professionals will encounter challenges as the transition takes place. DeSiervo (2004) identified the extensive knowledge and skills that an individual must acquire through education and experience for the safety profession. DeSiervo (2004) identified the diversity of the safety profession as unlike any other recognized profession, as demonstrated by the need for individuals entering the safety profession to be extremely heterogeneous.

The core competencies identified by Jovanis and Gross (2006) highlighted the relationship with knowledge, skills, and education. The five core competencies and learning objectives within each discipline identified by Jovanis and Gross (2006) also identified a direct relationship with the principles of SMS. These five competencies not only relied on experience but are also complemented with the education process.

With the new safety movement towardSMS taking effect, operational safety demands in the aviation community were also increasing. The aviation industry was experiencing more emphasis concerning safety practices through current conditions of regulatory demands, public perception, economic impact, and security measures (Wasson, 2006). As the movement to SMS took prominence within the aviation industry, the FAA (2007) emphasized the four strengths or pillars of this process: policy, safety risk management, safety assurance and internal evaluation, and safety promotion.

The organizational structures and activities of SMS were found throughout an organization, and every employee contributed to the safety culture, safety, and health of the organization. In larger organizations, the safety management activity would be more visible in some departments than in others, but the system had to merge into the operations throughout the establishment (Adams, 2007). The key element of SMS was that each employee had an equal stake and responsibility for safety, from the highest level of management down to the entry-level worker.

# Chapter 3: Research Method

To achieve the purpose of identifying core competencies required of aviation-safety professionals, the researcher first addressed several methodological concerns. The methodological issues involved in completing the study were (in addition to providing a restatement of the research question) identification of hypotheses, outlining of the proposed research design, identification of the variables, discussion of the methods and procedures in developing the instrument, and explanation of the statistical techniques needed to analyze the data gathered. In addition, this chapter content will offer an enumeration of the ethical issues involved in the proposed study and the corresponding recommendations to address such issues.

The parameters of this study will examine the statement of the problem. The focus of the problem this study addressed was the lack of governmental and industry requirements and qualifications for aviation-safety professionals to control risk and prevent accidents (Brantley, 2008). Aviation-safety professionals had no mandated regulatory requirements based on the fundamentals of education level, professional licensing and certification, and competencies. The government body regulating the U.S. aviation industry, the FAA, does not define any specific requirements or qualifications for aviation-safety professionals (FAA, 2012).

## Hypotheses

The primary goal that was addressed in this research was to translate the direct relationships among professional endorsements, education, and competencies required to be an effective aviation-safety professional. Regulatory compliance requirements did not define the requirements for aviation-safety professionals employed by commercial and transport aviation companies. The principal question to be addressed in this research is: what competencies should aviation-safety professionals possess and what direct relationship to experience, managerial level, area of work, education level, professional licensing, and professional certification was associated with each competency?

Using analyses and reliability tests, the researcher identified which aviation industry best predicts core competencies measured on the study survey. Statistical significance was determined at the .05 confidence level. The hypothesis related to and would answer RQ2: To what extent, if any, did the competencies reported by the respondents' functional experience and the level of their responsibility differ at the entry, middle, or the senior level of management? In all hypotheses, the opinions were based on the longevity of the experiences of the officials in the industries:

The researcher examined mean differences among groups. Appropriate *post-hoc* analyses will determine accurately where mean differences lie to reduce probability of Type I error. Statistical significance will be determined at the .05 confidence level.

**Research Method and Design**

The proposed study examined the comparative relationship of competencies, level of education, professional licensing, and professional certification deemed necessary for aviation-safety professionals. This research was necessary or even essential because aviation companies and organizations neither have a uniform, standard set of qualifications nor are they required for aviation-safety managers. Because of inconsistencies and extensive variation in required qualifications for aviation-safety professionals, aviation organizations may not be functioning at their maximum safety level. This research will also be a valuable contribution to aviation safety because few studies have been conducted in this specific area of concern.

The research methodologies and analytical tools in this study followed quantitative and qualitative (mixed methods) principles and constructs. An important methodological feature of the proposed study was the development and adaptation of an original competency and complementing learning outcome result from the Jovanis and Gross (2006) study to aid in the identification of competencies using descriptive statistics. This survey instrument was similar in context to the Montgomery (1983) study while employing the use of a 7-pointLikert scale as a statistical method validated and used in studies from Blair (2001) and DeLeo (2002). Respondents were asked to assign a value to each competency listed on the questionnaire by use of a 7-pointLikert-type survey instrument, and the construction of the questionnaire would facilitate statistical analysis.

To determine the most appropriate data-gathering technique for statistical analysis and rating of competencies, the researcher reviewed several studies and certification procedures, including the studies conducted by Morris (1989), Montgomery (1983), DeLeo (2002), Blair (2001), Soule (1993), Weijia (2005), Jovanis and Gross (2006), and Cangiano (2005). Although all of the studies reviewed involve instruments of safety in general, the majority of instruments were not considered applicable to this study because of the differences between the traditional safety competencies and the competencies requisite for addressing safety-related issues in the aviation industry, including those of safety equipment, procedures, and work environments. Because the proposed study was concerned specifically with aviation safety, no appropriate, valid, and reliable survey instrument is available. Therefore, the development and adaptation of a new instrument would facilitate data gathering with regard to aviation-safety competencies.

**Participants**

The researcher proposed several constructs to aid the examination and investigation of the research questions. These constructs included the rating and evaluation of competencies important to aviation-safety managers and professionals, as identified by a core group of professionals from aviation safety. The individual evaluation of competencies would use a 7-point Likert scale by members of this core group. This core group of participants consisted of safety professionals from commercial and transport aviation companies. Also included were the individual listing and examination of the individual demographic variables of education level, professional licensing, and professional certification. These constructs were the measure of the derived importance of the competencies by the respondents and by individual demographic responses through applicable statistical analysis and an analysis of the current aviation industry leadership because of responses to the competency survey.

**Competency Evaluators**

The researcher contacted the competency evaluators via e-mail through contacts from the International Society of Air Safety Investigators and Certified Safety Professionals (CSP) from the aviation domains of maintenance, air traffic control, airline and commercial operations, government regulatory agencies, and manufacturers. Three competency evaluators represented each of the domains to ensure balance and to circumvent bias. These experts evaluated the five core competencies and complementing learning objectives they considered to be important requirements for an effective aviation-safety professional (Jovanis & Gross, 2006; Montgomery, 1983). The instrument evaluation process was based on simple reasoning with either a *yes* or *no* response to the five core competencies and complementing learning objectives. This expert group also evaluated and provided feedback for the instrument in whole to assess comprehension, correctness, and accuracy. The list of competencies and learning objectives appraised by these competency evaluators would become the preliminary basis for the validation of the Likert-survey questionnaire that would be used eventually to determine validity of the required competencies needed for aviation-safety professionals.

**Pilot Study**

Prior to its use in the study, the researcher testedthe questionnaire in an e-mail-based pilot study utilizing a limited random sampling of 100 aviation-safety professionals (expert panel) as a pilot study group to validate the instrument's comprehension, effectiveness, and accuracy. The 100-member panel of experts consisted of professionals known to be leading figures in aviation safety (Montgomery, 1983).Criteria for selecting professionals for the panel included educational attainment, professional certification, leadership positions in safety organizations, professional publications andpresentations, membership in governmental and nongovernmental organizations, and positions held within the expert's company or organization. Based on the solicitation size of the expert panel for the completion of the pilot study, the electronic surveys were sent and requested for completion within a 14-day timeframe. Because the purpose of employing the quantitative methodology was to acquire a comprehensive description of what an aviation-safety professional should be able to perform and what knowledge he or she should possess, there wasno attempt to establish the value of the listed competencies during the initial stage of data collection.

**Survey Population**

Following the review and identification of the competencies by the pilot study group, the researcher soliciteda third group of 3,000 participants (competency generators) from the mailing list database of the *Flight Safety Information* newsletter. This newsletter is a daily publication with more than 40,000 aviation centric subscribers, including aviation-safety professionals, managers, and legal representatives. The solicitation of the 3,000 participants conformed to the requirement that participants work for an aviation entity. This group would not consist of participants from the competency evaluators or expert panel pilot study groups.

Using analyses and reliability tests, the researcher would be able to identify which aviation industry best predicts core competencies measured on the study survey. Statistical significance was determined at the .05 confidence level. Appropriate *post-hoc* analyses determined accurately where mean differences lie and will reduce probability of Type I error.

The researcher examinedmean differences among groups. Thus, the sample size calculations indicated that solicitation of responses from 3,000 participants would be sufficient. Such a solicitation size would prevent deficiencies in the study due to low power even in the event of a low response rate.

This *Flight Safety Information Newsletter* compiles and disseminates data on accidents, incidents, and other pertinent information pertaining to the aviation industry as well as being connected to one of several websites for the integration of data on aviation safety to make that data accessible to those concerned with aviation safety (Wald, 2007). The third group of competency raters represented a statistical sample of the aviation-safety profession (Wald, 2006) and consisted of members of professional organizations such as the Air Transport Association, the Flight Safety Foundation, the Regional Airline Association, the Air Transport Executive Committee of the National Safety Council, and airframe and engine manufacturers such as Boeing, Airbus, Rolls Royce, Pratt Whitney, and General Electric. This group determined the values of the pre-identified competencies by evaluating them with a 7-pointLikert-type scale. Following this evaluation and upon the application of various statistical analyses, the researcher generated a list of the most significant competencies.

**Power Analysis**

The most commonly identified statistical analysis was the determination of whether or not there are existing significant differences or similarities in a certain population by using the data gathered from the sample. The data collected in a research study were submitted to perform a significance test. The data also examined the practicability of the null hypotheses.

The possibility of obtaining a value (*p*-value) as provided by the significance test and using it to reject the null hypotheses was a function of three factors. These factors are identifiedon the basis of the following statements: (a) the larger the observed effect, the larger the sample size; (b) the more liberal the criterion required for the significance of the alpha; and (c) the greater the likelihood that the test will generate a significant *p*-value. A mistake frequently made by those inexperienced with statistical power is that power is a property of a study or experiment. In actuality, any statistical result that has a p-value possesses an associated power.

