1-1-2022

An Evaluation Of The Relationships Between Resilient Safety Culture, Safety Risk Parameters, And Mindfulness In The International Air Show Community

Emmanouil "Manolis" Karachalios

AN EVALUATION OF THE RELATIONSHIPS BETWEEN RESILIENT SAFETY CULTURE, SAFETY RISK PARAMETERS, AND MINDFULNESS IN THE INTERNATIONAL AIR SHOW COMMUNITY

by

Emmanouil “Manolis” Karachalios
Bachelor of Science, Hellenic Air Force Academy, 2000
Master of Business Administration, Coventry University, 2016

A Dissertation

Submitted to the Graduate Faculty

of the

University of North Dakota

in partial fulfillment of the requirements

for the degree of

Doctor of Philosophy

Grand Forks, North Dakota

May
2022

Name: Emmanouil "Manolis" Karachalios

Degree: Doctor of Philosophy

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

DocuSigned by: DANIEL KWASI ADJEKUM

Daniel Kwasi Adjekum, Ph.D., Chairperson

DocuSigned by:

Mark Dusenbury, Ph.D.

DocuSigned by: Joseph Vacek

Joseph Vacek, J.D.

DocuSigned by: F. RICHARD FERRARO

Richard Ferraro, Ph.D.

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

DocuSigned by: Chris Nelson

Chris Nelson
Dean of the School of Graduate Studies

4/22/2022

Date

PERMISSION

Title	An Evaluation of the Relationships Between Resilient Safety Culture, Safety Risk Parameters, and Mindfulness in the International Air Show Community
Department	Aerospace Sciences
Degree	Doctor of Philosophy

In presenting this dissertation in partial fulfillment of the requirements for a graduate degree from the University of North Dakota, I agree that the library of this University shall make it freely available for inspection. I further agree that permission for extensive copying for scholarly purposes may be granted by the professor who supervised my dissertation work or, in his absence, by the Chairperson of the department or the dean of the School of Graduate Studies. It is understood that any copying or publication, or other use of this dissertation or part thereof for financial gain shall not be allowed without my written permission. It is also understood that due recognition shall be given to me and to the University of North Dakota in any scholarly use, which may be made of any material in my dissertation.

Emmanouil Karachalios

May 1, 2022

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

KEY DEFINITIONS

Numerous definitions exist throughout international aviation authorities involving air show performers and air bosses, which may confuse the reader (European Airshow Council [EAC], 2020; Federal Aviation Administration [FAA], 2020a; United Kingdom Civil Aviation Authority [UK CAA], 2022;). However, for this study, "air show performers" will be defined as all pilots/operators flying any aircraft or Unmanned Air System (UAS) who perform aerobatics–solo or formation, or dynamic maneuvering–solo or formation, as per the FAA (2020a). Then, an "air boss" will be mentioned as the person in charge of the flight operations at an aviation event, as per the FAA (2020a).

In addition, the following definitions will be referenced in the current paper under CAP 403 (UK CAA, 2022):

Crowd line	The line delineating the closest edge of any area, including car park(s), accessible to spectators concerning the display area/display line.
Display line	A line defining the track along which displaying aircraft may operate.
Flying display	Any flying activity deliberately performed for the purpose of providing an exhibition or entertainment at an advertised event open to the public.
Flying control committee (FCC)	A group of suitably experienced persons assembled to assist the FDD in the safety management of a flying display.

Flying display director (FDD)	The person responsible to the authorities for the safe conduct of a flying display.
Show center or display datum	The display datum is the point upon which individual displays are based and is normally the center point of the crowd.
Spectator area	An area specifically designated for spectators by the event organizer or FDD and approved by the FDD for flying display safety purposes which includes all areas to which spectators have access during the flying display.
Minimum aerobatic height	The minimum height above which the aircraft must be capable of complete recovery from an aerobatic maneuver. This will be the most restrictive of: • The minimum aerobatic height specified in the Permission. • The minimum aerobatic height quoted on the relevant pilot's display authorization (in relation to the aircraft category being flown); or • The minimum aerobatic height imposed by the FDD.

Minimum pyrotechnic release height (MPRH)	The minimum height above the surface level from which pyros may be ignited, released, or emitting product such that any dross/embers are completely burnt out when reaching surface level.

ABBREVIATIONS

Abbreviation	Definition
ACE	Aerobatic Competency Evaluator
ANOVA	Analysis of Variance
ADM	Aeronautical Decision Making
AGFI	Adjusted Goodness-of-Fit Index
AVE	Average Variance Extracted
BADA	British Air Display Association
BC	Bias-Corrected Confidence
CAA	United Kingdom Civil Aviation Authority
CFA	Confirmatory Factor Analysis
CFI	Comparative Fit Index
CFIT	Controlled Flight Into Terrain
CMIN	Minimum Discrepancy or Model Chi-Square
COVID-19	Coronavirus Disease 2019
CPA	Causal Path Analysis
CR	Critical Ratios
DA	Density Altitude
EAC	European Airshow Council

Abbreviation	Definition
EASA	European Union Aviation Safety Agency
ECS	Environmental Control System
FAA	Federal Aviation Authority, United States
FCC	Flying Control Committee
FIO	Flight Into Object
FIT	Flight Into Terrain
FOD	Foreign Object Debris / Damage
FPRS	Flight Risk Perception Scale
FRMS	Fatigue Risk Management Systems
GFI	Goodness-of-Fit Index
GIVD	G-Induced Vestibular Dysfunction
G-LOC	G-Induced Loss Of Consciousness
HA	Hazardous Attitudes
HRO	High-Reliability Organization
ICAO	International Civil Aviation Organization
ICAS	International Council of Air Shows
IFI	Incremental Fit Index
IFR	Instrument Flight Rules
IMC	Instrument Meteorological Conditions
LOC	Loss Of Control
MAAS	Mindful Attention Awareness Scale

Abbreviation	Definition
MAC	Midair Collision
MF	Mindfulness
MI	Modification Indices
ML	Maximum Likelihood Estimation
MLE	Maximum Likelihood Estimates
NFI	Normed Fit Index
PA	Path Analysis
PCFI	Parsimony Comparative Fit Index
PNFI	Parsimony Normed Fit Index
PTSD	Posttraumatic Stress Disorder
RI	Risk Indicator
RMSEA	Root Means Square Error of Approximation
RP	Risk Perception
RSC	Resilient Safety Culture
RT	Risk Tolerance
SEM	Structural Equation Modelling
SME	Subject Matter Expert
SMS	Safety Management System
SPI	Safety Performance Indicator
SPSS	Statistical Package for Social Sciences
SVFR	Special Visual Flight Rules
TLI	Tucker Lewis Index

Abbreviation	Definition
U/C	Under Carriage
VFR	Visual Flight Rules
VMC	Visual Meteorological Conditions

ACKNOWLEDGMENTS

First and foremost, I want to express my gratitude to my Lord and Savior for providing me with the strength and health necessary to complete this dissertation.

Despite the fact that I was working away from home on this study, I feel fortunate to have had so many people who encouraged me with their positive energy and kindness. I am deeply indebted to my faculty advisory committee members for their continuous assistance and support during my PhD program: Professor Joe Vacek helped me enroll at the UND and then led me through my studies. Professor Mark Dusenbury inspired me with a topic relevant to the air show community that I hope will be beneficial for years to come. Professor Richard Ferraro prompted me with insightful questions throughout the preparation of this study, which helped me focus on the mindfulness component. And, of course, there are no words to describe my gratitude for my committee chair, Professor Daniel Kwasi Adjekum, who mentored me for the last two years and taught me the science of resilient safety culture; even though we are thousands of miles apart and more than nine time zones away from each other, I feel as if I have known him forever.

Additionally, I give my sincere thanks to all the professors and instructors in my Ph.D. program who guided me and provided me with the resources necessary to complete this study. I would also like to express my thanks to Dr. Colleen Berry for editing my dissertation and working with me when I was struggling with my writing.

I would like to thank the international air show community for its support in this endeavor, particularly the Chairman of the European Airshow Council, Gilbert Buekenberghs, and the Executive, Charles Skiera, along with my fellow EAC board members, as well as the President of the International Council of Air Shows, John Cudahy, and the Vice President, Dan Hollowell. I want all the survey respondents, the focus group participants, and the SMEs I interviewed to know how much their time and cooperation mean to me. This study could not have been carried out without their assistance, dedication, and commitment to aviation safety in our community. To Panos Podimatas for allowing me to be part of his Team—thank you! From the air show community, the one to whom I owe the most is Des Barker, who shared with me not only his statistical data on the community over the years but also his enthusiasm for air show safety and excellence—Des, your legacy will endure for years to come in the air show community.

To my former and current employer, who provided me with a safe work environment while I carried out this study, especially during the stressful times of the COVID-19 pandemic, I am so thankful. Mr. Khaled A. S., in particular, has my heartfelt appreciation for providing administrative support that allowed me to minimize my daily commute and optimize my time on this project.

I am indebted beyond words to my mother, Maria Nikolakaki Karachaliou, for ensuring I had everything I needed as a child and as a cadet at the Hellenic Air Force Academy—you are my hero. To my father, Manolis Karachalios, even though I have no memories of him, I am grateful for the years he has been angel-guarding me. I am so thankful to my brother Efstratios and my sisters Sofia and Argiro for their love. I am indebted to my uncle Theodoros Karachalios for assuming the role of my second father; I will never forget you. I am also truly thankful to my in-laws, Ioannis Klapakis and Dimitra Klapaki, for their love and support over the years.

Next, I want to apologize to my daughters, Maria Georgia and Dimitra Michaela, for the missed weekends, which I hope to recover from soon. I adore you both.

Finally, to Mariangela Klapaki, the woman with whom I share my life: I am eternally grateful for your kindness, support, understanding, passion for life, patience with my work and studies, and, of course, for your love, which keeps me standing.

Thank you – Σας ευχαριστώ - شكرا

To Mariangela, Maria, and Dimitra.

You make my life meaningful.

.

ABSTRACT

A convergent mixed-methods approach with data triangulation was utilized to assess the strength of relationships between operational risk factors, hazardous attitude, and resilient safety culture when mediated by mindfulness in the international air show community. An anonymous online survey of respondents' perceptions, semi-structured interviews of air show experts, focus-group on air show performers, field observation at an air show, and a documentary analysis of air show safety event data was used to collect data. The quantitative findings suggest a good fit of a hypothesized structural model showing the relationships between study variables using structural equation modeling (SEM). Mindfulness (MF) significantly mediates the predictive relationship between hazardous attitudes (HA), risk perception (RP), risk tolerance (RT), and resilient safety culture (RSC) with a high effect size. There was significant predictive relationship between MF and RSC with medium effect size. Demographically, *married* respondents had significantly lower mean scores on MF compared to *single* and *divorced* while *single* respondents had higher mean scores on RT than *married* or *divorced.* The qualitative findings indicate that the RSC of air show performers has a negative correlation with RT and HA. The triangulation suggests military air show background was strongly correlated with RSC, MF, and a negative correlation to HA. This study provides a validated measurement model to assess the relationships between the study variables and fills a gap in the literature related to resilient safety culture in the airshow community. Theoretical and practical

implications of this study provide a framework for continuous improvement of safety in the air show community.

CHAPTER 1. INTRODUCTION

The Tiger Airshows performer Mark Nowosielski and Team Chambliss' mechanic and pilot Steve Andelin's fatal crashes on two continents on the same weekend have brought into focus some of the critical operational and safety challenges rife in the air show community (Tulis, 2020). These accidents highlight the fact that stringent safety and performance standards are required of air show professionals (Papadakis, 2008). The highly focused attentional qualities expected of these professionals that ensure minimal distractions during such high-energy performances have to warrant empirical inquiry (Australian Transport Safety Bureau, 2005; Barker, 2020a; Defense Safety Authority, 2019). The need for optimized time-sensitive safety decisions while in the air show performance sequence requires a high level of adaptability and mindfulness (Barker, 2020a; Fusco, 2018). Despite all these highlighted operational and safety challenges, there seems to be a paucity of empirically researched studies that aims to unearth safety cultural variables, safety risk parameters, and human-performance factors that are causal or contributory to safety occurrences during air shows.

Barker (2003, 2020a), in a seminal analysis of the unique characteristics of air show aviators, suggested that display pilots are nominally characterized by high levels of flying experience, stringent standards, exceptional professionalism, and dexterity in aircraft handling skills. Moreover, these pilots are typically selected after going through a rigorous audit and assessment.

Yet, a major causal finding of air show accident investigation reports is that human error and other contributory human performance factors were involved (Air Accidents Investigation Branch [AAIB], 2017; Barker, 2020a; UK CAA, 2021;

Department of the Navy, 2016; United States Air Force [USAF], 1994, 2018).

These safety occurrences enumerated earlier have led various national regulators, military organizations, and international air show associations to implement several rules and regulations to reduce aerial events' inherent hazards (Ministry of National Defence, 2021; National Transportation Safety Board [NTSB], 2012; UK CAA, 2021, 2022; United Kingdom Royal Air Force, 2010; USAF, 2021; Webster, 2007).

Safety culture is defined by the United States Nuclear Regulatory Commission (NRC, 2020) as "the core values and behaviors resulting from a collective commitment by leaders and individuals to emphasize safety over competing goals to ensure the protection of people and the environment." Both proactive and reactive initiatives, such as training and regulatory oversight (Barker, 2020b), have improved the air show industry's safety records, enhanced risk awareness, and nurtured the existing safety culture.

However, there is an inherent safety risk posed by humans' hazards associated with such high-energy aerobatic maneuvers at air shows (Barker, 2003). Ensuring a zero-accident or incident air show industry may not be realistic, and the international air show community should understand that errors will occur that could lead to safety occurrences (Reason, 2016). Thus, the focus of inquiry may be on means to mitigate the risk posed by these hazards to a level that is as low as reasonably practicable (Stolzer & Goglia, 2016). Some of these measures could be developing and sustaining a resilient safety culture and operational adaptability during the planning and execution of such high-tempo air shows (Adjekum & Fernandez-Tous, 2020b; Akselsson et al., 2009; Hollnagel, 2014; Reason, 2016).

According to Reason (1997), resilience is both a personal attitude and organizational property; it is grounded on the concepts of mindfulness, proactive reasoning, flexibility, and adaptability. The air show industry's safety experts might need to focus on aspects of resilience to prevent adversities from happening or becoming worse or even to recover from an unexpected situation once it has happened (Reason, 2016).

One emerging aspect of resilience is focused on a resilient safety culture that acknowledges adaptability as an essential feature of both crisis-prepared organizations and individuals (Hollnagel et al., 2011; Nemeth & Hollnagel, 2016; Reason, 1997). Rigorous flight training (Loudenslager, 2014), complemented by mindfulness training (Meland et al., 2015, p. 48), could sharpen air show performers' flying and mental skills and eventually improve the industry's overall resilience.

An assessment of the human behavioral attributes, safety risk perceptions, and resilient techniques to vulnerabilities of other high-risk and extreme sporting performers can unearth positive lessons beneficial to the air show community (Baretta et al., 2017; Brymer, 2005; Brymer & Mackenzie, 2017; Filho et al., 2016; Smith & Smolianov, 2016; Sparks, 2016; Stocker et al., 2017). By the rigorous performance standards and associated high risk of activities, the air show community can be categorized in the same group as high-wire acrobatic artists; Formula 1, MotoGP, and extreme cross-country drivers; acrobatic skydivers; parachuting and base jumping; bungee jumping; rafting, and mountain skiing to name a few. These activities require minimal margins of error, and performers must perceive safety risks, manage distractions and deal effectively with pressures to produce superlative outcomes before demanding spectators (Ross & Shapiro, 2017).

Background of Study

Aerobatic displays are the hallmarks of air shows and provide entertainment and educational values to the spectators while ensuring economic returns for organizers and performers (Barker, 2020b). Some educational values are ground talk shows on aircraft performances and capabilities (Cudahy, 2019; National Aeronautics and Space Administration, 2021), while the economic values are revenue generated through financial sponsorship from entities such as airlines, watchmaker companies, and aircraft manufacturers (EAC, 2020).

Personnel involved in the organization and management of air shows have a responsibility to demonstrate high levels of professionalism and performance standards, and they must be accountable for maintaining the highest standards of personal and professional conduct in order to provide integrity, safety, and passion to the air show business (British Air Display Association, 2022; EAC, 2020; France Spectacle Aérien, 2022; International Council of Air Shows [ICAS], 2021). Meticulous planning for all flying and ground activities is necessary (UK CAA, 2022; FAA, 2020a).

High-risk activities such as air shows must be conducted with careful thought towards ensuring that the risks to the general public, spectators, and flying and nonflying participants have been considered and that the activity is as safe as reasonably possible (Air Combat Command, 2021a, 2021b; FAA, 2020a; UK CAA, 2021, 2022). Hence, the impromptu, ad hoc, unrehearsed or unplanned must never be attempted (UK CAA, 2021, 2022).

According to Reason (2016), safety has two distinct aspects: One negative and one positive, and even though it is mainly the former that claims attention, the latter is the one that reflects an organization's "health" regarding safety. The positive face of safety relates to an attainable, realistic safety goal: The maximum intrinsic resistance to operational hazards rather than zeroing accidents. The nature of positive safety is a single view of safety that does not rely exclusively on infrequent episodes of the "unsafe."

An accident-free air show relies on the training and experience of the participating pilots, the aircraft's airworthiness, and the planning and risk management of the event (Barker, 2020b). Regulations, guidance, and oversight provide the framework for these activities (AAIB, 2017). Nevertheless, to ensure a proactive safety culture, there should be a drive for continuous improvements in safety and an assessment of the relationship between safety risk perceptions and resilient safety culture among performers in the air show community.

Previous studies have suggested that flight personnel's perceptions of the inherent safety culture can influence their safety behavior, and at-risk safety behaviors can serve as precursors for accidents and other safety occurrences (Adjekum et al., 2015; Dillman et al., 2010; Hunter, 2006a).

A vital element of a resilient safety culture in any organization is organizational flexibility or adaptability to changing demands and potential vulnerabilities (Adjekum & Fernandez-Tous, 2020b; Hollnagel, 2014; Hollnagel et al., 2011; Reason, 2016). Resilient safety culture is also a defining property of high-reliability organizations such as aviation (La Porte, 1996; Pariès et al., 2019). Yet, air show performers need to be equipped with even more resiliency skills than other aviators to deal effectively with situations for which there is no precedent and that neither rules nor standardization can cover or predict (Dekker, 2014; Hollnagel et al., 2011).

Many mental skills required for performance excellence in sports, the performing arts, and circus arts are essential for air show performers, such as resilience, commitment, concentration, and confidence (Ross & Shapiro, 2017). Additionally, some mindfulness-based interventions used to manage social anxiety and emotion control in elite athletes (Birrer et al., 2012) and circus performers (Filho et al., 2016; Ross & Shapiro, 2017) are critical for air show performers.

Looking specifically at the demanding low-level aerobatic flights, we see that the presence of spectators can increase the pressure on air show performers (Papadakis, 2008). Studies in other fields of high-risk, high-performance activities, such as the circus arts, have identified the presence of an audience as a cause of perceived pressure by the performers (Filho et al., 2016). As part of mitigation efforts to ensure safe and optimal performance outcomes during these high-risk activities, researchers such as Ross and Shapiro (2017) and Sutcliffe, Vogus, and Dane (2016) suggested that attentional control strategies, such as mindfulness, be used to mediate perceived task pressures and the observed performance outcomes.

Mindfulness is defined as "paying attention in a particular way, on purpose, in the present moment, and nonjudgmentally" (Kabat-Zinn, 1994, p. 4). Mindfulness can be individual or collective (Reason, 2016); individual mindfulness can lead to systemic resilience, while collective mindfulness needs organizational support to improve the foresight and "error wisdom" (Reason, 2004a, p. ii28) of the air show performers.

It is not enough to provide one-off training programs to instill the necessary mental skills (Sutcliffe et al., 2016; Weick & Sutcliffe, 2001, 2009). Similar to technical skills, cognitive skills need to be continually managed, practiced, and refreshed (Reason, 2016). As such, mindfulness training could complement the existing mental training for individuals engaged in high-performance activities.

The reduction of unsafe maneuvers and sequences during air show performances by display pilots has become a primary objective for air show organizers and safety managers (EAC, 2020; FAA, 2020a; ICAS, 2021; UK CAA, 2022). The implementation of effective safety initiatives such as safety management systems (SMS) has positively affected the safety culture and enhanced the accident prevention strategies in several aviation programs (Adjekum, 2014; Adjekum et al., 2015).

Despite the generic safety guidelines nominally required by regulators during air shows, it is a common convention within the civilian air show community for high levels of operational autonomy when it comes to the adoption of formalized initiatives, such as SMS in operations (UK CAA, 2022). There are more inclinations to individualized safety standards that complement the scope and complexity of each activity (Barker, 2020a).

A critical assessment of the relationships between perceptions of resilient safety culture, safety risk parameters, and hazardous attitudes/ behaviors mediated by mindfulness may provide insight and benefits of continuous improvements in safety and optimized performances during air shows despite the seeming lack of formalized initiatives, such as SMS.

Some of the safety risk parameters that would be assessed include safety risk tolerance and safety risk perceptions for air show performers. Due to their concomitant effects on decision-making during displays and safety outcomes such as accidents and incidents, it is expedient to measure and understand the effects on resilient safety culture when mediated by mindfulness (Barker, 2020b; Teske & Adjekum, 2022).

Problem Statement

The problem addressed in this research is the lack of empirical studies to determine how perceptions of safety risk parameters and hazardous attitudes/behaviors can influence resilient safety culture within the international air show community when mediated by mindfulness. There seems to be a gap in research, and there is a need for such an evidence-based approach to provide findings that will be beneficial to this at-risk community leading to continuous improvements in safety and optimized air show performances.

Existing research on resilient safety culture in aviation has mostly focused on commercial aircraft operations, flight training programs, and air traffic control management (Adjekum & Fernandez-Tous, 2020b; Akselsson et al., 2009; Hollnagel, 2014, 2018; Reason, 2016). Specific studies on resilient safety culture in general aviation, such as the air show sector, seem limited if not completely missing in the United States and internationally. Also, extant literature suggests a paucity of studies that assess the relationships between the effects of resilient safety culture and safety risk parameters, such as risk perceptions and tolerance, and hazardous attitudes within the air show community.

Risk assessment and management are critical components of a pilot's decision-making process (Martinussen & Hunter, 2018). Numerous studies identified a negative association between risk perceptions and higher risk-taking tendencies (Drinkwater & Molesworth, 2010; Joseph & Reddy, 2013; You et al., 2013). Furthermore, inadequate risk assessment can lead to poor decision-making, resulting in catastrophic aircraft accidents (AAIB, 2017; Brugnara et al., 2022; Jensen & Benel, 1977; Kelly & Efthymiou, 2021).

However, an extensive search of literature suggests the nonexistence of previous or extant research that has explored the association between risk perception and risk tolerance among air show performers. Thus, the current study provides an opportunity to investigate the strength of the relationship between risk perception and risk tolerance, as well as to explain the risk assessment and management processes of air show performers.

One of the numerous psychological constructs that have been studied as a potential factor affecting decision-making and impacting the possibility of accident involvement is hazardous attitudes (Martinussen & Hunter, 2018). Yet, display pilots might act unsafely without any previous indications of hazardous attitudes due to the latent factor of social facilitation bias (Papadakis, 2008). Thus, this paper delves into whether there is an association between hazardous attitudes and risk perception and tolerance among air show performers.

According to Reason (2016, p. 247), individual mindfulness is more important than the technical skills required to achieve excellence in a task. Moreover, mindfulness contributes to efficient decision-making (Gautam & Mathur, 2018) and has a negative correlation with pilots' anxiety (Li et al., 2020). Display pilots mentally prepare themselves with visualization techniques and apply the "30-minute bubble" rule (Barker, 2020a) or the "sacred 60-minute" policy (Hollowell, 2012) before their performance. Therefore, this study will examine other possible methods of mindfulness practiced by air show performers. Then, this study will explore the mediation role of mindfulness for risk perception and tolerance and hazardous attitudes for resilient safety culture.

Several studies have discovered that experience, either in flying or other acts, has a definite positive association with risk perception (Crundall et al., 2013; Ferraro et al., 2015; Joseph & Reddy, 2013; Winter et al., 2019; You et al., 2013). Moreover, Gibson, Michayluk, and Van de Venter (2013), and Hallahan, Faff, and McKenzie (2004) concluded that age has an inverse relationship with risk tolerance, while Hallahan et al. identified additional factors that significantly affect risk tolerance scores, such as marital status. Additionally, Adjekum et al. (2015) revealed a significant relationship between aviation collegiate students' perception of safety issues and their educational level, while Chionis and Karanikas (2018) concluded that aviation professionals holding a bachelor's degree or lower qualification compared to postgraduate professionals were more risk-averse.

Despite the findings of these researchers on how various demographic characteristics of pilots influence their risk tolerance, Barker (2003), in an earlier analysis of air show accident data, suggested that a paradox exists in air show performers' demographic characteristics. Barker advocated that extensive flying experience and demonstrable expertise in flying skills did not necessarily prove to be a safeguard that leads to an uneventful flying display, as commonly accepted in general aviation. Therefore, it may be expedient to assess and understand the relationships between the variables stated earlier and demographic characteristics of air show performers, such as total display experience, military or civilian experience, age, educational background, and marital status.

Purpose of Study

This convergent mixed-methods study with data triangulation intends to assess and understand the relationships between resilient safety culture and safety risk parameters when mediated by mindfulness in the international air show community. Specifically, the purpose of the quantitative part of this study was to examine the relationship between the attitudes of air show performers toward safety risk parameters and resilient safety culture initiatives while mediating these factors with mindfulness.

The purpose of the qualitative part of the study was to explore air show performers' and air bosses' perceptions of risks and hazards during air show performances and their implications for resilient safety culture and gain an in-depth understanding of the study variables while eliciting pragmatic recommendations for policies and practices from these air show operators that will enhance a culture of high resilience and safety.

Finally, the study provides a holistic overview of the state of safety in the international air show community through the use of a data triangulation analysis which entails the correlations between the various research methods to identify areas of concurrences and differences (Creswell & Creswell, 2018) in the air show community. The data triangulation approach consisted of documentary analysis, an air show event observation, a quantitative survey instrument with items that will measure perceptions on variables, and semi-structured and focus group interviews with SMEs in the international air show community. It was contemplated that the triangulation approach would provide vital information needed to develop a robust, resilient safety culture in the air show sector of aviation.

This research was envisaged to provide results to minimize adverse human performance factors such as errors and optimize show performances. It was also anticipated that the results would provide assessment strategies to develop policies and practices necessary for continuous safety improvements during air shows. Moreover, the results potentially would close a gap in the literature on safety in the air show community and proffer pathways for future empirical studies on the air show community.

Research Questions

The quantitative part of the study addressed the following research questions:

1. What are the strengths of relationships between risk perception, risk tolerance, hazardous attitudes, and resilient safety culture when mediated by individual mindfulness among members of the international air show community?
2. What are the differences in the study constructs on resilient safety culture, risk factors, mindfulness, and hazardous attitudes in air show performers based on demographic variables (air show flying experience, military or civilian flying experience, age, educational background, and marital status)?

The qualitative part of the study addressed the following research questions:

3. What forms of mindfulness strategies do air show performers employ preflight?
4. How do air show performers perceive and tolerate risk preflight?
5. How do air show performers perceive and tolerate risk inflight?
6. What are the most common hazardous attitudes observed among

air show performers?

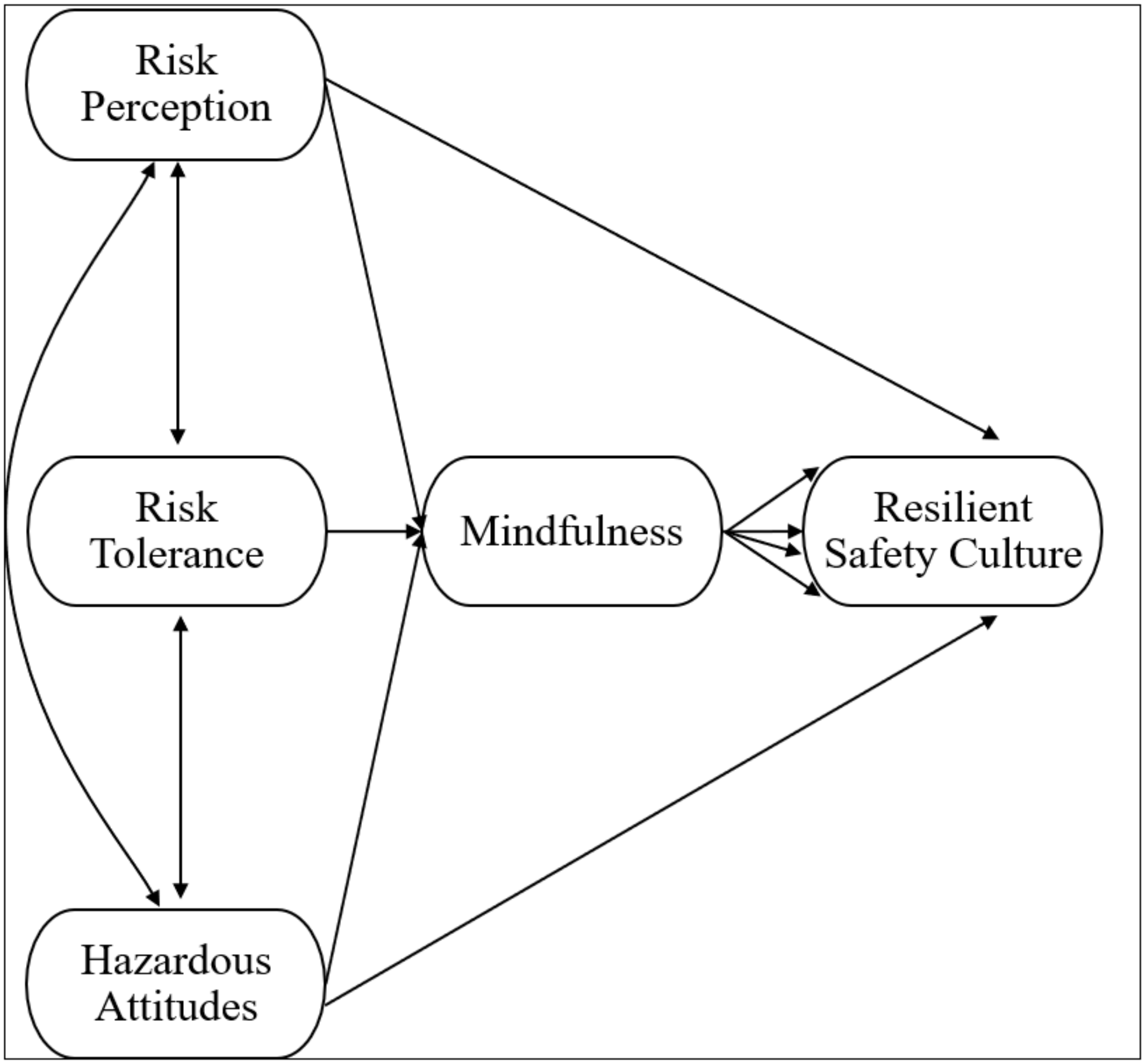
7. How does air show performers' operational experience influence their perception of resilient safety culture?

Statement of Hypotheses

A measurement model was proposed to illustrate graphically the interactions between the study variables and how they are linearly related to each other. The model also shows the hypothesized linear relationships between the study variables. The proposed measurement model is depicted in Figure 1, combined with all the hypothesized pathways.

Figure 1

A Hypothetical Model of the Relationship Between Risk Perception, Risk Tolerance, Hazardous Attitudes, Mindfulness, and Resilient Safety Culture



Risk Perception, Mindfulness, and Resilient Safety Culture

Hunter (2002, p. 21) suggested that attempts to change a pilot's risk tolerance should be preceded by risk recognition training. This study hypothesized that mindfulness could enhance the air show community's safety promotional efforts regarding risk identification.

This study explored the relationships between the air show community's perceived risk, mindfulness, and resilient safety culture. The related hypotheses proposed are as follows:

***H_1*.** Risk perception is related to the air show community's risk tolerance.

***H_2*.** Risk perception is related to the air show community's mindfulness.

***H_3*.** Risk perception is related to the air show community's resilient safety culture.

***H_4*.** Risk perception is related to the air show community's resilient safety culture when mediated by mindfulness.

Risk Tolerance, Mindfulness, and Resilient Safety Culture

Based on the extant literature (Meland et al., 2015), this study predicted that measuring the effects of mindfulness training in elite individuals working in high-performance environments — with the air show sector having such characteristics — would demonstrate a stronger resilient safety culture and tolerate lower levels of risk. Additionally, it was hypothesized that mindfulness would enhance the resilient safety culture for the members of the air show community and improve their risk tolerance.

This study explored the relationships between the air show community's risk tolerance, mindfulness, and resilient safety culture. The related hypotheses proposed are the following:

***H_5*.** Air show community's risk tolerance is related to their mindfulness.

***H_6*.** Air show community's mindfulness mediates the relationship between their risk tolerance and resilient safety culture.

Hazardous Attitudes, Mindfulness, Risk Perception, Risk Tolerance, and Resilient Safety Culture

The extant literature suggests that hazardous attitudes contribute to poor pilot decision-making (Hunter, 2005; Ji et al., 2011). As mentioned above, FAA (2016, pp. 2–5) lists five hazardous attitudes that can restrict a pilot's sound judgment: Antiauthority, impulsivity, invulnerability, machismo, and resignation. With the proper antidote, these attitudes can be effectively counterbalanced. This study hypothesized that mindfulness could be just such an antidote to air show performers' hazardous attitudes and enhance the air show community's resilient safety culture.

In this study, the relationships between the air show community's perceived hazardous attitudes, mindfulness, risk tolerance, risk perception, and resilient safety culture were explored. The related hypotheses proposed are as follows:

***H_7*.** Air show performers' hazardous attitudes are related to the air show community's mindfulness.

***H_8*.** Air show performers' hazardous attitudes are related to the air show community's resilient safety culture.

***H_9*.** Air show performers' hazardous attitudes are related to the air show community's resilient safety culture when mediated by mindfulness.

***H_{10}*.** Air show performers' hazardous attitudes are related to the air show community's risk tolerance.

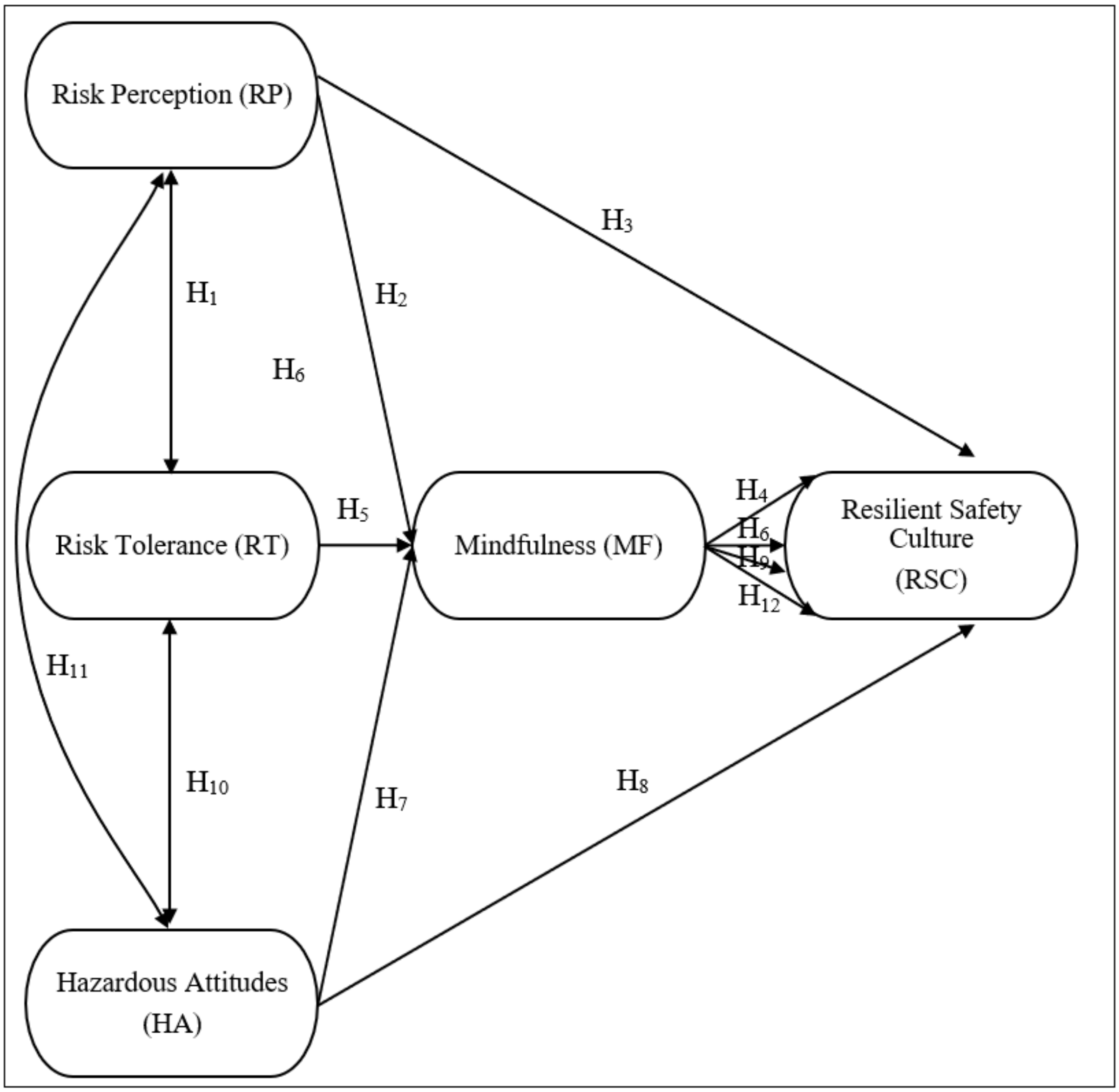
***H_{11}*.** Air show performers' hazardous attitudes are related to the air show community's risk perception.