The researcher can perform power analysis either before (*a priori*) or after (*post hoc*) the collection of data. Conducted prior to the research study, *a priori* power analysis was generally employedfor an appropriate sample size to establish and achieve adequate power. The researcher executed*a priori* power analysis during the planning of the study to predict the likelihood that the study would yield significant effect based on the same factors as the significance test. A *posthoc* power analysis,however, was conductedafter the completion of the study and used the generated sample size and effect size to determine the power in the study. This analysis proceeded under the assumption that the effect size in the sample is equal to the effect size in the population.

The closed system in power analysis forms when the three factors of effect size, sample size, and critical significance level combined with power. Upon the determination of the three factors, the fourth will also be completely determined. The objective of a power analysis was to create an appropriate balance among these factors by considering the primary objectives of the study and the resources available to the researcher.

The term *effect size* refers to the enormousnessof the effect under the alternate hypothesis. The nature of the effect size would change from one statistical method to the next, but its function in power analysis was the same in all procedures. The effect size should represent the smallest effect that would be of quantifiable or substantive significance; for this reason, effect size will change from one study to the next.

Researchers sometimes assume that they cannot perform a power analysis if there is no pilot data. However, it is usually possible to perform a power analysis entirely based on a logical assessment of what constitutes a theoretically important effect. The effect observed in prior studies could provide an estimate of the true effect, but it is notlikely to be the true effect in the population. Because the effect size used in power analysis is not the true population value, the researcher had the option to offer a range of power estimates.

Cohen (1988) suggested the use of conventional values for small, medium, and large effects in the social sciences. These values may be a check of certainty or to ensure that the values specified are relative to conventional values. This method also allowed the researcher to operate directly with one of the conventional values rather than specifying an effect size.

Sample size is the number of observations in the sample. Based on any given effect size and alpha, an increase in the sample size will constitute an increase in the power. With validity of effect, size, and alpha, sample size cannot be observedseparately but rather as an element in acomplicated balancing act. In some studies, it may also be significant to uncover even a small effect while maintaining high power. Depending on the available resources, the researcher needed to find the largest population for the sample and work backwardto find a suitable balance between alpha and beta. For studies involving two groups, power was generally maximized when the subjects are divided evenly between the two groups. When the number of cases in the two groups was not equally distributed, the effective population for computing power tended to fall much closer to the smaller sample size than to the larger one.

The fourth element in this closed system is power. With the given of effect size, alpha, and sample size, power is known. According to Cohen (1988), one principle states that power should be set at 80%, but this rule has no logical basis. The researcher should and did decide the appropriate level of power on a case-by-case basisby considering the potential harm of a Type I error, the determination of an action effect, the potential sample size, and the significance of identifying an existing effect.

**Materials/Instruments**

As discussed elsewhere in this proposal, the researcher designed and developeda questionnaire to satisfy the needs and to encompass the distinctly specific scope of the proposed study. As identified by Jovanis and Gross, the five core competencies and complementing learning objectives for the highway transportation safety professionals wereapplied and adapted to the domain of aviation. To facilitate the design and development of the questionnaire, the researcher solicited 20 experts (competency evaluators) for participation from established and recognized safety professionals of the aviation industry.

The types of validity included credibility, transferability, and dependability. According to Trochim (2006), the concept of validity is more normally recognized in quantitative social science research than in qualitative social science research. However, Trochim also argued that the question of truth or falsity of an observation of an external phenomenon, which is a major issue for validity, should not be addressed. Hammersley (as cited in Winter, 2000) further elaborated on the issue of validity by stating that validity of an account was a precise representation of the different aspects of a phenomenon and was purported to devise a description, explanation, or theory.

In the development of the survey instrument, the question of credibility must be addressed. The results of the research must provide credible information and plausible arguments, especially to those who participated in the study. The dependability of the instrument to arrive at similar findings may vary, depending on the increase in physical time between studies. Some differences in results generated by the questionnaire may also be a potential limitation because of the variable nature of the aviation industry and differences in the equipment, processes, and procedures familiar to and used by aviation professionals.

**Instrument Validity**

The validity of the instrument used for this research was content validity. "Validity refers to the degree to which a test measures what it is supposed to measure and, consequently, permits appropriate interpretation of scores" (Gay, Mills,& Airasian, 2009, p. 154). The content validity of the survey instrument was assessed by an overview of the content presented by the pilot study group (expert panel). This validity was the degree to which the survey measured an intended content area. No formula or statistic exists that can calculate the content area; neither can itbe expressed quantitatively (Gay et al., 2009). During the pilot study, the content validity was based on the ease of the respondent's ability and comprehension to complete the survey without encountering any problems with the questions asked. The feedback provided from the pilot study of the face validity of the survey instrument allowed the researcher to analyze each question asked and revise as necessary. The final survey instrument was based on the comprehensive feedback from each of the respondent's answers to all questions of the pilot survey. The individuals of these two groups will make their own judgments about the relevance of each item of the survey instrument and about the precision of their formulation (Gay, Mills, & Airasian, 2009). A major distinction of content validity was whether the individuals used for evaluation were either experts in the field or belong to the target population (Gay et al., 2009).

**Instrument Reliability**

Following the pilot study group, the researcher testedratings of competencies and learning objectives and reliability of the instrument "…the degree to which a test consistently measures whatever it is measuring" (Gay, Mills, & Airasian, 2009, p.158). The questions on the survey questionnaire addressed the hypotheses of this research dissertation and asked questions that would represent the perceptions of aviation-safety professionals. Cronbach's alpha tested the internal consistency reliability coefficient of the total instrument and of the five domains (Cronbach, 1951). The researcher used Predictive Analytics SoftWare (PASW), formerly known as Statistical Package for the Social Sciences (SPSS), for the calculation of Cronbach's alpha. This alpha test measured the extent to which item responses obtained at the same time correlated highly with each other (Cronbach, 1951).

**Operational Definition of Variables**

Based on the proposed research design, the competency questionnaire used a 7-point Likert scale to aid in the measurement of competencies. The 7-point scale rather than a 10-point scale was employed because similarly structured questionnaire-based studies have used it effectively (Blair, 2001; DeLeo, 2002). The questionnaire requested that the respondents assess the competencies in terms of several variables. The researcher examined each competency rating for an overall rating and as a comparative relationship with each of the variables of education level, professional licensing, and professional certification.

**Competencies: Criterion Variable (Y)**

The first variable (Y) was examined for these hypothesis statements and focused on the rating of competencies. The dependent variable for all hypothesis statements was competency ratings. Ratings of competencies were identified from responses to questions 13 through 47. The *complex multidisciplinary domain* consisted of items 13-21, the *history* domain was items 22-27, the *collection and analysis* domain was items 28-33, the *identification and treatment* domain was items 34-39, and the *program management* domain was items 40-47. The competencies were rated on a Likert scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). The mean of each section was calculated from the constituent items and serve as the dependent variable. A total competency ratings score was also calculated from the mean of all items 13-47.

For the Hypotheses 1 to 4, the mean competency ratings in the five domains were the dependent variables. *A posteriori* contrasts of specific means would follow up this measurement if necessary. The goal would determine which competency domains had the highest mean scores (and thus most important) and which had the lowest mean scores (perceived as least important).

**Education: Independent Variable ($X_1$)**

A second variable ($X_1$) with respect to competency rating was the educational level attained by the aviation-safety professional. An examination of the educational level variable established a baseline for collegiate level degrees held by aviation-safety professionals. Further examination of this variable determined if the aviation-safety professional's concept of competency importance varies with educational level or if the competency was ranked similarly across the entire educational level.

The independent variable for hypothesis statement two was participant education level. Education level was identified from question one of the survey instrument. The independent variable is based upon all participants' holding a degree from the associate degree, bachelor degree, master's degree, to the doctorate degree.

**Licensing: Independent Variable ($X_2$)**

A third variable ($X_2$) was the professional license variable. Specific aspects of this professional license variable included pilot licensing, mechanical and maintenance licensing, and other sublicenses. An example of key issues in this variable was the presence of significant differences in the way competencies are rated by a licensed mechanic or a licensed pilot versus a non-license holder. The researcher also assessed the seemingly similar variable of professional certification.

A study conducted by Blair (2001) on identifying occupational safety management competencies tested professional certification as a variable. Specifically, Blair focused on safety educators and Certified Safety Professional (CSP) as respondents. Although there were no differences between the competency perceptions of safety educators and CSPs based on the findings of Blair, the competency ratings placed by a CSP may be more significant than the rating of safety educator because of the greater probability that a CSP has more hands-on exposure and experience (BSCP, 2012).

The independent variable for hypothesis statement three was Professional Licensing. Licensing was identified from Questions 9 and 10 on the survey instrument. The independent variable was based upon all participants' holding an FAA issued license from the choices of pilot, flight engineer, airframe and power-plant mechanic, airframe mechanic, or power-plant mechanic.

**Certification: Independent Variable ($X_3$)**

The fourth variable ($X_3$) is the professional certification variable. An examination of the professional certification variable established a baseline for professional certifications for aviation-safety professionals. This variable included the comparative examination between the rating of competencies and professional certifications. These professional certifications served as the catalyst for examination based on their recognition from the BCSP, OSHA, and the National Association of Safety Professionals (NASP).

The independent variable for this hypothesis statement was Professional Certification. Certification was identified from Questions 5 and 6 of the survey instrument. The independent variable was based upon all participants' holding a professional certification from the choices of Certified Safety Professional (CSP), Graduate Safety Practitioner (GSP), Associate Safety Professional (ASP), Certified Industrial Hygienist (CIH), Occupational Health and Safety Technologist (OHST), Construction Health and Safety Technician (CHST), Certified Loss Control Specialist (CLCS), Safety Trained Supervisor (STS), Certified Safety Auditor (SAC), Certified Safety Manager (CSM), or Certified Safety Administrator (CSA).

**Descriptive Relationships**

Descriptive relationships among the constructs and the variables were those that may have strong correlation with each other, focusing on the observation, the identification of subject identifier, and the description of their traits. The study by DeLeo

(2002) on competencies for a doctoral degree in occupational safety employed many of the same techniques and processes in the identification of competencies for aviation-safety professionals. This study was an example of a descriptive research involving quantitative variables measured on an ordinal point value scale such as the Likert scale.

DeLeo (2002) used a secured web site for gathering, rating, ranking, and accepting/rejecting the highest mean-ranked competency as well as for distributing the results of his study. Sixteen ASSE-identified safety experts identified the list of 138 competencies for the doctoral degree in occupational safety, which served as the basis of the selection. A Review Panel scaled down the list to 58 and, by means of a secured website, used a Likert scale format to rate the competencies by their importance. The 30 competencies rated *very important/important* were posted on the Web site to be ranked by the Expert Panel. Finally, the Expert Panel had the right to accept or reject the highest mean-ranked competencies. Then, the final list of 15 competencies that the expert-led study found to be most important was posted on the secure web site. The study by DeLeo (2002) had many similarities to the proposed dissertation study concerning the identification of competencies necessary to aviation-safety professionals. Therefore, the descriptive, quantitative portion of the proposed study followed the pattern in the DeLeo study.

**Confounding Variables**

Among the literature included in the review, no study provided a discussion of confounding variables. However, the proposed dissertation may have confounding variables. Confounding variables may be represented by the ages of the respondents, their educational level, their postsecondary degree and certification level, and their choice of the value of these components in their selection and ranking of the competencies. Other confounding variables may also be inherent in the study, considering the scope or geographical location (domestic) of the respondents, laws and regulations (domestic) that govern their respective aviation programs, and their level of experience.

**Data Collection, Processing, and Analysis**

To investigate the research questions, the researcher examinedthe previously mentioned three constructs extending from the identification of the competency requirements in the aviation-safety profession to the analysis of the existing aviation-safety professionals resulting from the responses of the competency requirements. In addition, the four formulated hypotheses were also tested. The need for the development of a different type of questionnaire for this study has already been justified in previous sections.

To cultivate the necessary survey instrument, the researcher determined that the initial phase of the questionnaire development would involve the identification of competencies by distributing open-ended survey instruments to five experts (competency constructors). Aside from the expertise and knowledge of aviation safety that these members must possess, utilizing the members of this group ensured that responses were not limited to a purely local context but could include answers based on a national aviation context. An open-ended questionnaire was distributed as it would provide a structure for the respondents' answers while minimizing limitations of the respondents' articulation on the subject matter. As a result, no entailed restrictions would affect the substance and the approach by which responses were made (Kerlinger, 1973).

After the researcher sent the initial invitation to and received acceptances from the 100-member expert panel via e-mail, the randomly selected sample of aviation-safety professionals were asked to evaluate five competencies with learning outcomes in the context of safety-related professions, including aviation safety, ground safety, employee safety, and environmental safety components. When the initial evaluation of competencies was complete, the 100-member expert panel received the pre-identified competencies via confirmed e-mail, which would ensure delivery and read-confirmation response through similar technology as Microsoft Outlook. Afterward, the identified competencies were collected, reviewed, and evaluated. Duplicate responses were discarded, and the remaining responses created a shortlist of the five core competencies and the top five identified learning objectives. These five competencies and top five learning objectives were the focus of the questionnaire. The expert panel completed the review and evaluation phase because of their highly competent status in aviation-safety industry.

After completion and development, the questionnaire was distributed via e-mail to the third group of respondents, consisting of 3,000 safety professionals drawn from members of the mailing list of the *Flight Safety Information Newsletter*. The process of evaluating the competencies included an invitation to participate in rating the competencies and the address of a website where the questionnaire could be found. This website would facilitate data collection and analysis, which in turn would enable the selection of the competencies for statistical analysis.

The competency raters from the third group were asked to rate the competencies using the 7-point Likert scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*).

With the use of a mean score rating, the Likert scale determined the extent of importance of each competency. The competencies having the highest mean score rating would be the most important.

All communications, requests, and notifications involved in the data gathering procedures were distributed via e-mail to ensure timely distribution of questionnaires and prompt receipt of responses from the three groups of respondents. Upon completion of the methodological processes to gather pertinent data, the researcher conducted data analysis with statistical programs. The proposed statistical methodologies for the study on the competencies for aviation-safety professionals included several of the methodologies employed in the studies conducted by Morris (1989), Montgomery (1983), DeLeo (2002), Blair (2001), Soule (1993), Weijia (2005), and Cangiano (2005).

**Methodical Assumptions**

The research tool for this study was based on comparative and quantitative methods. The design of this instrument facilitated the discovery of the interconnecting relationship of competencies, level of education, professional licensing, and professional certification in a particular sample. This design allowed for the identification of similarities between and within variables. The instrument design matched the purpose of this research based on methodology that it measured the same variables within one population group.

A survey instrument was the basis for the design of this comparative research. Based on the significant number of participants, all survey questionnaires contained the same structure and questions to solicit their attitudes and opinions. The survey questionnaire methodology was the best appropriate means to study the multiple variables for this study and had been used on similar prior studies by safety professionals.

### Limitations

The ability to obtain information for a large scale of participants utilizing the survey questionnaire method contributed to the power of the study. Because of cultural and language differences, some participants might have been unable to understand and articulate technical terminology. Language and cultural barriers may identify weaknesses of the survey methodology and may infer restriction or exclusion of participation of the population for cultural and language differences.

### Delimitations

The means to prevent the presence of bias or prejudices would also have an effect on the parameters of data collected via the survey instrument. Collectively, participation in this research study is voluntary, and each participant's honesty, willingness, and integrity were assumed as a gesture of goodwill in completing the survey.

### Ethical Assurances

If the dissertation study could be revised and rewritten, the researcher would recommend the following changes to make the study fully conform to the most stringent ethical standards for conducting research. First, the study would be more ethically appropriate if the competencies to be identified pertained to a specific job title only and not to the concept of aviation-safety professionals in general. If this specific change were made, a number of biases could be avoided in respondents' answers to the survey instrument. These biases result from the effects of differences in tasks involved in various positions within aviation safety. Narrowing the general concept of aviation-safety professionals to a more specific job title would ensure uniformity and standardization for almost all tasks involved in the research and would eliminate biases by respondents, as they would be assessing a position. The specificity of stating the position would encourage respondents to focus on the specific tasks of the job rather than considering a broader range of activities under the positions within the area of aviation-safety professions to make it simpler for the respondents to generate a list of competencies.

Second, the proponent of the study must possess as much technical knowledge of aviation safety as possible. If the proponent perceives that his aviation knowledge is inadequate, he must perform additional research or consult with experts on the subject. The proponent must distance himself from any possible biases relayed to him by any of the respondents within each of the three levels. For example, if there are technical questions, he must have enough technical competence at his own level to make accurate, unbiased responses to any queries from the respondents.

More details for the initial five-expert sample survey would also be preferable. Where did the proponent obtain the questions for this initial survey? The opinion of experts would again be needed. How would this first survey be designed? A literature search could ensure partly that the initial draft of the instrument conforms to the opinions of the panel of experts. The proponent should make clear specifications in research procedures. More particularly, the proponent should ensure that the selected sample would represent the entire group of aviation professionals. There should be a specification of whether the group represents aviation professionals at the regional or national level and an explanation for why these aviation-safety professionals were chosen as the main body to be involved in the evaluation of the first survey by listing the initial set of competencies. The proponent of the study must prove that his selection of this body is properly justified.

Additionally, because the instrument is to be designed originally by the proponent, each instrument should therefore undergo a pretest prior to use so any problems or comments may be addressed and so necessary adjustments can be made to the survey and/or the other instruments. In this way, validity and effectiveness of the instrument would be assessed.

Various tools for power analysis were also presented in the study, but there was no mention of the specific tool that would be used. Ethics in research would require that for every piece of theoretical presentation, the researcher should emphasize the relationship of the theory to the study. Which power analysis tool is best for the design presented in the study? All of these should be specified in the research as this specification would reflect consultations with other statistics practitioners.

Another important ethical issue that must be resolved is the lack of provision for the anonymity of respondents as well as for the issue of privacy in the manner by which the methodological instruments are sent to the respondents and returned to the proponent. Methods of sending and returning the finished surveys must be tamper-proof, and the proponent must be able to ensure both security and convenience in the respondent's return of the instrument. For instance, if the survey is to be sent via e-mail, the proponent should make certain that the instrument is sent through the private e-mail address of the respondent and not to a group address for viewing. The respondents must also return the completed surveys in an equally secure manner, guaranteeing that they remain private and tamper-proof.

In every research study, the anonymity of the respondents is essential. The researcher should exclude any knowledge of the respondents' personalities so the objectivity necessary to produce personally unbiased results remains. The express written consent of all respondents is equally important as this consent proves that there was no coercion whatsoever involved in their participation in the study and that the respondents answered the survey instrument(s) presented to them voluntarily and with informed choice.

Because several studies on the same area have appeared as part of the Review of Related Literature, the proponent must be careful not to show any bias in favor of or against any of the studies. He must reveal only the methodologies and results of the studies from their proponents. Explicitly favoring one study and belittling others might create the impression that the proponent is already biased to certain results, thus implying that there is a tendency that the proponent might compare the results of this study with the favored study.

Ethically, there is nothing wrong with attempting to compile a list of competencies that aviation professionals need to possess. However, some element of bias can occur in the comparison between a safety educator and a Certified Safety Professional (CSP) based on Blair's study because the language by the proponent seems to belittle the position of the safety educator. His input would still be part of the research but with the implication that the research automatically should give more weight to the opinions given by a CSP compared to the input of a safety educator, raising the question if it is ethical to reveal one's opinions of the quality of inputs from these two types of professionals. This element of bias could also cause harm to the reputations of safety educators who might be tapped to offer their own input in the surveys. If the possibility exists that the opinions of the safety educators were inferior to those of the CSPs, questions might also be raised regarding the integrity of the research. This issue may cause concern in other aviation-safety professionals who may be led to perceive their participation in the study as simply a token act rather than a significant contribution.

Last, the proponent must conduct himself/herself with utmost professionalism throughout the execution of the study, especially when interacting with those aviation experts whom he wishes to contribute professionally for the proposed body of work in aviation safety. His presentation of himself must give credence to his goal of seeking to improve the safety of millions of passengers and aviation professionals who take to the air daily. An aura of professionalism will likewise prompt all respondents to state their professional and honest answers to the survey instruments at all times, thus helping ensure the integrity of the results of the study.

**Summary**

The main objective of the study was to identify the core competencies that an aviation-safety professional must possess to manage aviation-safety programs. The research was critically essential in that airline companies lack a uniform, standard set of qualifications for airline safety managers. Furthermore, the research was a valuable contribution to aviation safety because studies conducted specifically on identifying competencies in aviation safety have, until the present, been more limited in their scope.