***H_{12}*.** Mindfulness is related to the air show community's resilient safety culture.

The hypothesized structural equation modeling-path analysis (SEM-PA) model of all the study variables and their interrelationships are depicted in Figure 2.

Figure 2

SEM-PA of the Hypothesized Measurement Model of the Relationship Between RP, RT, HA, MF, and RSC



Convergent Mixed-Methods Design

According to Creswell and Creswell (2018, p. 17), a mixed-methods approach provides a pragmatic worldview, allowing a more comprehensive understanding of a research problem using qualitative and quantitative methods, where the strengths of one can counterbalance the inherent flaws of the other alone. Therefore, a convergent mixed-methods design with triangulation was used to analyze quantitative, qualitative, and documentary/artifactual data. These three databases were compared and cross-validated to determine areas of convergence, divergence, or combinations in the findings. Subsequently, in the discussion and recommendation section, the data findings were integrated and thoroughly analyzed.

Rationale for Method

The above method was selected for this study to allow a holistic understanding of the research problems and questions. Due to multiple aspects of human factors involved in air show performers' performance, combining qualitative and quantitative methodologies were considered as necessary and appropriate. Mixed-methods allowed an integrated and holistic approach to crosscheck and highlight any differences between the quantitative evidence and the qualitative data. Moreover, the qualitative data collected from the air show SMEs provided valuable insight into the existing safety culture of the international air show community.

This approach had numerous advantages that were appropriate to the objective of this study. Collecting both qualitative and quantitative data online was cost-effective and helped the researcher to overcome challenges that were inherent due to the health measures and travel restrictions introduced globally as a result of the COVID-19 pandemic.

Limitations of the Convergent Mixed-Methods Design

Significant time, resources, and effort were required to conduct a study using this approach with both quantitative and qualitative methods. It was a logistical challenge to assemble all the respondents for the focus group meeting, even though an online portal was used due to scheduling issues, which was finally conducted following an EAC safety workshop that all respondents attended. The management of research data and necessary analyses of data required to make evidence-based recommendations from findings required additional time and consultations with respondents (member-checking) on the part of the researcher.

Quantitative Research

The quantitative aspect of this research involved a survey instrument administered to air show performers and air bosses, which sought to answer the quantitative questions related to the relationships between the attitudes of air show performers (or display pilots) toward risk perception (RP), risk tolerance (RT), hazardous attitudes (HA), and resilient safety culture (RSC) initiatives while mediating these factors with mindfulness (MF). 28 survey items representing the five constructs for the quantitative section of this study, including eight demographics items, were adopted from the validated and reliable survey instruments presented in Table 1.

Table 1

Variables, Number of Scale Items on the Survey, and Instrument Sources

Variable name	Number of scale items	Instrument sources
Hazardous attitudes (HA)	4	Hazard Attitude Scale (Ji et al., 2011)
Resilient safety culture (RSC)	4	Resilient Safety Culture (Adjekum & Fernandez-Tous, 2020b)
Risk tolerance (RT)	4	Risk Tolerance (Ji et al., 2011)
Risk perception (RP)	4	Flight Risk Perception Scale (Winter et al., 2019)
Mindfulness (MF)	4	Mindful Attention Awareness Scale (Brown & Ryan, 2003)

Slight modifications were made to the selected items to accommodate the air show performers' unique demography, such as experience in flying low-level aerobatics in front of people. Beta testing of the modified survey instrument was completed through a pilot study, using a selected sample of 5 display pilots in the air show sector. Several questions were generic, according to pilots, and did not refer to any specific aircraft type, such as a helicopter, fast jet, vintage trainer, or aerobatic propeller. The researcher considered the comment during the survey instrument design process and elected to maintain the integrity of the validated instruments in order to maintain a generic approach to the aircraft type and focus on the pilot's overall perception of the measured scales. Another remark was made about the instrument's usage of the English language. Pilots noted that having a survey focused exclusively on the worldwide air show community and available in a single language could limit participants' comprehension of the survey items. Yet, it was assumed that all the respondents had a good comprehension of the English language. The Qualtrics survey tool had a feature to translate the survey into various languages, and that option was activated to help respondents and minimize biases due to language barriers. The final survey instrument is outlined in Appendix B.

Qualitative Research

The qualitative portion of the research commenced with an observation at a European air show. The researcher examined operational elements that contributed to risk and hazards for air show performers and air bosses while shifting position from observer to air boss and vice versa (Creswell & Creswell, 2018, p. 189). The observation was held at the event's primary operating locations, including the main briefing room, the aircraft parking areas, the control tower, and the crisis and disaster control center, allowing the researcher to witness various aspects of inherent risks and hazards.

A purposive sample of subject matter experts (SMEs) from the air show community participated in semi-structured interviews to share their expert opinions on existing air show performers' hazardous attitudes, risk perception and tolerance, mindfulness strategies, and the overall perception of resilient safety culture in the air show community.

A sample of air show performers volunteered to take part in a focus group session during the preseason convention of the European Air Show Council, which provided a general understanding of cross-sectional viewpoints on safety-related risk factors, mindfulness practices, and resilient safety culture in the air show community.

The final phase of the research entailed a documentary analysis of international air show regulations and air show statistical data, which was conducted to provide the evidentiary context in the triangulation of the findings from the observations, interviews, focus group session, and an anonymous online survey. The documents analyzed included numerous international air show rules and regulations – both from civilian and military organizations - and newsletters from ICAS and EAC.

Research Assumptions and Limitations

The qualitative and quantitative data were collected in a challenging period for the air show industry. Due to the COVID-19 pandemic, most air events were canceled or postponed for at least one display season. As such, most of the air show performers—especially the nonmilitary—have only been flying practice sessions to maintain their low altitude display currency.

This lack of active participation in air shows during the study period could have adversely affected respondents' perceptions of study variables. Nevertheless, this perspective adds significant value to the study due to the uniqueness of the time in which the study was conducted and may provide insight into how research variables can be influenced by global health and socioeconomic factors.

As part of a more diversified cross-sectional study, efforts were made to include participants from a broader spectrum of display pilots and air bosses based on gender, aircraft type, military/nonmilitary, and geographical location, to name a few. Display pilots and air bosses from all five continents were contacted, and they participated in semi-structured interviews and responded to the anonymous online survey. That provided a more globalized perspective to findings from the data and resulted in recommendations reflective of a diverse and inclusive community.

Additionally, the concepts of safety culture, resilient safety culture, risk perception, risk tolerance, and mindfulness are substantially subjective (Adjekum & Fernandez-Tous, 2020b; Akselsson et al., 2009; Harris, 2011; Hunter, 2002; Ji et al., 2011; Teske & Adjekum, 2022) and eliciting responses from such a diverse sample provided a practical approach to minimize biases from sociocultural and operational differences that could influence findings.

The surveys and interviews were conducted in the English language, and it was assumed that all the respondents had a good comprehension of the English language. The Qualtrics survey tool had a feature to translate the survey into various languages, and that option was activated to help respondents and minimize biases due to language barriers. Also, during an interview session, to minimize any potential language barrier, a facilitator who spoke English and Spanish fluently assisted the researcher in interpreting questions posed to the interviewee and responses provided by the interviewee.

Explicit causal inferences may not be justified in cross-sectional studies such as an anonymous online survey of respondents' perceptions (Creswell & Creswell, 2018); however, the use of structural equation models (SEM), confirmatory factor analysis (CFA), and path analyses (PA) determined the strengths of relationships between the study variables and explained the proportions of variances in the endogenous variable that can be explained by the effects of exogenous variables. Another empirical limitation of cross-sectional studies is that they limit the observations at one specific point in time and preclude a reflection of the observed group's long-term perceptions (Maxwell, 2012).

Scope of Research and Exclusive Criteria

This study focused only on the aspects of the existing resilient safety culture, risk perception and tolerance, potential hazardous attitudes, and the air show performers' mindfulness strategies. Other safety-related issues were beyond the scope of this research. Moreover, the conditions evaluated were hypothesized as representative and relative to the constructs under examination. The collection of quantitative data was purposefully limited to 8 weeks during the 2021 display season.

Moreover, the anonymous online survey portion of the study was limited to air show performers and air bosses. Ground support associates and staff such as maintainers and logistics personnel were not sent an invite with the anonymous survey link. The rationale was to focus on personnel actively involved in the flight operations portion of air shows. Further details of the research participants in this study are provided in Chapter 4.

CHAPTER 2. LITERATURE REVIEW

This chapter reviews the literature related to the study, including safety resilience, risk perception and tolerance, hazardous attitudes of pilots, the effects of mindfulness on human performance, and existing air show-related safety issues. The theoretical construct presented in Figure 2 depicts the studied relationships between safety resilience, hazardous pilot attitudes, risk perception, risk tolerance, and mindfulness. To date, these relationships in the air show sector have not been explored in the existing literature. The mediating role of mindfulness and other endogenous variables, such as the impact of risk perception on safety resilience, are of particular interest in constructing a model for evaluating the existing resilient safety culture for air show performers and flying display directors.

Theoretical Foundation

Resilience

Resilience is a capacity with numerous models and definitions. Hollnagel, Pariès, Woods, and Wreathall (2011, p. xxxvi) defines *resilience* as "the intrinsic ability to adjust its functioning before, during, or following changes and disturbances so that it can sustain required operations under both expected and unexpected conditions" while according to Kouzes and Posner (2017, p. 158), resilience is "the ability to recover quickly from setbacks and continue to pursue a vision of the future.

Moreover, Richardson (2002, p. 313) defines resilience as "growth or adaptation through disruption rather than just to recover or bounce." Likewise, Lengnick-Hall et al. (2011) argue that resilience can be viewed in two ways. In the first, it is viewed as a capacity for recovery; in the second, it is viewed as a capacity for thriving in the face of unexpected challenges and change. Finally, according to Sutcliffe and Vogus (2003), resilience is the ability to recover stronger and more resourceful from adversity. All the above demonstrate that resilience can be a positive response in the face of adversity.

Significance of Resilience

No matter large or small crises, harsh conditions can arise at any time. How a person responds is decided by their capacity for resilience when facing a challenge. Resilient people show emotional stability, flexibility, and adaptability to changes while using practical stress management methods. They are able to function efficiently under pressure and solve problems with confidence and calmness (American Psychological Association [APA], 2012).

In the findings of a study conducted by the University of North Dakota on helping airport and air carrier employees cope with traumatic events, it was suggested that physical resiliency is an essential attribute for airport employees who have experienced human-caused catastrophic events or natural disasters (National Academies of Sciences, Engineering, and Medicine, 2009). Another study examined the relationship between posttraumatic stress disorder (PTSD) symptoms, sleep problems, resilience, and neurocognitive functioning of firefighters and suggested that PTSD symptoms of firefighters were related to low resilience (Han et al., 2021). Yet, mindfulness training (Denkova et al., 2020), as well as the use of virtual simulations of distressing situations (Francis et al., 2018), could be an effective way to bolster resilience in firefighters.

Then in a socio-technical system, resilience is a multidisciplinary strategy that focuses on the ability of a system to reform and adapt sustainably in order to achieve desired outputs and constant growth (Serfontein & Govender, 2021). For example, the

United States air transportation network, between March and August 2020, remained robust and resilient despite dramatic reductions in flight and passenger volumes due to the COVID-19 pandemic (Bauranov et al., 2021). Additionally, resilience demonstrated by the leadership in an aviation organization may be critical during times of upheaval, such as the COVID-19 pandemic, in order to enhance the safety culture and assure continuing accident-free flight operations (Byrnes et al., 2022). By contrast, Gössling (2020) argued that commercial aviation has historically demonstrated poor resilience in the economic aspect of operations and considered the COVID-19 pandemic as an opportunity to reassess the global aviation system's fundamentals.

Developing, Sustaining, and Enhancing Resilience

Individual Resilience.

The broaden-and-build theory of positive emotions (Fredrickson, 2001) suggests that positive and negative emotions have complementary and distinct adaptive functions and physiological effects. Positive emotions have been revealed to broaden thoughts and actions, while negative emotions are related to behavioral tendencies that narrow them. Therefore, maintaining a positive attitude is a critical factor in creating, sustaining, and reinforcing an individual's resilience.

Conner's (1993) resilience model comprises five essential characteristics: Positivity, focus, flexibility, organization, and being proactive. These five essential characteristics of a resilient person also shed light on how to become more resilient. Conner argues that people can view life as an opportunity to stay positive, have a clear vision of their goals to remain focused, be flexible when responding to uncertainty, use structured approaches to ambiguity, and be proactive with change rather than resisting it.

Mowbray (2011) suggested that the aim of strengthening resilience is to build individual capacity in personal attributes. His approach to enhancing resilience is a model with seven elements: Vision, self-determination, interaction, relationships, problem-solving, organization, and self-confidence. Overall, Mowbray's suggested model focuses on being optimistic while facing difficulties, maintaining good relationships with family and friends, and enhancing self-confidence.

A study by Ungar et al. (2007) reported seven unique pathways to resilience across diverse cultures: The availability of material resources such as education, employment, food, shelter, and clothing; access to supportive relationships within an individual's family and community; experiences of helping self and others; knowledge and attachment to one's culture and values; the development of a sense of purpose; a feeling of cohesion socially and spiritually with others; and experiences of social equity and justice.

The APA (2012) also described ten ways to build resilience. It is implied that people need to develop and maintain healthy relationships with close family members, friends, or others; avoid seeing events that are stressful as intolerable problems; accept situations and conditions that cannot be changed; develop realistic objectives and move toward achieving them; take decisive actions in adverse circumstances and look towards rediscovering oneself after a battle with loss.

Other ways mentioned by the APA (2012) are developing self-confidence in one's ability to find solutions to problems; looking at the bigger picture when dealing with a problematic situation; being hopeful that the good things one wants will happen in life; taking proper care of one's feelings and needs; and searching for other methods to reinforce resilience and enhance higher psychological wellbeing, such as mindfulness-based stress reduction training as proposed by Nyklíček and Kuijpers (2008).

Furthermore, different types of meditation are effective in enhancing resilience in stressful conditions. According to Brennan (2005), reduced anxiety and depression, reduced irritability and moodiness, improved cognitive ability and memory, increased satisfaction, and improved emotional health are just a few of the psychological benefits of meditation. Additionally, Brown and Ryan (2003) revealed that improvements in mindfulness were associated with a decline in mood disturbance and stress in cancer patients.

In their book "The Resilience Factor," Reivich and Shatte (2003) argued that resilience is the single most crucial factor in determining whether an employee is satisfied, successful, and happy. The authors share seven techniques to enhance resilience skills, and they claim that through practice, one can become more resilient, more optimistic, more productive, and, in the end, happier in their personal and professional life. All in all, Reivich and Shate suggested that building resilience could curtail stress and lessen the risks of depression and mental illness.

Organizational Resilience.

For an organization to prosper, its resilience strategy must incorporate both a holistic perspective and traditional strategies (Bell, 2020). Additionally, in highly volatile and uncertain times, organizations must develop a resilience capacity that enables them to function effectively with unexpected events, recover from crises, and even facilitate success in the future. This resilience capacity is represented by three successive stages of resilience: Anticipation, coping, and adaptation. According to Weick and Sutcliffe (2001, 2009), high-reliability organizations (HROs) that consistently outperform expectations in any circumstance never take anything for granted; instead, they are ready to manage the unexpected. In this attempt, a decision support system could be a tool to enhance an organization's resilience (van de Walle & Turoff, 2008).

Hollnagel (2010) claimed that to become resilient, a firm needs balance and the ability to respond, monitor, anticipate, and learn. These are all abilities that are likely to affect faster responses, resulting in a decrease in incidents. However, developing these abilities requires underlying attributes such as knowledge, competence, resources, and time.

Based on the type of organization, different approaches to developing, sustaining, and enhancing organizational resilience could be identified. In a health care setting, processes could be identified through which in situ simulation can act as a source to develop integrated accounts of high-reliability organizing and resilience engineering (Macrae & Draycott, 2019). Then, a port resilience framework could ensure its operational continuity (Vanlaer et al., 2021), while in a pharmaceutical organization, it was identified that pharmacists with strong short-term resilience are more effective (Jin & Tang, 2021). Additionally, organizational resilience has been researched in elite sports organizations and has been related to an organization's dynamic potential to effectively adapt to changing circumstances (Fasey et al., 2021). Nevertheless, the concept of resilience has made little progress in the oil and gas industry in terms of comprehending the dynamics of adaptive processes (Bento et al., 2021).

Moreover, according to Kirkman, Stoverink, Mistry, and Rosen (2019), building a resilient team is the foremost part of creating a healthy and productive working environment. A team's resilience is just as important as an individual's resilience, yet the study's authors discovered that resilient teams have four characteristics—and they are different from those of resilient people. These teams believe that they can collectively complete tasks effectively, and they share a common mental model of teamwork—such as seen in the example is the seamless coordination of the crew of U.S. Airways Flight 1549 in 2009 (NTSB, 2009).

As per Kirkman et al. (2019), the other two characteristics of resilient teams are the ability to improvise in the face of adversity, as demonstrated by the Apollo 13 mission operations team's ingenious response (Granath, 2017), and the ability to trust one another. Resilience can be learned and developed by anyone on the team because it comprises learning how to think and act differently. By developing these four characteristics, team leaders can improve their team's resiliency.

Comcare of Australia (Comcare, 2008) recognized that a balanced working environment that fosters wellness and fitness is critical to maintaining resilience. Leaders who promote resilience in their teams should understand the importance of supporting their employees during times of change; they must realize that even a group with high morale can have difficulty dealing with increased work demands for an indefinite period without sufficient recovery time; fatigue and burnout can become a challenging factor. As a result, a resilient system should emphasize team members' well-being.

Safety Resilience

According to Reason (1997), resilience is based on the principles of mindfulness, constructive reasoning, flexibility, and adaptability and is both a personal and organizational trait. The aviation industry is considered a high-reliability organization

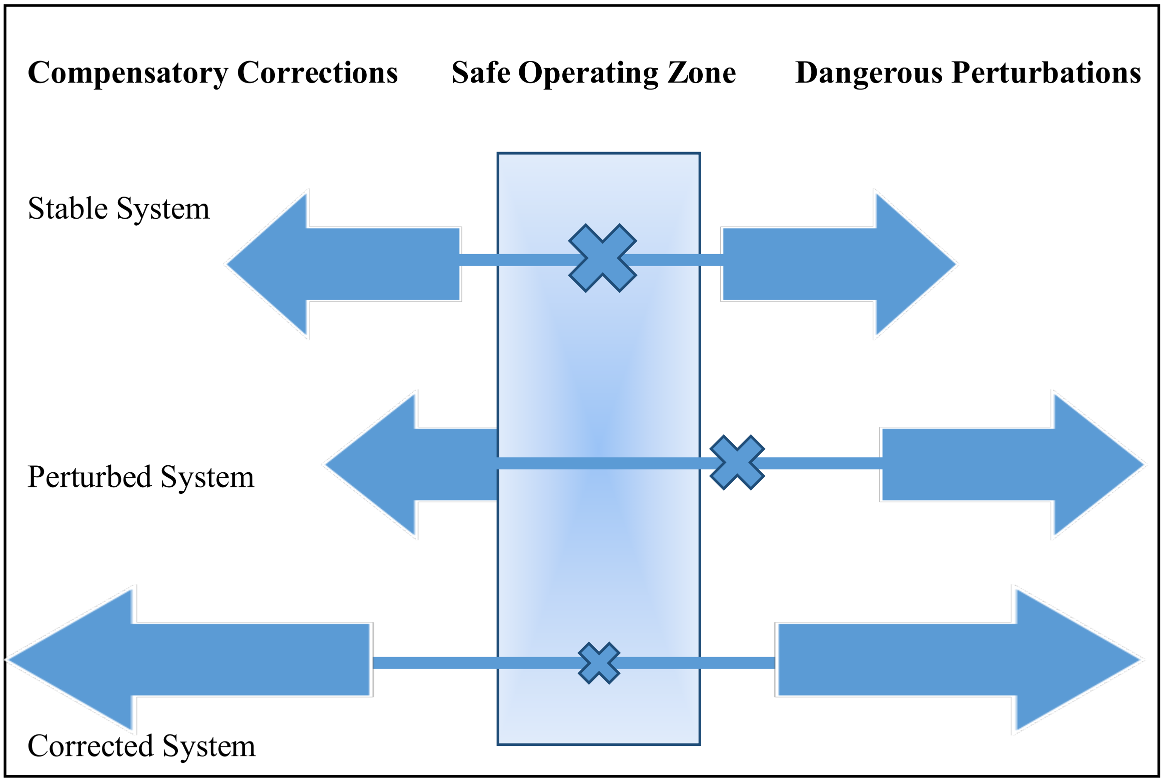
(HRO; Dekker & Woods, 2010; Reason, 2016), and as such, aviation leaders are challenged daily to face situations that require high levels of organizational resilience. Moreover, according to Adjekum and Fernandez-Tous (2020a), safety resilience provides a margin against vulnerabilities ensuring that HROs operate under robust safety defenses. Therefore, both proactive safety culture and safety resilience are essential in implementing and improving effective SMS (Teske & Adjekum, 2022).

Reason (2016) used an intriguing metaphor to explain the nature of safety resilience: The rubber-band model (see Figure 3). When a rubber band with a knot in the middle is stretched to one side by a dangerous perturbation, then an equal, opposite, and simultaneous amount of tension needs to be exerted on the exact opposite side so that the knot will return to the original place (the safe operating zone).

Any delay in applying the correction will allow the knot to move out of the safety zone. However, Weick (1987) argued that the system controller's knowledge and experience are critical in understanding and recognizing these alarming states. Moreover, he stated that this knowledge and experience are more likely to be found in those frequently exposed to unstable operating conditions.

Figure 3

Three States of a Knotted Rubber Band (Reason, 2016, p. 280)



At the organizational level, safety resilience may be used as a tool for safety management, enabling an organization and its people to adapt safely to unforeseen scenarios and conditions (Provan et al., 2020). Additionally, the safety II principles, as advocated by Hollnagel (2018), which emphasize the importance of examining why things do happen right in an organization, may aid safety managers in enhancing their organization's safety resilience potential (Dekker, 2020). Furthermore, safety resilience engineering could establish methods for determining when organizational complacency is a consequence of overconfidence in previous excellent results, as well as when intense performance may nullify any safety concerns (Dekker & Woods, 2010).

Safety Culture

The term "safety culture" has been widely applied in numerous industries and organizations, including aviation, yet there is no consistent definition for safety culture in the literature. *Safety culture* is described by the NRC(2020) as the core values and behaviors that result from a mutual effort by leaders and individuals to prioritize safety over competing interests to protect people and the environment, while as per the United Kingdom Health and Safety Executive (2002), safety culture encompasses an organization's behavioral and situational aspects. Moreover, safety culture reflects a group's shared values, customs, assumptions, and outlooks related to safety and risk (FAA, 2020b; Mearns & Flin, 2018; Yorio et al., 2019).

Extant research (Akselsson et al., 2009; Clarke, 2000; Glendon & Stanton, 2000; Hollnagel, 2014; Merritt & Helmreich, 1996; Patankar et al., 2012) suggested that safety culture is a subculture of other more significant cultures for an organization, similar to an onion with many layers of skin (Hofstede et al., 2010). National culture or another primary culture could be the outer layer while the employee is in the center. At times, conflicting cultural values might exist (Liao, 2015); therefore, any safety culture model should extend beyond the organization's boundaries (Harris, 2011, p. 284).

Reason (1997) supported the idea that few concepts have been studied so much and yet understood so little as the safety culture. If organization members are convinced that they have an adequate level of safety culture, they are usually mistaken; for Reason, safety culture involves continuous effort and is rarely achieved. Yet, a strong safety culture can help improve the safety performance of an organization (Shirali et al., 2016).

The UK CAA (2022) considered a positive safety culture as crucial to a safe flying display community within the air show community. This culture is influenced by a number of factors, including the behaviors of authorities, flying display directors, and display authorization examiners; the adherence of display pilots to established standards; and the encouragement of open and honest reporting of any incidents that may result in the transmission of lessons learned. Moreover, as part of the approach of implementing and integrating an SMS, the FAA (2020b) considers it necessary to foster a positive safety culture throughout the organization, characterized amongst other attributes by information sharing.

Building a safety culture is a process that needs gradual and collective efforts from all parties in an organization (FAA, 2020b; Hollnagel, 2014). Reason (1997) proposed the consistent application of practical measures while considering safety culture a multifaceted entity consisting of the following interacting elements: A reporting culture, a just culture, a flexible culture, and a learning culture. These elements interact to build an informed culture, which is the basis for the term "safety culture." Individuals at all levels in an organization should recognize their safety responsibilities and must be accountable for their actions to promote a safety culture (FAA, 2020b).

Nevertheless, Akselsson, Koornneef, Stewart, and Ward (2009) suggest that the concept of safety culture requires more context in discussions to address some identified limitations in scope. The reasons for this could be the apparent focus by some organizations on singular aspects of such a multidimensional construct (an example is the focus on just culture as representative of the entire safety culture dimension). Moreover, organizations advocating for a strong safety culture might disregard the aspect of resilience due to a lack of management commitment or communication. Finally, inconsistencies between what is stated or written and what is practiced might result in gaps in an organization's safety culture.

In addition to these suggested limitations, Shirali, Shekari, and Angali (2016) suggested that there is minimal to no standardized approach to deriving qualitative attributes or characteristics to describe the safety culture dimension. The existing dimensions used to measure safety culture are based on concepts such as behavior, values, assumptions, and norms while excluding any dynamic interactions among people, technology, and administration.

Resilient Safety Culture

The concept of resilient safety culture has been suggested to provide better context in the discussion on safety culture (Weick & Sutcliffe, 2001, 2009). Shirali et al. (2016) defined *resilient safety culture* as a safety culture that focuses on resilience, learning, continuous enhancements, and cost-effectiveness. According to Akselsson et al. (2009), a safety resilience culture is no different in theory than a safety culture, and the main difference lies in how it is practiced. Akselsson et al. (p. 4) also provided a more thorough definition of *resilience safety culture*: "Resilience safety culture is an organizational culture that fosters safe practices for improved safety in an ultra-safe organization striving for cost-effective safety management by stressing the resilience engineering, organizational learning, and continuous improvements."

Thus, resilient safety culture has some characteristics that differentiate it from a safety culture in an organization. According to Shirali, Motamedzade, Mohammadfam, Ebrahimipour, and Moghimbeigi(2015), the attributes of resilient safety culture in an organization are situational adaptability, institutional learning, continuous improvements, and cost-effectiveness in operations. Moreover, resilient safety culture is based on three types of capabilities: Psychological/cognitive, behavioral, and managerial/contextual (Pillay et al., 2010).

Akselsson et al. (2009) stated that an organization with a resilient safety culture has the following characteristics: It has a safety culture that emphasizes the need for a learning culture backed by a just culture; it strives for resilience, developing and using forward feed control to keep processes within safe limits; it strives for efficiency in safety management and the integration of safety and core business performance; and, it is mindful. Additionally, a culture of reliability may function in concert with certain fundamental organizational traits, allowing mindfulness, a distinguishing attribute of HROs, to thrive and grow (Cantu et al., 2020).

The enhancement of a strong safety culture with a proactive resilient safety culture can help not only to improve the safety performance of an organization but also to recover from an upset (Shirali et al., 2016). Even when incidents do occur, a resilient safety culture can enable an organization to adapt, successfully recover, and operate effectively within the margins of safety (Hollnagel, 2014).

The concept of resilient safety culture in the aviation industry has been the focus of several studies (Adjekum & Fernandez-Tous, 2020b; Akselsson et al., 2009; Heese et al., 2014; Hollnagel, 2014; Hollnagel et al., 2011; Reason, 2016, Teske & Adjekum, 2022). In general, these studies advocate for a resilient safety culture as essential in improving an organizational safety culture that fosters safe practices.

The concept of resilient safety culture has also been proposed in other industries, such as the health care and petrochemical industries. Resilient health care systems are continually adapting to changing circumstances (Sujan et al., 2019), and the safe delivery of health care is fundamentally derived from cultivating individual and organizational safety resilient cultures (Smith & Arfanis, 2013). In their study, Shirali et al. (2016) concluded that adopting opportunities in safety culture and resilience engineering can drive improvements in petrochemical safety performance.

Hazardous Attitudes

One of the numerous psychological constructs that have been studied as a potential factor affecting decision-making and impacting the possibility of accident involvement is *hazardous attitudes* (Martinussen & Hunter, 2018). Regulatory guidance from the FAA suggests five critical attitudes that can lead to hazardous events: Macho, Antiauthority, Invulnerability, Impulsivity, and Resignation (FAA, 2016). Hazardous attitudes need to be identified without delay, managed, and corrected immediately to mitigate any flight hazard risk.

The FAA guidance provides a set of antidotes to mitigate the adverse effects of the five hazardous attitudes identified among pilots: A macho attitude can be mitigated with a "taking chances is foolish" approach; an antiauthority attitude needs a "follow the rules—they are usually right" method of correction; invulnerability requires an "it could happen to me" approach; while, impulsivity needs the pilot to slow down and "not [act] so fast. Think first"; and, finally, pilots who have a resigned attitude should be supported with an approach that says, "I am not helpless. I can make a difference" (FAA, 2016, pp. 2–5). Figure 4 shows the hazardous attitudes and their corresponding antidotes.

Figure 4

Hazardous Attitudes and Corresponding Antidotes (FAA, 2016, p. 2–5)

Hazardous Attitude	• **Antidotes**
Macho	• Taking chances is foolish.
Antiauthority	• Follow the rules. They are usually right.
Invulnerability	• It could happen to me.
Impulsivity	• Not so fast. Think first.
Resignation	• I'm not helpless. I can make a difference.

Several factors could affect a pilot's safety behavior, hence influencing the safety performance of an aviation organization. A sense of calling, which can be construed as the intrinsic feeling by employees in an organization that their work is the most significant aspect of life, could have a positive effect on pilot safety behavior (Xu et al., 2022). Also, personality traits such as agreeableness, neuroticism, extraversion, and openness to experience have been identified as consistent predictors of safety behavior (Doerr, 2020).

Furthermore, risk tolerance and risk perception may influence pilot safety behavior; as risk perception improves, the detrimental effects of risk tolerance on safety operating behavior could gradually diminish (Ji et al., 2011). Additionally, internal locus of control - the degree to which individuals believe that they have influence over the results of their actions (Rotter, 1954) - was identified as having a direct effect on a pilot's safety behavior (You et al., 2013). Also, mindfulness was suggested as a method to optimize airline pilots' safety behavior, whereas flight experience was indicated as a means to enhance mindfulness's effect on pilots' safety behavior (Ji et al., 2018).

Nevertheless, personality theories have limitations that a researcher should consider. According to Harris (2011, p. 106), western European and North American cultures dominate commercial aviation, affecting these theories' perspectives. Specific cross-cultural differences should be anticipated between Chinese dimensions of personality, for example, and those encountered in the Western scientific literature. Hofstede (1984, 2001) suggested that concepts like power distance cannot sufficiently explain Chinese authoritarianism.

An unsafe attitude can lead to unsafe behavior that can hinder display pilot performance. Barker (2020a, p. 622) defined a *rogue display pilot* as "an unprincipled pilot living apart from the display community and having destructive tendencies." According to Barker, rogue pilots are characterized by placing their ego above all: They push the boundaries and limits with aggression and arrogance in their ignorance—which could be attributed to the Dunning-Kruger effect (Dunning, 2011)—and they risk not only their lives but also the lives of other pilots, and the air show spectators.

The B-52 accident at Fairchild Air Base in 1994 has been identified as an example of a rogue aviator incident (Barker, 2003, 2020a; Diehl, 2002; Kern, 1995; Thompson, 1995; USAF, 1994). Therefore, to prevent or minimize such egocentric attitudes and, consequently, the rogue attitude, it is critical that the air bosses demonstrate effective leadership during the planning and execution phase of the air show (Barker, 2020a; Chen & Chen, 2014; Schopf et al., 2021). Roger Beazley, former flying display director of the

Farnborough International Airshow, suggested a leadership approach that air bosses could take to identify and mitigate any egocentric attitudes by the air show performers when he argued (Barker, 2020a, p.50) that an aircrew safety briefing “works wonders in clearing the air and starting the new day fresh,” by ensuring “an open and free debate, in private, on previous days problems involving all participants.”

Display pilots might act unsafely without any previous indications of hazardous attitudes due to the latent factor of social facilitation bias (Papadakis, 2008). According to Jarvis (2009), the effect of the social facilitation bias might be so strong that it prevents a display pilot from realizing a hazardous situation when it is developing. Barker (2020a) suggested that the significant disparity in accidents during actual air shows and practice can be attributed to the pressure induced by the existence of spectators, among other causes.

Risk Assessment

One of the core components of a pilot’s decision-making process is risk assessment and management (Martinussen & Hunter, 2018). Inadequate risk assessment can lead to poor decision-making, ending in fatal aviation accidents (AAIB, 2017; Brugnara et al., 2022; Jensen & Benel, 1977; Kelly & Efthymiou, 2021). Based on the findings of a study assessing pilots’ risk perceptions, O’Hare (1990) concluded that an unreasonable estimation of the risks involved could be a factor in pilots’ decision to press on into deteriorating weather.

Risk Perception

According to Sjoberg, Moen, and Rundmo (2004, p. 8), “risk perception is the subjective assessment of the probability of a specified type of accident happening and how concerned we are with the consequences." Hunter (2002) had earlier described risk perception as the awareness of the risk inherent in a situation, implying that risk perception could be influenced by the type of situation and the characteristics of the pilot involved. Martinussen and Hunter (2018) considered risk perception a cognitive activity that involves an accurate assessment of internal and external states.

Several studies have discovered that experience has a definite positive association with risk perception. Young drivers have more distorted perceptions of driving hazards than older drivers, according to a range of research (Rhodes & Pivik, 2011; Tränkle et al., 1990; White et al., 2011). Hunter (2002, 2006b) studied risk perception and tolerance extensively and produced scales to measure their correlation with pilot involvement in hazardous aviation events. Hunter concluded that risk perception, compared to risk tolerance, was a more important predictor of hazardous aviation events.

Joseph and Reddy (2013), in a study conducted among Indian army helicopter pilots, found that lower risk perceptions were associated with higher risk-taking tendencies and higher risk attitude scores. Similar results were identified in another study conducted in Australia (Drinkwater & Molesworth, 2010), where a significant negative correlation in terms of risk perception and risk acceptance by pilots who elected to fly a risky flight scenario was found. In a study of Chinese airline pilots, You, Ji, and Han (2013) found that high levels of risk perception and an internal locus of control increase the likelihood of a pilot engaging in safety-oriented activities, including enhanced situation awareness and efficient decision-making.

Industries other than aviation have also considered the importance of risk perception to safety. Şimşekoğlu, Nordfjærn, Hezaveh, Mamdoohi, and Rundmo (2013) suggested that poor risk perception and high-risk tolerance are associated with car driver accidents. HROs in fields such as petrochemicals (Kao et al., 2008) and off-shore petroleum (Cairns et al., 2008) have recognized the significance of risk perception as a factor in safe operations.

Risk Tolerance

Hunter (2002) suggested that risk perception and risk tolerance are two related but often confused constructs. Risk tolerance, according to Hunter, is "the amount of risk that an individual is willing to accept in the pursuit of some goal" (2002, p. 3). Risk tolerance is influenced by a person's general risk aversion as well as the personal value attached to the goal of a given situation (Martinussen & Hunter, 2018). Specific goals are more important than others while flying, and the more important the goal, the more risk an individual is willing to take.

The concept of risk tolerance also exists in aviation and the finance industry. Numerous studies on financial risk tolerance highlight the relationship between risk and reward that individuals may be seeking (. In their studies, Gibson et al. (2013) and Hallahan et al. (2004) suggest that age has an inverse relationship with risk tolerance. Hallahan et al. further suggest that marital status, number of dependents, income, and total wealth had a significant relationship with an individual's risk tolerance scores.

Several studies have recognized a strong correlation between risk tolerance and hazardous behaviors, driving breaches, and injuries at the workplace (Arnett et al., 1997; Christian et al., 2009; Paul & Maiti, 2007). In contrast to the above studies, Hunter (2002) suggests no significant relationship between risk tolerance and hazardous aviation events.

Mindfulness

The extant literature contains a plethora of studies on the concept of mindfulness (Baltzell & Akhtar, 2014; Birrer et al., 2012; Brown et al., 2007; Cole et al., 2015; Gethin, 2011; Holas & Jankowski, 2013; Kabat-Zinn, 1994; Katz et al., 1956; Krieger, 2005; Li et al., 2020; Nilsson & Kazemi, 2016; Sawyer et al., 2022; Shonin & van Gordon, 2015; Stocker et al., 2017), yet, its exact definition remains vague. In an extensive study, Nilsson and Kazemi (2016) identified 33 definitions of mindfulness and five core elements: Attention/awareness, external events, ethical mindedness, cultivation, and present-centeredness.

One of the most cited historical definitions of *mindfulness* is Kabat-Zin's (1994, p. 4): "Paying attention in a particular way: On purpose, in the present moment, and nonjudgmentally." Wallace (2006, p. 59) expanded on the concept of mindfulness by explaining that it is a state in which distraction and forgetfulness do not exist. Additionally, Brown, Ryan, and Creswell (2007, p. 212) defined mindfulness as "a receptive attention to and awareness of present events and experience."

While the concept of mindfulness is based on Asian spiritual/philosophical frameworks, it has almost nothing to do with religion (Kabat-Zinn, 1994). According to Kabat-Zin, mindfulness should not conflict with one's culture, traditions, or beliefs; instead, it can fill gaps in the process of one's self-development.

Individual Mindfulness

Mindfulness can be individual and collective (Reason, 2016, Chapter 13). Individual mindfulness leads to systemic resilience, and collective mindfulness needs organizational support to improve the pilots' foresight and error wisdom. According to

Reason, an individual’s mental preparedness or mindfulness is more important than the technical skills required to achieve excellence in a task.

Experts in the domains of aviation psychology have begun to recognize the potential benefits of mindfulness. It has been suggested that mindfulness could improve the levels of safety performance by supporting pilots in managing job-related anxiety and feelings of burnout more effectively (Li et al., 2020). Then, mindfulness was suggested as a method to optimize airline pilots‘ safety behavior (Ji et al., 2018). Yet, individual mindfulness may be compromised when aircraft operators are confronted with uncommon and severe incidents, primarily as a result of safer modern technology (Oliver et al., 2019).

Organizational Mindfulness

Weick and Sutcliffe (1999) established a mindfulness theory based on their research of organizations with a strong safety record despite their complex organizational systems. “Mindful organizing” focuses on high-reliability organizations (HROs), like nuclear power plants and air traffic control systems. HROs follow certain mindful organizing processes to make sure they can address issues efficiently and effectively while they recover during unexpected circumstances. (Sutcliffe et al., 2016; Vogus, 2011; Vogus & Sutcliffe, 2012; Weick & Putnam, 2006).

Critical additional dimensions for mindful organizing were reported to be accountability and coordination between groups (Callari et al., 2019). In the aerospace industry, Teske and Adjekum (2022) identified a strong relationship between mindful organizing and SMS among aerospace organizations. Ray, Baker, and Plowman (2011) reported that organizational mindfulness could enable business colleges to organize in a way that reduces weaknesses by becoming more situationally aware.

Mindfulness Training

The effective practice of mindfulness, although seemingly simple, requires commitment, effort, and discipline (Kabat-Zinn, 1994). Automaticity, habitual unawareness (Kabat-Zinn, 1994), and chronic distractibility (Wallace, 2006) are the main obstacles to being mindful while still paying attention. Meditation practice (Kabat-Zinn, 1994) and mindfulness training (Ricard et al., 2014) are potential methods for moderating attention.

Mindfulness training is believed to exert positive effects in numerous areas of human performance. Holzel et al. (2011) reported that mindfulness training affects attention regulation, body awareness, emotion regulation, and change in perspective. Denkova et al. (2020) suggested that firefighters might benefit from short-form mindfulness training in bolstering their psychological resilience. Moreover, Brown et al. (2007) concluded in their study that mindfulness has positive outcomes in several important life domains, including mental health, physical health, behavioral regulation, and interpersonal relationships.

Mindfulness training can also regulate one's ego (Cole et al., 2015; Katz et al., 1956; Shonin & van Gordon, 2015; Stocker et al., 2017; Verney, 2009), manage and reduce stress levels (Chiesa & Serretti, 2009; Russ, 2015), and efficiently intervene in anxiety (Hofmann et al., 2010; Li et al., 2020).

Blackburn and Epel's (2018) Nobel award-winning research concluded that meditation practice has proven to have an astonishing ability to safeguard our telomeres.

According to the research, chronic stress, depression, and pessimistic thinking all work together to shorten telomeres and shorten life spans. However, this corrosive effect is shut down through mindfulness and meditation, effectively extending human longevity.

In the military, the U.S. Army developed Mindfulness-based Mind Fitness Training (MMFT, or M-fit) that assists those with posttraumatic stress disorder (PTSD; Russ, 2015; Seppälä et al., 2014). Brintz et al.(2019) found promising results in managing chronic pain and psychosocial issues for men and women in the military after a mindfulness-based intervention.

Evidence from research demonstrates that mindfulness training could also benefit high-performance populations. The mental skills related to failure, pressure, performance anxiety, social anxiety, and emotion control in elite athletes (Birrer et al., 2012) and circus performers (Filho et al., 2016; Ross & Shapiro, 2017), as well as their overall performance, can also be enhanced by mindfulness-based intervention.

Reason (2016) argued that providing one-off training programs is insufficient to instill the necessary mental skills in pilots. Similar to technical skills, cognitive skills need to be continually managed, practiced, and refreshed. Mindfulness training could complement existing mental training for high-performance populations (Baltzell & Akhtar, 2014; Stocker et al., 2017). Meland et al. (2015) conducted a high-performance combat aviation population study and concluded that mindfulness training is a feasible and acceptable enhancement to current mental training.

Similarly, Gautam and Mathur (2018) suggested that mindful decision-makers are prone to efficient decision-making due to their openness to feedback and being less prone to misapprehending situations. A study conducted on Chinese airline pilots by Li, Chen, Xin, and Ji (2020) concluded that mindfulness negatively correlates to civil pilots' anxiety.

Mindfulness-based training has various approaches, but all share the primary goal of enhancing self-awareness. Kabat-Zinn (1994) suggested three basic exercises during mindfulness-based training: Yoga, body scan, and sitting meditation. Ross and Shapiro (2017) noted that circus performers' mental preparation includes breathing techniques and imagery. Display pilots mentally prepare themselves with visualization techniques (e.g., chair flights, group talking rehearsals, walk-the-talk) and apply the "bubble rule" 30 min before their performance (Barker, 2003, 2020a).

The end state of mindfulness is an optimal state of experience—the flow. Csikszentmihalyi (2008) defined *flow* as the experience of an entirely immersed individual in the activity they are engaged in. The psychological state of flow, developed by Mihaly Csikszentmihalyi, is a state of mind that anyone can use in life: Mountain climbers use flow to shut out their nerves about the possibility that they could be injured during their climb. Artists frequently use flow in their everyday lives to help them disconnect from the objective of finishing the piece and focus solely on the process of creating art (Csikszentmihalyi, 2008).

Air Show-Related Literature

A search of extant literature suggests that the air show industry has a paucity of empirically-based literature. Typically, regulations and other directives that guide operational activities in the air show industry are provided by national aviation regulatory agencies such as the Federal Aviation Authority in the USA, EU Aviation Safety Agency, UK Civil Aviation Authority, and South African Civil Aviation Authority. These regulators also ensure strict compliance with directives and standards. However, other institutions, such as the International Council of Air Shows (ICAS), the European Airshow Council (EAC), and the British Air Display Association (BADA), support the above agencies with their knowledge, expertise, and industry-best standards that may be more stringent than regulatory requirements.

The historical paucity in the literature related to air show safety and the lack of data analysis on air show safety statistics led to the seminal work of Barker (2003), which provided a good overview of safety in the air show industry. Barker (2020a) provided an update to his work by analyzing a total of randomly selected 1,364 air show accidents and incidents between 1908 and 2018, covering all applicable categories of air show accidents. The material is derived from investigation accident reports filed by air forces, the NTSB, and the UK AAIB, as well as newspaper articles, television newscasts, online conversations, and eyewitness stories.

Air show accidents or incidents analyzed by Barker included "any accident or incident in an air show, either during practice or during the actual exhibition that lessons can be learned" (2020a, p.67). Air races and aerobatic competitions were also included in the accidents and incidents analyzed.

In Barker's (2020a) analyses of the air show accidents and using the 3M accident taxonomy (FAA, 2001; International Civil Aviation Organization [ICAO], 1993) - huMan, Machine, and Medium - it was suggested that 69 % of the accidents were caused by human factors followed by 24% caused by machine/equipment malfunctions, and finally 7% due to the medium or environment in which the operations were being carried out (see Appendix K, Figure 76).

According to Barker (2003, 2020a), the main human contribution to air show accidents and incidents was related to errors, either decision, skill-based, or perceptual (FAA, 2001; Reason, 1990), with the result being a flight-into-terrain (FIT), midair collisions (MAC), and loss-of-control (LOC).

Machine-related air show accidents and incidents comprised mainly mechanical engine failures and structural failures, mainly of the wing's load-bearing component (Barker, 2020a). The medium-related air show accidents and incidents included environmental factors such as bird strikes, wind gusts, wake vortex, and clouds, resulting in FIT, MAC, or LOC (Barker, 2020a, p.75).

An air show accident or incident is suggested to be more likely to occur during an actual air show than a practice (Barker 2003, 2020a; Papadakis, 2008). Both social facilitation (Zajonc, 1965) and plan continuation bias (Reason, 1990) of air show performers may contribute to this phenomenon (Barker, 2020a; Papadakis, 2008).

Furthermore, aerobatic maneuvers could pose a significant contributory role in air show accidents or incidents (Barker, 2020a, p. 79; Webster, 2007). The aileron roll and the loop were identified as the maneuvers with the highest role in air show accidents or incidents, mainly resulting in LOC or FIT. Also, the ICAS (2018) confirmed that a substantial hazard to air show pilots was maneuvering close to the ground and acknowledged the contribution of safety distances from the crowd, as well as operational restrictions directing aircraft energy away from the spectators, has been an effective mitigation method to protecting the public in the event of an air show accident.

In addition, Ballard and Osorio (2015) suggested that aerobatic flight increases the risk of air show-related fatal crashes. Also, de Voogt and van Doorn (2009) reported that aerobatic flight is the most significant risk factor for fatal injury in U.S. general aviation accidents, mainly due to not maintaining sufficient altitude.

In a safety survey conducted by the ICAS (2008), the following question was examined: “Who is responsible for air show safety?” The results were mixed. The majority of performers (80 percent) felt that individual performers were most responsible for preserving safety at air shows. Producers and event organizers were split between the waiver holder, performers, and the air boss. Performers tend to think of air-show safety in terms of aircraft accidents, either during flight or on the ground. Their focus is on flying the aircraft and flying their routine, as it should be.

Given that focus, it is not surprising that four out of five air show performers are most responsible for air show safety. While it is true that performers are most responsible for safely operating their aircraft, a review of the accidents from the last 10 years tells a different story (ICAS, 2008). The findings from the ICAS review suggested that about eighty percent of the accidents were caused by human factor-related elements. Some of the human factor elements are errors, loss of situational awareness, fatigue, stress, poor decision-making, and feelings of being rushed with primers well beyond the actual flying of an aircraft.

The findings imply that, while the performer bears the primary responsibility for safely operating his or her aircraft, everyone from the event organizer to the hotel clerk to the fuel truck operator is accountable for creating the conditions necessary for it to occur. These interesting findings bring into focus the question of who is ultimately responsible for air show safety and who bears accountability when there are safety events. The review recommended a shared responsibility for safety at air shows by all stakeholders and, ultimately, the event organizers being accountable for air show safety.

The UK CAA (2018) published the Health and Safety Laboratory's final report exploring human factors in air displays, which the UK CAA commissioned. More specifically, the error paths that lead to flying display accidents were examined, including the potential for negative transfer of behaviors between aircraft. The processes related to the assurance of the competence of air display pilots were a recurring contributory factor highlighted in accident reports (AAIB, 2017; Military Aviation Authority [MAA], 2012; NTSB, 2012; USAF, 2018). These included training, supervision, practical experience, and assessment.

Human factors play a crucial role not only in single-ship air show performances but also in formation-flying displays (Rozenberg et al., 2016). Formation aerobatic flying consists of a group of aircraft flying and maneuvering in close proximity (UK CAA, 2022). Moreover, in formation-flying experience, piloting skills and cooperation among the group members are crucial for the team's overall safety performance (Rozenberg et al., 2013).

There seems to be a paradox in terms of air show performers flying experience and safe execution of the task (Barker, 2020b). In contrast to general aviation, where a pilot's experience can be the precursor for the safe execution of a flight, flying experience has not proven to be a safeguard that necessarily leads to an uneventful flying display. There seems to be a paucity of data-driven studies on the cognitive processes of experienced display pilots that leads to poor decisions or courses of action resulting in fatal outcomes (Barker, 2020b). However, Barker (2020a) suggests that the superior judgment and flying skills of a pilot during an air display may not always be guaranteed. That may be due to the physiological demands and information processing limitations on the pilot while flying at high Gs, high roll rates, and extremely high closure rates (Barker, 2020a).

A factor that has been identified as a "door to disaster" (Barker, 2003, p. 212), if not channeled appropriately, is the power to impress peers and spectators (Papadakis, 2008). There has been no empirically-based study to assess the cognitive skills and extent of the decline in the decision-making process of air show pilots. However, best practices suggest minimal room for distractions and emotions (Barker, 2020a). Emotions such as grief (Plutchik, 2001), disgust (Plutchik, 2001), anger (Parrott, 2001), and sadness (Parrott, 2001; Plutchik, 2001; Weiner & Graham, 1984) must be held under control due to the extremely dynamic environment and the high energy levels associated with maneuvering an aircraft at low altitude. Mindfulness is a form of mental or cognitive training tool suggested to help mitigate the emotions discussed, and mindful practices have become an industry-best norm (Meland et al., 2015).

In a biography, Robert "Bob" Hoover (2014), a legendary U.S. pilot, argues that air show pilots need qualities similar to test pilots, such as alertness, precision, and intuitive skills. Hoover also considers the ability to focus on precise and well-planned routines, effective energy management, and finesse in flying as skills that are unique to air show pilots. Hoover, however, reiterates that the low-altitude environment that air show pilots operate in leaves little room for error (2014, p. 258). Hoover also suggests that the slightest error in judgment cannot be tolerated (2014, p. 288), highlighting that unexpected, unplanned, and random events - unrelated to the pilot - might happen during an air show that could lead to an accident. After such an accident, investigators may wrongly blame the pilot, possibly due to hindsight bias (Dekker, 2004).

Aerobatic flying could cause physiological effects of G acceleration, mainly as pertain to inflight G-induced loss of consciousness (G-LOC) by the pilot (Convertino, 1998; Kirkham et al., 1982; Rickards & Newman, 2005; Sekiguchi et al., 1986; Tu et al., 2020; Yilmaz et al., 1999). G-LOC has been identified as a contributing factor in a number of fatal accidents involving pilots performing aerobatic maneuvers (AAIB, 2017; MAA, 2012; NTSB, 2012; USAF, 2018). Moreover, changes from positive to negative Gs and vice versa, known as the push-pull effect, are suggested to reduce tolerance to positive Gs, forcing the pilots to initiate an anti-G straining maneuver at lower levels than usual (Mikuliszyn et al., 2005).

Another G-induced human condition related to air show performers and competition aerobatic pilots is known as G-induced vestibular dysfunction (GIVD; Muller, 2002). According to Muller (2002), GIVD usually occurs during high negative G maneuvers (less than negative four Gs), yet it can also occur when a pilot is subjected to a high positive G-load following a negative G-load (push-pull effect). GIVD is consistent with vertigo and makes pilots, after landing and walking from their aircraft, experience an extremely unstable gait with nausea symptoms without vomiting, which they call the "wobblies." Even a healthy vestibular system could be negatively affected within the aerobatic environment and some vestibular disorders, such as the GIVD, become exaggerated or impaired during aviation activities (Demir & Aydin, 2021).

CHAPTER 3. METHODOLOGY

Research Design-Concurrent Triangulation Mixed-Methods Approach

The current study utilized a concurrent, cross-sectional, triangulation mixed-methods design in which the researcher integrated quantitative and qualitative data to provide a comprehensive analysis of the research problem, as per Creswell and Creswell (2018). The researcher collected both forms of data from September 2021 to February 2022, analyzed them separately, and then integrated the findings to determine areas of concurrences and divergences.

The quantitative data consisted of an anonymous online survey, while the qualitative data were derived from semi-structured interviews with subject matter experts in the air show industry, a focus group session with a sample of air show pilots, and in-situ observation of an air show event by the researcher. The final portion of the qualitative data analysis was a documentary analysis of air show safety events data. All the findings from the data sources were triangulated and discussed.

The current study expanded on Adjekum and Fernandez-Tous' (2020b) work that assessed the relationship between organizational management factors and resilient safety culture in a collegiate aviation program with SMS. The researcher in this current study tested and validated measurement models using some of the variables in the previous study and included some new ones, such as risk perceptions and hazardous attitudes. This study used a distinct research population from the international air show community. A data triangulation approach enabled a comprehensive discussion of the findings from the various research methodologies used in this research.

Specifically, the quantitative data were used to assess the relationship between the attitudes of air show performers and air bosses toward safety risk parameters and resilient safety culture initiatives while mediating these factors with mindfulness, as measured by awareness of mindful attention. The qualitative data explored air show performers' hazardous attitudes, risk perception and tolerance, mindfulness strategies, and the overall perception of resilient safety culture in the air show community. Finally, triangulation of the findings from both data sources were compared to factual data derived from a documentary analysis.

Data Collection Procedures

Qualitative Data

Qualitative data are obtained scientifically and reliably when proper techniques are used (Harrell & Bradley, 2009). Therefore, the accuracy, validity, and reliability of study results would benefit from better data collection techniques. As a result, the qualitative data for this study were collected from semi-structured interviews and focus group, as well as an air show event observation. Finally, as part of the data triangulation, a comprehensive documentary analysis was performed.

Air Show Site Observation

The qualitative portion of the research commenced with an observation at an air show in southeast Europe. The researcher examined operational elements that contributed to risk and hazards for air show performers and air bosses while shifting position from observer to air boss and vice versa (Creswell & Creswell, 2018, p. 189). The observation was held at the event's primary operating locations, including the main briefing room, all aircraft parking areas, the control tower, and the crisis and disaster control center, allowing the researcher to see various aspects of inherent risks and hazards.

The air show site observation was an opportunity to examine and comprehend the correlations between the previously mentioned variables by using a comprehensive data triangulation strategy (Creswell & Creswell, 2018) in the air show community. The observation also allowed the researcher to understand the research environment, which was helpful when extracting salient codes and themes from the interviews and focus group.

Finally, observation was chosen as a valuable approach for exploring issues that air show performers and air bosses may be uncomfortable discussing (Creswell & Creswell, 2018, p. 188). Thus, this type of data collection was deemed helpful in closing a gap in the relevant information needed for empirical inquiries and could provide a direct approach to identify perceived risks by air show performers and air bosses during an actual air show.

Semi-Structured Interviews and Focus Group

Semi-structured interviews with twelve air show performers and air bosses (n = 12) were conducted in one-on-one online sessions, lasting from 39 min to 2 hr and 21 min (see Table 2). Then, during the 2022 display preseason period, a focus group with eight air show performers (n = 8) took place. Appendix D contains the interview protocols for the semi-structured interviews and the focus group.

Table 2

Semi-Structured Interviews Duration and Respondents' Demographics

Respondent	Background	Experience (years)	Interview duration (hr: min)
1	Civilian	6	1:17
2	Military	8	1:40
3	Military	4	1:44
4	Civilian	39	2:21
5	Civilian	6	0:57
6	Civilian	21	2:06
7	Civilian	18	1:55
8	Military	5	0:39
9	Civilian	38	1:34
10	Civilian	8	1:55
11	Civilian	21	2:09
12	Military	47	0:56

Note. Participants spent on average 1 hr 39 min during the semi-structured interview sessions.

Scope of Semi-Structured Interview Sessions. A selected group of SMEs from the international air show sector participated in the semi-structured interview process to provide their perspectives on the existing air show performers' hazardous attitudes, risk perception and tolerance, mindfulness strategies, and the overall perception of resilient safety culture in the air show community.

Scope of Focus Group Session. A selected group of air show performers participated in the focus group interview process to provide their perspectives on the existing air show performers' hazardous attitudes, risk perception and tolerance, mindfulness strategies, and the overall perception of resilient safety culture in the air show community.

Population and Sample

The semi-structured interviews and focus group were conducted with a selection of SMEs and experienced performers from the international air show community.

Data Recording Procedures

The respondents who agreed to take part in the study received an invitation with a link to participate in the interview via the Zoom teleconferencing platform. Each participant also received a copy of the interview plan before the interview to review the questions ahead of time. Participants were also given consent forms for electronic signature before the interviews. During the interview sessions, empirically sound interview protocols were devised and applied (Creswell & Creswell, 2018; Maxwell, 2012). The Zoom teleconferencing platform has audio recording capability, which was used, and the video component was not enabled for participants to ensure more privacy during the sessions.

Only the audio components were recorded, and the audio data files were stored on the researchers' password-protected storage devices. The audio data files were transcribed using the Otter.ai software. After the transcription, a Microsoft Word output of each session was sent to respective respondents for cross-checking and validation as part of trustworthiness before using it for further analysis. The audio data files were then deleted, and the verified transcripts were used for subsequent thematic analyses.

Documentary Analysis

As part of the overall research objective of data triangulation, a comprehensive documentary analysis was performed, as suggested by Maxwell (2012). On top of the documents analyzed in the literature review chapter, the material analyzed included numerous international air show rules and regulations, both from civilian and military organizations, presentations, and newsletters from the ICAS and the EAC (see Table 3).

To ensure a broad search for air show-related documents, numerous search tools were utilized, including Google Scholar, Scopus, and the search feature of the UND Chester Fritz Library. The researcher chose the following keywords individually or combined: “air show,” “accident,” “incident,” “display pilot,” “air show performer,” “risk,” “hazardous attitude,” “safety culture,” and “resilient safety culture.” The inclusion criteria searched for research published in peer-reviewed journals within the last 20 years (2002 to 2022) in the English language. Nonetheless, the majority of the air show-related material was discovered in ICAS and EAC members-only resource areas, which are not accessible to the general public.

The identified documents were stored in the researcher’s personal online library and screened using Excel software (see Figure 5). The information was then themed, and key phrases underlined to ensure relevance.

Table 3

Documentary Analysis, List of Documents Analyzed

Document	Source
CAP 1724, Flying display standards document, Edition 2, February 2020	UK CAA
Airshow separation distances, July 1993	Cranfield Aviation Safety Center
CAR Part VI Standard 623	Transport Canada
STANAG 3533 FS (edition 6) - Flying and static displays, 3 February 2003, NSA(AIR)1216-FS/3533	North Atlantic Treaty Organization (NATO)
JAA administrative & guidance material, Section one: General, Part 3: Temporary guidance leaflets (01.02.97): Leaflet no 5: The organization and conduct of flying displays	Joint Aviation Administration (JAA)
EGAST: Safety at flying displays and events, a guide for pilots	European Aviation Safety Agency (EASA)
F-16 Single-ship demonstration flights, February 2010	Hellenic Air Force
F-16 Demo team - Support manual, February 2010	Hellenic Air Force
T-6A Single-ship demonstration flights, March 2006	Hellenic Air Force
2021 Support manual, Air demonstration squadron Thunderbirds	United States Air Force
Display flying notes, August 2007	Defense Aviation Safety Centre, Royal Air Force
FAA Order 8900.1 Volume 3, Chapter 6, Section 1	FAA
FAA Order 8900.1 Volume 5, Chapter 9, Section 1	FAA
FAA Order 8900.1 Volume 6, Chapter 11, Section 10	FAA
FAA Order 8900.1 Volume 6, Chapter 11, Section 11	FAA
ICAS ACE manual; Aerobatic Competency Evaluation (ACE) program (January 1, 2019, Revision 9)	ICAS
ICAS Air Boss Recognition Program (ABRP) manual	ICAS
Putting accident/incident analysis to work for our air show family	ICAS

Table 3 (Continued)

Document	Source
Voices of experience: Air show veterans on flying low-level aerobatics	ICAS, Performer safety
Volume 52, Number 3, Third Quarter, 2021	ICAS, Air shows journal
Volume 3, Number 3, June 29, 2010: Photo passes	ICAS, Operations bulletin
Volume 3, Number 5, August 17, 2010: Practice makes safety	ICAS, Operations bulletin
Volume 3, Number 7, September 17, 2010: Get comfortable with knock it off	ICAS, Operations bulletin
Volume 4, Number 3, April 5, 2011: Offering constructive criticism	ICAS, Operations bulletin
Volume 4, Number 8, June 27, 2011: Corner markers and you	ICAS, Operations bulletin
Volume 4, Number 9, July 19, 2011: An additional smoke oil cutoff alternative; Lessons learned so far in 2011: hope for the best, but prepare for the worst; Who is on your team?	ICAS, Operations bulletin
Volume 4, Number 11, September 7, 2011: Safeguarding the sacred 30 minutes	ICAS, Operations bulletin
Volume 5, Number 1, March 15, 2012: Making best use of preseason downtime; mechanicals plague 2009 season	ICAS, Operations bulletin
Volume 5, Number 3, April 10, 2012: Preliminary NTSB report on Pardue crash	ICAS, Operations bulletin
Volume 5, Number 5, May 10, 2012	ICAS, Operations bulletin
Volume 5, Number 6, May 23, 2012: Fly the flaw; smoke oil cutoff	ICAS, Operations bulletin
Volume 5, Number 11, October 1, 2012: Sacred sixty minutes: An update from the field	ICAS, Operations bulletin
Volume 6, Number 3, May 16, 2013: Clarification on night shows and 8900.1	ICAS, Operations bulletin
Volume 7, Number 2, March 27, 2014: Get set…; Knocking off the rust	ICAS, Operations bulletin

Table 3 (Continued)

Document	Source
Volume 9, Number 1, March 18, 2016: Emergency extraction information; Decide right now that safety is your priority this year; Oil the machine; ICAS publishes performer documents	ICAS, Operations bulletin
Volume 9, Number 6, October 28, 2016	ICAS, Operations bulletin
Get comfortable with knock-it-off	ICAS, Operations bulletin
Practice makes safety	ICAS, Operations bulletin
Density altitude, part one	ICAS, Operations bulletin
Density altitude, part two	ICAS, Operations bulletin
Density altitude, part three: Gyroscopics	ICAS, Operations bulletin
Potpourri of pilot/performer punditry, part one	ICAS, Operations bulletin
Risk management at air shows	ICAS, Operations bulletin
Best practices for event organizers: Static display aircraft	ICAS, Operations bulletin
Best practices for event organizers: Operations	ICAS, Operations bulletin
Best practices for event organizers: CFR	ICAS, Operations bulletin
Amanda switch	ICAS, Operations bulletin
Who is responsible?	ICAS, Operations bulletin
Rules you can live with	ICAS, Operations bulletin
Airshow accident/incident reviews: 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, and 2019	Des Barker, EAC
The zero-height waiver, Presentation, 2008	Des Barker, EAC
Fast jet air displays in Europe and the USA – Contrasting experiences, 7 March 2009	RNLAF F-16 Demo Team, EAC
Fast jet display flying, Presentation, 2010	UK RAF Typhoon Demo Team, EAC
The challenge of introducing a new aerobatic aeroplane, Presentation	Royal Jordanian Falcons, EAC
Review of the 2015 Shoreham Airshow Air Display, Risk Assessment, February 2016, MSU/2016/04	Health and Safety Laboratory (HSL)

Table 3 (Continued)

Document	Source
Review of the risk assessment sections of CAP 403, 20 June 2016, MSU/2016/13	Health and Safety Laboratory (HSL)
Aircraft accident human factors report, Hawker Hunter G-BXFI, Shoreham airshow, 22 August 2015	Royal Air Force Centre of Aviation Medicine
Display order 2021	Athens Flying Week International Airshow
Crisis management plan 2021	Athens Flying Week International Airshow
Introduction to aerobatic judging, Student handout	International Aerobatic Club (IAC)
Behavioral markers of surgical excellence	(Carthey et al., 2003)

Figure 5

Documentary Analysis, Example of Theming Process

Author	ICAS	ICAS	ICAS	ICAS
Article	Volume 9, Number 6, October 28, 2016	Volume 4, Number 11, September 7, 2011	Fly ins and airshows	Volume 7, Number 2, March 27, 2014
Theme	Safety Reporting Culture	Mindfulness	Air Show Experience	Risk Assessment
Phrases	*Constructive criticism*	*Pilots learn early in their flight training to compartmentalize.*	*In short, airshows and fly-ins are exciting, super-charged aviation experiences.*	*As legendary Canadian Survivorman Les Stroud teaches, survival begins with assessing three zones around oneself to have a greater understanding of one's capabilities, thereby increasing the odds for success.*
Expressions	*Peer-reviewed community*	*Minimize the distractions and give performers the opportunity to focus on the task at hand:* ***safely entertaining the air show audience.***		
Link	https://airshows.aero/GetDoc/3646		https://myemail.constantcontact.com/CALLBACK-497--June-2021---Fly-Ins-and-Airshows.html?soid=1101073741327&aid=wgQW0O0XRC4	https://airshows.aero/GetDoc/3244

Following the preliminary documentary analysis, an assessment of factual air show data (Barker, 2020a) was conducted. Appendix K includes a comprehensive depiction of the analyzed factual air show data.

Ethical and Bias Considerations

Ethical concerns considered while administering the online interviews were related to the risk of exposing respondents' opinions to third parties (Creswell &

Creswell, 2018). Therefore, all recognized safeguards were applied to protect the interviewees' rights: No personal information was shared in the study, no personal information was stored during the data analysis of the interviews, Zoom was not allowed to store the recordings of the interviews, the researcher saved in a safe and secure storage space all the recorded interview and focus group sessions, and the final decision regarding participating in the study rested with the interviewee.

Due to constraints such as language barriers, cultural differences, or distance communication that prevents the informant from communicating body language to the researcher, qualitative research can result in misunderstandings, miscommunication, and misconceptions of constructs (Creswell & Creswell, 2018). Since the concept of resilient safety culture might be unfamiliar to the air show community, every attempt was made to prevent bias in the interviewees. Therefore, to enhance interviewees' awareness, a definition for the construct of resilient safety culture was included in the invitation email, and further details were provided during the introduction phase of the semi-structured interviews and focus group.

Lastly, researcher bias might affect the collection of the study's data. Therefore, to control the researcher-induced bias, the survey instruments were given to SMEs for review, comments, and suggestions. Moreover, the researcher maintained their credibility and objectivity by consistently administering the same questions in the same way during all interview sessions (Harrell & Bradley, 2009; Maxwell, 2012).

As suggested by Maxwell (2012), the researcher took some time breaks to stand off the actual operations to prepare reflective notes on the observed behaviors, risks identified, and other safety-related issues (see Appendix J, Figure 70). In addition, during the observation phase of the study, a member of the air traffic control team provided their objective feedback on the detected risks and hazards during the days of the air show (see Appendix J, Figure 71), similar to the researcher's identified risks and hazards. Also, despite all these efforts, it may be impossible to eliminate all biases in qualitative inquiries in which a researcher is an active entity, and the researcher's theories, beliefs, and conceptual lens can always have an impact (Maxwell, 2012, p. 124). It was assumed that the researcher's professional ethics and integrity and the stringent oversight of a research advisory committee should suffice in ensuring the validity of the data collected (Maxwell, 2012).

Quantitative Data

The research protocols were authorized by the University of North Dakota's Institutional Review Board (see Appendix A), and a convenient and purposive in nature sampling method was employed to send an anonymous online survey link through email, social media messages on WhatsApp, Viber, or direct messages on LinkedIn to available air show performers and air bosses. The online survey, administered through Qualtrics, was used to collect the quantitative data for the research.

Survey participation was entirely voluntary, and the participants had 8 weeks to respond to the survey items. The aim of the study, objectives, and contact details for the researchers were included in the online consent statement approved by IRB, as well as a digital consent option, which enabled users to consent to or decline to participate in the survey. A Microsoft Word copy of the quantitative survey items can be found in Appendix B.

Population

Air events occur globally but are most predominant in the USA, Canada, EU countries, Brazil, South Africa, Egypt, United Arab Emirates, Singapore, China, Australia, and Russia (Barker, 2020a). Therefore, every effort was made to ensure that the population of this study included air show performers and air bosses from all over the world.

For this study, the researcher assumed demonstration teams to be considered as single air show performing entities, sharing the same safety culture, risk perceptions, and mindfulness strategies (Barker, 2020a). Due to the detrimental effects of the COVID-19 pandemic, it was reported in the EAC (2022b) annual convention that several civilian air show performers have stopped being actively involved in the air show community, and that had an adverse effect on recruiting participants still actively engaged in air show activities.

Based on the above-mentioned information and considering the data provided by the ICAS (personal communication, 2022), an approximate number of known active air show performer entities – as of the date of this study‘s data collection – reached a total of 460 (see Table 4).

Table 4

Active Air Show Performer Entities

Region	*N*	Percentages
North America	283	61.6%
Europe	100	21.8%
Africa	25	5.4%
Australia	20	4.4%
South America	15	3.3%
Japan	5	1.1%
Middle East	5	1.1%
Southeast Asia	5	1.1%
China	1	0.1%
India	1	0.1%
Total	460	100%

The number of current air bosses across the world was not specified in the available sources. However, information provided by the EAC (personal communication, 2022a) and the ICAS (personal communication, 2022) estimated the current active air bosses in Europe and North America to be 100 and 153, respectively. Consequently, the estimated population of active international air show performer entities and air bosses at the time of conducting the current study was 713 (see Table 5).

Table 5

Estimated Population of Active Air Show Performer Entities and Air Bosses

Role	*N*	Percentages
Active air show performer entity	460	64.5%
Air boss	253	35.5%
Total	713	100%

Sample Size Determination and Power Analysis

Based on the assumptions and limitations discussed in the previous paragraphs, a sample from the total population was drawn for this study, and they voluntarily participated in the online survey, focus group session, and semi-structured interviews. However, this research will look for a sample size of more than 200 participants, based on Kline's (2016) SEM recommendations for meaningful effects and appropriate fit of the measurement model.

Even though a larger sample could provide more accuracy in the inferences made (Taherdoost, 2020), recruiting almost every air show performer as a participant in this study within the context of the limitations listed earlier was impractical and resource-intensive. Moreover, due to the COVID-19 pandemic, significant travel restrictions did not allow the researcher to travel and personally visit other respondents, either for an interview or for the survey administration.