The researcher proposed several constructs to facilitate in the evaluation and investigation of the research questions. The first construct included the identification of competencies critically important for an aviation-safety manager, as evaluated by an expert panel of professionals from aviation safety. The second construct included the individual evaluation of competencies, through the use of 7-point Likert scale, by members of the domestic aviation-safety professionals industry. The third construct included the listing and testing of individual demographic variables of the involved professionals through use of a Likert Scale, with such variables as educational background/degree, professional licensing and professional certification. The fourth construct included the measure of the derived importance of the competencies by the respondents and by individual demographic responses through applicable statistical analysis. The final construct included an analysis of current aviation industry leadership as derived from responses to the competency questionnaire.

For the proposed study, the researcher employed a quantitative research approach methodology. Because the scope of the study was very specific, the existing instruments available were not perfectly applicable in this study, so this study must develop an original questionnaire specific to the aviation-safety domain. The creation of a new and adapted authored instrument will also serve to prevent duplication of the results of previous studies, thereby maintaining the integrity of this dissertation.

To accomplish this goal, five aviation-safety experts (competency generators) evaluated five core competencies and supporting learning outcomes they considered most important for aviation-safety professionals to possess. The researcher translated the product of the review and evaluation of the expert panel into a newly developed questionnaire in a pilot study consisting of a 100-member panel to test the instrument's effectiveness and validity. The instrument for this study was solicited to a distribution population of 3,000 domestic aviation-safety professionals (competency generators). The questionnaire used on a 7-pointLikert-scale format with values assigned to each competency depending on its level of importance as perceived by the competency raters. The data gathered from these survey questionnaires was analyzed through frequency distribution testing. For the researcher to test the hypotheses involving the influence of demographic characteristics, the *p*-value was set at ($p<0.01$).

One limitation of the study was the high degree of reliability of the instrument. To address this concern, the researcher conducted a pretest of the instrument to assess the reliability, effectiveness, and suitability of the instrument to the proposed study, and possibly to future studies. If the instrument proved to be valid and effective, this validity would become strength for the proposed study. Once validated, this instrument facilitated the stated goal of developing a standardized set of required competencies for aviation-safety professionals and rendered the process of identifying the core competencies much simpler.

Multiple recommendations were made regarding ethical concerns not specifically addressed in the proposal. These concerns included narrowing the concept of aviation-safety professionals in general into a more specific safety-related job title to lessen bias, specifying the provisions to preserve respondent anonymity and addressing and diminishing biases inherent in the reviewed literature. Maintaining specificity in every method, procedure, and technique in the study was also recommended, along with the necessity of the proponent's maintaining utmost professionalism throughout the execution of the study.

# Chapter 4: Findings

The purpose of this mixed methods study was to explore the comparative relationships among selected core competencies, education, professional licensing, and certification of aviation safety professionals in commercial and transportation aviation industries. The specific comparative relationships were between required education courses to obtain the course competencies and the direct and indirect relationships between professional licensing and the certification beyond licensing to verify competencies for safety professionals. Reliability tests were performed on the core competencies: complex multidisciplinary system, history, collection and analysis, identification and treatment, and program management.

This study incorporated a mixed methods design of quantitative questions and qualitative questions (using a Likert scale of measurement). Hypotheses were tested by means of correlations. This study was implemented in three phases: Phase 1, Identification of Competencies; Phase 2, Pilot Study with Competency Evaluators; and Phase 3, Final Sample of Working Professionals in the Aviation Safety Industries.

The first phase was the creation of an instrument identifying specific competencies required to ascertain whether employees, equipment, and facilities were in compliance with safety regulations. In the second phase, an initial Pilot Study assessed the appropriateness of this new instrument among this population, using a small sample of 100 participants. In the third final phase, a larger sample for the final comparative study was collected. This newly created instrument was validated formally and used along with additional demographic information to compare and evaluate participant characteristics and selected core competencies: complex multidisciplinary system, history, collection and analysis, identification, identification and treatment, and program management. Based on the purpose and goals of this study, the following research questions and corresponding hypotheses were proposed and then tested.

**Research Questions**

The Research Questions were revised to reflect the IRB Approved Survey Instrument that was used. The revised research questions were as follows:

RQ1: To what extent, if any, did the competency ratings reported by respondents differ by levels of education?

RQ2: To what extent, if any, did the competency ratings reported by respondents differ by the major field of their study?

RQ3: To what extent, if any, did the competency ratings reported by respondents differ by professional certification and licensure?

RQ4: To what extent, if any, did the reported competency ratings differ by respondents' membership in their respective departmental safety teams?

**Hypotheses**

The hypotheses were also revised to reflect the IRB Approved Survey Instrument. The revised hypotheses are as follows:

H1o: There is no relationship between core competency and educational attainment of respondents.

H1a: There is a positive relationship between core competency and educational attainment of respondents.

H2o: There is no relationship regarding core competencies and respondents' major field of study.

H2a: There is a positive relationship regarding core competencies and respondents' major field of study.

H3o: There is no relationship regarding difference in opinions regarding core competencies among respondents with a professional safety certification (license) from the FAA or training in a major field of study.

H3a:  There is a difference regarding difference in opinions regarding core competencies among respondents with a professional safety certification (license) from the FAA or training in a major field of study.

H4o: There is no relationship between opinions of respondents regarding core competencies and respondents' membership in their respective departmental safety committees.

H4a: There is a relationship between opinions of respondents regarding core competencies and respondents' membership in their respective departmental safety committees.

**Variable Measurement or Control Group Differences**

The present study was completed in three phases. Different goals and methods were implemented at each phase to reach the final comparison phase (Phase 3). The following section details how variables were conceptualized and measured at each phase of the study.

**Phase 1 of the Study**

**Collection of Sample of Competency Evaluators**

To construct the initial competency measures for this study, a panel of experts in the air safety field was recruited to assist in identifying specific competencies relevant to the field of air safety. This sample was collected by first identifying groups of experts within their corresponding areas of air safety. They were selected by contacting respective agencies and requesting permission to invite experts within their agencies by an e-mail listserv. Once identified, the researcher invited potential competency evaluators through e-mail contacts from the International Society of Air Safety Investigators and Certified Safety Professionals (CSP) from the aviation competency domains of maintenance, air traffic control, airline and commercial operations, government regulatory agencies, and manufacturers. Three competency evaluators represented each of the domains to ensure balance and to circumvent research bias.

The experts also determined any complementing learning objectives they considered to be important requirements for an effective aviation-safety professional (Jovanis & Gross, 2006; Montgomery, 1983). The instrument evaluation process was based on simple reasoning with either a *yes* or *no* response to the five core competencies and complementing learning objectives. This expert group of four individuals also evaluated and provided feedback on the instrument as a whole to assess comprehension, correctness, and accuracy in the core competencies.

The list of competencies and learning objectives appraised by these competency evaluators became the preliminary basis for the validation of the Likert-scale survey questionnaire. This survey was used to determine the validity of the required competencies needed for aviation-safety professionals. This method has been a standard way initially to validate or create a measure.

The Competency Evaluators were:

1. Dr. Steven Buckner -FAA Safety Team (FAASTeam) Regional Operation Manager, Federal Aviation Administration
2. Mr. Eugene Carroll - Director of Safety & Regulatory Compliance, Continental Airlines, Inc. (Ret.)
3. Mr. John Darbo – Manager of Flight Safety for Internal Evaluation and Investigation, American Airlines, Inc. (Ret.)
4. Ms. Erin Carroll, Manager Safety Investigations, Southwest Airlines, Inc.

**Phase 2 of the Study**

**Pilot Study with Professionals**

In the second phase of the study, a Pilot Study was designed and implemented to test and assess the questionnaire (survey). This phase of the study was implemented to assess comprehension, effectiveness, and accuracy of the created measure. A pilot study is a common method of testing the reliability and accuracy of the survey by using the survey and a sub-set of the participants. Even more so, "A pilot study is important in the planning and conduct of research [because]…it is unethical to conduct a study involving large numbers of subjects that proves to be inconclusive because of problems that could have been detected with a well-planned pilot study" (Connelly, 2008, p. 412).

This Pilot Study was conducted using an e-mail based format utilizing a convenience sample of 118 aviation-safety professionals (expert panel). The panel of experts consisted of professionals known to be leading figures in aviation safety (Montgomery, 1983). Criteria for selecting professionals for the panel included educational attainment, professional certification, leadership positions in safety organization, professional publication and presentations, membership in governmental and non-governmental organization, and positions held within the company or organization of the experts.

The draft survey instrument was coded and uploaded to the online survey software program, SurveyMonkey. A link was made available to prospective expert respondents via the online *Flight Safety Information* newsletter (www.fsinfo.org). Once respondents clicked on the link, they were first introduced to the goals of the total study and given information regarding their voluntary participation and provided with a consent form to confirm informed consent. The respondents next were asked to provide feedback, corrections, deletions, or any suggested changes to the competency survey. Corrections, suggestions, and additional feedback were collected and recorded in an Excel data file.

For this Pilot Study, the researcher proposed to collect a sample of 100 participants but concluded with a total of 118 respondents. In general, most respondents were in agreement (or provided reliability for) with the survey and offered positive feedback regarding the use of the particular items in the survey. Feedback from the Pilot Study participants resulted in three items undergoing minor language changes and revised for Phase 3 of this study—a qualitative Likert scale.

## Phase 3 of the Study

## Likert Scale Data Collection

For the third and final phase of the study, the targeted sample population came from the *Flight Safety Information* Newsletter Subscriber database, resulting in a total of 707 survey responses. The response data were collected from a total possible pool of 3,000 adult male and female participants responding to the survey. The targeted population for this sample was composed of individuals who were subscribed to a daily newsletter created by the researcher.

The newsletter is called the *Flight Safety Information (FSI)* newsletter, a daily publication with more than 45,000 aviation-centric subscribers, including aviation-safety professionals, managers, and legal representatives. All subscribers to this newsletter work for an aviation entity. The sample was recruited from this population pool via an advertisement in the FSI daily newsletter and contained a detailed explanation regarding the purpose of the survey, including the assurance of anonymity and confidentiality. Because the sample pool was also recruited from the same newsletter population to prevent duplicate participants from Phase 1 to Phase 3, a question was added to the survey to help differentiate between those who responded to the Pilot Study and those who responded to Phase 3 of the study. The question specifically asked whether they had previously participated in the survey. If the respondents answered *no*, they continued to the rest of the survey. If the respondents answered *yes*, they were thanked for their participation and not given the revised survey.