For the quantitative research portion of this study, a power analysis was also conducted to determine the minimum sample size that will produce a significant effect when assessing the relationships between the variables of risk perception and tolerance, hazardous behaviors, mindfulness, and resilient safety culture. The G*Power analysis software was used (Kang, 2021) to determine a total sample size of 80 participants, considering a chi-square for the goodness-of-fit test (see Appendix E).

Research Participants

The participants in the survey were mainly air show performers with a variety of air show flying experience: Active and retired; solo display pilots and demo team members; fast jets, piston-engine aircraft, helicopters, or gliders; with military or civilian aerobatic backgrounds.

Additionally, air bosses participated in the survey with a variety of display directing experience: Active and retired; with or without display flying experience; with a civilian background. Participants represented a variety of nations, which included the United States, the United Kingdom, and Canada, and were contacted through the EAC, the ICAS, and the France Spectacle Aérien.

Instrumentation – Survey Design

A quantitative survey instrument was designed to examine the strength of relationships between the constructs of risk perception (RP), risk tolerance (RT), hazardous attitudes (HA), and resilient safety culture (RSC) while mediating these constructs with mindfulness (MF) among air show performers.

Survey Instruments Used to Collect Data. Preliminary items about air show performers' risk perception and tolerance, hazardous attitudes, mindfulness, and resilient safety culture were culled from existing validated scales, and some items were modified to create the online survey used in this study. The validated survey instruments utilized are shown in Table 6.

Table 6

Variables and Instrument Sources

Variable name	Instrument sources
Hazardous attitudes (HA)	Hazardous Attitude Scale (Ji et al., 2011)
Resilient safety culture (RSC)	Resilient Safety Culture (Adjekum & Fernandez-Tous, 2020b)
Risk tolerance (RT)	Risk Tolerance (Ji et al., 2011)
Risk perception (RP)	Flight Risk Perception Scale (Winter et al. 2019)
Mindfulness (MF)	Mindful Attention Awareness Scale (Brown & Ryan, 2003)

To investigate the air show performers' risk perception and tolerance for risk, this study sought to identify the human behavior factors that contribute to an erroneous perception of risk, as Hunter (2002, p.21) indicated. Additionally, Meland et al. (2015) recommended a continuation for implementing and measuring the effects of mindfulness training (MT) in elite individuals working in high-performance environments – and the air show sector has such characteristics (Barker, 2020a).

In terms of specificity of demography, this study builds upon recommendations from previous studies on the association of experience - either in flying or other acts - with risk perception and tolerance (Barker, 2003; Crundall et al., 2013; Ferraro et al., 2015; Joseph & Reddy, 2013; Winter et al., 2019; You et al., 2013), age with risk tolerance (Gibson et al., 2013; Hallahan et al., 2004), marital status with risk tolerance

(Hallahan et al., 2004), and educational level with risk perception (Adjekum et al., 2015; Chionis & Karanikas, 2018).

Validity of Scores Using the Instrument. Selected items from the five validated instruments were used, with slight modifications, to accommodate the air show community's unique demography. Pilot testing of the composite survey instrument was then conducted through a pilot study, using a selected sample of five air show performers, who provided technical verbiage modification suggestions to ensure the final survey instrument was more global in terms of international air show operations. The final survey instrument is outlined in Appendix B.

Reliability of Scores on the Instrument. The instrument utilized in the current research has been derived by a slight modification of the existing instruments to fit the wording and the construct measured within the air show community. By combining these five instruments in the study, the original validity and reliability may not hold for the new instrument; therefore, the researcher thought it necessary to conduct corroborative validity and reliability analysis as part of this research.

Content of Instrument. Twenty-eight survey items were derived from the above instruments representing the five constructs and the demographic data for the quantitative section of this study, which sought to answer the research questions (see Appendix B and C). It should be noted that depending on the item measured in the survey, different types of scales were utilized: The instrument items that measured the five constructs used Likert-type scales, while the demographic items used categorical scales. An example of an item in each construct is depicted in Table 6 and Table 7.

Figure 6

Example of Answered Instrument Items: HA, RSC, and RT

HA. Please provide your degree of agreement regarding the following statements about yourself:

	Strongly disagree (1)	Somewhat disagree (2)	Neither agree nor disagree (3)	Somewhat agree (4)	Strongly agree (5)
I am a display pilot due entirely to my hard work and ability. (1)	⊗	○	○	○	○

RSC. Please provide your degree of agreement regarding the following statements about resilient safety culture in the air show community:

	Strongly disagree (1)	Somewhat disagree (2)	Neither agree nor disagree (3)	Somewhat agree (4)	Strongly agree (5)
Safety is recognized as being everyone's responsibility, not just that of the air boss. (1)	○	○	○	⊗	○

RT. Please provide your degree of agreement regarding the following statements about risk tolerance during an air show event:

	Strongly disagree (1)	Somewhat disagree (2)	Neither agree nor disagree (3)	Somewhat agree (4)	Strongly agree (5)
A demo pilot has enjoyed flying a spectacular sunset show over the sea with 25 miles visibility, wind calm conditions, and no wave waters. As he pulls up for a barrel roll, at about 1,500 feet, he loses sight of the horizon, and the sea water seems to be indistinguishable from the sky. He keeps the backpressure on the stick and continues the maneuver. (4)	○	○	○	⊗	○

Figure 7

Example of Answered Instrument Items: RP and MF

RP. Please rate the level of risk present if you were to experience the situation tomorrow.

	1 (Low risk) (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7 (7)	8 (8)	9 (High risk) (9)
Fly a display over a large lake or sea at 300 feet above ground level. (1)	○	○	○	○	○	○	○	⊗	○
Fly a display over water, at 500 feet above ground level. (3)	○	○	○	○	○	○	⊗	○	○

MF. Please indicate how frequently or infrequently you currently have each experience:

	Almost always (1)	Very frequently (2)	Somewhat frequently (3)	Somewhat infrequently (4)	Very infrequently (5)	Almost never (6)
I rush through the maneuvers without being really attentive to them. (2)	○	○	○	○	○	⊗

Pilot Testing. Pilot testing was conducted before the final instrument was distributed to the sample of air show performers to establish the code validity of scores on the current instrument and provide an initial evaluation of the internal consistency of the items, as well as to improve questions before the final distribution, as per Creswell and Creswell (2018). Five air show performers tested the instrument, and their feedback was incorporated into the final instrument revisions, who provided technical verbiage modification suggestions to ensure the final survey instrument is more global in terms of international air show operations. Also, a suggestion was provided to translate the survey into languages other than English to help respondents and minimize biases due to language barriers. Therefore, the Qualtrics survey tool's feature for translating the survey into various languages was activated. Furthermore, during the instrument's pilot testing, the time required to complete the survey was measured so that the survey would be structured to ensure expedited feedback and reduce response drop-offs.

Administering the Survey. Personal emails were sent to ICAS and EAC members, as well as other international air show performers and air bosses, to take part in the survey. In addition, the study was publicized on the EAC website, inviting volunteer air show performers and air bosses to take part in the survey. Additionally, social media messages on WhatsApp, Viber, or direct messages on LinkedIn were used to disseminate the anonymous survey link to some of the respondents. A 4-phase administration process was implemented to assure a high response rate, as suggested by Creswell and Creswell (2018, p.155).

First, an email/private message with a brief advance notification letter was sent to all members of the sample; then, a second email/message contained the actual email survey link, which was disseminated around a week following the advance notice email. A week after the initial questionnaire, a third email/message was sent to all members of the sample. The fourth and final email/message was sent 3 weeks after the second email/message to all nonrespondents. The survey was conducted over 8 weeks using the Qualtrics software registered with the University of North Dakota. The estimated number of invitations sent was approximately 900.

Variables in the Study. Five variables were measured in the current study: RP, RT, HA, and RSC initiatives, while mediating these factors with MF. RSC was the dependent variable, with the other four variables, i.e., RP, RT, HA, and MF, being the independent variables.

Ethical and Bias Considerations

During the online survey administration, all recognized ethical considerations were taken into account, as per Creswell and Creswell (2018). Nonetheless, the risks associated with disclosing respondents' personal information in the event of a cyberattack were deemed the most serious. Therefore, the following safeguards were applied to protect the respondents' privacy and confidentiality of data: No personally identifiable information was elicited in the anonymous online survey, and the Qualtrics survey software did not save the IP address or geolocator information of respondents. The survey was strictly voluntary, and the final decision regarding the completion of the survey rested with the respondent.

To avoid the possibility of social desirability bias during the survey administration, an anonymous link to the survey was generated, which was embedded in an invitational email to all respondents (Ried et al., 2021). The mode of administration also avoided physical contact of the researcher with a respondent, which could potentially introduce biases and privacy intrusion (Grimm, 2010). It was also acknowledged that misunderstanding and construct misconceptions might emerge as a result of the survey research approach (Creswell & Creswell, 2018). Therefore, respondents were informed in the invitation email to contact the researcher for any clarification or questions about the survey.

Instrumentation and Operationalization of Constructs

The variables that were employed in the measurement model and assessed the constructs in this study are thoroughly discussed below. Scale items were measured using a 5-point Likert scale unless otherwise stated for some constructs where a different point Likert-like scale was used. After the data had been collected, the internal consistency of the items in the form of composite reliability and Cronbach Alpha were calculated for each factor. As a criterion for acceptable reliability, a minimum alpha value of 0.70 (α = 0.70) was utilized (Field, 2018).

Table 7 shows the cross-reference of the variables and specific survey items. Also, Appendix C outlines the survey instrument codebook.

Table 7

Variables and Items on the Survey

Type of variable	Variable name	Item number on survey
(Demographics)	(Demographics)	1-8
Independent	Hazardous attitudes (HA)	9-12
Dependent	Resilient safety culture (RSC)	13-16
Independent	Risk tolerance (RT)	17-20
Independent	Risk perception (RP)	21-24
Independent/ mediator	Mindfulness (MF)	25-28

Resilient Safety Culture

The first scale to be assessed is the result of prior work by Adjekum and Fernandez-Tous (2020b). The purpose of this study was to validate an instrument that investigated the association between resilient safety culture and organizational management parameters in a collegiate aviation program with SMS (Adjekum & Fernandez-Tous, 2020b). The survey instrument consisted of 40 items, and all items were answered on a 5-point Likert scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*).

Some of the questions were paraphrased from their original form to fit the community of air show performers better. For example, except for military display teams, civilian air show performers are not obligated to follow a specific organizational structure; instead, they frequently use an autonomic organizational model (Barker, 2020b). The term "Air Show Performer," for example, has been used to allude to the "Top Leadership."

In addition, Adjekum and Fernandez-Tous (2020b), using structural equation model (SEM) and causal path analysis (CPA), assessed the conceptual models and suggested that all four management factors, i.e., Principles, Policy, Procedures, Practices, had a significant predictive relationship with resilient safety culture. Therefore, for this study, four items with a high factor loading were chosen to represent the survey instrument, which could also meet the needs of air show performers (Pri3, Pol5, Pra5R, and Pro4). Furthermore, a confirmatory factor analysis (CFA) will be used to validate consistency.

Risk Perception

Winter, Truong, and Keebler (2019) produced a new 13-item scale based on Hunter's scale (2006b) that will be used in the current study for the pilot's self-assessment of risk perception. Winter et al. reported good psychometric values of the goodness-of-fit index (GFI), adjusted goodness-of-fit index (AGFI), comparative fit index (CFI), normed fit index (NFI), normed chi-square (χ^2), and root means square error of approximation (RMSEA). As a result, for this study, four items with a high factor loading were chosen to represent the scale, which could also meet the needs of air show performers (RP9, RP10, RP11, and RP13). The responses were given on a scale of 1 (*Low Risk*) to 9 (*High Risk*). Certain scale items were amended in the current study to reflect the differences encountered when flying in air displays, such as applying a "90-degree angle of bank" rather than a "45-degree angle of bank." A CFA will be conducted to analyze the validity and reliability of the constructs.

Risk Tolerance

The risk tolerance scale to be assessed in the present study is the result of prior work by Ji, You, Lan, and Yang (2011), who further expanded Hunter's (2002) and Pauley et al.'s (2008) research on risk tolerance. Their suggested scale consists of sixteen items in the form of a sentence describing an event or situation, including aircraft system failure risk tolerance (three items), crew operation risk tolerance (six items), and flight weather risk tolerance (seven items; Ji et al., 2011). The risk tolerance scale assessed the participants' level of acceptance of the behavior presented, with six options provided: *Definitely no approval* (1) to *approval* (6) to rate the likelihood that they would personally be willing to accept the flight.

A mean score of all items provides an overall risk tolerance score. Higher ratings suggested that the respondent was willing to take on more risk.

Four items with a high factor loading were chosen for this study to represent the scale, which could also meet the needs of air show performers (RT3, RT7, RT10, and RT15). Some of the questions were paraphrased from their original form in the current study, or specific phrases were deleted to fit the air show performers' community better. For example, since air show performers hand-fly the aircraft during air displays (Barker, 2003), terms referring to "the autopilot" have been omitted. Furthermore, a CFA was conducted to analyze the validity and reliability of the constructs.

Hazardous Attitudes

In this study, the 24-item hazardous attitudes scale developed by Ji, You, Lan, and Yang (2011) was utilized to measure air show performers' hazardous attitudes. This scale was a revision of Hunter's Hazardous Attitude Scale (Hunter, 2005), which examined the factors (antiauthority, macho, invulnerability, impulsivity, and resignation) linked to pilots being involved in accidents. However, Ji et al.'s (2011) scale extracted six factors, including self-confidence (six items), impulsive (five items), worry/anxiety (four items), macho (three items), antiauthority (three items), and resignation (four items). All the items were answered on a 5-point Likert response scale ranging from 5 (*strongly agree*) to 1 (*strongly disagree*).

A mean score on each of the hazardous attitudes was constructed based on the items measuring the factored attitude. Therefore, a high score on a factor indicated a negative attitude towards aviation safety, meaning low preferences for safety behavior in aviation.

For this study, four items with a high factor loading were chosen to represent the scale, which could also meet the needs of air show performers (HA1, HA5, HA16, and HA17). Additionally, in the present study, some of the questions were rephrased to meet the needs of air show performers better. For instance, phrases associated with "night" have been substituted with "poor visibility conditions" since the majority of air shows are permitted in the daytime (UK CAA, 2022). A CFA will be conducted to analyze the validity and reliability of the constructs.

Mindfulness

The Mindful Attention Awareness Scale (MAAS) was utilized to measure the enhanced self-awareness of air show performers (Brown & Ryan, 2003). The MAAS is a 15-item scale that shows strong psychometric properties and has been validated with college, community, and cancer patient samples (Brown & Ryan, 2003; Brown et al., 2007). MAAS rates how frequently respondents had the experience described in each statement on a 6-point Likert scale ranging from 1 (*almost always*) to 6 (*almost never*), with higher scores indicating greater mindfulness.

To score the scale, a mean of the fifteen items must be calculated. Higher MAAS scores indicate higher degrees of dispositional mindfulness (Brown & Ryan, 2003). Consequently, high-score respondents are more "in-tune" with and capable of altering their emotional states, and they are more likely to meet basic psychological requirements.

For this study, four items with a high factor loading were chosen to represent the MAAS, which could also meet the needs of air show performers (MF7, MF8, MF10, and MF14). Furthermore, in the present study, some of the questions were paraphrased from their original form to fit the requirements of air show performers better. For example, phrases pertaining to “drive” were replaced with “fly” to emphasize the current study’s focus on the flying-related mindfulness practices of air show performers. Lastly, a CFA will be conducted to analyze the validity and reliability of the constructs.

Data Visualization Procedures

To visualize the data collected, data values were converted in a systematic and logical way into visual elements that made up the final chart (Wilke, 2019). In the current study, the types of data visualizations utilized were pie charts, bar charts, and correlation heatmaps based on accurately conveying the data to the reader. Proportions of data were visualized as pie charts, or side-by-side bars, as suggested by Wilke.

Joint displays, such as a correlation heatmap, may be an effective way to conduct a thorough and transparent synthesis of qualitative and quantitative data and generate acceptable and relevant inferences in mixed-methods studies (Younas et al., 2021). In the current study, two correlation heatmaps were utilized to jointly display the comprehensive association of the research variables that were derived after the quantitative and qualitative data had been triangulated into a mixed data set.

Heatmaps are visualizations that allow the reader to capture trends in the data swiftly; nevertheless, a heatmap’s limitation is that it is abstract in nature (Wilke, 2019). While correlation heatmaps highlight significant patterns in the data, they can obscure the underlying data points, which might lead to inaccurate conclusions. Nevertheless, for the purpose of this study, a trade-off between presenting significant patterns and displaying raw data was made by employing correlation heatmaps as a visualization tool.

CHAPTER 4. DATA ANALYSES, RESULTS, AND DISCUSSIONS

Quantitative Data

Demographic Information

After eight weeks, the survey was closed, receiving one hundred and fifty-nine (*n* = 159) responses. Nevertheless, one hundred and forty-five (*n* = 145) were considered for analysis, which completed the survey past the consent page. Six (*n* = 6) responses were deleted due to not consenting to the survey and did not provide adequate data for analysis; eight (*n* = 8) were deleted because they did not provide any answers after consenting to participate in the survey. The online survey response rate was approximately 30%, which is sufficient for most online surveys (Tse-Hua & Xitao, 2009).

Any missing data were substituted using a regression-based technique using a single input. A regression-based imputation strategy replaces missing scores with a predicted value using multiple regression on nonmissing scores on other variables (Kline, 2016, p. 58). However, according to Vriens & Melton (2002), as cited in Kline (2016), a limitation of single-imputation approaches is that they frequently underestimate error variance, especially when the proportion of missing observations is significant.

The following demographic groups are represented in the responses: (a) age (see Table 8); (b) gender and country of origin (see Table 9); (c) marital status and educational background (see Table 10); and (d) current role in the air show community, air show flying experience, and aerobatics background (see Table 11). In addition to Canada, France, the United Kingdom, and the United States, the respondents originated from the following seventeen countries: Belgium, Chile, the Czech Republic, Denmark, Finland, Germany, Ghana, Greece, Italy, Jordan, the Netherlands, Norway, Poland, Romania, South Africa, Sweden, and Switzerland.

Table 8

Frequency Table, Demographic Variable: Age

Demographic variable	*N*	Percentages
Year group		
18 – 24	1	0.7%
25 – 34	9	6.2%
35 – 44	41	28.3%
45 – 54	34	23.4%
55 – 64	36	24.8%
65 or older	21	14.5%
Missing	3	2.1%
Total	145	100%

Table 9

Frequency Table, Demographic Variables: Gender and Country of Origin

Demographic variable	*N*	Percentages
Gender		
Male	134	92.4%
Female	4	2.8%
Missing	7	4.8%
Total	145	100%
Country of origin		
Canada	7	4.8%
France	24	16.5%
United Kingdom	31	21.4%
United States	42	29.0%
Other	41	28.3%
Total	145	100%

Table 10

Frequency Table, Demographic Variables: Marital Status and Educational Background

Demographic variable	*N*	Percentages
Marital status		
Single	13	9.0%
Married	113	77.8%
Widowed	1	0.7%
Divorced	7	4.8%
Separated	4	2.8%
Registered partnership	4	2.8%
Prefer not to answer	3	2.1%
Total	145	100%
Educational background		
High school	47	32.4%
Bachelor's degree	54	37.2%
Master's degree	37	25.5%
PhD or higher	7	4.8%
Total	145	100%

Table 11

Frequency Table, Demographic Variables: Current Role in the Air Show Community, Total Air Show Flying Experience, and Aerobatics Background

Demographic variable	*N*	Percentages
Current role in the air show community		
Air show performer	119	82.2%
Air boss	13	8.9%
Other	13	8.9%
Total	145	100%
Total air show flying experience		
< 1 year	7	4.8%
1-3 years	17	11.6%
4-6 years	22	15.8%
7-10 years	16	11.0%
10+ years	83	56.8%
Total	145	100%
Aerobatics background		
Civilian	81	55.8%
Military	61	42.1%
None	3	2.1%
Total	145	100%

Quantitative Data Analysis and Validation

Quantitative data were extracted from Qualtrics and analyzed using IBM SPSS Statistics 28 and IBM SPSS Amos 28 Graphics. Unless otherwise noted, all analyses were performed at the 0.05 alpha level (2-tailed). Given that the scales used in this study had already been used in other studies, CFA was used to examine if scale items that measured latent constructs, for example, RSC and RP, were consistent with the researcher's perception of that construct. Additionally, it was utilized to determine whether the research data conformed to the hypothesized measurement models for the relationships between study constructs/variables. The scale's reliability was tested using the composite reliability method, by Field's (2018) recommendation, of a value of 0.70 or greater for determining reliability.

Furthermore, the average variances extracted (AVE) approach was used to determine convergent validity. When determining the existence of convergent validity, Fornell and Larcker (1981) recommend a value greater than 0.50. The current study's researcher evaluated discriminant validity by comparing the square root of each AVE to the correlation coefficients for each variable. To compensate for the relatively small sample, the bootstrapping method was utilized to transform the collected quantitative data. Five thousand bootstrapping samples were used with bias-corrected confidence intervals (CI) of 95%.

The goodness-of-fit indices and factor loadings were estimated using IBM SPSS Amos 28 Graphics. The chi-squared (χ^2) index, the root mean square error of approximation (RMSEA), the comparative fit index (CFI), the Tucker-Lewis Index (TLI), incremental fit index (IFI), and the normed fit index (NFI) were used to assess the fit of the 4-factor measurement model showing the relationships between scale items and their latent construct.

The chi-square (χ^2) test is frequently assessed; however, it is sample size-dependent (Vandenberg, 2006). According to Kline (2016), a significant chi-square test with between 200 and 300 cases (n = 200-300) can indicate the presence of substantial flaws that warrant rejecting the model. Given the present sample size of approximately 150 cases, chi-square data were analyzed comprehensively.

The RMSEA is another frequently used metric for evaluating model fit. Unlike the chi-square, the RMSEA statistic is not sample size-dependent but rather can be affected by model complexity (Brown, 2015). An RMSEA of less than 0.05 is desirable, whereas values greater than 0.10 suggest problems with the model's fitness (Kline, 2016).

Another often-used statistic fit index is the Bentler comparative fit index (CFI). According to Kline (2016, p. 208), the CFI is an incremental fit index that assesses the researcher's model's relative gain in fit over the baseline model. The CFI statistic can range between 0 and 1.0, with a value greater than or equal to 0.95 indicating a satisfactory fit (Kline, 2016).

The Tucker-Lewis index (TLI), a nonstandard fit index, is the next fit index to consider. The TLI may have values beyond the range of 0–1.0; however, it is preferable to have a value close to 1.0. (Brown, 2015). Similar to CFI, a TLI greater than 0.95 indicates a good model fit.

The final two statistics analyzed are the normed fit index (NFI) and the incremental fit index (IFI). NFI and IFI values should be greater than 0.90; otherwise, it indicates the need for model enhancements (Bentler & Bonett, 1980). Combining reported fit indices can benefit in determining the optimal model fit. According to Hu and Bentler (2009), implementing TLI and CFI cutoff values of 0.95 in conjunction with an RMSEA cutoff value close to 0.06 appears to result in lower Type II error rates at the cost of Type I error rates that is acceptable.

A first-order CFA was conducted to assess the strength of relationships between scale items and their latent constructs (RP, RT, HA, MF, and RSC). It was also carried out to ascertain the correlations between these latent constructs and model fit. The initial CFA model with all the factors and their items had a poor fit based on all the fit indices (see Table 12).

A second competing CFA model was derived by using the recommendations from the AMOS modification indices function to covary the error terms e3 & e4 (see Figure 9). Another analysis was performed, and the results suggested improvements in the fit indices. A third competing model was explored by covarying the error terms e3 & e4 and e9 & e10 (see Figure 10). This improved the various fit indices.

It was also observed that some of the items had extremely low loadings, which could affect item reliability and validity. Based on the recommendations from modification indices and guided by theoretical considerations for parsimony, the items: MF_1, RP_2, and RSC_3 were eliminated.

Another round of AMOS analysis was conducted that further improved all the fit indices across the board and also the factor loadings of remaining items in the respective factors. The resulting model III was adopted among the competing models. No further adjustments to the scale items were made, and Table 12 shows the goodness-of-fit indices for all the competing models.

Table 12
Goodness-of-Fit Estimates, CFA Models

Model	χ^2	CMIN/DF	NFI	IFI	TLI	CFI	RMSEA
I	178.46***	1.64	.89	.95	.94	.95	.07
II [a]	161.91**	1.50	.90	.96	.95	.96	.06
III [b]	149.73**	1.50	.90	.97	.96	.97	.05

Note. ** $p < .005$, *** $p < .001$

[a] Covarying error terms e3 & e4

[b] Covarying error terms e3 & e4, e9 & 10

Figure 8

CFA Model I

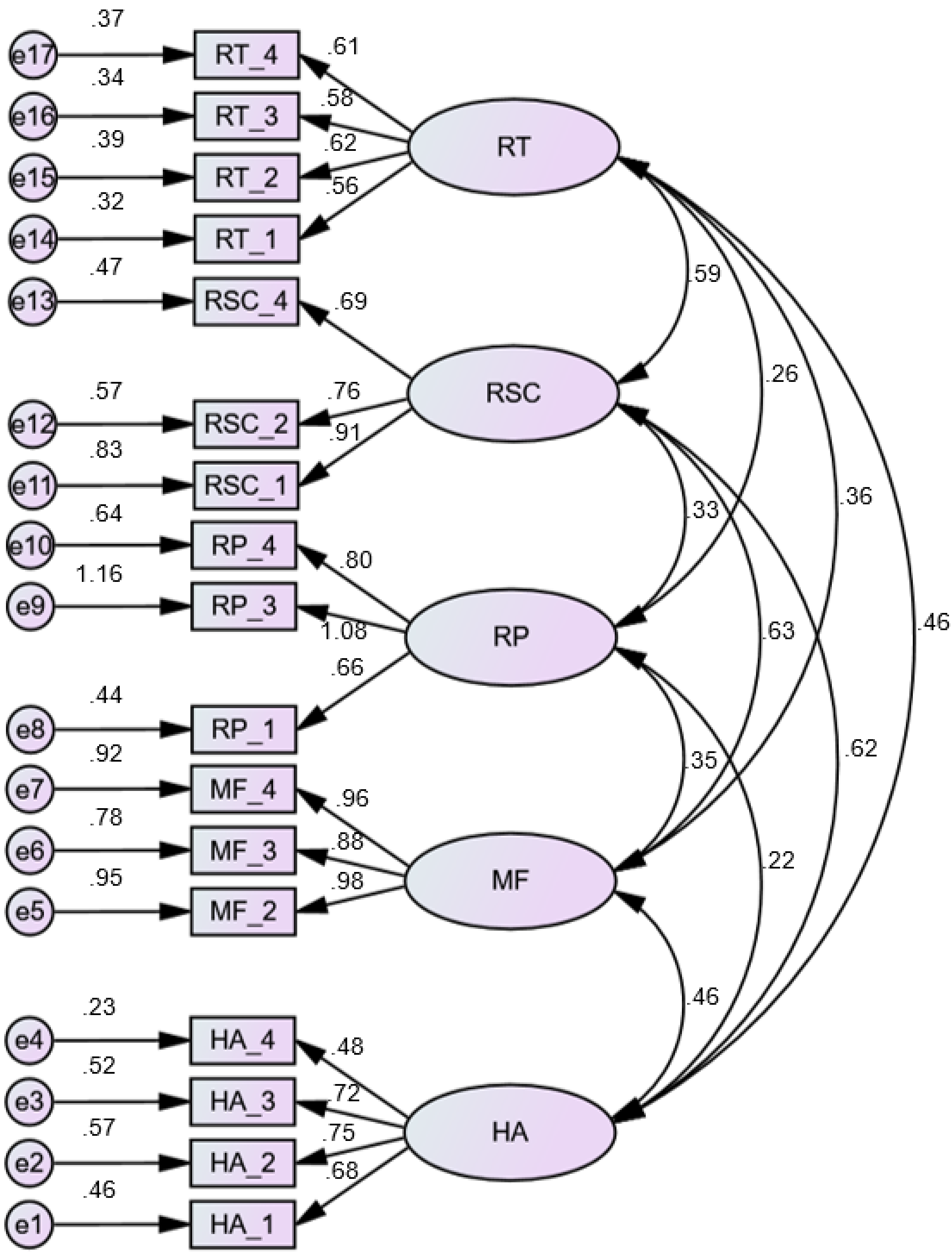


Figure 9

CFA Model II (Covariance Error Terms e3 and e4)

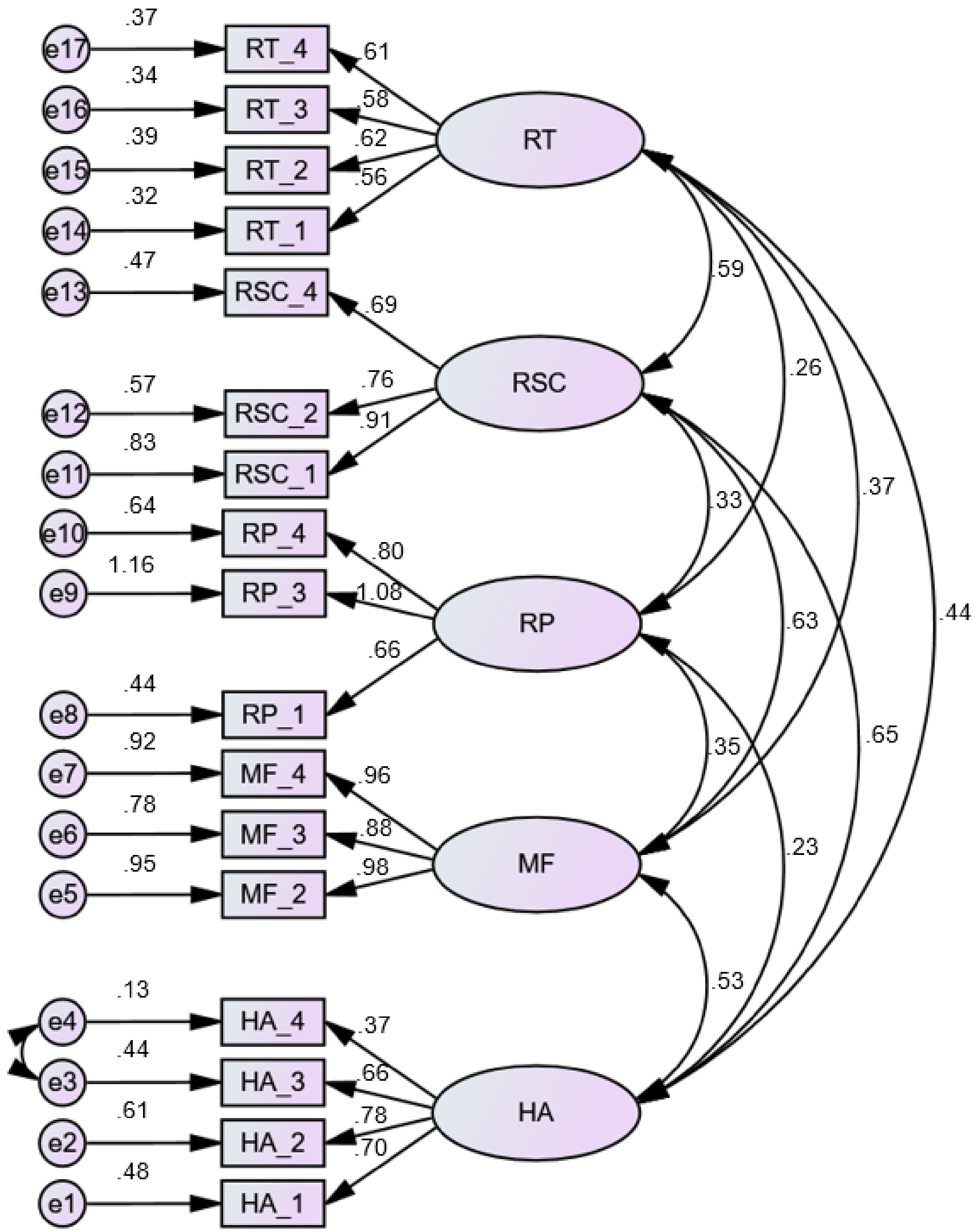
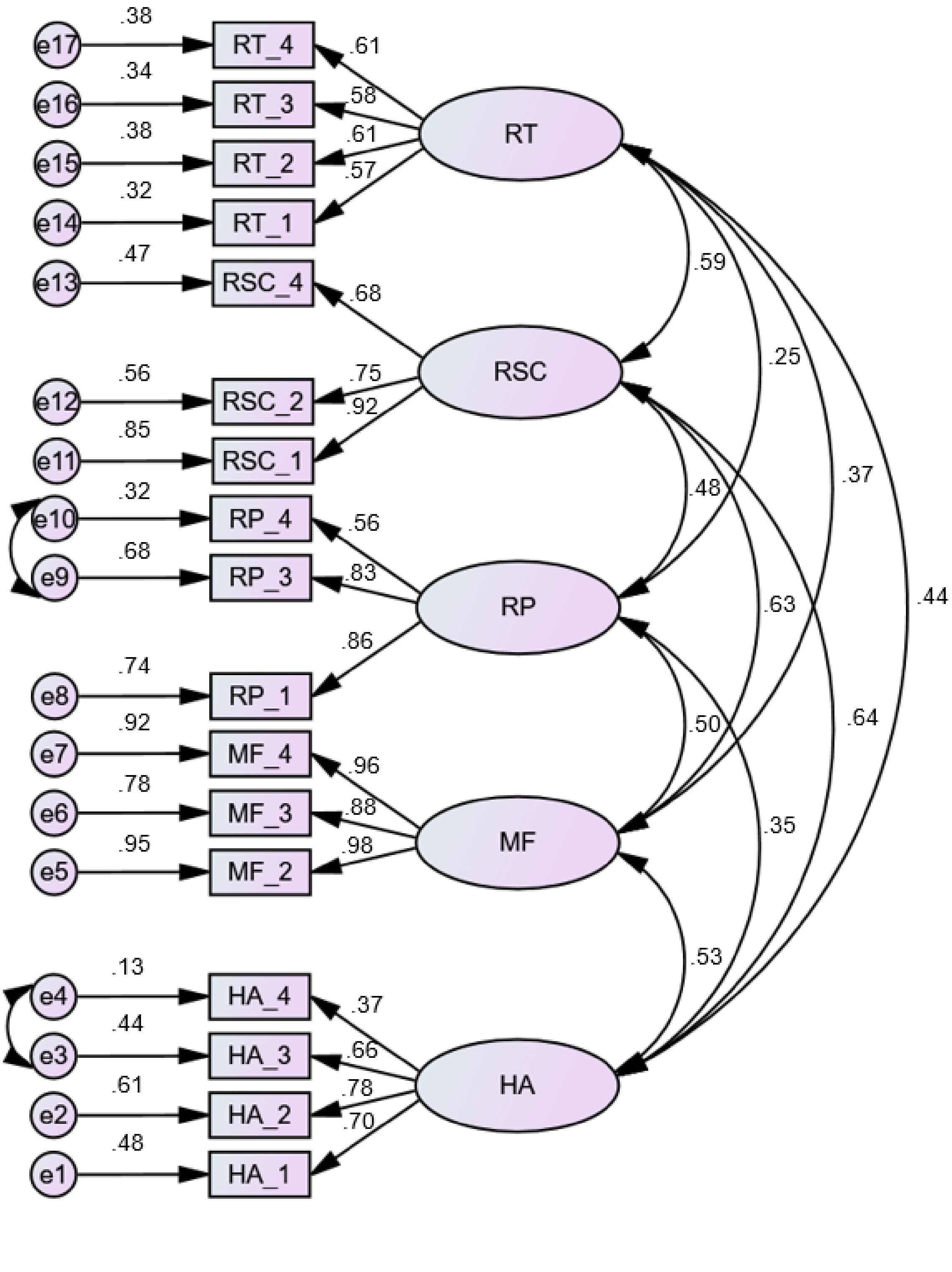


Figure 10

CFA Model III (Covariance Error Terms 3 and 4; 9 and 10)



After the CFA analysis, the remaining items for each factor were analyzed for normality. The mean, median, standard deviation, normality tests (kurtosis and skewness), and visual inspection of normal distribution curves were performed using IBM SPSS Statistics 28 (see Table 13)

Table 13

High indications of kurtosis were observed for the RSC variable, which could be a result of some extreme scores for items related to the resilient safety culture survey. Interestingly, similar observations had been reported by Adjekum and Fernandez-Tous (2020b). Because robust sampling techniques, such as bootstrapping with 5,000 samples were being used, it was assumed that the high indications of kurtosis might not affect the outcomes.

The internal consistency of scale items (reliability) in each construct was assessed using the Cronbach alpha, which was calculated using the SPSS software. All items had alpha values greater than the 0.70 threshold. Table 13 shows the descriptive statistics and reliability values for scale items.

Table 13

Descriptive Statistics and Composite Reliability for Study Variables

	Variable				
	HA	RT	RP	MF	RSC
N	145	145	145	145	145
Mean	3.20	1.80	3.85	4.63	3.84
Median	3.67	1.67	4.00	5.25	4.33
Standard deviation	1.33	1.00	2.06	1.86	1.24
Skewness	-1.19	.39	-.23	-1.73	-2.09
Std. error of skewness	.20	.20	.20	.20	.20
Kurtosis	.58	.51	-.85	1.59	3.92
Std. error of kurtosis	.40	.40	.40	.40	.40
Composite reliability	.76	.70	.86	.96	.78
Number of items on scale	4 [a]	4 [b]	3 [c]	3 [d]	4 [e]

[a] HA items: HA_1, HA_2, HA_3, HA_4; [b] MF items: MF_2, MF_3, MF_4,

[c] RP items: RP_1, RP_3, RP_4; [d] RT items: RT_1, RT_2, RT_3, RT_4,

[e] RSC items: RSC_1, RSC_2, RSC_3, RSC_4.

The AVE method was utilized to determine convergent validity, as suggested by Fornell and Larcker (1981). The AVE method is used to determine the extent to which the construct captures variance in comparison to the variance explained by error (Fornell & Larcker, 1981). An Excel spreadsheet (see Figure 11) was used to calculate the AVE and square root of AVE. Except for RT (0.35) and HA (0.42), all scales had values greater than the 0.5 threshold.

Figure 11

Excel Spreadsheet for AVE Calculation

IV		LV	Standardized Loadings	Square of std loadings	Sum of SSL	Number of indicators	**AVE**	Square root of AVE Discriminant Value
HA_1	<---	HA	0.7	0.49	1.6709	4	**0.417725**	0.6463165
HA_2	<---	HA	0.78	0.6084				
HA_3	<---	HA	0.66	0.4356				
HA_4	<---	HA	0.37	0.1369				
RT_1	<---	RT	0.57	0.3249	1.4055	4	**0.351375**	0.5927689
RT_2	<---	RT	0.61	0.3721				
RT_3	<---	RT	0.58	0.3364				
RT_4	<---	RT	0.61	0.3721				
RP_1	<---	RP	0.86	0.7396	1.7421	3	**0.5807**	0.7620367
RP_3	<---	RP	0.83	0.6889				
RP_4	<---	RP	0.56	0.3136				
MF_1	<---	MF	0.98	0.9604	2.6564	3	**0.885467**	0.9409924
MF_2	<---	MF	0.88	0.7744				
MF_4	<---	MF	0.96	0.9216				
RSC_1	<---	RSC	0.92	0.8464	1.8713	3	**0.623767**	0.789789
RSC_2	<---	RSC	0.75	0.5625				
RSC_4	<---	RSC	0.68	0.4624				

It can be suggested that except for HA and RT, all the other constructs showed acceptable convergent validity. The discriminant validity of each AVE was determined by comparing its square root to the correlation coefficients for each construct. If each AVE's square root is greater than the correlation coefficient, it is considered that discriminant validity exists (Fornell & Larcker, 1981). Therefore, discriminant validity might be assumed based on the analysis (see Table 14).

Table 14

The Square Root of the AVE (Diagonal) and Correlations Between Constructs (Off-Diagonal)

	AVE	RSC	MF	RP	RT	HA
RSC	0.62	**0.79**				
MF	0.89	0.63	**0.94**			
RP	0.58	0.48	0.50	**0.76**		
RT	0.35	0.59	0.37	0.25	**0.59**	
HA	0.42	0.64	0.53	0.35	0.44	**0.65**

Quantitative Research Questions

The quantitative part of the study addressed the following research questions.

Research Question 1

What are the strengths of relationships between risk perception, risk tolerance, hazardous attitudes, and resilient safety culture when mediated by individual mindfulness among members of the international air show community?

Following the assessment of construct and discriminant validity, as well as the reliability of scale items, the next phase involved assessing the goodness-of-fit for all measurement models. The SEM technique was employed to ascertain the strength of correlations between the constructs' measured variables. The following fit indices were reported: χ^2, NFI, IFI, and CFI. Due to the model complexity, the RMSEA fit indices for all the competing models were above 0.10 and were not used to determine an acceptable fit. Also, χ^2 is sensitive to sample size, therefore, it was not considered relevant.

A preliminary assessment was conducted on the hypothesized fully-mediated measurement model that depicted the variables' relationships. The initial examination of the fully mediated measurement model produced a satisfactory goodness-of-fit indices across all fit indices. Figure 12 shows the initial fully-mediated measurement model. A competing partially-mediated measurement model was explored based on recommendations by the IBM SPSS Amos 28 Graphics modification indices function. The pathway between RP and RSC was removed, and another round of analysis was conducted. The resulting model didn't show significant improvement in fit indices as compared to the initial one, and Figure 13 shows the model and paths with regression weights.

The third competing measurement model was derived from the second competing model when the pathway between RT and MF was removed (see Figure 14) as suggested by IBM SPSS Amos 28 Graphics modification indices function. Even though this model had a better fit in terms of the χ^2 index, the other indices were lower when compared to model II.

Figure 12

Model I – Fully Mediated Measurement Model Showing Paths for all Variables (Selected)

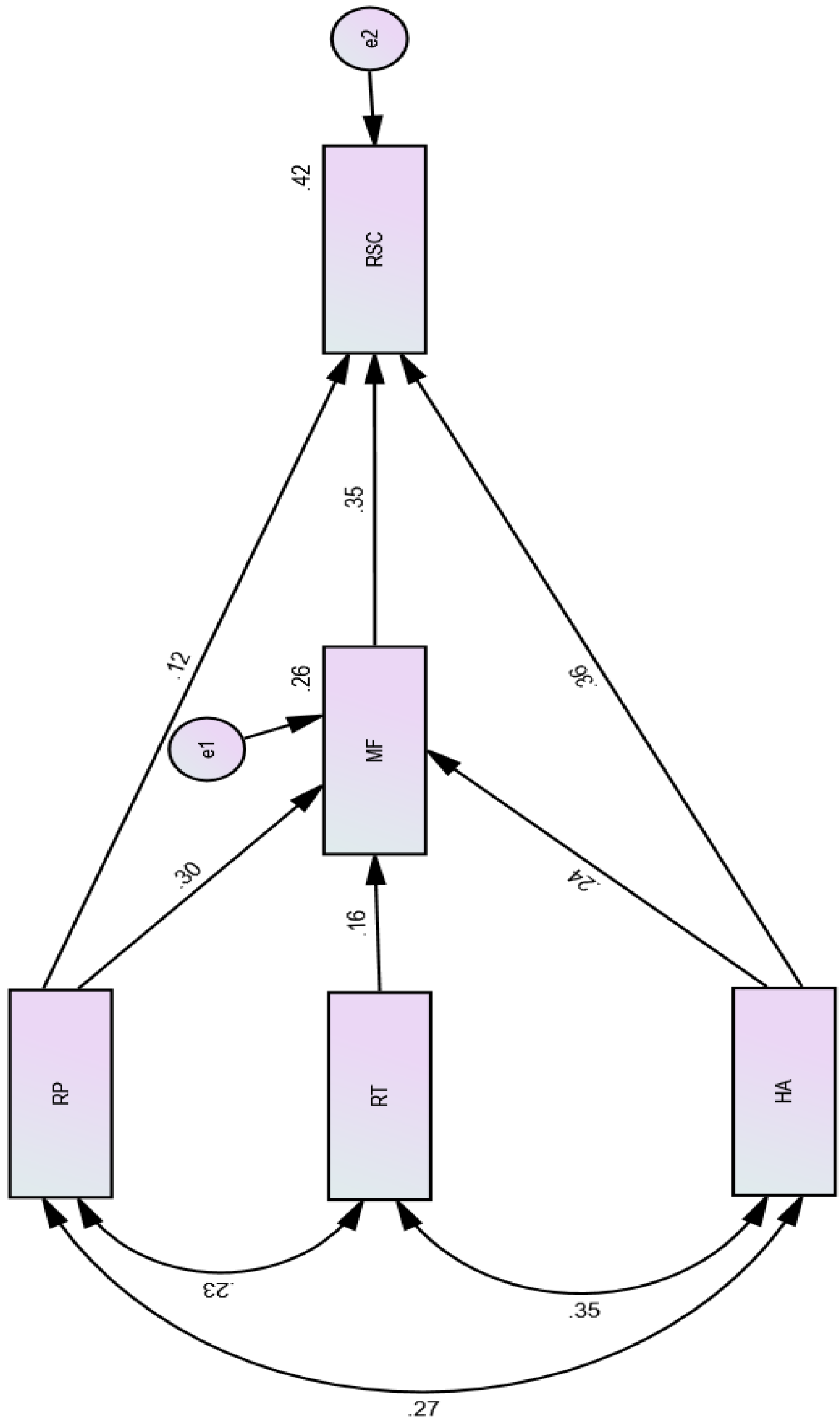


Figure 13

Model II – Partially Mediated Measurement Model (Path RP-RSC Removed)

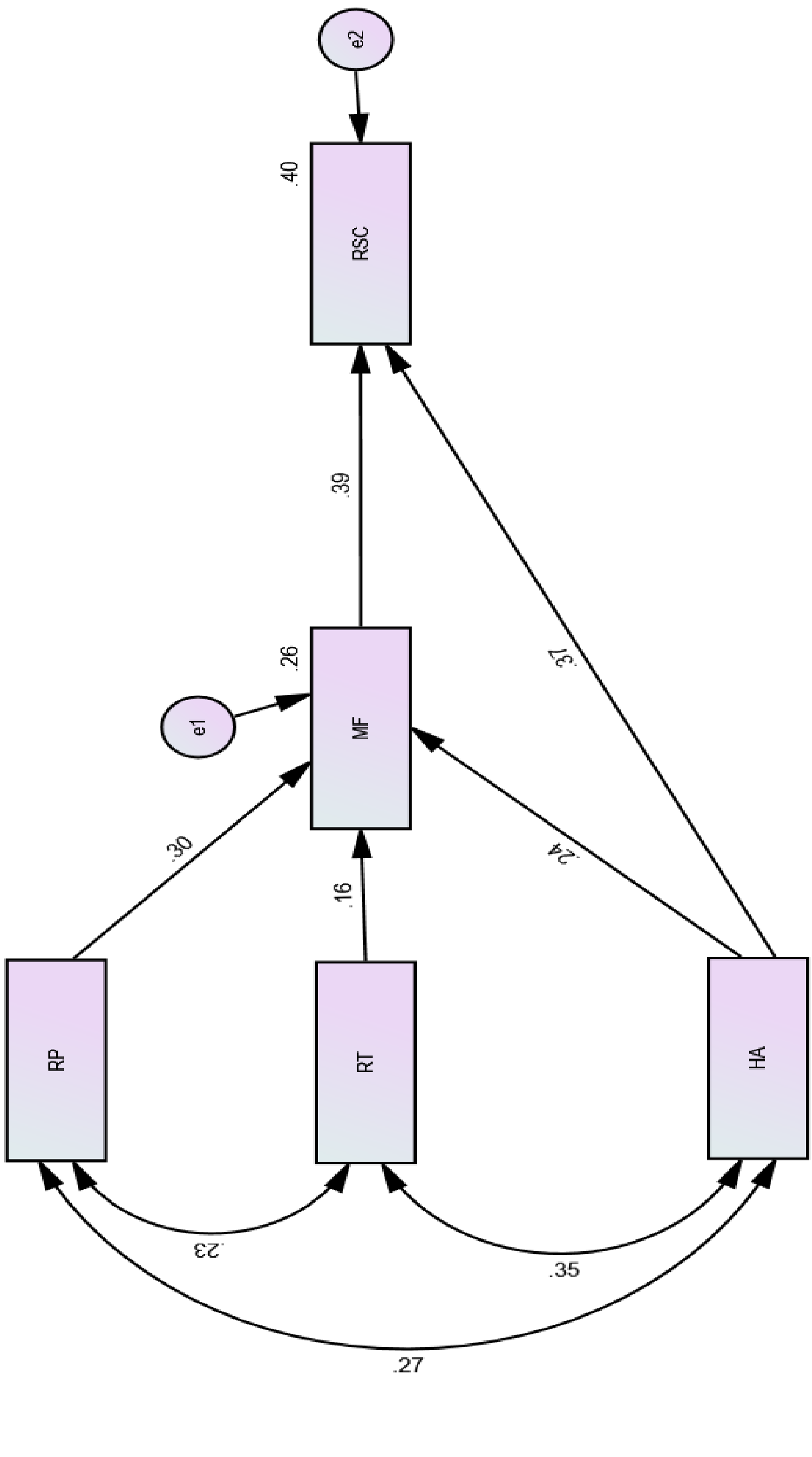
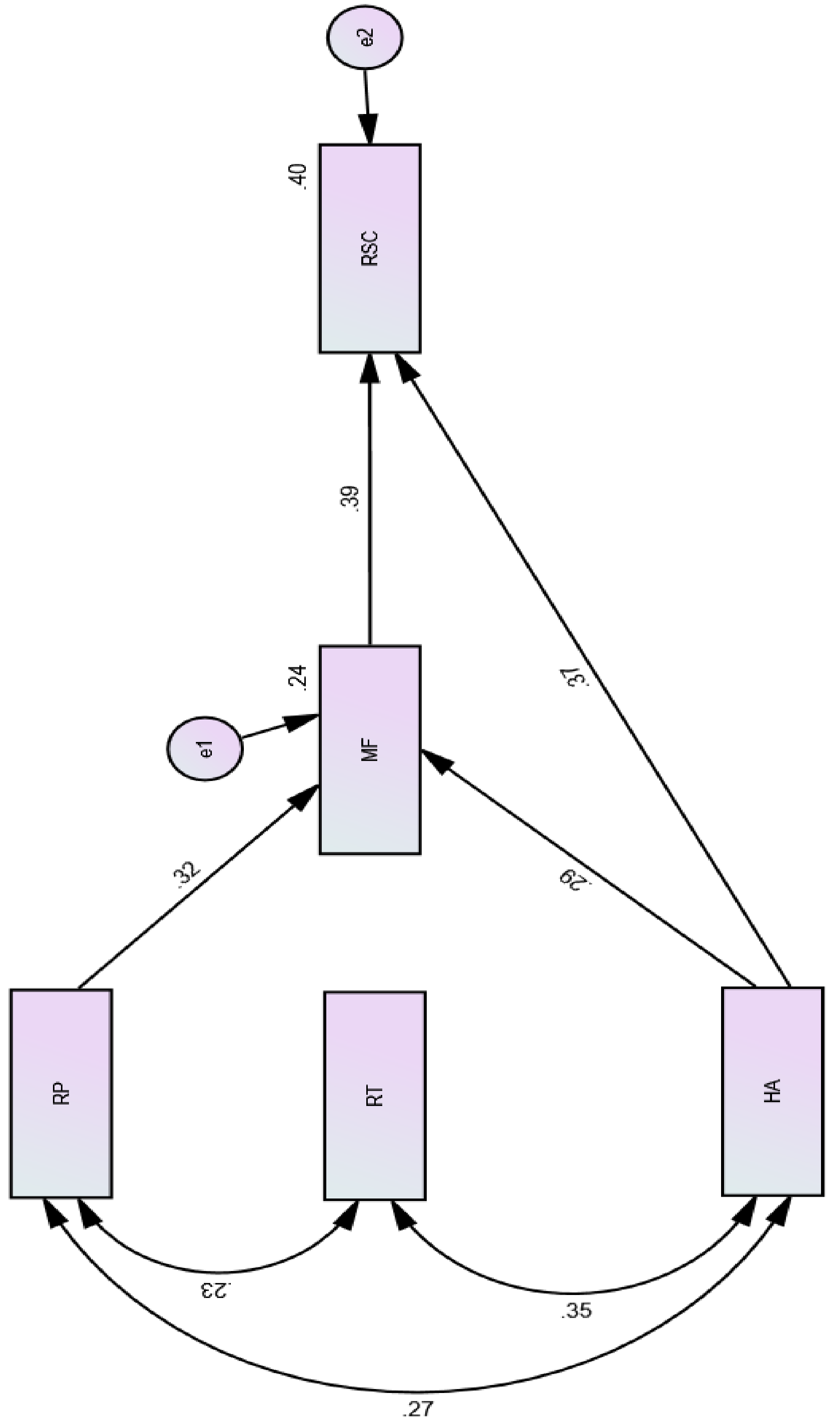


Figure 14

Model III – Partially Mediated Measurement Model (Paths RP-RSC and RT-MF Removed)



Overall, model I's NFI, IFI, and CFI indices were higher than the two other competing models. Based on theoretical considerations and testing of hypotheses requirements, model I was finally selected for testing of hypotheses. Table 15 shows the goodness-of-fit indices for all the competing measurement models.

Table 15

Goodness-of-Fit Estimates - Competing Measurement Models

Model	χ^2	CMIN/DF	NFI	IFI	CFI
I (selected)	9.07**	9.07	.94	.95	.95
II[a]	11.96**	5.98	.93	.94	.94
III[b]	16.05***	5.35	.90	.92	.92

Note. Structural equation modeling was used for the analysis.

[a] In model II, the pathway between RP to RSC was removed.

[b] In model III, pathways between RP to RSC and RT to MF were removed.

**$p < .005$. ***$p < .001$

Then, the mediation effect of MF to RP, RT and HA to RSC was examined. A bootstrapping method was performed, as suggested by Abu-Bhader and Jones (2021), using SPSS Hayes (2017) Process Macro to examine if MF mediated the relationship between RP and RSC, RT and RSC, and HA and RSC.

First, the results of the regression analysis show that RP was a significant predictor of MF ($b = .40$, $t = 5.27$, $p < .001$). Next, while controlling for MF (mediator), the results of the second regression analysis show that RP was a significant predictor of RSC ($b = .10$, $t = 2.25$, $p < .05$).

The results of the indirect effect based on 5,000 bootstrap samples show a significant indirect positive relationship between RP and RSC mediated by MF ($a*b$ = .22, Bootstrap CI_{95} = .12 and .31). The mediator, MF, amplified the effect on RSC and accounted for approximately 50% of the total effect [P_M = (.11) / (.22)]. Also, there was a statistically significant direct effect between RP and RSC ($b = .10$, $t = 2.25$, $p < .05$). Table 16 displays the results of the mediation analysis.

Then, the results of the regression analysis show that RT was a significant predictor of MF ($b = .47$, $t = 3.90$, $p < .001$). The results of the indirect effect based on 5,000 bootstrap samples show a significant indirect positive relationship between RT and RSC mediated by MF ($a*b$ = .42, Bootstrap CI_{95} = .02 and .28).

The mediator, MF, amplified the effect on RSC and accounted for approximately 31% of the total effect [P_M = (.13) / (.42)]. Also, there was a statistically significant direct effect between RT and RSC ($b = .28$, $t = 4.21$, $p < .001$). Table 17 displays the results of the mediation analysis.

Furthermore, the results of the regression analysis show that HA was a significant predictor of MF (b = .48, t = 4.87, p < .001). Next, while controlling for MF, the results of the second regression analysis show that HA was a significant predictor of RSC (b = .30, t = 5.32, p < .001). The results of the indirect effect based on 5,000 bootstrap samples show a significant indirect positive relationship between HA and RSC mediated by MF ($a*b$ = .42, Bootstrap CI_{95} = .03 and .25).

The mediator, MF, amplified the effect on RSC and accounted for approximately 29% of the total effect [P_M = (.12) / (.42)]. Also, there was a statistically significant direct effect between HA and RSC (b = .30, t = 5.32, p < .001). Table 18 displays the results of the mediation analysis.

Table 16

Mediation Analysis (Hayes Method) – RP, MF, and RSC

Variable/ effect	*b*	*SE*	*t*	*p*	95% CI	
RP→MF	.40	.73	5.27	< .001	.24	.53
RP→RSC	.10	.05	2.25	.026	.01	.19
RP→MF→RSC	.22	.05	4.59	< .001	.12	.31
Effects						
Direct	.10	.05	2.25	.026	.01	.19
Indirect*	.11	.04			.04	.20
Total	.22	.05	4.59	< .001	.12	.31

* Based on 5,000 bootstrap samples

Table 17

Mediation Analysis (Hayes Method) – RT, MF, and RSC

Variable/ effect	*b*	*SE*	*t*	*p*	95% CI	
RT→MF	.47	.12	3.90	< .001	.23	.71
RT→MF→RSC	.42	.07	5.75	< .001	.15	.42
Effects						
Direct	.28	.67	4.21	< .001	.15	.42
Indirect*	.13	.07			.02	.28
Total	.42	.07	5.75	< .001	.15	.42

* Based on 5,000 bootstrap samples

Table 18

Mediation Analysis (Hayes Method) – HA, MF, and RSC

Variable/ effect	*b*	*SE*	*t*	*p*	95% CI	
HA→MF	.48	.10	4.87	< .001	.29	.68
HA→RSC	.30	.05	5.33	< .001	.19	.42
HA→MF→RSC	.42	.06	7.29	< .001	.31	.54
Effects						
Direct	.30	.06	5.32	< .001	.19	.42
Indirect*	.12	.06			.03	.25
Total	.42	.06	7.29	< .001	.31	.54

* Based on 5,000 bootstrap samples

Table 19 summarizes the maximum likelihood estimates (MLE), standard error (*SE*), critical ratios (CR), *p*-values, standardized regression weights (β), correlation coefficients (*r*), and assumptions for the final measurement model with the best goodness-of-fit.

Table 19

Estimates of Selected Measurement Model of the Relationship Between RT, RP, HA, MF, and RSC (Model I)

Interactions			Estimate	*SE*	CR	*p*	*β*	*r*	Direct effect	Indirect effect	Total effect	Hypothesis testing
RT	↔	RP	5.45	2.04	2.68	.007		.23				**Supported**
MF	←	RP	.29	.07	4.02	***	.30		.30		.30	**Supported**
RSC	←	RP	.11	.05	4.59	.026	.11		.11	.10	.22	**Supported**
RSC	←	RT							.28	.13	.42	**Supported**
MF	←	RT	.24	.12	2.04	.042	.16		.16		.16	**Supported**
MF	←	HA	.31	.10	3.07	.002	.24		.24		.24	**Supported**
RSC	←	HA	.30	.06	5.32	***	.37		.30	.12	.42	**Supported**
RSC	←	MF	.25	.04	5.65	***	.39		.39		.39	**Supported**
RT	↔	HA	6.17	1.56	3.96	***		.35				**Supported**
RP	↔	HA	7.66	2.43	3.15	.002		.27				**Supported**

*$p < .05$. **$p < .001$. ***$p < .000$.

Hypothesis Testing

The purpose of this study was to examine the effect of risk factors, hazardous attitudes, and mindfulness on the resilient safety culture prevalent in the international air show community, as measured by a hypothesized measurement model that had a good fit and showed the strength of relationships between the variables RT, RP, HA, and RSC with MF as a mediator.

The results from the SEM-PA were used to test the 12 hypotheses postulated in the hypothesized model. Standardized regression coefficients were used to determine the effect size and proportion of variances in the outcome variables that can be accounted for by the predictor variables. The analyses were also expedient to determine the mediating role of MF in the model.

Hypothesis 1. The first hypothesis examined respondents' perceptions of the relationship between risk perception and air show community's risk tolerance. The results indicated that the relationship between RP and RT was statistically significant ($r = .23$, $SE = 2.04$, CR = 2.68, $p < .01$) and supported the rejection of the null hypothesis.

Hypothesis 2. The hypothesis tested the respondents' perceptions of the relationship between risk perception and air show community's mindfulness. The results indicated that the relationship between RP and MF was statistically significant ($\beta = .30$, $SE = .07$, CR = 4.01, $p < .001$) and supported the rejection of the null hypothesis.

Hypothesis 3. The hypothesis tested the respondents' perceptions of the relationship between risk perception and the air show community's resilient safety culture. The results indicated that the relationship between RP and RSC was statistically significant ($\beta = .11$, $SE = .05$, CR = 4.59, $p < .05$) and supported the rejection of the null hypothesis.

Hypothesis 4. The hypothesis tested the respondents' perceptions of the relationship between risk perception and the air show community's resilient safety culture when mediated by mindfulness. The results suggest that MF significantly mediates the relationship between RP and RSC ($\beta = .11$, $p < .05$); therefore, the hypothesis was supported within the study population.

Regarding the mediation, the standardized total (direct and indirect) effect of RP on RSC was .22. This is attributed to both direct (unmediated) and indirect (mediated) effects of RP on RSC; when RP increases by 1 standard deviation, RSC increases by 0.22 standard deviations.

Hypothesis 5. The hypothesis tested the respondents' perceptions of the relationship between the air show community's risk tolerance and mindfulness. The results indicated that the relationship between RT and MF was statistically significant ($\beta = .16$, $SE = .12$, CR = 2.04, $p < .05$) and supported the rejection of the null hypothesis.

Hypothesis 6. The hypothesis tested the respondents' perceptions of the relationship between risk tolerance and the air show community's resilient safety culture when mediated by mindfulness. The results suggest that MF significantly mediates the relationship between RT and RSC ($\beta = .42$, $p < .001$); therefore, the hypothesis was supported within the study population.

Regarding the mediation, the standardized total (direct and indirect) effect of RT on RSC was .42. This is attributed to both direct (unmediated) and indirect (mediated) effects of RT on RSC; when RT increases by 1 standard deviation, RSC increases by 0.42 standard deviations.

Hypothesis 7. The hypothesis tested the respondents' perceptions of the relationship between air show performers' hazardous attitudes and air show performers' mindfulness. The results indicated that the relationship between HA and MF was statistically significant ($\beta = .24$, $SE = .10$, CR = 3.07, $p < .05$) and supported the rejection of the null hypothesis.

Hypothesis 8. The hypothesis tested the respondents' perceptions of the relationship between air show performers' hazardous attitudes and the air show community's resilient safety culture. The results suggest that there was a statistically significant relationship between HA and RSC ($\beta = .30$, $SE = .06$, CR = 5.36, $p < .001$). The null hypothesis was rejected in favor of the alternate hypothesis, which was supported within the study population.

Hypothesis 9. The hypothesis stated that mindfulness mediates the relationship between air show performers' hazardous attitudes and the air show community's resilient safety culture. The results suggest that MF significantly mediates the relationship between HA and RSC ($\beta = .12$, $p < .001$); therefore, the hypothesis was supported within the study population.

Regarding the mediation, the standardized total (direct and indirect) effect of HA on RSC was .42. This is attributed to both direct (unmediated) and indirect (mediated) effects of HA on RSC; when HA increases by 1 standard deviation, RSC increases by 0.42 standard deviations.

Hypothesis 10. The hypothesis tested the respondents' perceptions of the relationship between air show performers' hazardous attitudes and the air show community's risk tolerance. The results indicated that the relationship between HA and

RT was statistically significant ($r = .35$, $SE = 1.56$, CR. = 3.96, $p < .001$) and supported the rejection of the null hypothesis.

Hypothesis 11. The hypothesis tested the respondents' perceptions of the relationship between air show performers' hazardous attitudes and the air show community's risk perception. The results suggest that there was a statistically significant relationship between HA and RP ($\beta = .27$, $SE = 2.43$, CR = 3.15, $p < .01$), rejecting the null hypothesis and supporting the alternative hypothesis within the research population.

Hypothesis 12. The hypothesis tested the respondents' perceptions of the relationship between the air show community's mindfulness and resilient safety culture. The results indicated that the relationship between RSC and MF was statistically significant ($\beta = .39$, $SE = .04$, CR. = 5.65, $p < .001$) and supported the rejection of the null hypothesis.

Research Question 2

What are the differences in the study constructs on resilient safety culture, risk factors, mindfulness, and hazardous attitudes in air show performers based on demographic variables (air show flying experience, military or civilian flying experience, age, educational background, and marital status)?

A one-way ANOVA between subjects was used to analyze differences in the mean of perception scores for respondents on outcome variables depending on demographical groupings. In addition, an evaluation of histograms revealed a normal distribution. To ensure that the data had normal variances, the Levene test for homogeneity was applied before any other tests. If normal variance assumptions cannot be made, a robust ANOVA was utilized.

The age group was the first demographic group to be evaluated. The results indicated that there was no significant difference in mean scores for RP, RT, HA, and RSC based on year-group (see Appendix F, Table 24). However, ANOVA revealed that MF was significant, F (4, 103) = 3.48, p = .011. The 55 – 64-year group respondents showed higher mean scores (M = 5.7, SD = .4) as compared to all the rest of the respondent groups.

Marital status was also assessed to determine any varying perceptions on the outcome variables. The results indicated that there was no significant difference in mean scores for RP, HA, and RSC based on marital status (see Appendix F, Table 25). However, ANOVA revealed that RT was significant, F (5, 102) = 2.32, p = .049, as well as MF, F (5, 105) = 3.77, p = .004.

Tukey and Bonferroni's posthoc analyses indicated that single-group respondents had significantly higher mean RT scores (M = 1.8, SD = .9) than the other respondent groups. This result suggested that single respondents had higher risk tolerance than married, divorced, and those with registered partnerships.

Then, Tukey and Bonferroni's posthoc analyses indicated that married-group respondents had lower mean scores of MF (M = 5.4, SD = .5) as compared to all the rest of the respondent groups. This result suggested that married respondents had lower levels of mindfulness than single, divorced, and those with registered partnerships.

The third demographic group assessed was the educational background. The results indicated that there was no significant difference in mean scores for RP, HA, and RSC based on the educational background (see Appendix F, Table 26). However, ANOVA revealed that RT was significant, F (3, 102) = 2.76, p = .046, as well as MF, F

(3, 105) = 3.36, $p = .022$.

A Tukey and Bonferroni posthoc analysis indicated that the master's degree-group respondents had the lowest mean scores of RT ($M = 2.0$, $SD = .7$) as compared to all the rest of the respondent groups. This result suggested that master's degree respondents had lower risk tolerance than high school, bachelor's degrees, and those with PhD or higher degrees.

Then, another Tukey and Bonferroni posthoc analysis indicated that high school-group respondents had higher mean scores of MF ($M = 5.6$, $SD = .4$) as compared to all the rest of the respondent groups. This result suggested that high school respondents had higher levels of mindfulness than bachelor's degrees, master's, and those with PhD or higher degrees.

A one-way ANOVA was used to assess whether there were any differences in the mean of responses to RP, RT, HA, MF, or RSC between participants with and without air show flying experience. Respondents were asked to indicate their air show flying experience in years. There were no statistically significant differences based on this demographic variable (see Appendix F, Table 27).

The last demographic group assessed was the aerobatics experience, either civilian or military. The results indicated that there was no significant difference in mean scores based on aerobatics experience (see Appendix F, Table 28).

Qualitative Data

Air Show Site Observation

First, the researcher conducted a field observation during the rehearsal and display days at a southeastern European air show scheduled for the first weekend of September

2021. While switching from observer to air boss and vice versa (Creswell & Creswell, 2018, p. 189), the researcher examined operational elements that contributed to risks and hazards for air show performers and air bosses.

The observation was held at the event's primary operational locations (see Figure 15), including the main briefing room (see Figure 16), the aircraft parking areas (see Figure 17 and Figure 18), the control tower (see Figure 19 and Figure 20), and the crisis and disaster control center, allowing the researcher to witness various aspects of inherent risks and hazards.

The observation commenced at the aircrew safety briefing and ended after the landing of the aircraft of the last air show performer. More specifically, the observation on the rehearsal day lasted from 9 am until 8 pm, then on the first air show day from 11 am until 8 pm, and lastly on the second day of the air show from 9 am until 6 pm. It is imperative that this observation took place in the natural environment of the air show performers with little or no bias on their behavior and risk assessment process.

Figure 15

Air Show Site, Airport Layout with Primary Observation Locations (Credit: Jeppesen)

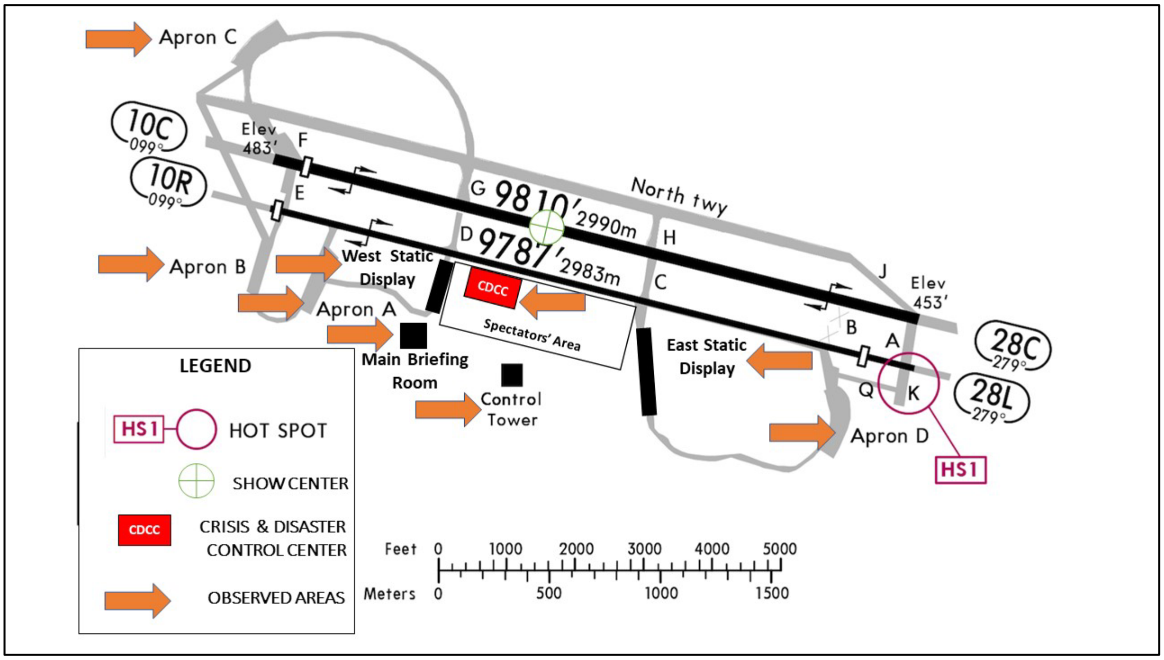


Figure 16

Air Show Site, Main Briefing Room (Source: Author)

Figure 17

Air Show Site, Example of Parking Area - East Static Display (Source: Author)

Figure 18

Air Show Site, Example of Parking Area - Apron C (Source: Author)

The researcher conducted the observation both covertly and overtly. While in the main briefing room, the aircraft parking areas, and the crisis and disaster control center, the researcher conducted the observation covertly to ensure insulation from the biases of being noticed as a researcher, as well as to capture as many as possible potential hazards and risks. Once the observation was conducted at the control tower, the researcher informed the personnel involved with the air show traffic management and the flying control committee (FCC) about the observation that would be carried out. No hesitation or concerns were expressed; rather, everyone observed expressed their eagerness to participate in this study.