A qualitative Likert scale was used for measurement in Phase 3. The web-based survey was implemented electronically allowing participants enter responses using proprietary information and resources from their business or association. The survey was distributed to the sample population through e-mail and included all ratings and forced choice responses which were different from the Pilot Study survey. The rating and forced choice responses included the domains of a complex multidisciplinary system, history, collection and analysis, identification, identification and treatment, and program management. A Likert scale was used for measurement and totaled to compute different sub-scaled scores or a total score.

## Reliability of Correlation Tests

A *high* value of alpha often is evidence of measuring a construct with detailed argument and measured tests. The *high alpha* does not necessarily suggest that the measure is one-dimensional. With measuring internal consistency and producing evidence that the scale is one-dimensional, additional analyses may be needed to provide evidence that the scale in question is one-dimensional. One method of checking dimensionality is exploratory factor analysis considering strict definition. Cronbach's alpha is a coefficient of reliability or consistency. Cronbach's alpha is a function of the number of test items and the average inter-correlation among them. For conceptual purposes, the formula for the standardized Cronbach's alpha is listed below:

$$\alpha = \frac{N \cdot \bar{c}}{\bar{v} + (N-1) \cdot \bar{c}}$$

**Reliability: Cronbach's Alpha**

**Scale: Aviation Safety Competencies**

Three reliability measures were calculated beginning with Cronbach's alpha. According to Trobia (2008), "Cronbach's alpha is a statistic that measures the internal consistency among a set of survey items that (a) a researcher believes all measure the same construct, (b) are therefore correlated with each other, and (c) thus could be formed into some type of scale" (p. 171). Cronbach's alpha provided a coefficient score of .961 (see Appendix G), suggesting that the scale items consistently were answered in the same manner. All items used a specific construct which is defined in air safety travel as aviation safety competencies. This alpha coefficient was based on the scores of the 28 items for all respondents in the sample.

**Split-Half Reliability**

This second reliability test is a measure of reliability or of consistency when a researcher splits the test in two. The scores for each half are compared with one another. When the test is consistent, the researcher is led to believe that it is most likely measuring the same thing. This test is not the same as testing for validity. For validity, the researcher determined that the test measured what it was supposed to measure and to a high degree of reliability.

The split-half reliability is another alpha reliability score that compared the reliability scores of 14 items and compared the scores with each other. The overall split-half reliability scores ranged in the .910 (.917 and .943). This range suggested that the sample approached the items in a similar manner, indicating strong reliability in the items measuring the construct of competency in air safety.

**Reliability: Split-Half**

**Scale: Aviation Safety Competencies**

Organization of the study allowed for analysis of the revised research questions and supporting hypotheses. The organization also analyzed the content validity coefficient and homogeneity reliability coefficient by serving as referential indicators for objective evaluations of the test or scale suitability (Aiken, 1980). The appropriateness of the survey included reliability coefficients and subscale scores.

The three phases of the study allowed for a structured format and logical manner in evaluating the data separately. The phases also permitted the possibility of computing subscale scores, evaluating their distribution, and evaluating any missing data or potential outliers. Different phases in the study also allowed for the ability to evaluate the reliability of the newly created measure, primarily with Cronbach's alpha. Data for the predictor variables were retrieved from the responses from the Internet-based survey implementation (see Appendix B).

**Data in Section Titles Related to the Hypotheses**

The distribution of the actual subscales was reported, providing the means, medians, skewness, and kurtosis scores and histograms for each of the five competency subscales (see Appendix F). For inferential statistics, the correlation coefficient value and p-value were calculated. The researcher described the use of or a non-parametric test or Spearman's Rho, based on the type of data (ordinal) and the skewed distributions. Not rejecting the null hypothesis does *not* conclude that any association or differences exist. The analysis simply did not detect any association or difference between the variables.

**Return Rate**

With a preliminary time frame of one week for preparation, the Pilot Study ran for two weeks or 14 days. The second phase ran for a total of two weeks or 14 days. In the third phase of study, the final survey covered a period of two weeks including time for e-mail invitations.

**Demographic Characteristics**

In the final phase, a total of 707 individuals responded to the revised survey. One hundred percent of participants had aviation experience within the industry. Appendix F includes demographic characteristics and frequency information for the study sample.

In the breakdown of the actual measure, the researcher describes these scores. The instrument was scored by subscales so there are five dimensions or competency areas in the instrument: complex multidisciplinary system, history, collection and analysis, identification and treatment, and program management. Based on the overall responses, the sample overall scored all of the competencies very highly so the data for some of outcome measures is skewed. From the skewness scores for each subscale, a score between positive 1.0 and negative 1.0 is within an acceptable range to approximate some normality. However, all skewness scores are close to 1.0 or above1.0, indicating that most people scored on one side of the scoring. Basically everyone in the sample provided high scores for each competency. From the histograms, indeed the data has some skewness**.** Kurtosis revealed how flat or how the distribution peaked was, also suggesting the data were not normally distributed or interpreted the same way (+1 and -1.0).

Table 1

Competency Scale Demographics by Subscale.

| | | | **Descriptives** | | |
|---|---|---|---|---|---|
| *Variable* | *N* | *M* | *SD* | *Skewness* | *Kurtosis* |
| Complex Multi-disciplinary System Composite Score | 472 | 6.1100 | .82741 | 1.870 | 6.754 |
| History Aviation System Composite Score | 470 | 5.6639 | .95651 | .820 | 1.158 |
| Collection and Analysis System Composite Score | 471 | 5.8804 | .94515 | 1.361 | 3.657 |
| Identification and Treatment System Composite Score | 469 | 5.9857 | .88828 | 1.145 | 1.832 |
| Program Management System Composite Score | 468 | 5.8434 | .94331 | .969 | 1.368 |

Results offer scale reliability and item reliability for each variable scale, which was used to test the data. Mean scores were calculated. Proper implementation of data collection procedures instruments was accomplished. The assumptions of each test proved to be reliable using three separate tests. The researcher supported each assumption through statistical analysis of both the Pilot Study (quantitative) and the final sample study in a qualitative Likert scale (Creswell, 2005). The data did not fit into the curve (Creswell, 2005) according to the measure of skewness, kurtosis, and the actual histograms (see Appendix F). The data approximated normality according to the visual representation below using the Spearman-Brown formula.

**Inferential Analyses**

The researcher used correlations first to investigate the relationships among proposed variables followed by using these variables as predictor variables to identify specific competencies (outcome variables). The data were additionally cleaned and organized to address outliers and any missing data. Measures of central tendency were evaluated to assess data and its appropriateness for the proposed analyses. Correlation coefficients were computed to ascertain the direction and strength of relationships among variables of interest. All analyses were computed using the statistical software tool, SPSS version 21. "The Spearman-Brown formula will give a close approximation to the reliability of the total form, as split halves will in general be nearly equally reliable" (PsycINFO Database Record, 2012, p.1). The Spearman–Brown prediction formula is referred to as the *Spearman–Brown prophecy formula* and relates reliability to test length (Bruin, 2006). "The Spearman—Brown prophecy is expressed in the following equation:

$$\hat{r}_{tt} = \frac{kr_{AB}}{1 + (k-1)r_{AB}},$$

Where *k* is the factor by which the length of the test is changed or the ratio of the new test length to the old test length, *rAB* is the reliability of the original test, and it is the estimated reliability of the test *k* times as long as the original test" (Kingston, & Tiemann, 2010, p. 1404).

*N* is the number of *tests* combined. The formula predicts the reliability or consistency of a new test by replicating the current test *N* times (*N* parallel forms of the current exam). Thus, *N* = 2 implies doubling the exam length by additional similar items like those in the current exam. Values of *N* less than 1.0 may be used to predict the effect of shortening a test (Bruin, 2006).

Psychometricians often use this formula to predict the reliability of a test after changing the test length. This relationship is vital to the split-half and related methods of estimating reliability. This method is also sometimes known as the *Step Up* formula. The formula helps the researcher to understand the nonlinear relationship between test reliability and test length. Test length will grow by increasingly larger values as the desired reliability approaches 1.0 (Bruin, 2006). The Spearman-Brown Coefficient and Guttman Split-half coefficient are non-parametric counterparts of reliability measures that also provided reliability scores in the .90's. The Spearman–Brown split-half reliability coefficient has represented the "best practice for expressing reliability of a set of measurements obtained from multi-item scales" (Beckstead, 2013, sect. 4.2).

The researcher used correlation and correlation matrixes (Spearman's Rho coefficients) first to investigate relationships among proposed variables followed by using these variables as predictor variables to identify the five specific competencies (outcome variables): complex multidisciplinary system, history, collection and analysis, identification and treatment, and program management. The data were additionally cleaned and organized to address outliers and missing data. Measures of central tendency were evaluated to make certain data were appropriate for proposed analyses. The Spearman Rho Correlation is appropriate for ordinal data, skewed data, and discrete data. All apply to the variables. The following matrix looks at the relationship among the competency subscales. Overall, the subscales seem to be highly related to one another. These subscale items suggest that participants responded to all items in a similar fashion. Those who scored highly favorable on one scale also scored highly favorable on the other competency scales.

The ***bolded, italicized numbers*** in any table correlations indicate the strength of the relationship between the subscales. For example, the Complex Multi Disci System was correlated with the History Aviation System subscale at .676 and significant at the .000 with a sample of 470 people. Each correlation has different sample totals because only those individuals who had complete scores for both of the subscales were compared. Based on this correlation, only 470 had complete scores for both subscales. These scores overall simply stated how the sample as a whole scored on the subscale competency scores and described how each subscale was answered similarly to the other subscales.

Table 2

*Correlations among Competency Scores.*

| Variable | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 1 Complex Multidisciplinary | 1.00 | | | | |
| 2 History Aviation | .676** | 1.00 | | | |
| 3 Collection and Analysis | .674** | .734** | 1.00 | | |
| 4 Identification & Treatment | .692** | .637** | .723** | 1.00 | |
| 5 Program Management | .670** | .692** | .732** | .778** | 1.00 |

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

**Hypotheses**

Measures obtained for each variable are reported clearly, following standard procedures. Adjustments or revisions to the use of standardized research instruments are justified, and any effects on the interpretation of findings are clearly described.  Data analysis (presentation, interpretation, explanation) is consistent with the research questions or hypotheses and underlying theoretical and conceptual framework of the study.

RQ1:  To what extent, if any, did the competency ratings reported by respondents differ by levels of education?

As further explained by Englander (2012), "In order for phenomenological research to achieve the same rigorous quality as natural scientific research, it is important that the research process be methodologically articulated in such a manner that data collectionand data analysis are both seen as part of a single, unified process with the same underlying theory of science" (p. 15).

H1o: There is no relationship between core competency and educational attainment of respondents.

H1a: There is a positive relationship between core competency and educational attainment of respondents.

**Education Level and Competencies**

For the first hypothesis, Education Level was not related to how the competencies were rated, as evident from the extremely low correlations (almost 0 for many of them), and none of them were significant. Thus, the results lead to the rejection of the null Hypotheses 1a.

Table 3

*Correlations among Competency and Level of Education*

| **Variable** | **1** | **2** | **3** | **4** | **5** | **6** |
|---|---|---|---|---|---|---|
| 1 Complex Multidisciplinary | 1.00 | | | | | |
| 2 History Aviation | .676** | 1.00 | | | | |
| 3 Collection and Analysis | .674** | .734** | 1.00 | | | |
| 4 Identification & Treatment | .692** | .637** | .723** | 1.00 | | |
| 5 Program Management | .670** | .692** | .732** | .778** | 1.00 | |
| 6. Education Level | .081 | .010 | -.003 | -.008 | -.034 | 1.00 |

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

RQ2: To what extent, if any, did the competency ratings reported by respondents differ by the major field of their study?

H2o: There is no relationship regarding core competencies and a respondents' major field of study.

H2a: There is a positive relationship regarding core competencies and respondents' major field of study.

**Degree and Competencies**

There was also no relationship between competencies and whether an individual had a degree or specialization in the safety field. Thus, the results rejected the null Hypothesis 2o.

Table 4

Correlations among Competency and Safety Competencies.

| **Variable** | **1** | **2** | **3** | **4** | **5** | **6** |
|---|---|---|---|---|---|---|
| 1 Complex Multidisciplinary | 1.00 | | | | | |
| 2 History Aviation | .676** | 1.00 | | | | |
| 3 Collection and Analysis | .674** | .734** | 1.00 | | | |
| 4 Identification & Treatment | .692** | .637** | .723** | 1.00 | | |
| 5 Program Management | .670** | .692** | .732** | .778** | 1.00 | |
| 6. Safety Competencies | -.058 | .050 | -.085 | -.034 | .020 | 1.00 |

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

RQ3: To what extent, if any, did the competency ratings reported by respondents differ by professional certification and licensure?

H3o: There is no relationship between respondents' opinions regarding core competencies and opinions of respondents with FAA professional safety certification (license) or training in the major field of study.

H3a: There is a relationship between respondents' opinions regarding core competencies and opinions of respondents with FAA professional safety certification (license) or training in the major field of study.

**Degree in Safety Field and Competencies**

There was also no relationship between competencies and whether an individual had a degree or specialization in safety field. Thus, the results lead to the rejection of the null Hypothesis 3a.

RQ4: To what extent, if any, did the reported competency ratings differ byrespondents' membership in their respective departmental safety teams?

H4o: There is no relationship between opinions of respondents regarding core competencies and respondents' membership in their respective departmental safety committees.

H4a: There is a relationship between opinions of respondents regarding core competencies and respondents' membership in their respective departmental safety committees.

In the relationship between competencies and percentage of time individuals function as a safety team, and the relationship between whether they function as a member of safety team, no relationship seems to be found between these factors and the competencies endorsed.Thus, the test results lead to the rejection of the null hypothesis H4o.

Table 5

*Correlations among Competency and Work on a Safety Team.*

| **Variable** | **1** | **2** | **3** | **4** | **5** | **6** | **7** |
|---|---|---|---|---|---|---|---|
| 1 Complex Multidisciplinary | 1.00 | | | | | | |
| 2 History Aviation | .676** | 1.00 | | | | | |
| 3 Collection and Analysis | .674** | .734** | 1.00 | | | | |
| 4 Identification & Treatment | .692** | .637** | .723** | 1.00 | | | |
| 5 Program Management | .670** | .692** | .732** | .778** | 1.00 | | |
| 6 % Function on Safety Team | .043 | .027 | .039 | .043 | .048 | 1.00 | |
| 7. Member of Safety Team | -.009 | -.005 | .025 | .006 | .006 | -.685** | 1.00 |

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

## Summary and Conclusion

The purpose of this mixed method correlation study was to examine associations among a set of core competencies: complex multidisciplinary system, history, collection and analysis, identification and treatment, and program management. Table 7 in Chapter 5 summarizes the three reliability tests and scores that reject the null hypotheses and accept the high reliability of the findings. These findings naturally lead into the topics in Chapter 5: Implications, Recommendations, and Conclusions. Chapter 5 particularly emphasizes recommendations for the future.

## Chapter 5: Implications, Recommendations, and Conclusions

The purpose of this quantitative correlations study was to investigate whether associations existed among selected core competencies, education, professional licensing, and certification of aviation safety professionals in commercial and transportation aviation industries. At the time of this study, the FAA had no regulatory requirements to assess or confirm competencies for an aviation safety professional. The study results indicated that measurable perspectives via a survey may have limited data collection.

Leaders and aviation safety professionals should welcome the results of this research study because three separate reliability tests confirm correlations in the Pilot Study and the final sample survey, from the professional and organizational experts to current field professionals. Specifically, the results will assist all aviation safety professionals who can and should learn from and then implement the information found in the results. The importance, meaning, and significance of the findings in Chapter 4 (Simon, 2006) are confirmed statistically in Chapter 5.

### Findings and Interpretations

**Recommendation for practice.** The intent of this last chapter is to present the findings, implications, and recommendations for subsequent leadership implementation and actions. Studies for future research will be based on the results of this research study (Creswell, 2005). This study has exhibited evidence that the variables in this study are related in a high degree of reliability. For summary and review, the hypotheses are:

H1a: There is a positive relationship between core competency and educational attainment of respondents.

H2o: There is no relationship regarding core competencies and respondents' major field of study.

H2a: There is a positive relationship regarding core competencies and respondents' major field of study.

H2o: There is no relationship regarding core competencies and respondents' major field of study.

H2a: There is a positive relationship regarding core competencies and respondents' major field of study.

H3o: There is no relationship regarding difference in opinions regarding core competencies among respondents with a professional safety certification (license) from the FAA or training in a major field of study.

H3a:  There is a positive relationship regarding difference in opinions regarding core competencies among respondents with a professional safety certification (license) from the FAA or training in a major field of study.

H4o: There is no relationship between opinions of respondents regarding core competencies and respondents' membership in their respective departmental safety committees.

H4a: There is a positive relationship between opinions of respondents regarding core competencies and respondents' memberships in their respective departmental safety committees. Table 6 summarizes the high reliability of the findings and the three reliability tests and scores that reject the null hypotheses.

Table 6

*Hypotheses Statistical Tests for Rejection of Null Hypotheses.*

| **Hypotheses** | **Test Applied** | **Test Score** | **Meaning** | **Results** |
|---|---|---|---|---|
| H1o and H1a | Mean<br>Std. Dev.<br>Kurtosis | 6.11<br>.827<br>6.75 | The data approxi-mated normality using the Spearman-Brown formula. | Rejection of the null hypothesis |
| H2o and H2a | Cronbach's alpha | .961 | Correlation is significant at the 0.01 level (2-tailed). | Rejection of the null hypothesis |
| H3o and H3a | Spearman-Brown Coefficient<br>Guttman Split-Half Coefficient | .919<br>.<br>.918 | The Spearman Brown Coefficient and Guttman Split-Half coefficient also provided scores in the .90's. | Rejection of the null hypothesis |
| H4o and H4a | Spearman's Rho | Reliability scores ranged in the .910, .917, and .943 areas. | This range suggested strong reliability in the items measuring the construct of competency in air safety. | Rejection of the null hypothesis |

**Recommendation for future research.**

First, a quantitative study using a larger sample size that includes other variables may be useful to assess and explain the variances within the study. Therefore, additional research can ascertain whether additional variables might affect reliability to an even higher degree than .910. However, Chronbach's alpha contains a paradox as it nears the maximum value (1.00). A scale with an alpha of 1.00 would mean that all items in that scale are perfectly correlated with each other. "As such, if alpha values much exceed 0.90, a researcher should consider whether or not all of the items need to be measured or used in subsequent surveys using the scale" (Trobia, 2008, p. 171).

Second, the FAA needs to examine the competencies confirmed by the three reliability tests to establish standard regulations rather than its current recommendations. These regulations can establish national standards within the main government regulatory agency in air safety aviation. Because one of Competency Evaluators for the Pilot Study works for the FAA (Dr. Steven Buckner - FAA Safety Team (FAASTeam) Regional Operation Manager, Federal Aviation Administration), the likelihood of direct knowledge by the FAA of the findings of the competencies and reliability of such is more likely to initiate FAA research.

Third, educational institutions could therefore use the competencies and regulations to guide them in establishing new courses. Institutions could also modify and change current courses for degree seeking students in the field of aviation safety. Similar to the field of competencies in law, educational institutions need consistent and reliable competencies as a framework for programs in alignment with national standards.

In addition to or in conjunction with education, DeSiervo (2004) recommends some period of *apprenticeship* or work under the guidance of a veteran safety professional (formal, educational internships) with additional lifelong **s**tudy. Even with the adoption of these practices, educational institutions must conduct further research to ascertain the viability of acceptance.

Much like the findings of this research in relation to future recommendations, previous studies outline similar findings for a doctoral degree in aviation study. While the DeLeo study is similar to the Morris and Soule studies in regard to curriculum, DeLeo's main area of concern is the identification of core competencies for a doctoral degree in occupational safety. DeLeo uses 16 identified safety experts from the American Society of Safety Engineers (ASSE) to create an initial list of 138 degree competencies. A panel reviews and evaluates the competencies utilizing a Likert scale rating on three different occurrences, producing a final list of 15 competencies required for the degree program.

The study by DeLeo (2002) on competencies for a doctoral degree in occupational safety employs many of the same techniques and processes in the identification of competencies for aviation-safety professionals. This study is an example of a descriptive research involving quantitative variables measured on a nominal point value scale such as the Likert scale.

## Conclusions

The findings do support the primary purpose of this research: to explore the comparative relationship among selected core competencies--education, professional licensing, and certification of aviation safety professionals in commercial and transportation aviation industries. In the quantitative aspect of this study, the research questions and hypotheses testing outline findings and interpretations. The hypotheses are organized by the level of importance in the study. A sub-section title explains the results, making it clear that findings do not support or do support the hypotheses according to three tests of reliability.