Figure 19

Air Show Site, View From the Control Tower to the Show Center – Indoor Perspective (Source: Author)

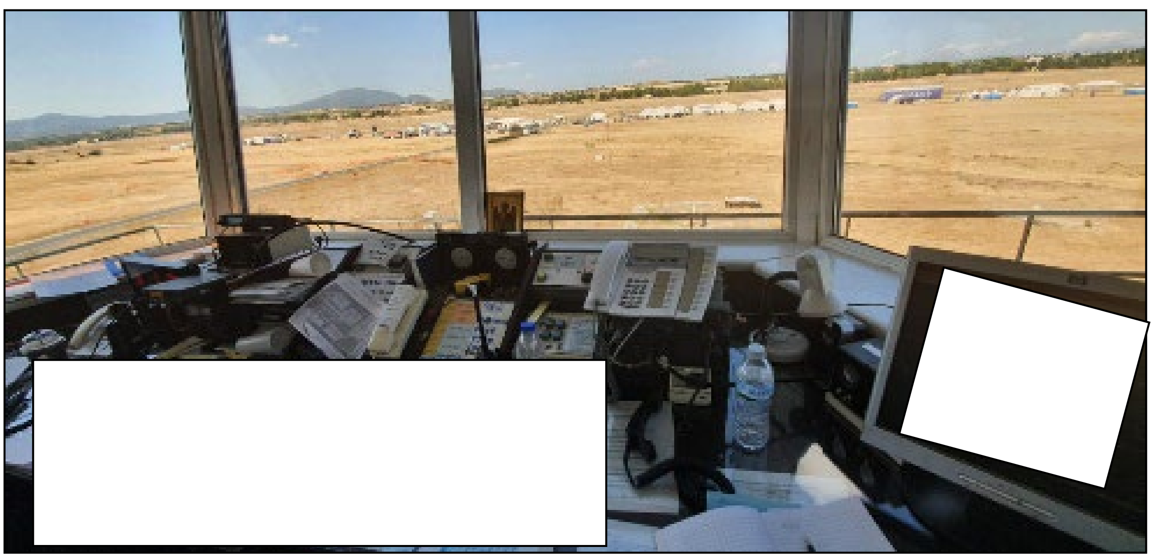


Figure 20

Air Show Site, View From the Control Tower to the Show Center – Outdoor Perspective: Smoke-Painting on Sky (Source: Author)

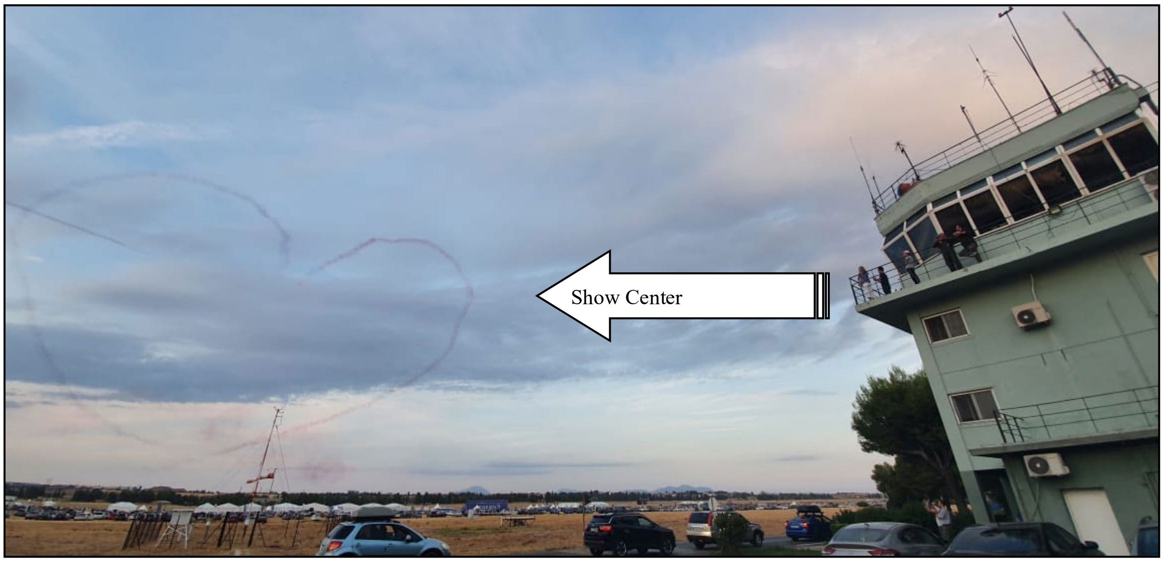


Figure 21

Air Show Site, View From the Control Tower to the Show Center – Indoor Perspective: Smoke-Painting on Sky (Source: Author)

The researcher concentrated on observing any safety-related issues that occurred throughout the event (see Figures 22, 23, 24, 25, and 26) in order to provide responses to the study's research questions. The main factors that were observed were related to air show performers' risk perception and tolerance, hazardous attitudes, and mindfulness methods.

Figure 22

Researcher's View From the Control Tower, Army Parachute Demonstration Team (Source: Author)

Figure 23

Researcher's View From the Control Tower, 8-Ship Formation in a Right-Hand Turn Using 90-Degrees Angle-of-Bank; Repositioning to Show Center (Source: Author)

Figure 24

Researcher's View From the East Static Display, Head-on Crossover of Demonstration Team's Synchro-Pair (Source: Author)

Figure 25

Researcher's View From the Control Tower, Fast Jet Performing an Inverted Flypast (Source: Author)

Figure 26

Researcher's View From the East Static Display, Mixed Formation Flypast (Source: Author)

Mission items related to the execution of the air show performances were assessed for each air show performer. Timetables, the ICAS risk assessment matrices, flight plans, aircrew safety briefings, and weather reports were examined thoroughly to identify any safety-related information applicable to the current study (see Appendix J).

Synopsis of the Field Notes

The air show is the country's major aviation event and one of the largest in the region. After a gap year in 2020, owing to the COVID-19 pandemic, this air show was organized and conducted in 2021. Strict health measures were implemented, including the mandatory wearing of masks at all venues and the requirement for all air show performers and the general public to produce proof of vaccination or PCR testing.

The observation took place at the air show on September 3rd, 4th, and 5th, 2021. The air show was held at an Air Force base on relatively flat terrain: It featured a single runway of approximately 11,000 feet in length, two parallel taxiways, and four available aprons for parking all participating aircraft, as well as two aprons for static displays of helicopters and airplanes.

Additional administrative facilities included briefing rooms and halls, eateries, a medical center, and crash and rescue equipment and vehicles. Additionally, the control tower was located on the air show premises, providing complete control of the air traffic via ground, display, and approach frequency for air show-related traffic ground movements, display flying, arrivals, and departures.

The operational portion of the event comprised activities that ensured the air displays were conducted safely. The flying control committee (FCC) was charged with the responsibility of planning, briefing, monitoring, and controlling all ground and flying activities during the air show. The FCC was led by a flying display director, who happened to be the current researcher and author of this paper, assisted by three flying display director assistants, two of whom had extensive military operational experience and the third of whom specialized in helicopter operations.

They were stationed in the control tower – abeam the show center – giving them a bird's eye view of the display area as well as of all ground movements and activities of the participating aircraft. Additionally, the FCC was assisted by ATC personnel from the local Air Force in several aspects of the event's execution. Additionally, a ground managing crew, comprised of two follow-me cars, supervised all ground activities associated with the event, including aircraft start and taxi, public control, or any other coordination required.

The event featured 15 air show performer entities (see Table 20). The air show performers represented a range of experience and types of flying activity, including three international military fast jet solos, two international aerobatic teams, a formation of two international military fast jets that demonstrated closed circuits and flybys in front of the public.

There were helicopters and fast jets from the three branches of the local armed forces, namely the Air Force, Navy, and Army, which demonstrated tactical scenarios in front of the public, and military parachutists. Additionally, the public was allowed to visit two static display areas: One in the west, which included six helicopters from the local Army and Navy, and another in the east, which featured military aircraft from numerous Air Forces: Three fast jets and three modern military trainers.

Table 20

Air Show Site Observation, Air Show Performers Participating

Participant	Aircraft		Type of performance
	Type	*N*	
Royal Danish Air Force	F-16 Fighting Falcon	2	S, F
Rafale Solo Display	Rafale	1	F
Patrouille de France	Alpha Jet	8	F
Saudi Hawks	Hawk	6	F
United States Air Force	F-15 Eagle	2	FP
Hellenic Army	CH-47 Chinook	1	S, P
Hellenic Army	OH-58 Kiowa, AH-64 Apache, UH-1 Huey	5	S, F
Hellenic Navy	S-70 Aegean Hawk	1	S, F
Hellenic Air Force	P2002, CL-415	2	FP
Hellenic Air Force	F-4 Phantom, F-16 Fighting Falcon, Mirage 2000, Super Puma	6	S, SF
Hellenic Air Force	Spitfire Mk.Vb/c	1	S, F
Hellenic Air Force	F-16 Fighting Falcon	1	F
Glider	Swift S-1	1	F
Aegean Airlines	Airbus 320neo	1	FP
RC Kavala	Remotely control aircraft	1	F

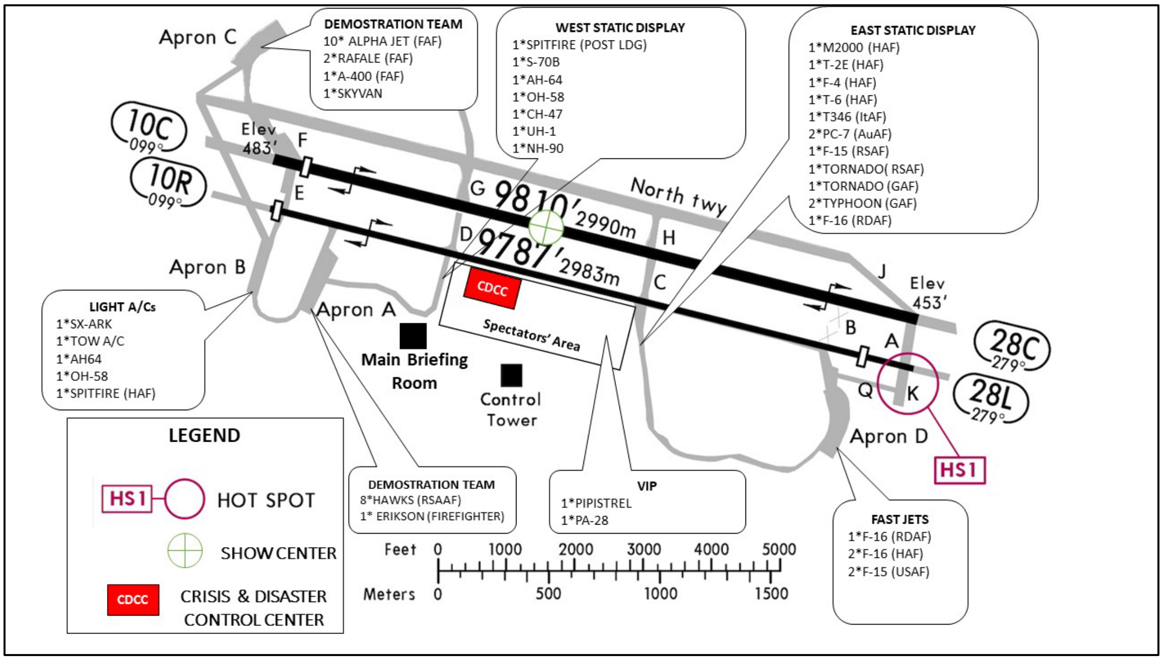
S: Static display F: Flying display
P: Parachutist drop FP: Fly past SF: Show of force

Furthermore, four aprons were provided to accommodate the participant aircraft (see Figure 27). Apron D, on the southeastern side of the show center, was dedicated to five solo display jets, including the primary and spare jets; Apron A, on the southwest side of the show center, was dedicated to an aerobatic team's jets, as well as a firefighter helicopter; and Apron B, on the west side of the show center, was dedicated to two attack helicopters, as well as a warbird when was out of a covered hangar that was protected overnight.

Last, on Apron C (see Figure 18), in the northwest corner of the show center, ten fast jets from an aerobatic team, two fast jets for a solo display team, and a heavy support aircraft from the same Air Force were parked. Additionally, a photo-ship was located near the parking area, which conducted inflight photo join-up missions with several participating aircraft prior to, during, and after the air show.

Figure 27

Air Show Site, Airport Layout with Aircraft Parking Locations (Credit: Jeppesen)



The event was organized by a private firm that specializes in large-scale social activities, with the agreement of the local Armed Forces and Air Force and with the support of the local authorities, including the Ministries of Defense, Development, Interior, and Tourism as well as the Regional Municipality. Moreover, the event was sponsored by a number of partners, most of whom were associated with the country's aerospace industry.

Due to the size of the event and the risk of an incident or accident occurring during the air show, it was necessary to involve all national crash and rescue organizations. The police, fire brigade, general directorate of protecting civilians, ambulances, and hospitals, as well as the local Civil Aviation Authority, provided not only assistance but also their expertise in preparing and effectively planning the event.

Twenty thousand people attended the event over the weekend, reaching the capacity set by the Ministry of Health's COVID-19 standards. Vaccination was required in four distinct zones to achieve social segregation and optimal health protection. Between the two static exhibition sections, the crowd area was placed south of the southern taxiway and included facilities such as eateries, retail stores, and restrooms.

Observation Data Analysis

The qualitative phase of the research began with an observation at a European air show during the first weekend of September 2021. While transitioning from observer to air boss and vice versa (Creswell & Creswell, 2018, p. 189), the researcher looked at operational variables that contributed to risk and hazards for air show performers and air show bosses. The researcher observed numerous aspects of inherent risks and hazards at the event's principal working venues, including the main briefing room, the aircraft parking areas, the control tower, and the crisis and disaster control center.

It is critical that this observation be conducted in the natural setting of the air show performers, with little or no influence on their behavior or risk assessment process. This method of conducting field research in the air show community was deemed novel, and a variety of data types were collected, including field notes, photographs, videos, preflight aircrew safety briefings, weather data, and risk assessment matrices.

Due to the fact that this type of actual observation has never been conducted in the air show community, the findings indicated that these observation notes might imply various major and valuable conclusions, comments, and recommendations via the triangulation approach.

Moreover, the current air show observation demonstrated how the air show industry could be prepared for potential risks prior to and during the event, not just from the air show performers' standpoint but also from the organizers', air bosses', and aviation authorities' perspective.

Nonetheless, this is the first time this type of observation has been conducted for academic research purposes and displays a practical application of resilience engineering, as defined by Hollnagel (2006), in such a distinct segment of the aviation industry as the air show community.

Air show performers observed during both the preparation and execution phases of the event displayed a high level of adaptability to a dynamically changing flying environment. For example, constantly changing weather conditions, changes in daylight hours and sun angles, and changes in takeoff and display times due to delays caused by other operational considerations, such as runway inspection for foreign object damage, were among the factors that affected the normal flow of air show performers' display.

Nevertheless, the air show performers' extensive operational expertise enabled them to be resilient and so ensure the event's safety. This extensive operating experience substantiates Hollnagel's (2006) assertion that safety is not a matter of luck but rather a result of resilience.

Research Question 3, Field Notes.

What forms of mindfulness strategies do air show performers employ preflight?

Numerous mindfulness practices were observed at the air show site during the observation period. The first phase of observation began with the aircrew safety briefing in the main briefing room at the start of the rehearsal day. Each day of the air show, an aircrew safety briefing session was held, which included a review of existing rules and regulations, weather updates for the period of the air show, and an overview of all air traffic control procedures from takeoff through landing.

Furthermore, the most recent update to the air show timeline was examined in detail, while the air boss provided time for the air show performers to address any concerns about their performance. Overall, the aircrew safety briefing had set the tone for everyone involved, resolving any misunderstandings and initiating the process of reminding everyone of their upcoming performance.

Additionally, the air boss organized additional individual air show safety briefings as part of the event’s fatigue risk management plan. More specifically, the air boss prepared later briefing hours for air show performers who were scheduled to perform during the air show’s later part in an effort to allow them enough time to rest before their performance.

Having their safety officer at the control tower throughout their performance, who was in direct radio communication, in a discrete frequency, with the display pilot or the demonstration team commander during the demonstration, was a key approach implemented by all military demonstration teams.

It was indicated as a method that adds an extra layer of safety and mindfulness to the display, preventing any air traffic control-induced distraction. Furthermore, the safety observer communicated with their team’s air show performers in their native language to avoid any misunderstandings caused by the language barrier when communicating with the local air traffic controllers.

Furthermore, all air show performers respected the withdrawal from social media prior to displaying. Air show performers have adhered to the "sacred 60-minute" rule (ICAS, 2012) prior to their flight, avoiding becoming distracted by social media use.

Research Question 4, Field Notes.

How do air show performers perceive and tolerate risk preflight?

During the planning phase, air show performers had identified and addressed all expected risks. However, the majority of air show performers perceived wind direction as a significant hazard preflight that could affect their display flow, as well as their adherence with the display lines.

Nonetheless, the COVID-19 rules and regulations that took place and affected the event in various ways presented an intriguing highlight in the researcher's air show site observation. Masks, social distancing, and avoiding using objects that had not been sanitized, such as papers and pencils, during the briefing had a considerable impact on the air show's organizers and flying control committee.

During the planning and implementation of the event, the potential of COVID-19 viral transmission was a significant consideration. As a result, one of the innovative ways to reduce the risk of a pandemic was to use QR codes, electronic timetables, electronic distribution of the display order, electronic signature of briefing attendance, and, last but not least, video calls using apps like Zoom or WhatsApp to replace physical briefings for air show performers. These ways of avoiding viral infection and decreasing virus dissemination during an event like an air show serve as a case study, not only for the air show industry but also for similar activities like music concerts and car racing during a pandemic.

Research Question 5, Field Notes.

How do air show performers perceive and tolerate risk inflight?

Both demonstration team leaders noticed winds aloft as a hazard during the rehearsal day. To accept the additional risk, they provided extra buffers to the display lines to assure the safe execution of their display profile.

Research Question 6, Field Notes.

What are the most common hazardous attitudes observed among air show performers?

An impromptu flying by air show performers with a civilian background was observed. Because of their considerable experience in demonstrating their aircraft or the performance characteristics of the aircraft exhibited, such an attitude represented a combination of antiauthority and macho attitude.

Semi-Structured Interviews and Focus Group

Then the semi-structured interviews took place remotely with the use of Zoom. All necessary interview protocols for asking questions and recording replies were devised and applied (Creswell & Creswell, 2018; Maxwell, 2012). During one interview session, to minimize any potential language barrier, a facilitator who spoke English and Spanish fluently assisted the researcher in interpreting questions posed to the interviewee and responses provided by the interviewee.

The demographics of the respondents are displayed in Table 21, while the duration of the sessions lasted on average 1 hr 39 min.

Table 21

Semi-Structured Interviews, Respondents' Demographics

Background		Air show flying experience		Role		Continent				
Military	Civilian	< 10 years	> = 10 years	Air boss	Air show performer	Africa	America	Asia	Europe	Oceania
4	8	4	8	2[a]	12[a]	1	5	0	5	1

[a] Respondents with parallel experience as air bosses and air show performers.

All interviews were audio-recorded and then transcribed. An initial evaluation of the transcripts was conducted by the researcher to check for accuracy by reading the transcript while the recording was played. To ensure trustworthiness, member checking on the transcript was completed by sending a copy of the transcript to each participant for evaluation and acceptance as genuine representations of their responses to interview questions.

A focus group session, which included eight air show performers (*n* = 8), was conducted remotely through the use of Zoom and lasted approximately 1 hr and 30 min. The session was audio-recorded, and field notes were taken. Next, a transcript was created, which was forwarded to the group's participants for review and validation. The demographics of the focus group respondents are displayed in Table 22.

Table 22

Focus Group, Respondents' Demographics

Background		Air show flying experience		Role		Continent				
Military	Civilian	< 10 years	> = 10 years	Air boss	Air show performer	Africa	America	Asia	Europe	Oceania
8	0	8	0	0	8	0	0	0	8	0

In terms of qualitative data coding and theming, categorization methodologies were utilized to analyze the collected data, as suggested by Maxwell (2012), and all the transcripts and field/reflective notes were manually organized using a deductive approach in NVivo 12 into codes, and concept-driven themes related to risk factors, mindfulness, hazardous attitudes, and resilient safety culture in the international air show community. Additionally, NVivo's auto coding and word cloud (see Appendix G) features were utilized to reveal other codes that the researcher had not identified inductively. These topics were then evaluated to ascertain trends in the responses of the participants.

The coding process yielded 15 themes (see Table 23). The number of files and references per code can be found in Appendix H. The outcomes of interview questions, observation, and air show-related literature were reviewed during the data triangulation analysis (see Figure 28 and Appendix I, Table 29). Nevertheless, the triangulation analysis attempted to spotlight the answers to the qualitative questions, recognizing that they cannot all be discovered within the time constraints of this project.

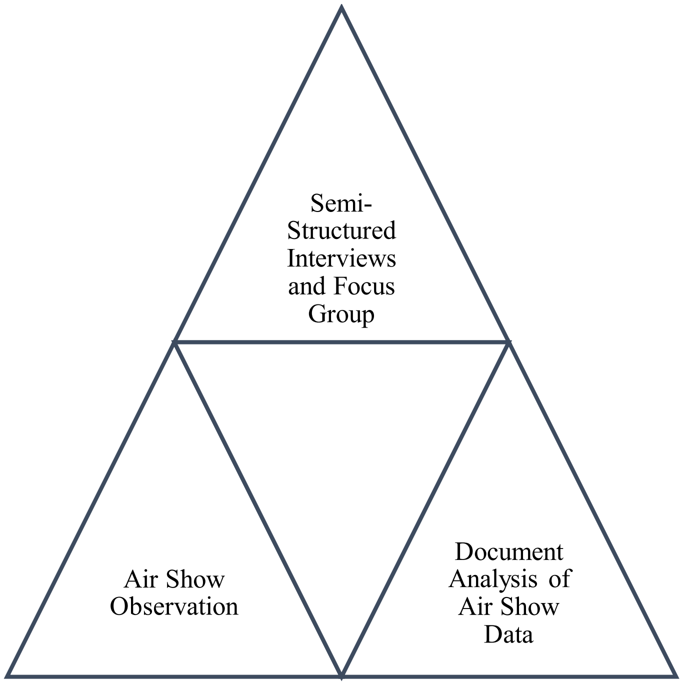
Table 23

Themes List

Deductive concepts	Sub-themes/codes
Risk perception and tolerance	Financial risk
	Level of air show display flying risk
	Risk management
	Unexpected situation
	Zero-tolerance
	5 Ms
Hazardous attitudes	Concealed hazardous attitudes
	FAA recommended hazardous attitudes
Mindfulness	Consistency
	Exogenous factors control
	Preshow preparation
	Visualization
Resilient safety culture	Continuous enhancements
	Culture
	Ownership

Figure 28

Triangulation Analysis, Qualitative Data



The semi-structured interviews and focus group examined air show performers' perspectives on four primary areas: Existing hazardous attitudes, risk perception and tolerance, mindfulness strategies, and the overall perception of resilient safety culture in the air show community.

Finally, as suggested by Creswell and Creswell (2018), to ensure consistency and reduce researcher-induced bias, an independent audit of interview transcripts was conducted by an air show SME with extensive experience in air show operations as a pilot in a military fast jet demonstration team. The SME was also a native English speaker.

Ten different excerpts that highlighted key deductive concepts/themes from the transcripts for the semi-structured interviews were presented to the SME, who was asked to generate codes and assign themes based on experiences as an SME. The SME assigned a similar coding to eight out of ten of the excerpts as the researcher. Consistency analysis of this type delivers an 80 percent reliability to the resulting themes.

In the end, to strengthen interrater consistency even further, all themes initially emergent from the analysis by the researcher were presented to the auditor, who compared them to what was emergent during the audit. These results suggest a good level of match and consistency between the two analyses. Details of the audit are shown in Appendix I, Table 30.

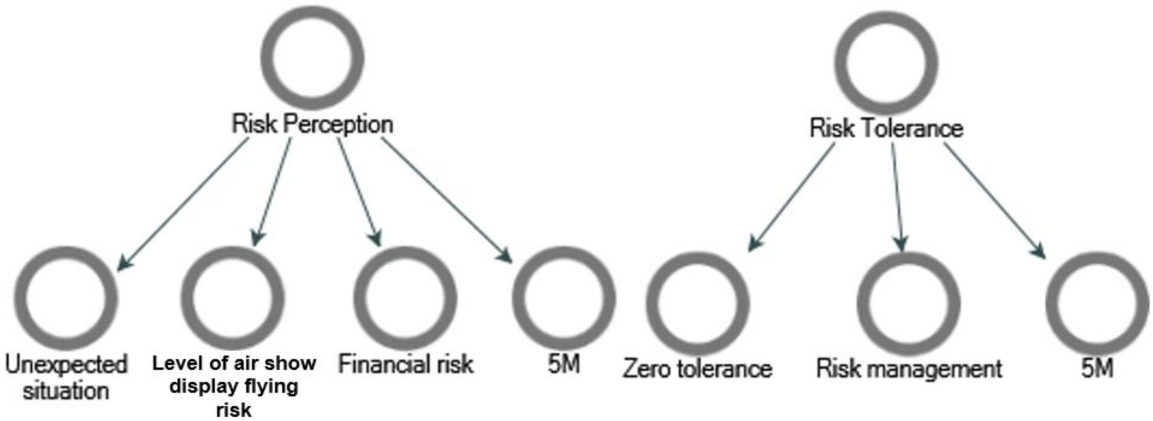
Risk Perception and Tolerance, Themes

In the semi-structured interviews and the focus group, the first set of questions focused on risk perception and risk tolerance. The themes under the risk perception and risk tolerance areas of study were the financial risk, the level of air show display flying risk, an unexpected situation, zero-tolerance, risk management, and the 5Ms, i.e., the human, the machine, the medium, the management, and the mission.

The questions aimed to assess interviewees' general perceptions of the most significant risks that adversely impact air show displays, as well as the types of risk they were willing to accept when flying in an air show. Figure 29 shows theme maps for the risk perception and tolerance area of focus.

Figure 29

Risk Perception and Risk Tolerance, Themes Map



Financial Risk. The financial risk was reported as a covert risk that affects all levels of management of aerial events and all categories of air show performers, whether civilian or military. According to the interviewees, financial constraints mainly affect aircraft maintenance and training, as well as the currency of a display pilot. Moreover, insufficient financial resources have an impact on all levels of operation and have been identified as a contributory factor in aviation accidents and incidents (Aalberg et al., 2020; Causse et al., 2011; ICAO, 1993, 2018; Stolzer & Goglia, 2016).

Some participants in both semi-structured interviews and focus-group sessions identified a lack of financial resources and sometimes competition for scarce financial resources as a potential hazard to air show safety. They intimated that inadequate financial resources could put an operational strain on air show performers and event organizers, with severe consequences for flying safety since it could affect the hiring of more safety observers. Figure 30 provides a coding map for the financial risk theme.

The competition for scarce financial resources between operational logistics such as fuel and lubricants as compared to safety controls such as collision avoidance technology is put under strain in such situations. A quote by an interviewee highlights the critical role of financial resources in the air show industry: “Money is the main danger element.”

According to another interviewee, financial pressures could also be experienced at the personal level of the air show performers, and a quote highlights the point:

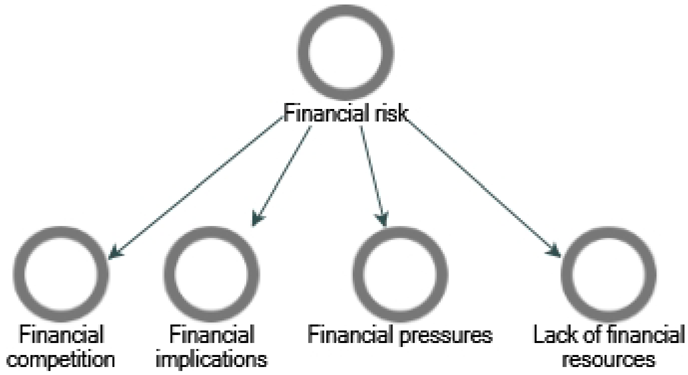
> And one more time, the problem is that several air forces or more in the civilian world sometimes you do not have enough resources to do the proper training to do enough training, and it can be a risk.

While for another interviewee, the financial risk can be related to air show events themselves:

> The air show organizer was financially in trouble when they had to run the air show, and they did not want to refund tickets. Other organizers that I know would not have allowed flying on that day, but they allowed the flying, and there was one pilot in particular who went up and flew in conditions that they should not have been flying.

Figure 30

Financial Risk Theme, Coding Map



Level of Air Show Display Flying Risk. All interviewees acknowledged the increased risk involved in low-altitude air show flying. Several factors can influence the performance of air show performers, and a plethora of mishaps are possible. Simultaneously, unanticipated problems may arise that necessitate a high level of skills, experience, and training to address. One interviewee mentioned the significant amount of risk, particularly in fast jet formation flying, by noting: "That dynamic flying in itself is a higher risk level. Based on you are head-to-head 300 knots each, and we are trying to make a pass around in a close distance."

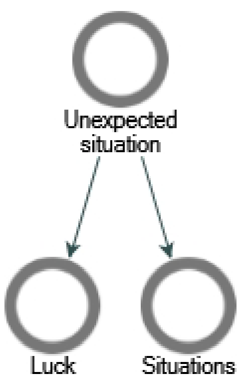
While another interviewee discussed the balance between risk and reward and the potential implications: "There is too much risk. The reputational and the financial damage of not doing it safely and having an outcome where it can come back on the pilot or back on the organizer, it is just not worth it."

Some interviewees noted that even though the focus on safety in the air show community has been huge in the past years, it was unfortunate that fatal accidents still happen, and people lose their lives every year. An interviewee with extensive air show experience suggested that the high level of risk involved in air show flying required the appropriate and relevant level of professionalism and risk management from all levels of management, starting from aviation authorities to air show organizers, air bosses, and the air show performers themselves.

Unexpected Situation. During the analysis of the data collected in the semi-structured interviews and focus group session, unexpected situations emerged as a theme and are highlighted in Figure 31. Numerous problems may arise during an air show performance that might cause distractions or situations where great talent, high knowledge, extreme professionalism, and, in the end, pure luck can save the day.

Figure 31

Unexpected Situation Theme, Coding Map



There were alternate views from respondents regarding unexpected traffic in the air show airspace. It was very interesting to note that a member of a fast jet military demonstration team claimed, "I am not usually concerned too much about other aircraft in the airspace—that is usually very well sanitized and very well monitored. That is not usually a concern."

This was not the shared view of a civilian air show performer flying a propeller aircraft who stated, “I am very worried about unexpected traffic, which sometimes poses a threat on less organized air shows.”

Respondents noted that traffic in the air show airspace could pose a substantial hazard and result in a high risk for a potential midair collision (MAC), and there was a need for adequate planning before the air show with the introduction of restricted operating airspace that prohibits any aircraft from entering without permission.

Several factors could have influenced these two responses, but the researcher determined that the level of complexity of the air show profile was a critical component that influenced these two interviewees’ responses. As a result, when military demonstration teams visit air show venues, they expect high levels of ATC sanitization to assure the safety of their display. They usually fly in large and well-organized air exhibitions.

On the contrary, for air show performers flying solo propeller aircraft, it is expected that they may have less stringent requirements in the air show airspace; thus, they may operate in less structured air show events, with limited airspace sanitization capabilities, i.e., operating off an airfield under the support of a remote ATC agency.

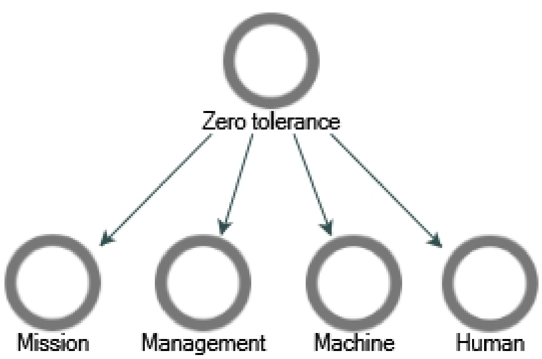
It was also intriguing what an interviewee reported regarding luck. The quote from this interviewee highlights the point: “Everybody needs a little bit of luck. Let us call it luck, but you cannot control your whole life sometimes.” In the air show community, luck is still regarded as a survival factor; however, air bosses and air show performers should leave nothing to fortune, as another interviewee highlighted.

Proper risk management and risk anticipation could help the air show industry to enhance the current levels of safety. Unexpected events may occur; nevertheless, the best way to proceed forward is to reduce the number of unexpected events by sharing lessons learned and making the unexpected the usual, as suggested during the semi-structured interview sessions by a civilian air show performer.

Zero-Tolerance. The theme of zero-tolerance represented the red lines that the air show community is unwilling to accept, as per the interviewees (see Figure 32). The codes that comprised the zero-tolerance theme are related to the systems perspective approach in aviation organizations, as suggested by Harris (2011), i.e., the human, the machine, the mission, and the management.

Figure 32

Zero-Tolerance Theme, Coding Map



The majority of the interviewees agreed that they were unwilling to accept any risk within their control. One interviewee made a representative statement:

I am not happy to accept any risk specifically for a display more than just a normal flight; because there is no reason to die, not for money, not for glory, not

> to entertain the spectators is no reason to die. So, our professionalism is to mitigate and limit as much as we can the risk.

The preceding phrase emphasized the air show performers' comprehension and acknowledgment of the high-risk environment in which they operate without being prepared to jeopardize the flight safety of an air show by taking any risks. Regardless of their air show expertise or how long they have been active in the air show industry, air show performers should accept no unintentional risk that could harm their display profile, as per an interviewee with extensive air show flying experience. Furthermore, an air show performer with military fast jet experience highlighted that there is no risk to accepting that it is worth the lives of the crowd watching the display.

Then, another interviewee reported the importance of management in the air show industry to adopt a zero-tolerance mentality in specific cases such as the following:

> People could, even if they did not hurt themselves physically, they could hurt themselves in the pocket because the system will not tolerate a persistent rule breaker, and that is a good thing. I mean, if someone is a persistent rule breaker, most flying display directors - air bosses - will say he may be a very spectacular pilot, and it is a lovely airplane, but I do not want him in my air show because he sets a bad example.

Zero-tolerance necessitates a commitment from leaders to inspire members of the air show community to strive for excellence and safety (Galloway, 2012). Particularly air bosses, who supervise and engage with air show participants on a daily basis, should be formulating pragmatic policies and ensure accountability for safety among air show participants. As per an interviewee with civilian air show flying experience, any type of rulebreakers are identified by air bosses, and via word of mouth, they will gain a negative reputation and be excluded from the air show community, losing their jobs and not being rehired.

Another interviewee indicated that in their country, there is zero-tolerance for any unsafe physiological condition and at-risk behaviors of a display pilot, not only by the event organizers but also by the air show performers' fraternity. This interviewee stated:

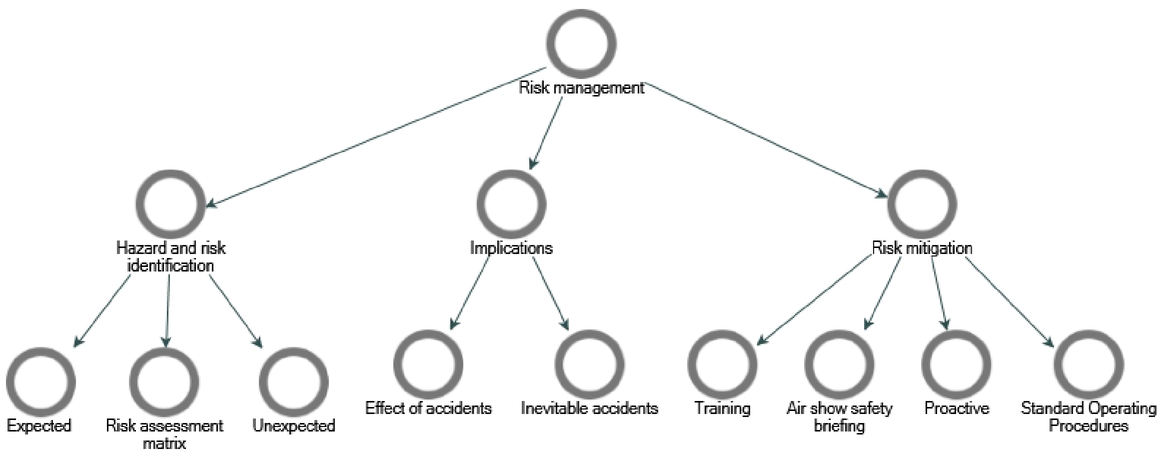
> Most of the pilots know each other, all the organizers know each other, and so if it has found that there is a particular pilot that is turning up tired, maybe stayed at the bar too long last night, they will not get invited back-it's as simple as that. We do not want that sort of stuff; we cannot afford to have that sort of pilot there.

The preceding statement emphasizes the air show community's recognition of zero-tolerance for flying while fatigued or under the influence of alcohol and other controlled substances/medications. Furthermore, the air show community is aware of the demanding tasks related to performing low-level aerobatics; thus, a pilot must maintain their complete focus and preparation. According to a civilian air show performer, any deviation from the policy prohibiting flying while fatigued or under the influence of alcohol and other controlled substances/medications could result in an incident or accident during an air show, causing a terrible domino effect throughout the international air show industry.