Three tests for reliability find a lack of statistical errors. In some cases, a clear picture does not emerge. The hypotheses could have poor phrasing, with the limitations affecting the results more than originally indicated. In the Recommendations Section, the researcher outlines the major themes and suggests actions for leaders in the aviation safety field.

## Recommendations

Recommendations follow the same logical flow as the findings and interpretations. Each recommendation correlates around the major theme or results of testing in the same order (Creswell, 2005). Recommendations suggest actions, how leaders can apply the results of the study. Those who need to pay attention to the research results are beginning research students, recognized experts in the field of air safety, and all professionals working in all areas of air safety. The results might be disseminated through e-mail, newsletters, bulletin postings, and recognized professional publications (Simon, 2006). A narrative of topics needs closer examination to generate a new round of questions.

## Researcher Reflections

The researcher has been reflecting on possible researcher bias, assumptions, experiences, education, and preconceived ideas even before the completion of the study.

The researcher has changed because of the study in the following views and assumptions. The views include the role of demographic variables, the surprising results of high reliability, and how changing the variables might produce different results.

### Suggestions for Future Research

The results of this study imply it would be useful for future research by other researchers or professionals in the areas of aviation safety. Second, new doctoral students would welcome insight on ideas for possible dissertation topics by reading the suggestions for future research sections of dissertations in such areas as aviation safety and human factors. The study can expand with different survey populations such as government, industry, and/or academia. Future study can ask to what extent, if any, do the competencies reported by the respondents' functional experience and the level of their responsibility differ at the entry, middle, or the senior level of management?

## Summary

For Chapter 5, this mixed methods study explores the factor that the theoretical framework proposes that competency development is linked to both theory and practice. According to the 118 participants interviewed in this study, both sets of influences are determinants that guide competency decisions. While themes vary as to individual values, the underlying conclusion of the survey data in this research study maintains a high degree of reliability. Chapter 5 concludes this research study. The findings produce themes that reveal education, gender, profession, and experience as major influences on air-safety field competencies. The researcher notes that the recommendations invite and encourage all aviation personnel and stakeholders to be aware of the high scores of reliability indicated by three statistical tests.

Overall, it seems that there is no relationship among any of the variables and the different groups. Everyone in the sample rates the competencies quite high, so there is not much variability between their responses or their scored subscales. The final sample respondents think that all of the competencies are very important, so no particular group rates the competencies higher or lower, based on education, number of degrees, or the other variables. Everyone rates the competencies in the same manner, a finding that also helps explain the reliability scores because the sample rates in the same fashion (most people rate all competencies quite high) for all of the competencies.

The measure itself seems to be reliable in the way that the individuals responded. However, one of the interesting findings is that, overall, everyone who answers the measure endorses all competencies to be quite important. It seemed to be measuring the importance of competencies in this field as opposed to differentiating between which competencies are important and which are not. The scores are so close that statistically, none of the items are significantly different from each other in terms of how individuals endorsed or rated the items. Everyone in the sample rates all these competencies as important in the aviation safety field.

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# Appendixes

**Appendix A:**

**Demographic Survey**

1. What best describes your highest level of education?

( ) High School Diploma ( ) Master Degree

( ) Associate Degree ( ) Doctorate Degree

( ) Bachelor Degree ( ) None of these

2. What type of degree(s) do you hold? (Please check and number all that apply)

( ) Engineering ( ) Management

( ) Law ( ) Business Administration

( ) Science ( ) Education

( ) Arts ( ) Medical

( ) Other ________________ ( ) NA

3. Do you have a degree with a minor, major, or specialization in the safety field?

( ) Yes ( ) No ( ) NA

4. Do you have a degree with a minor, major, or specialization in human factors?

( ) Yes ( ) No ( ) NA

5. Do you feel that an individual's education level contributes to their job performance?
( ) Yes ( ) No

6. Do you feel there should be an education degree requirement for aviation safety professionals?

( ) Yes ( ) No

7. Do you have a professional certification in the safety field?

( ) Yes ( ) No

8. What professional certifications in the safety field do you hold? (Please check all that apply)

( ) Certified Safety Professional (CSP)

( ) Graduate Safety Practitioner (GSP)

( ) Associate Safety Professional (ASP)

( ) Certified Industrial Hygienist (CIH)

( ) Occupational Health and Safety Technologist (OHST)

( ) Construction Health and Safety Technician (CHST)

( ) Certified Loss Control Specialist (CLCS)

( ) Safety Trained Supervisor (STS)

( ) Certified Safety Auditor (SAC)

( ) Certified Safety Manager (CSM)

( ) Certified Safety Administrator (CSA)

( ) Other (such as Project Management, Quality Management System (ISO certifications, etc.)_____________________________( ) NA

9. Do you have a college level certificate of completion in the safety field?

( ) Yes ( ) No

10. What type(s) of college level certificate of completion in the safety field do you hold?

( ) N/A or ______________________ , ______________________,

______________________ ,

______________________

11. Do you currently hold any professional aviation certificates (licenses)? (Issued by the FAA)

( ) Yes ( ) No (skip question # 10)

12. Please identify your professional aviation rating(s). (Issued by the FAA)

( ) Pilot ______________________ , ______________________,

______________________ , ______________________ ,

______________________ , ______________________

Check all that apply.

( ) ASEL

( ) AMEL

( ) Commercial

( ) Airline Transport Pilot

( ) Flight Engineer What type? ( ) Turbojet ( ) Turboprop

( ) Airframe & Power plant Mechanic

( ) Airframe Mechanic (only)

( ) Power plant Mechanic (only)

13. Do you currently function as a member of a safety team/department, as part of your occupation / organization?

( ) Yes ( ) No

14. What percentage of your occupation requires you to function as part of a safety team/department?

( ) N/A ( ) 41-55%

( ) 1-09% ( ) 56-70%

( ) 10-25% ( ) 70-85%

( ) 26-40% ( ) 86-100%

**Appendix B:**

**Likert Scale Survey**

Based on your knowledge and experience of aviation safety professionals, fill in the blank next to each competency statement with the answer that best represents your feelings. Rate each statement with the following scale:

Strongly Disagree -- 1 ------ 2 ------ 3 ------ 4 ------ 5 ------ 6 ------ 7 --Strongly Agree

Domain: Complex Multidisciplinary System

Aviation safety professionals should be able to:

1. _____Describe the classification of aviation crash and injury severity factors and their relationship to the crash event (i.e., pre-crash, crash, and post-crash) by utilizing research models and matrixes.
2. _____Identify how factors interact and contribute to a crash event.
3. ____ Explain how effective safety management can be used to prevent fatalities associated with accidents.
4. _____Recognize the effectiveness of combining countermeasures/interventions to achieve improvements in safety.
5. _____Recognize how an aviation user decision-making is influenced by aviation design, transportation planning, aviation operations, and vehicle design.
6. _____Recognize the barriers that hinder collaboration across and within institutions.

7. _____Identify and demonstrate opportunities and the ability to improve safety through collaboration with individuals from diverse cultural, disciplinary, and educational backgrounds and institution.

Domain: History

Aviation safety professionals should be able to:

8. _____Understand the historical figures, benchmarks, decisions, and correlations with aviation safety.

9. _____Identify the safety aspects of major transportation legislation.

10. _____List and describe the goals of interest groups with a stake in safety-related policy, legislation, and investment decisions.

11. _____Describe the institutional roles and responsibilities within which safety is managed (e.g., local, regional, state, and federal government, transportation modes, and the private sector).

12. _____Identify the availability of current aviation safety training and education programs.

Domain: Collection and Analysis

Aviation safety professionals should be able to:

13. _____ Describe the national databases available for safety management and identifying/trending accidents and their contributing factors. (e.g., NTSB, FAA, OSHA)

14. _____Describe the process by which safety data are collected, including constraints associated with accurate, reliable field data.

15. _____For each of the information systems, use strengths and weaknesses for improvements.

16. _____Access and use aviation safety and public health data systems for identifying and tracking crash trends, targeting high-risk groups, and planning programs at the national, state, and local levels.

17. _____Describe the importance of using accident data to evaluate the implications of safety management actions, policies, and programs.

Domain: Identification and Treatment

Aviation safety professionals should be able to:

18. _____Identify the human factors/behavior, aircraft and equipment design, environment and their correlation to accidents.

19. _____Establish priorities for alternative interventions and countermeasures based upon their expected cost and effectiveness and select countermeasures to implement (e.g., utilizing current science-based research methods).

20. _____Evaluate the effectiveness of implemented intervention and countermeasure using appropriate statistical techniques in safety management.

21. ____ Understand the importance of analyzing the expected safety benefit/cost associated with implementing a countermeasure versus accepting associated risks and not implementing countermeasures.

22._____Identify, evaluate and monitor the effectiveness of countermeasures that address hazards that lead to accidents.

Domain: Program Management

Aviation safety professionals should be able to:

23._____Use scientific management techniques in planning, implementing, and evaluating aviation-safety programs.

24.______Identify strategies to integrate and amplify safety in transportation planning processes.

25.______Explain the need to provide leadership and funding for ongoing service/support enhancements such as professional development, staff education and training, upgraded computer hardware and software, and more.

26.______Establish multidisciplinary relationships necessary to support effective aviation safety initiatives.

27.______Identify opportunities for internal and external coalition-building and strategic communications for aviation safety initiatives.

28.______ Assess and promote effective outreach/public involvement Program development and implementation.

29. _______Do you feel that the competencies identified in questions 13 through 47 represent a valid baseline of requirements for aviation safety professionals.

( ) Yes ( ) No

**Appendix C:**

**Informed Consent Form**

**Purpose.** This pilot study will explore the principle core competencies for aviation safety professionals in the aviation industry. The study will depend on feedback from aviation safety professionals who live in the United States and internationally.

**Participation Requirements.** You will be asked information regarding specific competencies important in the aviation industry by answering and rating a set of questions on a survey. Your participation will require about 30 minutes of your time.

**Research Personnel.** You may contact the following person(s) who are involved in the research project at any time:

Curtis L. Lewis
Principal Investigator
Doctoral Candidate – Northcentral University
Cell: 817-845-3983
Home: 817-303-9096
Business E-mail: curt@curt-lewis.com

Melanie Shaw, Ph.D.
Dissertation Committee Chair
Phone: 559-734-7213
E-Mail: mshaw@ncu.edu

**Potential Risk/Discomfort.** There are no known risks in this study. You may refuse to answer any question for any reason or withdraw from the study at any time without penalty. I will keep and secure all information that you provide. I will not reveal any information to anyone. Others will not be able to identify you or your answers in any way.

**Anonymity/Confidentiality.** All information collected in this study will be treated as anonymous, with no details released to anyone outside the research staff, and that the data will be reported in summary form. The data to be collected in this pilot study will be maintained confidential at all times. I will code all data so that your name or personal information is not associated with any particular item. Additionally, the coded data will be available only to researchers associated with this project. You may contact me (Curtis L. Lewis) regarding any question that you may have about the study.

If you have questions about your rights as a research participant, any complaints about your participation in the research study or any problems that occurred in the study, please contact the researchers identified in the consent form. Or if you prefer to talk to someone outside the study team, you can contact Northcentral University's Institutional Review Board at irb@ncu.edu or 1-888-327-2877 ex 8014.

If you would like to participate, please complete and return the Informed Consent Form. You can do this in one of four ways; mail, fax, scan and email the form to curt@curt-lewis.com

I have read the above description of the doctoral study titled *Examining Principle Core Competencies for Aviation Safety Professionals*. My signature indicates that I agree to participate in the study.

Participant's Name: ________________ Researcher's Name: Curtis L. Lewis

Participant's Signature: ____________ Researcher's Signature

Date:________

## Appendix D:

E-mail to Participants Including Informed Consent Form

Dear Colleagues,

I am a student at Northcentral University. I would like for you to participate in a research study. The name of this study is titled: *Examining Principle Core Competencies for Aviation-Safety Professionals.*

This study is in the area of Safety Management Systems and aviation technologies. Your feedback will help evaluate core aviation safety competencies.

If you would like to participate, please complete and return the Informed Consent Form. You can do this one of four ways; mail, fax, scan and email the form, or checking an Informed Consent Agreement Box at the survey site.

The Survey is located at: SurveyMonkey: xxx.xxx.xxx

If you have any questions, please let me know. Thank you for your help in this research.

Respectfully,

Curtis L. Lewis
Doctoral Candidate – Northcentral University
1802 Briarcrest Lane
Arlington, TX 76012
Cell: 817-845-3983
Home: 817-303-9096
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Melanie Shaw, Ph.D.
Dissertation Committee Chair
Phone: 559-734-7213
E-Mail: mshaw@ncu.edu

**Appendix E:**

**Demographic Frequency Tables**

Sample Demographic and Results Tables:

Table 9

*Frequency and Percentage Breakdown of Independent Variables (N= XX).*

| | | | Descriptives | |
|---|---|---|---|---|
| *Variable* | *N* | *%* | *M* | *SD* |
| Age | 29 | | 5.31 | 13.699 |
| Gender | | | 1.4828 | 0.50855 |
| Male | 51 | 51.7% | | |
| Female | 41 | 48.3% | | |
| Variable Name | | | 1.07 | 0.258 |
| Yes | 27 | 93.1% | | |
| No | 26 | .9% | | |
| Variable Name | | | 1.6552 | 0.48373 |
| MH DX/NO CD | 10 | 34.5% | | |
| MH and CD DX | 19 | 65.5% | | |
| Variable Name | | | 0.7586 | 0.63556 |
| 127 | | | | |
| Yes | 3 | 10.3% | | |
| No | 16 | 55.2% | | |

| | | | | |
|---|---|---|---|---|
| N/A | 10 | 34.5% | | |
| Variable Name | | | 1 .6552 | 0 .48373 |
| Yes | 10 | 34.5% | | |
| No | 9 | 65.5% | | |

Table 10

*Sample Scale or Dependent Variables Table.*

*Dependent Variable Skewness and Kurtosis*

| Dependent Variable | *M* | *SD* | Skewness | Kurtosis |
|---|---|---|---|---|
| Competency Composite Score | .697 | .129 | 0.164 | -0.630 |
| Competency Subscale 1 Score | .731 | .131 | -0.572 | -0.534 |
| Variable | 72.38 | 27.98 | 0.069 | -0.579 |
| Variable | 64.97 | 25.36 | -0.457 | -0.533 |

*Note*. *M* = mean. *SD* = standard deviation.

## Appendix F:

### *Descriptive and Inferential Analyses for Third Phase Data Set*

The correlations in the tables are associations between specific demographic questions and their association to certain competencies. Spearman's Rho Correlation is appropriate for ordinal data, skewed data, and discrete data, all of which apply to the variables.

The tables examine the relationship among the competency subscales. Overall, the subscales seem to be highly related to one another meaning that participants responded to all subscale items in a similar fashion. Those who scored highly favorable on one scale also scored highly favorable on the other competency scales.

The ***bolded, italicized*** correlations show the strength of the relationship between the subscales; for example, the Complex Multi Disci System was correlated with the History Aviation System subscale at .676 and significant at the .000 with a sample of 470 people. Each correlation has different sample totals because only those individuals who had complete scores for both of the subscales were compared, so based on this correlation, only 470 had complete scores for both subscales. These scores overall simply explain how the sample as a whole scored on the subscale competency scores and how each subscale was answered similarly to the other subscales. These correlations are discussed in the reliability section of the measure in Chapter 4.

Table 11

*Number of degrees held by the individual.*

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | | | 41.0 | 67.1 | 67.1 |
| | 2.00 | 106 | 16.5 | 27.0 | 94.1 |
| | 3.00 | 23 | 3.6 | 5.9 | 100.0 |
| | Total | 392 | 61.1 | 100.0 | |
| Missing | System | 250 | 38.9 | | |
| Total | | 642 | 100.0 | | |

Table 12

*Do you have a degree with a minor, major, or specialization in human factors?*

| | | **Frequency** | **Percent** | **Valid Percent** | **Cumulative Percent** |
|---|---|---|---|---|---|
| Valid | Yes | 95 | 14.8 | 20.2 | 20.2 |
| | No | 367 | 57.2 | 77.9 | 98.1 |
| | N/A | 9 | 1.4 | 1.9 | 100.0 |
| | Total | 471 | 73.4 | 100.0 | |
| Missing | System | 171 | 26.6 | | |
| Total | | 642 | 100.0 | | |

Table 13

*Do you have a college level certificate of completion in the safety field***?**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | Yes | 114 | 17.8 | 24.6 | 24.6 |
| | No | 349 | 54.4 | 75.4 | 100.0 |
| | Total | 463 | 72.1 | 100.0 | |
| Missing | System | 179 | 27.9 | | |
| Total | | 642 | 100.0 | | |

Table 14

*Do you currently hold any professional aviation certificates (licenses), issued by the FAA?*

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | Yes | 310 | 48.3 | 66.4 | 66.4 |
| | No | 157 | 24.5 | 33.6 | 100.0 |
| | Total | 467 | 72.7 | 100.0 | |
| Missing | System | 175 | 27.3 | | |
| Total | | 642 | 100.0 | | |

In the breakdown of the actual measure, the researcher describes these scores. The instrument was scored by subscales so there are five dimensions or competency areas in the instrument. Based on the overall responses, the sample overall scored all of the competencies very highly so the data for some of outcome measures is skewed. From the skewness scores for each subscale, a core between positive 1.0 and negative 1.0 is within an acceptable range to approximate some normality. However, all skewness scores are close to one or above one, a suggestion that most people scored on one side of the scoring. Basically everyone in the sample provided high scores for each competency. From the histograms, indeed the data has some skewness**.**

Kurtosis reveals how flat or how peaked the distribution is, also suggesting the data was not normally distributed as this is interpreted in the same manner (+1 and -1.0).

Three reliability measures were Cronbach's alpha, which provided a coefficient score of .961, suggested the scale items were reliably answered in the same manner indicating they all were tapping into a specific construct defined as competency in air safety travel. This alpha coefficient was based on the scores of the 28 items for all the people in the sample

Table 15

*Scale Statistics.*

| **Mean** | **Variance** | **Std. Deviation** | **N of Items** |
|---|---|---|---|
| 165.8<br>483 | 472.<br>227 | 21.73078 | 28 |

The split-half reliability is an alpha reliability score that looks at the instrument, splits it into two parts, and then compares the reliability scores of 14 items and then compares the scores with each other. The overall split-half reliability scores are below, which also ranged in the .910 (.917 and .943) area suggesting the sample answered the items in a similar manner, indicating strong reliability in the items measuring some construct, in this case defined as competency in air safety.

The Spearman Brown Coefficient and Guttman Split-half coefficient are non-parametric counterparts of reliability measures and also provided scores in the .90's.

Table 16

*Reliability: Split-Half.*
*Scale: Aviation Safety Competencies.*

**Case Processing Summary**

| | | **N** | **%** |
|---|---|---|---|
| Cases | Valid | 389 | 60.6 |
| | Excluded[a] | 253 | 39.4 |
| | Total | 642 | 100.0 |

a. Listwise deletion based on all variables in the procedure.

The correlations are associations between specific demographic questions and their association to certain competencies.

Spearman's Rho Correlation is appropriate for ordinal data, skewed data and discrete data, all of which apply to the variables.

The following table examines the relationship among the competency subscales. Overall, the subscales seem to be highly related to one another meaning that participants responded to all subscale items in a similar fashion. Those who scored highly favorable on one scale also scored highly favorable on the other competency scales.

The ***bolded, italicized*** correlations show the strength of the relationship between the subscales; for example, the Complex Multi Disci System was correlated with the History Aviation System subscale at .676 and significant at the .000 with a sample of 470 people. Each correlation has different sample totals because only those individuals who had complete scores for both of the subscales were compared, so based on this correlation, only 470 had complete scores for both subscales. These scores overall simply explain how the sample as a whole scored on the subscale competency scores and how each subscale was answered similarly to the other subscales. These correlations are discussed in the reliability section of the measure in Chapter 4.

**Relationship between composite scores and belief whether competencies represent a valid baseline**

When looking at the relationship between those who feel competencies are valid baseline requirements and their responses to the competencies, the researcher noted there seemed to be a relationship between these variables. Although not a high correlation, the scores were acceptable, which shows that those who felt that competencies were important for safety aviation requirements also found each competency extremely important.

Table 17

*Correlations among Competency Scores.*

| | | | | | |
|---|---|---|---|---|---|
| 1 Complex Multidisciplinary | 1.00 | | | | |
| 2 History Aviation | .676** | 1.00 | | | |
| 3 Collection and Analysis | .674** | .734** | 1.00 | | |
| 4 Identification & Treatment | .692** | .637** | .723** | 1.00 | |
| 5 Program Management | .670** | .692** | .732** | .778** | 1.00 |