Operational Risk Management. Operational risk management was identified as a theme during the analysis of the semi-structured interviews and focus group (see Figure 33). Interviewees discussed hazard and risk identification and tolerance processes during the air show preparation, planning, and execution. Risks reported were further broken down into expected and unexpected: Expected risks included bird strikes, engine failure, and change of flying routine, while unexpected risks were related to the human factor, structural damage, unrecoverable out of control, and the control of the crowd after an accident.

Figure 33

Operational Risk Management Theme, Codes, and Subcodes Map



Interviewees mentioned numerous expected risks, that included operational risks during flight operations. Yet, the most common risks reported were associated with an engine failure and the potential for a bird strike. These points from the interviewees suggest that it is essential for air show pilots to have knowledge about potential hazards and associated risks during their display. Therefore, air show performers should be mentally and technically prepared to react quickly and effectively in the event of operational mishaps or abnormal situations during their display without jeopardizing the safety of both their spectators and themselves.

It is the unidentified hazards and their associated risk that was of most concern to interviewees, and the following statement by an experienced air show performer underscores the role of hazards associated with the human element: “One has to accept there is a fair amount of risk anyway because it is the human element that always introduces the unexpected into it.”

Another unanticipated risk was related to the hazards associated with crowd control during an accident. An interviewee with vast experience both as an air show performer and air boss mentioned that:

> On some of the bigger events that occurred, very often, you expect the crowd to behave in a particular fashion, i.e., if there is a big ball of flame, you would think they turn around and run away from it. These days, because everyone wants to get it on their cameras, there is a danger that they will rush towards it to try and see what is going on. Some of them may well be trying to help but generally speaking, they can get in the way of the crash and rescue personnel.

Observed behaviors and reactions during and after an air show accident by both participants and audiences attending an air show event may be challenging to predict, yet proactive consideration and risk assessments that provide prospective emergency management strategies during such events should be considered by air bosses and air show organizers.

It was interesting that the majority of interviewees suggested some forms of risk assessment matrix as a strategy for detecting hazards and risks before an air show. In particular, an interviewee who is currently a member of a military demonstration team stated that: “All the above issues have to be written in a document called the risk matrix, including all the identified risks and the people or the rank that have to sign and accept the risk for performing an air show."

In contrast, a civilian air show performer stated that:

> My risk matrix is looking if my airplane is in pretty good shape. I do try and get good people to do the annual, so I get my airplane looked at pretty well every year. I am pretty conservative with the engine life, so when it is time to do the engine, it is time to do it; even if it hurts to spend money, I do not defer maintenance on my airplane.

The findings suggest that risk assessment processes differ between the military and civilian air show performers even though both advocate for some form of preperformance hazard identification and risk assessment considering the complexity of their display and their organization's decision-making process. The feedback from the interviews and focus group suggests that within military organizations, the decision to participate in an air show is not only made by the display pilot but includes a higher chain of authority. The hierarchy for decision-making may involve the unit commander up to the level of the Wing Commander or even higher if the circumstances require such approvals.

In a civilian air show organization, however, the decision to participate in an air show and the perception of the risks and hazards rests with the individual air show performer or their demonstration team's decision-making policies. In the case of a solo aircraft, or individualized air show performance by members of the team, decision-making can be very localized. An interviewee shared an interesting opinion regarding the value of a risk matrix during the planning of an air show, especially for civilian air show performers, saying, “In Europe nowadays, we have to make a written risk assessment that I think it is not smart; anyone can fill it out for you, just to fill it out. It is not right.”

This statement demonstrates that formal and effective risk assessment processes in the air show community should go beyond “pencil whipping and ticking boxes.” Practical training in using risk assessment matrices could enable air show performers to understand its value and try to utilize it and not see it as a piece of paper that will be filled in and given to the air boss, only to fulfill the requirement from the air show event organizer.

Risk assessment processes by air show performers should reflect their unique appreciation of operational risk and must help in recognition of unacceptable risks during air show activities. The risk mitigation code, along with other subcodes, is included in the second section of the risk management theme.

Interviewees described techniques for mitigating expected and unexpected hazards in an air show by taking a proactive approach during display profile design by including safety buffers that could allow for errors during the display. More specifically, interviewees suggested as a common practice that they add altitude pads in the design of vertical aerobatic maneuvers to ensure a safe recovery from the dive in case of an unexpected event, such as an engine failure. Also, formation aerobatics for newly inducted air show performers are initially practiced in wider separation until a satisfactory level of experience has been gained.

To anticipate the unexpected, it was suggested by several interviewees that the display pilots could employ standard operating procedures with explicit go-no-go criteria and contracts, what-ifs, and contingency planning. The leader of a military demonstration team presented an example of integrated contingency planning in standard operational procedures, stating:

> When we fly, it has to be a search and rescue (SAR) helicopter at the air show site if a pilot has an accident to take him to the nearest hospital immediately. (…) So, in our procedures, it is mandatory to have a helicopter parked at the air show site or flying within a radius of 10 miles, both for practice and the actual air show.

Furthermore, flight training was emphasized as an essential part of instilling risk assessment skills, as well as quick reaction abilities in the event that an unexpected risk was present during their display. A military air show performer, in particular, reported that in order to prepare for an unintentional out-of-control condition, they attended, on an annual basis, an upset prevention recovery training (UPRT) program: "Once a year, you have to go to upset prevention recovery training."

Finally, the importance of the air show safety briefing as a risk mitigator measure was emphasized by the interviewees. One air show performer mentioned that:

> If there are other hazards that you can identify but cannot do anything about at the time, all you can do is make sure that during your briefings, you highlight the risks and make sure that the people who are going to respond have been prepared.

Air show safety briefings may be the final line of defense for both the air boss and the air show performer in identifying dangers and resolving them immediately prior to stepping out to the airplanes. As stated by an interviewee, the relevance of the air show safety briefing is crucial as it sets the tone not only for the performers but also for the emergency responders such as crash/rescue/firefighting teams and first aid/medical teams to react effectively and expeditiously in the event of an incident or accident.

The results suggest that risk assessment and mitigation do not end with the filling of the risk assessment matrix and clearance from one's superiors or after the air show safety briefing. Risk assessment and mitigation are dynamic activities that air show performers must engage in during their flight in the hostile low-level aerobatic environment. One interviewee made an intriguing comment from an interviewee for a dynamic, real-time, and last-minute risk assessment and mitigation approach: "If I get in that situation, I will test the clouds myself before I fly, especially if I am first."

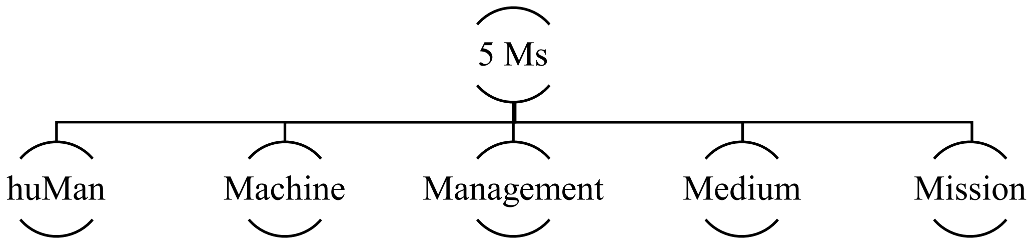
This statement demonstrates the rigorous risk assessment and decision-making abilities required of an air show performer to fly safely and efficiently in front of a public. This type of proactive safety practice should be encouraged in the daily display profile routine during air shows.

Air show pilots can also have safety margins and buffers, which may exceed required standards as part of their profiles and maneuvers. Nevertheless, air show pilots should accept the risk that is tolerable for the scope and complexity of a profile and enables them to react skillfully, correctly, and expeditiously to both anticipated and unanticipated threats while engaged in aerobatics, as recommended by Barker (2020a).

5Ms. Some of the interviewees identified the air show industry as a socio-technical system that encompasses a tight coupling of social and technical factors related to the human and its environment with implications for optimal performance, as suggested by Reason (2000) and Dekker (2014). Some of the themes mentioned by the interviewees related to human factors, the aircraft, the environmental conditions, the display profile itself, and the air show management by event organizers and air bosses. To encapsulate the safety risk associated with these socio-technical factors, the five-M model suggested by Harris (2011) was used as a guide to set the views of these respondents into perspective. Figure 34 illustrates the theme and sub-themes.

Figure 34

5Ms Theme Map



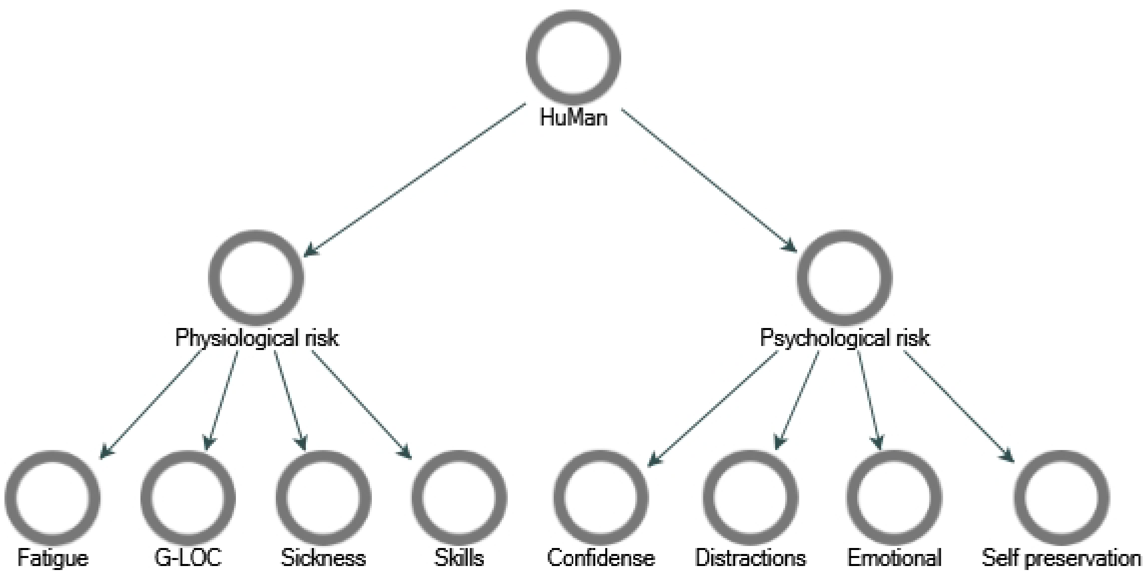
Human. Interviewees mentioned physiological and psychological risks related to the human factor (see Figure 35). Fatigue, G-induced loss of consciousness (G-LOC), sickness, and lack of skills were identified as physiological risks to the performance of a display pilot, as mentioned by the following interviewee:

> When acting as either a ground controller or a ringmaster, I need to ensure that the pilots are not fatigued; probably, that is the biggest latent risk. The more experienced pilots are aware of it, but the less experienced air show pilots work up to the air show, and then the air show weekend itself is very tiring and very fatiguing. If the air show has been on Friday afternoon or maybe Saturday, by the time you get to Sunday, they can be quite fatigued, and they may not recognize the fatigue aspects, and that is where the mistakes happen.

Fatigue is a latent hazard that progressively builds up during the air show weekend, with significant adverse safety risk implications for the pilot's mental and cognitive performance. An experienced civil air show pilot opined how symptoms of fatigue such as inadequate body hydration, low blood sugar, loss of mental focus and situational awareness, and reduced G-tolerance could adversely affect a pilot's performance and increase the risk of errors and lead to adverse safety events.

Figure 35

5Ms Theme, Human Codes, and Subcodes Map



Another sub-theme was the issue with dexterity in terms of handling and technical skills on the part of the performer, which could be affected by physiological factors. The interviewees highlighted that lack of air show performing experiences, lack of proficiency in aircraft handling, inadequate planning and preparation, and inadequate currency/recency in air show profiles as factors in this sub-theme. The following quote from an air show performer emphasizes the difference between currency and recency requirements:

> That is another point which is—the difference between currency and recency; you can maintain currency legally by flying every 30 days or whatever. But to be recently air show experienced, you need to fly the display you intend to do within a week, certainly.

The findings suggest that it is vital for an air show performer to arrive completely prepared and up-to-date with recent training that will showcase not only their outstanding flying abilities but also the aircraft's performance and level of maintenance.

Additionally, interviewees discussed approaches for pilots to tolerate risks associated with physiological issues through the use of fatigue risk management techniques and appropriate training that could improve the pilots' G-tolerance. A member of a military display team revealed a method applied for reducing fatigue risk: "How do we get around that? I think a lot of it just comes down to experience, kind of mentoring from the senior pilots, keeping an eye on the junior pilots." This finding suggests the vital role of mentoring new air show performers by their teammates as a critical management strategy for imparting knowledge about controlling and minimizing fatigue during the performance season.

However, an additional difficulty that performers mentioned was the cumulative fatigue that developed throughout the air show weekend, as noted by an air show performer with airline experience:

> For me, what helped was that because I was an international pilot, I have developed means to cope with sleep deprivation and methods to sleep. I would never leave my house without an eye mask to darken any light coming through the shutters. I can sleep with very high-quality earplugs, which take care of the

> noise factor. Using little things like that that came through from the airline's international operations helped me not to be as tired of the air show flying.

These are risk management techniques that could be applied to the air show community from another sector of aviation expertise, such as commercial flight operations. Best practices for risk tolerance and management, such as methods to cope with sleep deprivation, including high-quality earplugs to control the noise, and the use of eyeshades to darken any light coming into the bedroom, may be transferred from other areas of expertise or the aviation industry, and all of these best practices could be shared with the rest of the air show industry.

The ICAO (2011, 2016) has identified fatigue as a risk to safety. Fatigue management refers to the methods by which aviation service providers and operational personnel address the safety implications of fatigue. The fatigue risk management system (FRMS) has been offered to aviation service providers and operational employees as an effective technique for addressing the safety implications of fatigue (ICAO, 2016). Nevertheless, the interview and focus-group findings suggested that currently, there were no documented fatigue risk mitigation systems or rules on FRMS specific to the international air show industry. One interviewee highlighted the regulatory state for fatigue management in their country:

> There are no set rules for private operations; it is up to the individual pilot. We do not have anything in written any regulatory requirements that the display pilot has to be rested for 12 hours and must sleep, for example, in a quiet room with blackout curtains. There is nothing like that similar to the airline industry.

The findings suggest that fatigue risk management may be the responsibility of individual air show pilots. From an organizer perspective, there need to be some improvements in providing conducive accommodation that ensures adequate and good quality sleep, which is essential in fatigue risk management.

An air show performer also highlighted the importance of synchronizing air show schedules to prevent interference with the circadian rhythms of the display pilots since inappropriate timings for briefings and other preplanning activities can disrupt rest periods and increase fatigue risk.

Interestingly, interviewees suggested that pertinent operational display information and the time for the display are typically provided to them in advance to enable them to adjust their schedule and a good rest before the air show becomes the individual responsibility of each display pilot. An interviewee expressed it succinctly: "But for all performers, that is one air show after another; one weekend after another; you have to pace yourself. It is a marathon, not a sprint." Another interviewee noted that despite the period of intense flying, planning, and preparation associated with the air shows, air show performers must guarantee their fitness to fly by staying sufficiently rested and safe.

Psychological risks associated with the human element of the 5M theme, as indicated by interviewees, focused primarily on emotional risks, distractions, and an air show performer's confidence level. According to one interviewee, overconfidence was the primary risk factor for getting involved in a dangerous situation. However, another interviewee emphasized the need for maintaining a healthy degree of confidence and stated that:

> It is a thin line; it is kind of like fighter aviation where you have to be confident you have to walk into the room thinking you are the best pilot in the room at all times, but you can do so while staying humble.

An air show performer with military background intimated that it is vital for a display pilot to be reasonably confident in their aircraft handling skills and the capabilities of the airplane prior to flying. The interviewee further stated that a balance of healthy risk appreciation and self-awareness is necessary to minimize overconfidence and to ensure a safe and focused display throughout the air show.

Several interviewees emphasized air show performers' vulnerability to distractions and offered suggestions for mitigating distractions. An interviewee noted that distractions and interruptions during the display might disrupt the air show performer's mental flow and divert their attention away from the critical requirements of flying an accurate and precise display profile in the aggressive and high threat low-level aerobatic environment.

Radio chatter on the display frequency, weather-related factors, the crowd, and family issues related to an air show performer that could affect their psychological stability and distract them from concentrating on the core task of flying a display were issues reported by several interviewees. An example of a family-induced distraction is captured in this statement by an interviewee: "Once, I was flying with a family problem which I had to take some risk—it was not a funny time—and to get this out of my mind was not easy."

Another air show performer stated that family issues affect anyone, and an air show performer cannot be untouched by such an upheaval. The interviewee further stated that family, financial, or marital problems could upset the emotional stability of an air show performer, especially when that distraction happens before a display flight.

There was a consensus among interviewees that emotional hazards were inherent with air show participation. They stated that risk associated with emotional states of anxiety, indecision, loss of situational awareness, stress, and social desirability could not be discounted and had been experienced by all. One of the interviewees stated that anxiety was a natural sensation to one's level of operational experience, especially among novices in the air show community. The following statement highlights that point:

> I think that any pilot who is starting his display career, whatever his aviation background and experience is, will face some anxious attitude about doing his first displays. It is a little bit like the 'red flag syndrome' that if you survive your first five war missions, you feel comfortable with them from an emotional point of view, and your chance to survive is much higher.

An air show performer stated that as display pilots participate in more air show displays, the more confident they become, and their awareness of operational hazards associated with air shows increases. They also develop better emotional stability required for this form of high-risk flight operations.

Most interviewees reported risks related to their feeling of pressure induced by the time factor. Due to the tight time schedules planned for an air show, every display pilot has their designated time slot with a small margin for a delay so that there is a value for money for the crowd attending the event, as stated by an interviewee with air boss and air show flying experience.

The air boss prepares the schedule with an accuracy of a minute from the start to taxi, takeoff, and landing to accommodate all the participants in the air show with a strict and tight sequence. Especially in the big air shows, the time pressure is significant, as mentioned by an interviewee: “So, if you had some complex airspace structure, with very strict timing, in international air shows like Paris Airshow or Farnborough, 30 seconds or one minute late, then the following day, you will not fly.”

As another air show performer noted, this type of operation and planning by the air bosses places pressure on the pilot to maintain their time, causing them to push their mental and physical limitations by rushing through display profiles and tasks, which increases the potential for errors.

Psychologically-induced pressures in the air show community are sometimes amplified by external pressures, and the statement by one air show performer reinforced that point:

> You are stressed by external pressures, which should not exist because the way to limit risk is to standardize the performance as much as possible. Try and train the necessary number of displays and sorties. And finally, feel comfortable with everything that will happen according to your training.

Therefore, training in mindfulness and meticulous preflight planning was suggested to enable an air show performer to cope better under psychological pressures related to unexpected circumstances.

One interviewee, who is also a member of the flight control committee for a local air show, stated that:

> What we do not want is that they feel pressured to meet that time; therefore, we give them plenty of notice that the program does not change. If someone drops out, it becomes a vacant slot, we leave that slot open, and there is nobody in the sky—that is okay. But what we do not want is to try and bring someone forward and then put them under time pressure to get ready when they are not prepared.

This suggests that air show organizers should exercise extreme caution during the briefing to ensure that pilots are provided with necessary flight planning resources and adequate time for preparation to reduce the feeling of being rushed before an air show display. This point was reinforced by another air show performer, who added that a sufficient buffer in the timing should be provided to mitigate the risk created by the air show performer's timeline.

The concept of self-preservation was highlighted by some of the interviewees. An interviewee who has extensive experience both as an air show performer and as an air boss in big international air shows stated that: "The pilot's motivation for safety is one of self-preservation, not just self-preservation in terms of making sure his life is not at risk, but also protecting his income in some cases."

This concept was buttressed by another air show performer who intimated that air show performers should always consider self-preservation, so they do not overstretch their safety limits and endanger their life and their career, which has implications on their financial well-being. The interviewee further stated that :

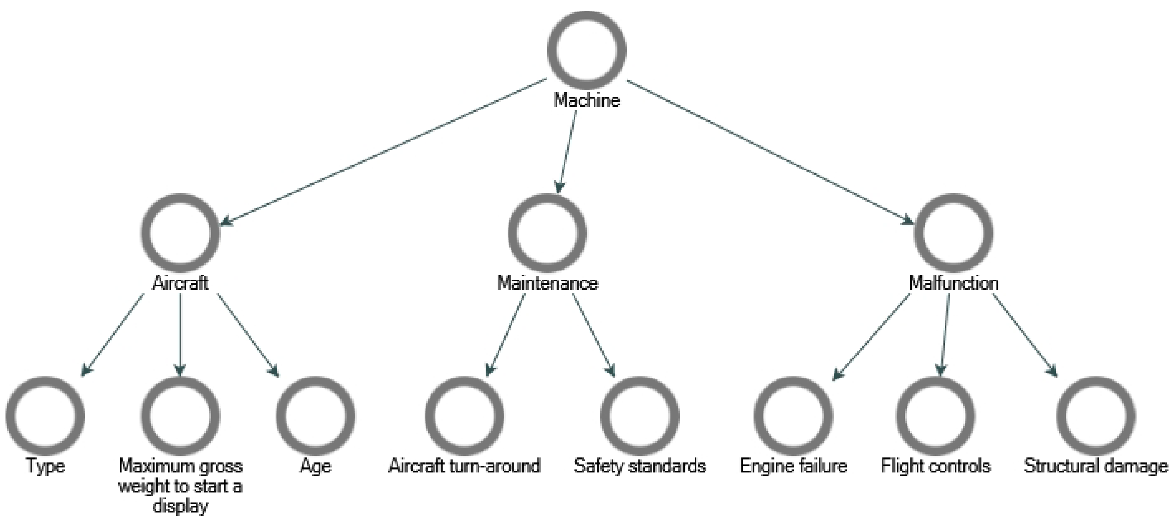
> Self-preservation of air show performers is also self-preservation for the air show industry as a whole, and no risk is acceptable when it jeopardizes the aviation industry in general and the air show community in particular, ruining the

reputation of not only the pilot who may be exposed to an incident or accident but also thousands of people who work in the air show business and earn a living from it.

Machine. The majority of interviewees highlighted a potential risk associated with an aircraft malfunction, such as an engine failure or a structural failure during an air show (see Figure 36). One interviewee stated, "The maintenance side of an aircraft is taken care of, but the severity of the outcome of one mechanical engine failure is quite very high." Another interviewee noted that even if an aircraft is well-maintained, air show performers should remain cautious of a potential engine malfunction that could lead to a flameout landing.

Figure 36

5Ms Theme, Machine Codes, and Subcodes Map



In the air show community, there are some operational risks associated with the flying of warbirds which are vintage airplanes that are no longer in production (Barker, 2020a). One of the notable hazards is the age of these aircraft and the risk associated with maintaining and flying such vintage machines. An interviewee with extensive warbird display experience said, “I was concerned about the age of the jets. When I was flying, it was many years later, but I was worried about the maintenance of the machines. So, that was a risk I accepted and dealt with.” Another vintage aircraft pilot supported the earlier view by intimating that pilots need to be aware of the risks associated with flying an aged airplane, and they should adapt flight display profiles that do not exceed the airplane’s operational limits. Another pilot noted the need for extra vigilance when flying such vintage aircraft since they are more prone to an engine-related emergency.

Interviewees also suggested that air show performers, particularly warbird flyers, are more concerned about the possibility of flight control-related emergencies during displays. According to an interviewee, there is a difference in risk perception between engine failure and flight control failure and stated that:

> If an engine fails, at least you can control the airplane, at least you can steer it somewhere, and hopefully, you will live and not hurt anybody on the ground (…) if you have no controls, you are out; you got no chance.

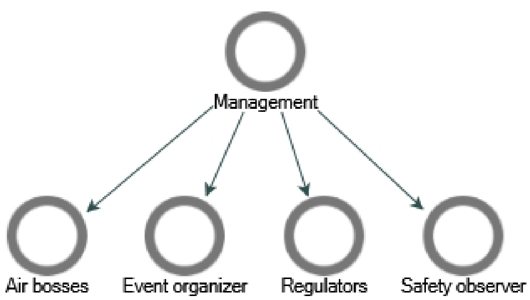
Management. Management of risks in an air show rests mainly with the air boss (see Figure 37); nonetheless, the event organizer is accountable for the organization and conduct of the aviation event, especially in the U.S. (FAA, 2020a). The air boss was frequently cited by interviewees for air show tactical management, and the following statements identify the air boss’s role:

> One of the biggest problems for safety in the air show world is air bosses. There is a notion that air bosses are there for people’s safety and that they are in control and things like that. And air bosses are there; they ran away and joined the circus

with us. But they want to get rehired, and air bosses are the least confrontational group at an air show; they are the least likely people to stick up for pilots; usually, there is one that, in particular, just will not have anything to do with that. But all in all, air bosses are in a position where they could weed out a lot of that pressure, and they do not. So, if you want to have a hidden risk in the air show business, it is that there is a notion that air bosses make air shows better and safer. In general, they are just there to serve their own needs.

Figure 37

5Ms Theme, Management Codes, and Subcodes Map

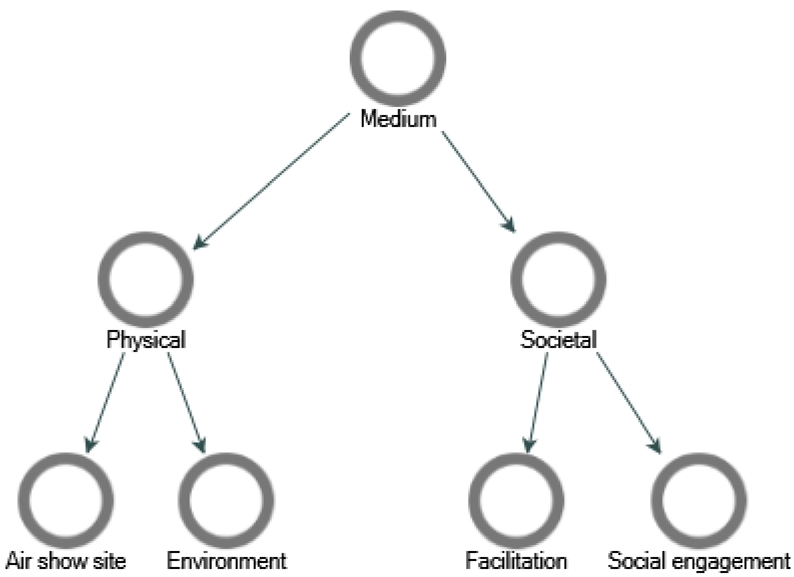


The air boss's responsibility in promoting safety and minimizing operational pressures on air show performers was also highlighted by another interviewee: "That is a standard thing in the briefing; they always say, 'Do not do anything new or different, do the same thing you have been doing.'" Another experienced civilian air show performer summed up the role of the air boss by affirming that air bosses carry the primary responsibility for the safe execution of an air show, and as such only well-trained, technically competent, and qualified individuals should be maintaining such a role.

Medium. The medium theme was undergirded by the codes of the physical medium and the societal medium, as per Harris (2011). The physical medium discussed by the interviewees was related to the air show site complexity, the air show site airspace, obstacles in the vicinity of the area, and the possibility of hitting them (see Figure 38). Various environmental factors were also addressed, including marginal weather conditions such as a low cloud ceiling, strong winds, and a high-density altitude; the sun's position in the sky; and bird and drone strikes. Moreover, several interviewees identified that social facilitation bias had a significant effect on air show performers.

Figure 38

5Ms Theme, Medium Codes, and Subcodes Map



According to one interviewee with a single-engine jet aircraft air show experience, bird strikes are a primary concern during displays:

> The most significant concern, just due to our airframe that we are flying in the shows, bird strikes would always be a huge consideration that we will be monitoring as far as bird activity around the airfield and the air show site.

This statement highlights the limitations of the single-engine airplane's performance in air shows and the higher risk of an engine failure due to a bird strike.

A concern comparable to a bird strike risk is unauthorized unmanned aerial vehicles (UAV) or drones violating the air show's airspace. An interviewee reported their experience with drones in the air show vicinity: "A lot of drone activity around air shows has spiked significantly last few years. We had to postpone shows because the drone will be flying, and they will have to try to track down whoever was on the ground." According to the same interviewee, those small-sized hazards flying near the air show box may pose significant threats to air show performers, particularly single-engine jet display teams.

According to numerous interviewees, the primary environmental risk is performing at high-density altitudes (DA). Under these conditions, the engine performance and flying characteristics of the aircraft drastically degrade, resulting in decreased performance, sluggish controls, a wider turning radius, and longer display duration. The leader of a jet demonstration team explained:

> If you have a high temperature and you want to take a little more energy- you just cannot do that. And it is pressing you to shorten your initial altitude, your sequence, and then finally, you do not feel comfortable. (...) Density altitude is important for the pilot, but it should also be considered by the display director for the timing. If you want to do the same thing, the same rhythm, same performance,

> same display above standard, it is just impossible. Because the same maneuver at the same indicated airspeed will take you more time because the increase of temperature by 10 degrees is a 30% increase in the turning radius, and that is basic.

Another interviewee discussed the impact of high-density altitude on human performance:

> People tend to die at high-density altitude shows more than they do at low [density altitude] shows, proportionally. It affects the pilot: I can tell my G tolerance; your body works harder; they talk about hydration, but your heart works harder, everything works harder. And so, you are just not as strong when you go to a high DA [density altitude] place; that is certainly a factor.

The same air show performer mentioned the following mitigation strategies when preparing for a high DA air show:

> I try and fly one high-density altitude show every year. It is good to go; get ready for it, and then what is nice is for about 6 weeks afterward, you are flying great. You go down to a normal place, and the airplanes perform great. It takes a long time to get used to nice performance again, but density altitude is a big problem.

Another air show performer stated that density altitude had been observed as a significant operational issue and suggested that with proper planning and preparation, a pilot may foresee the negative impact on their performance and change their display profile as needed.

Flying over water has also been noted as a potential environmental hazard by several air show performers interviewed. According to one of the interviewees:

> I fly higher over water anyway, so then you get something like that, and I will fly another 100 feet higher. (...) [Flying over] water is very difficult because it looks the same for a long, long, long time, and then all of a sudden, you are close; it is really weird. So, you have to give it a lot of respect.

The same interviewee experienced the same effects while flying over water in the late afternoon with a low sun-angle, as described below:

> We did a show, and it was later in the afternoon, around six o'clock, right this time of year. It was beautiful, blue sky and a very pretty day, and it was late in the afternoon, so there was no wind, so there was good light. So, everything is good. Then I got in, and I did my first maneuver in the vertical, and I turned around, and when I turned around, the smokes just hung in there—it was not even moving. But in your mind, it settles, it moves down, and I am looking down, and it just looks like a hole. It does not look like anything because the water is dark because it is dark enough; it was late, this close to sunset. So, I just pushed hard to be away above the smoke and then did not do any more outside maneuvering and gave it another little bit more altitude. Because it is different all the time, that is a tough one.

In terms of the medium's social risks, it was suggested by interviewees that social facilitation bias had a significant effect on air show performers. Specifically, an interviewee stated, "I do not fly differently when I am in front of people. Everybody else seems to try harder."

Other strategies that are used by the interviewee to minimize the risk associated with social facilitation bias are highlighted below:

> I had good training. I do not fly differently in front of people, and everybody else I know does, so I am not really affected by the size of the crowd. When my mom was alive, if she came to an air show, I had to move it up 50 feet, but that is about it; that is the only concession I would make for people in the crowd.

According to an experienced air show performer, sometimes the relationship between air show performers and event organizers may introduce latent tendencies to encourage performers to take unacceptable risks in order to keep the air show exhilarating and their jobs secure in the future. This statement highlights the point:

> You got to do unwise stuff to satisfy the event organizers. And that is, to me, that is the biggest financial implication: that you will do stuff because you want to please the people that are writing your checks, or they do not write a check again.

Another air show performer stated that air show facilitation might implicitly have a coercive effect on novices' pilots who wish to retain their jobs and remain in the air show industry, as well as experienced pilots who wish to impress event organizers, who may be personal friends.

Mission. The mission involved during an air show performance is multifaceted. Several factors and codes were revealed by interviewees related to the mission during an air show (see Figure 39). A risk mentioned by an experienced air show performer who was leading a jet demonstrational team was related to ferry flights:

> The most dangerous situation that I have ever faced was on ferry flights, not during displays. When you fly a display, normally, you have restricted airspace; you have acceptable weather. There are some rules for this, and if you are below

the weather conditions, you should not fly. Then, you know exactly what you have to do, and if you are properly trained, things should happen normally.

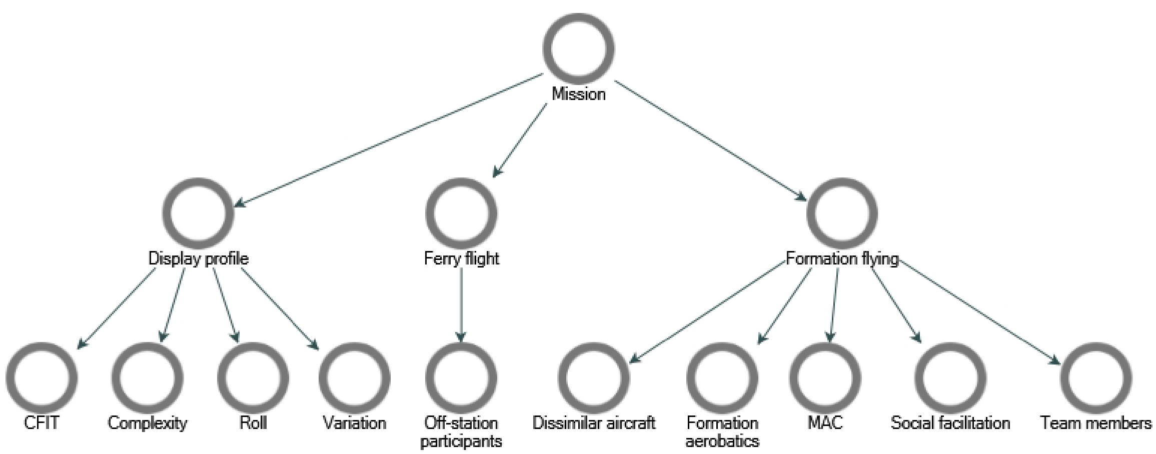
Another air show performer who was flying as a wingman in a propeller-powered aircraft demonstration team added:

> Flying the Pitts because it is not instrument flying rated; it is just an engine with wings. So, any IF [Instrument Flying] threat is a major threat, and you know, four aircraft, trying to make a flight of one and a half hours with that distance to cross was quite a thing to manage.

Ferry flights are often not seen as hazardous as they are not part of the display mission itself; nonetheless, various unexpected and unanticipated things may occur, as the same interviewee stated.

Figure 39

5Ms Theme, Mission Codes, and Subcodes Map



Several interviewees then stated that there was a risk of colliding with the ground or any object on the ground. One interviewee mentioned, "You cannot hurt yourself in an airplane until you hit something." A fast jet solo display pilot stated:

> The most important risk during the display is to hit the ground unintentionally. To mitigate that risk, I want to know the display sight and the surroundings, obstacles, altitudes of the buildings, and so on, to make sure that we can keep the margin in height above the ground.

The complexity of the display was another risk mentioned by several air show performers. It is interesting what was mentioned by a demo team leader: "I do not want to have maneuvers that need high skill to be executed because I cannot guarantee that I or any member of my Team is fit in every display." Regarding the intricacy of the air show profile, the same air show performer stated the following:

> The risk perception is also the sophistication of the way you set up your display; because if you set up something which is too complex, we are back to what we said before, which is that if you need 100% of your skills, and resources and capability to do a display the day you do not feel comfortable then when there are some distractions for any kind of reason, maybe you will not manage to do properly what you intend to do. So, let us consider that if you have to establish your display at a level of skill that requires about 80, or a maximum of 90% of your capabilities, then 99% you will kill yourself one day.

Regardless of being in a demonstration team or flying solo, performers should adjust their profile according to their experience and flying skills so that they always keep a safety margin during the execution of their display, as mentioned by another experienced air show performer.

Complex missions, such as circling the jumpers and flying in dissimilar-aircraft formations, may potentially create risks, as numerous interviewees indicated.

Additionally, downline rolls were noted to pose an additional risk to the display profile, which could result in a fatal accident, as the following interviewee mentioned:

> It looked almost like it was a done deal that he was going to try this maneuver or maneuvers, and as it was, he just went on a 45-downline doing this deep stalled rolling maneuver, and he just did not have the space to come out, he actually autorotated the other direction as well, so he was never going to make it.

These assertions corroborate Barker's (2020a) report that downline rolls are one of the maneuvers that air show performers should use extreme caution when putting in their display profile.

Several risks were mentioned by interviewees during formation flying, including the team leader's capabilities, considerations for the wingman, and the aerobatic maneuvers flown during a formation display. Yet, the most prevailing risk during formation flying, as argued by the majority of the air show performers who were members of a display team, was the MAC. An interviewee who was a member of a civilian piston-powered demonstration team said: "The risk that I was concerned about is the midair collision risk. (...) Midair collisions can occur when things do not happen as planned because the routine has changed."

All team members have a critical role when flying in formation. A member of a civilian piston-powered demonstration team reported another hazard that could lead to a midair collision: "The additional risk would be that the person I am flying with makes a mistake that is big enough to have a collision."

The importance of teamwork and acknowledgment of the contracts amongst the team members was highlighted by an interviewee who was also running the duties of a flying display director:

> We have had occasions where flying formations have not been constituted formations; we have had guys forming up in the wrong order. On one occasion, we had an aircraft touch another airplane because they both went for the number two slot. One was an ex-Navy guy, and the other guy was a civilian, and each thought the number two slot was on the other side.

Flying a display with other airplanes in close vicinity while maneuvering and executing aerobatics multiplies all the risks related to an air show performance, as mentioned by another interviewee.

Lastly, another risk that could be accepted is the added risk of flying with a passenger during a display, as reported by a military air show performer. The interviewee referred to the fact that:

> Some other risks that we will accept with the Team on practice shows, for example, during the air show season, are incentive rides to other air show acts and personnel as well as any fellow military pilots that are at the air show; we use it as a recruiting tool for the Team as well.

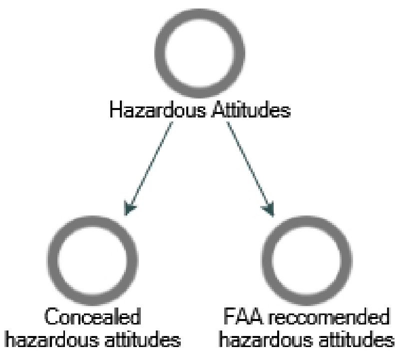
However, the same interviewee reported that this type of flight is only performed during the practice days to minimize the risk; during the actual display days, no passenger is allowed to be carried in the airplane, as per their regulations.

Hazardous Attitudes, Themes

In the semi-structured interviews and the focus group, a set of questions focused on hazardous attitudes. The themes revealed were the FAA-related hazardous attitudes and the concealed hazardous attitudes (see Figure 40).

Figure 40

Hazardous Attitudes, Themes Map



The FAA Recommended Hazardous Attitudes. During the semi-structured interviews and focus group, interviewees reported all FAA recommended attitudes as well as the combination of all attitudes, except resignation, connected to air show performers (see Figure 41). One interviewee recalled a display pilot with a mix of hazardous attitudes, as stated below:

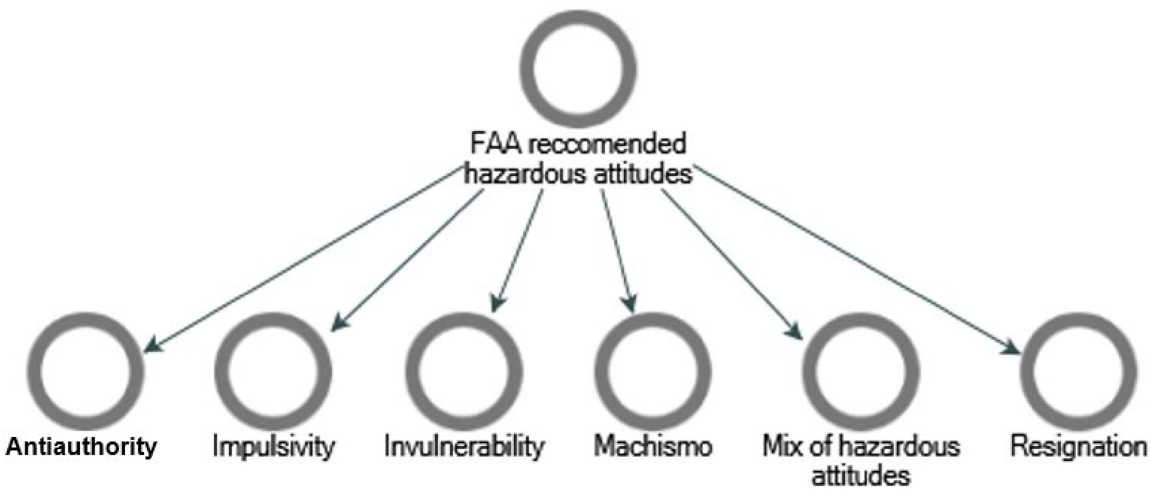
> This guy had this macho attitude, combined with invulnerability, combined with antiauthority, where he was told, "do not do anything funny." Instead, he was doing maneuvers that it was hard to understand that were possible in a full-size aircraft. He was doing them in his model aircraft; he was also a national RC model champion. So, he really could fly well, but he was trying to use that in a full-size aircraft, deep alpha-stalls, and stuff, for what reason? Those spectators

would not have appreciated what he was doing, and he messed it up, and he paid with his life. Horrible situation.

Unfortunately, as the interviewee mentioned, this air show performer had a fatal accident.

Figure 41

FAA Recommended Hazardous Attitudes Theme, Codes Map



According to interviewees, the most dangerous attitude was invulnerability, followed by the macho attitude, impulsivity, and finally, antiauthority. An interviewee made an interesting observation about the invulnerability of air show performers, "Anytime people say, 'it is going to work, we will take care, it is going to work,' it is just an unprofessional and unsafe attitude."

Numerous interviewees linked this invulnerable mindset to complacency, and one interviewee recounted:

> Sadly, in the last five years or so, particularly in my country, most of the accidents and incidents have been by very experienced pilots, and that is the bit that worries me now. It could be because of complacency—they have flown the same airplane,

> same routine, 24 times this season, so they just get in the airplane, and off they go, and they either forget to check, or they use the wrong height.

According to the same interviewee, this type of attitude could result in air show performers exceeding their limitations: "But you do get these pilots who determinedly fly down to the limit because he can, and they are the guys I worry about." Another interviewee with military fast jet display experience reported a form of complacency as under-stimulation for the display pilots who are towards the end of their season; in this case, they might become complacent and allow themselves to put their guard down and make mistakes.

Lastly, pushing the limits increases the already high risk in the performance of air show performers, leaving no margin for error, as mentioned by another interviewee. Regarding the macho attitude, an interviewee recounted an instance of an air show performer who exhibited this type of behavior but tragically died in an accident, as described below:

> He had that machismo, and he was sort of always out to prove something. He pushed an inverted maneuver too hard, well below where I thought or given the conditions of the day, as it was a very windy day. I was surprised that they allowed him to fly that day; it was that windy. And he pushed an inverted maneuver too low, and he recovered within feet of hitting the ground.

Almost half of the interviewees described the overconfident pilot as having a macho attitude, as indicated by one interviewee: "The ones that worry me are the overconfident ones, and sometimes overconfidence betrays itself in all sorts of ways."

Two interviewees revealed an overestimation of skills and capabilities as a component of an overconfident attitude, the following statement stood out:

> Over the years, yes, I have, and I have had some very nose-to-nose discussions with one or two of them. And the sad thing is that one of them subsequently went off and committed an error, and it was not an aerobatic error; that was the stupid thing about it. He elected to fly a display and then went to another field, did a low break, pulled up for a showy landing and made a complete mess of it, and put the airplane into the ground. I can only conclude that he just thought he was better than he was, and that was a shame.

Regarding the antiauthority attitude, a military solo display pilot reported that:

> I think the most dangerous display pilots are with the rogue behavior—the guy not willing to keep the rules. The guy who thinks the rules are only for the other guys and that they are better. I think if you imagine that you are better than all the other ones and that the rules are only for the other pilots, then I think you are dangerous.

Additionally, a civilian air show performer alluded to a tendency against authority that existed a few years ago:

> There were guys that would say it is my right to die, and that was common in the air show business not that long ago, 15 years ago. And then there were 10 or 12 guys dying in air shows every year. Now, it is kind of surprising when it happens because you do not get to say "It is my right to die" anymore and have people go, "Yeah, that is right."

Then another interviewee, who is also an air boss at a large air show, stated that:

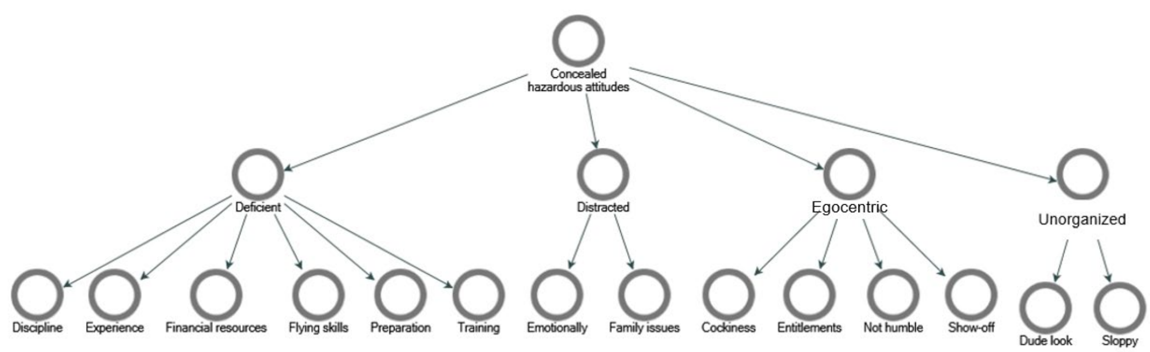
> Some pilots seem to make a deliberate attempt to fly exactly to the regulation or even a little bit low if they can; they are the guys I like to keep a very strong eye on, and there are one or two of them around the place that we know of, and the flying control committees are aware of these guys and watch very carefully, and we will take the guy to one side and just warn him.

The same interviewee emphasized the critical role of both the flying control committee (FCC) and the air boss in establishing regulations and ensuring that they are followed without variation by air show performers.

Concealed Hazardous Attitudes. Along with the FAA's hazardous attitudes, interviewees highlighted several types of behaviors that the researcher classified as concealed. Concealed hazardous attitudes encompass the attitude types of deficient, distracted, egocentric, and unorganized (see Figure 42).

Figure 42

Concealed Hazardous Attitudes Theme, Codes, and Subcodes Map



Air show performers who lack discipline, experience, financial resources, preparation, and training may pose a hazard not just to themselves but also to the air show community. The most frequently mentioned deficiency of an air show performer, as revealed by interviewees, is the limited aerobatic flying skills. An interviewee with substantial national and international air show expertise reported a case of an air show performer with problematic aerobatic flying skills:

> You could see how insecure the whole thing was. He was a very nice guy, not a showoff. He loved it, but he was not able to do it. He did not have the manual skills and the understanding of what he did.

Another interviewee stated, “The most dangerous is the guy who does not have the proper skill or the proper training.”

Having solid flying skills, as indicated below by an interviewee with military and civilian air show experience, is a precondition for the survival skills required of an air show performer: “People could say, ‘He did not have the skill’; I think that he had the skill, and I think all of us that have survived so far have the skill.”

An egocentric attitude refers to someone who is primarily concerned with themselves and disregards the greater benefit of the air show industry, as stated by an air show performer. Nevertheless, more than half of the interviewees reported that showing off was dangerous behavior. A military display pilot discussed this:

> I think the most dangerous air show pilots are the ones that are flying for other pilots. If they are trying to show off, they are not doing it for the crowd or themselves, but they are doing it to show how they can handle the airplane, and I think that kind of attitude is probably the most dangerous where you are trying to fly for other people. Of course, when we are doing a demonstration, we are flying

> for the crowd, but their entertainment value is our lowest priority; their safety is our top priority, the team's, and then our safety.

Another interviewee supported the assertion that some air show performers might be seeking fame by attempting a dangerous maneuver, such as in this example:

> But one should not say, "Okay, this is a risky maneuver, but I am going to do it because I am going to be famous"; this is the most unwise thing we could have if we want to stay in business for the long term….If people think that they are stars in the business and want to take power and rule the system, this arrogance is not according to our rules.

Another interviewee felt that air show flying is all about presenting the aircraft and not the pilot, as mentioned below:

> You are here to fly your display, present your aircraft, present the way you can control the aircraft, and control the flight paths in every situation. It is not about showing your skills as a pilot to show that you are the best; you are not here to prove that you are the best one; you are here to show your aircraft.

Then another interviewee brought up the fact that pilots with a show-off attitude might also want to impress their friends and family, as indicated below:

> Showing off is how people die. Usually, it is at their mom's barbecue, at the lake house, not that much at air shows. So, accidents that are doing aerobatics are not at the home field and not in the wavered airspace at a box but usually at somebody's party.

Another interviewee noted that new air show performers might be more prone to show off their abilities in front of the public: "The newer pilots in the air show they think they have to go out to impress, but it is not about that; it is not about trying to impress." A civilian interviewee noted that an air show performer's aviation training experience might affect their attitude, as discussed below:

> It is kind of a sense of not being humble; having an attitude of some sort is. But then look at the military pilots. A lot of the military guys have a very inflated sense of themselves, especially the Navy pilots, that are part of their culture is to be like huge egos. I have seen a couple of Blue Angel pilots either killed themselves or got fired quickly because they had such an inflated sense of ego. So, the military recognizes that too. It is also subtle.

Another concealed attitude was stated by interviewees to be related to distraction, either emotional or induced by family or other personal issues. A civilian air show performer shared a personal story about overcoming marital difficulties:

> Also, people who have a lot going on. Personally, the closest I have ever come to having an accident was when I was going through a divorce. I was not focused, and emotionally I was upset. I probably should have stood down and not flown.

Another interviewee reported that the presence of friends and family at the air show site could cause a distraction to the air show performers:

> The day that a fellow air show performer died, he was angry because he had a big confrontation about how his wife and very young son were being treated in the hangar at this air show. And he was agitated when he got in his airplane; was that causal? I do not know, probably not. But, your family and friends, you are better off without them in an air show. Also, other fellow air show performers, when

> their girlfriend or wife and kids are present at an air show, they were different—they were not getting ready in the same way.

Emotional issues that result in distractions could significantly affect the mental focus of air show performers deteriorating the safe conduct of the display, as mentioned by another air show performer.

Ultimately, the concealed hazardous attitudes described by interviewees were associated with unorganized attitudes (Nelson, 2007), such as a pilot being sloppy or carrying themself in an unprofessional manner. An air show performer reported the following:

> We all recognize them; we are like, that guy is going to be next because he does not have the right attitude, his plane is a mess, it is not even clean. He jumps onto the plane; he still got a pen in his pocket, and I know some of those people right now that I worry about because it is mostly mental. Sometimes it is the attitude; sometimes it is the way they carry themselves; sometimes they are just messy, they are not neat, they always look kind of sloppy, and they are always late getting to their plane. And those people are the ones that we say are going to be next. So, you do see that even now.

The same interviewee, who has vast experience performing at air shows, discussed an air show performer who exhibited this type of unorganized attitude and tragically died in a fatal accident, as mentioned below:

> He had this little surfer dude going, and I thought in the back of my mind I thought there is something it does not fit with air show pilots; it is not what you want to see around air shows and airplanes. It is cool, it is okay to go surfing, but

you do not have that attitude when renting an airplane. Sure enough, next year, it takes a kid up, crashes, and dies, and I never forgot that.

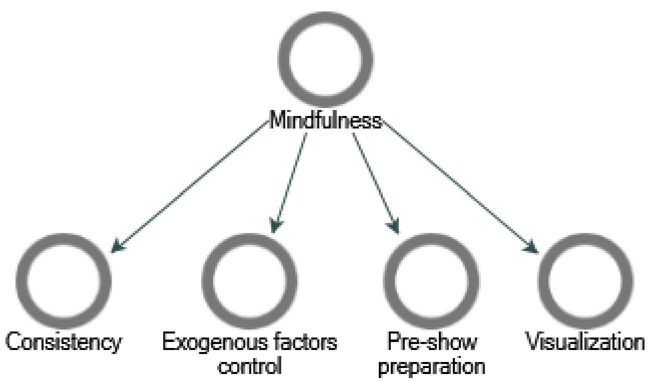
These types of behaviors are insidious and are hard to identify, yet they could have fatal results, as noted by another interviewee.

Mindfulness, Themes

In the semi-structured interviews and the focus group, a set of questions focused on mindfulness. Visualization, exogenous factor control, preshow preparation, and consistency were the themes associated with the mindfulness area of the current study that emerged during the theming process (see Figure 43).

Figure 43

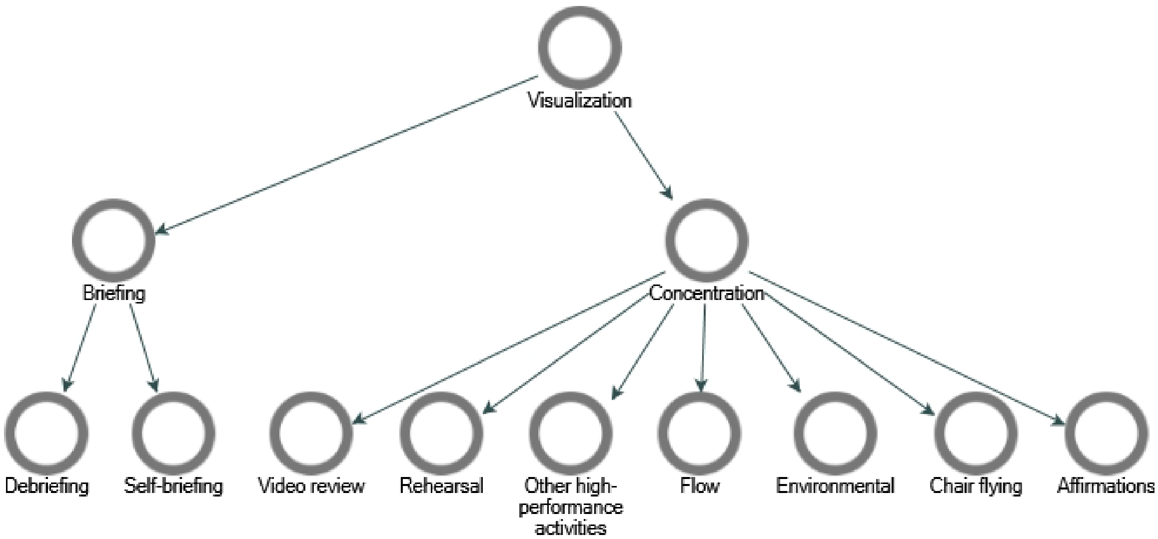
Mindfulness, Themes Map



Visualization. Mission briefing, flight debriefing, chair-flying, and staying focused before the display via a variety of methods, including a video review, were all mentioned by interviewees as ways to practice mindfulness through visualization (see Figure 44).

Figure 44

Visualization Theme, Codes, and Subcodes Map



The value and necessity of a preflight briefing were emphasized by the majority of interviewees, whether they were members of a demonstration team or solo display pilots. With the following statement, a team leader emphasized the importance of the briefing:

> As a team, the brief will be the generalization or the focus time before a flight. Our brief will generally be about an hour and a half prior to our air show time or the smoke on time, for example.

The length and style of the briefing differ based on the team and their culture, according to the same respondent:

> With a team, this briefing moment is very important. It is interesting because this varies depending on the team's culture. One team's briefing will last one-hour minimum, and it is very long, and they review so many things. (...) Another team is doing their briefing very easily: They brief in the jet number five on the ramp,

> and it is a quick briefing, with the leader who gives the air show's specifics, such as obstacles, antennas, weather, and he goes through the routine and the radio calls. But it is probably something like 10 minutes, (...) and that is the way I also did it: Ten minutes on the essential points on the air show site.

However, briefings are essential not only for teams but also for the solo display pilot, as mentioned by an interviewee below who has been flying a fast jet solo display profile for more than three years: "I would go through our standard briefing just as a routine, although I know I am just flying at my home base. Just make the standard briefing and go through the numbers from takeoff, landing, emergencies, and so on."

Another interviewee, who was an air show performer and currently holds an FDD position, expressed concern over civilian solo air show performers' self-briefing. More specifically, it was noted that:

> One of the things that worries me is the guys who do not leave themselves enough time to fully self-brief. Sometimes we get particularly on the civilian circuit, less the military because it is regulated differently, but on the civilian circuit, you will get a guy, particularly if he has got a very popular airplane; he might get two shows in a day. And then he has got to fly from his home base to the first show. Do the show, land, turn the airplane around, get airborne, and fly to the next place.

According to that same interviewee, flying successive air shows over the weekend may not provide enough time for an air show performer to prepare for a display, and not self-briefing may result in them losing crucial information about the air show venue they are planning to fly.

Furthermore, when it came to the primary means for air show performers to concentrate and focus before a performance, the majority of interviewees reported that they used chair-flying techniques to prepare for their performance mentally. The following statement by a civilian solo air show performer supported the notion when mentioned:

> That is how I prepare, and I just go away, and I am chair-flying the sequence a number of times; I just walk up and down and go through my sequence so that I am very clear about the into the wind and out of wind turns; which way the maneuvers are going to be based upon whether it is on the crowd or off-crowd; which way I need to turn to stay on the display lines.

Other air show performers, particularly demonstration teams, reported that they prefer to stand and walk their routines, as stated by a demonstration team leader:

> During the formation part of the air show, we walk together with the maneuvers that we will practice in the air with movements of hands and walking around in a room, repeating exactly what we will do in the air show.

Another approach for visualizing the display before or after an air show has been identified as analyzing flight videos captured by onboard or ground cameras. According to an interviewee with extensive civilian air show experience:

> What I would do then, by then, the GoPro video was starting to become quite common. I am an avid videographer, so I take a lot of videos, and I would watch previous displays to focus on just getting that view that you would have in the cockpit and just running through the imagination, that kind of sensations, and things to see and where to look.

One military demonstration team leader highlighted the usage of video review, particularly with new team members, to familiarize them with the risky activity they would be doing shortly by stating that:

> We have video recordings of all the incidents and accidents that the team had in the past, so the new pilots can see what could happen to them. So, this is the first shock, and they realize that "what I will do in the next five or 10 years, it is dangerous, and I have to take the advice that my instructor." (...) So, every briefing, every video, everything that he saw in this time is a part of preparation.

Finally, another air show performer revealed that they employ affirmations before entering the aircraft as part of their mental preparation: "When I walk up to my airplane, I will say, 'Let us have today not be the day.' So, I acknowledge the risk before, as part of a preflight."

Exogenous Factor Control. After interviewees acknowledged that continuous distractions and external pressures could impact their mental performance, the theme of exogenous factor control was developed (see Figure 45). The strategies air show performers use to manage distractions are based on learning from previous aerobatic competition experiences, staying focused on their task, seeking self-isolation, following the "sacred 30 or 60-minute" rule (ICAS, 2012) by avoiding interaction with the crowd at least 30 to 60 min before the display, adhering to the standards, and adhering to realistic training, according to interviewees.

When considering the control of exogenous forces, one interviewee noted that: "It is very important for me to have a 30-minute bubble before flying, depending on the pilot, you do not need more."

Before the display, the same interviewee stressed the need to avoid any interaction with the crowd prior to the display, and this was supported by the majority of the interviewees: "It is very important that you do not go through the spectators on your way from the big room to your jets because if you have people starting to ask for autographs, you just worry and lose your concentration."

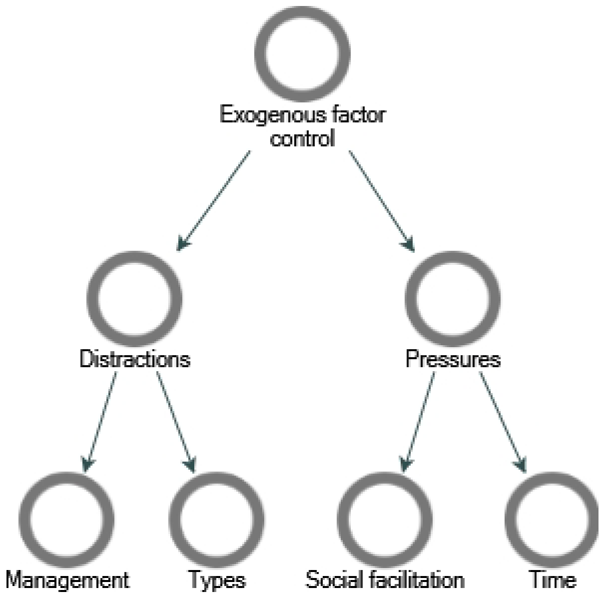
Military demonstration teams use different methods to guarantee that performers are not distracted before their display, such as delegating this job to public affairs personnel. A member of a military demonstration team reported that:

> As a Team, we have a public affairs officer that flies around with us, and his or her job is specifically to safeguard the Team from any of those air show distractions like autographs. In between that critical time, from the time we brief to the time we take off, there is nothing organized, nothing scheduled for us for that time.

On the issue of distractions, another interviewee made a clear observation: "Distractions are the second most dangerous; failure to recognize that distraction is number one."

Figure 45

Exogenous Factor Control Theme, Codes, and Subcodes Map



As described below, an air show performer stated that competitive aerobatics flying expertise was used to improve their ability to control distraction:

> But I learned all this in competition flying because in competition everybody is very careful to leave you alone. (...) I got really nervous; I did not get nervous at an air show, but flying in a box for competition, I was always nervous, and I had to learn all these tricks and mental how to manage my head game in competition flying. So, I was able to take that over to air show flying.

As one interviewee noted, sterile spaces in the air show venue for air show performers are used in various countries to avoid crowd-induced distractions and pressures:

> The FAA does not allow a lot of people behind the fence where planes are. That is great because I only want people that I know: My crew or people that are friends.

> [People] that they understand. So, there are only a few people that you want there. You do not want any distraction.

In response to the time restrictions that air show performers face, several interviewees stated that they follow a strict schedule on air show days. According to one of the air show performers interviewed:

> I schedule everything around my showtime. Suppose I have to sign autographs up in the main area or the tent. In that case, I will do that early or plan to do it after I fly, depending on what time I fly, but all those preparations are done in advance.

Distractions can lead to breakdowns of the display sequence, as mentioned during the focus group session. An air show performer with a fast jet solo display background observed, "If there is any hesitation about something, there is no hesitation; just go for the safer option."

The rest of the participants in the focus group showed consensus on this statement.

According to several interviewees, air bosses should do their utmost to ensure that participants have enough time buffer and that no unnecessary constraints are placed on them. According to one air show performer with vast experience as an air boss:

> We do make sure that there is plenty of time between the planned slot and the briefing. We leave him time enough in the program if he is flying more than once to adequately prepare from one display to another or to just be by himself if that is what he wants to do, just to tune himself up. We encourage them to go out to the airplane early because there is no public on the flight line; all he has got to do is walk around his airplane, think about what he is going to do, and then jump in and go.

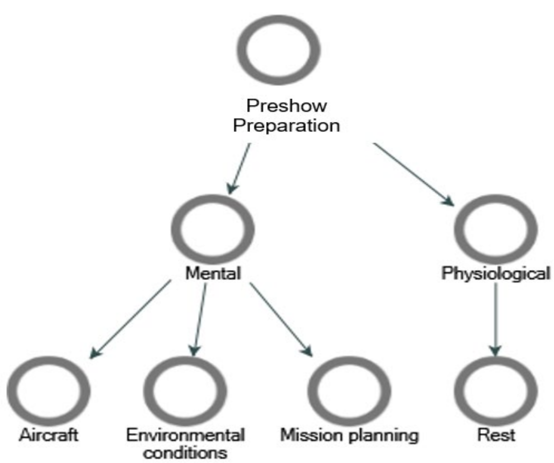
Preshow Preparation. By categorizing the interviewees' responses when describing the essential mental and physiological preparation prior to an air show, the preshow preparation theme emerged (see Figure 46). According to a military interviewee, this preparation takes several days before the air display, as mentioned below:

> The mental preparation, from my point of view, starts already several days before the air show when you prepare yourself for the display when you prepare your footprint on the surroundings, where you prepare the axes, the maps, and so on so that you think about everything, and you are not surprised by something you have not anticipated.

Another civilian air show performer added to the above statement by noting, "It starts before an air show, it starts at home, and it starts when you prepare your stuff, get your boxing supplies ready, and your ribbon cut balls: All of that is part of the mental preparation."

Figure 46

Preshow Preparation Theme, Codes, and Subcodes Map



For some of the interviewees, it was essential having their airplane's flight worthy before the display: "Then my airplane is always ready to go, so I left it ready to go, which is important to me to walk up to an airplane that's ready."

According to numerous interviewees, mentally preparing for the current wind and weather conditions at the air show site helped them develop their profile and think about their routine properly: "Then I prepare mindfully for the wind, which will be expected, and I also prepare for the wind that might be different." This was especially important because the wind direction is essential for many air show performers, as reported below by an interviewee:

> When I go to bed at night before the show, I think about what to do; I look at the weather. Especially as an air boss, you look at the weather and figure out what the wind is going to be doing. I fly the same way every time; no matter how the winds are going, it is always the same way. But the ribbon cut is wind-dependent.

The wind direction may modify the routine sequence for some air show performers, while others may keep the same sequence regardless of the wind, although display activities such as ribbon cutting are wind-dependent, according to two air show performers.

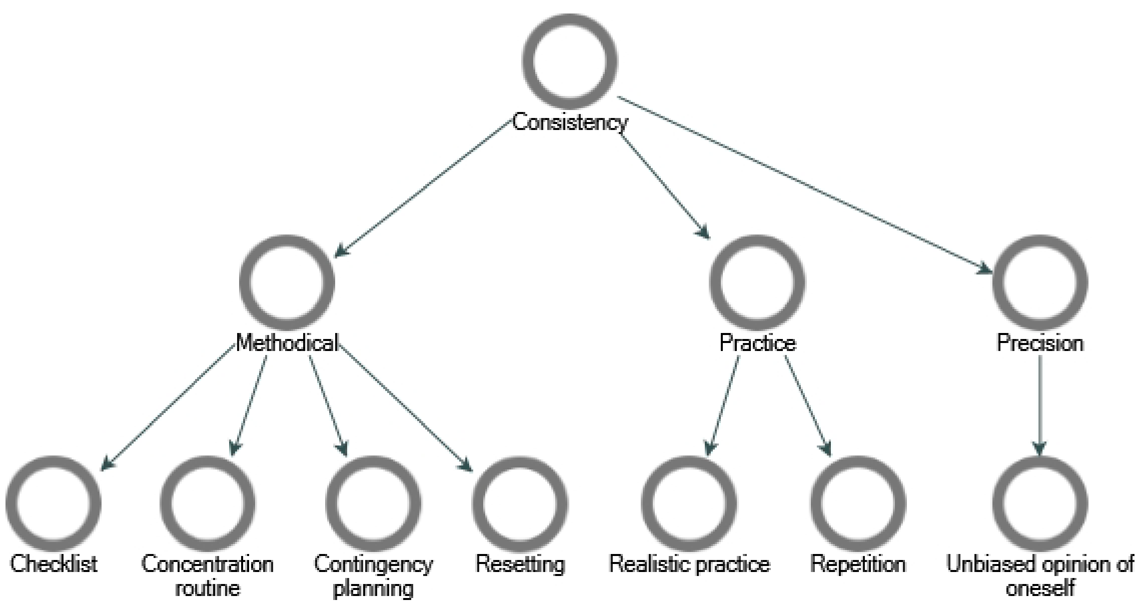
Finally, in terms of preshow preparation, the majority of the interviewees noted the need to be in good physiological conditions on air show days. Ensuring adequate and proper nutrition, which is vital, was mentioned by an experienced air show performer, while ensuring quality sleep was suggested by another interviewee as a prerequisite for optimal physiological condition.

Consistency. The consistency theme was based on statements referring to air show performers' mindful state (see Figure 47). Consistency codes included being methodical in conducting activities, repetition and practice, and maintaining an unbiased opinion to criticism. According to one interviewee, "The concentration routine is key: Briefing, strapping in, starting up the engine, taxiing, and fly."

In another interview, consistency was highlighted by an interviewee who noted, "I take some relaxed time, and then I go on my preparation for the flight. This preparation sequence is always the same, always the same." One approach that air show performers employ to maintain consistency during preparation and flying is the usage of checklists, confirmed by one interviewee: "I know a well-decorated air show performer that he uses checklists; that is how he does it." Then, another interviewee reported, "I would always fly to a show with a personal checklist of items that I would need."

Figure 47

Consistency Theme, Codes, and Subcodes Map



Resetting is a safety technique that an air show performer reported as the last defense for mitigating the risk of skipping a checklist step, even if they learned from making a mistake: “Flow goes along with that and resetting. One time, I lost that smoke cap because I did not reset.” The importance of consistent and realistic practice was then highlighted by two civilian air show performers, as described below:

> [In] every air show practice, I practice like an air show. So, I will do the same things in an air show that I do when I practice, and as I said, I practice a lot. If I did not practice very much, it would be different.

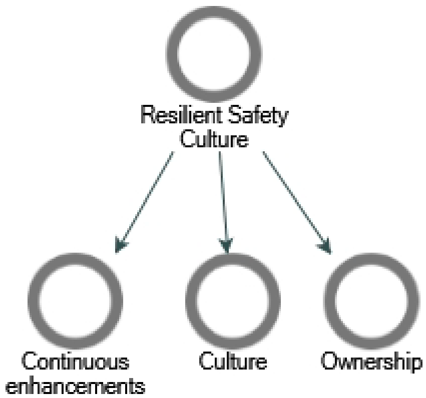
Then the second interviewee added, “But there is really only one way to do it correctly. You practice, and you learn from your mistakes, especially when you are up high.” It takes time and experience to develop consistency, but by repetition and by continuously striving for excellence, one may stay vigilant throughout their career, as mentioned by an interviewee, “I fly a sequence that’s either almost the same or exactly the same as the sequence that I flew—since the first year I had my airplane—so it is part of my DNA.”

Resilient Safety Culture, Themes

In the semi-structured interviews and the focus group, the last set of questions focused on resilient safety culture. The themes explored under the resilient safety culture area of study were culture, ownership, and continuous enhancements (see Figure 48). Due to the fact that the interviews covered a wide range of topics related to safety culture and resilient safety culture, significant coding, memoing, and analysis were used to narrow the number of themes in this area.

Figure 48

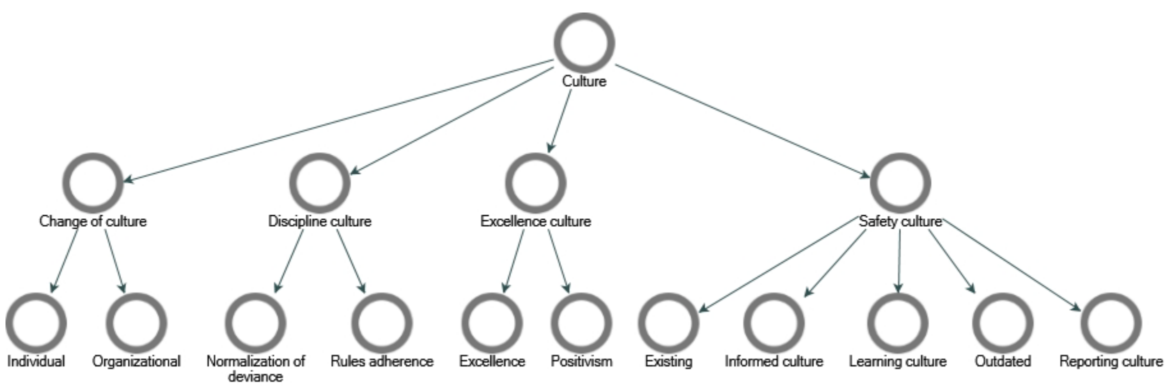
Resilient Safety Culture, Themes Map



Culture. The theme of culture emerged as one of the themes during the interview analysis (see Figure 49). The interviewees cited a variety of cultures linked to air show operations; nonetheless, the three main types of culture codes covered in the cultural theme were safety culture, excellence culture, disciplined culture, and the need for a cultural transformation.

Figure 49

Culture Theme, Codes, and Subcodes Map



The existing safety culture was described as robust by the majority of interviewees. According to one interviewee from North America, "I think it is robust if I can put it in one word. Here in North America, I feel it is a very robust culture." Another interviewee with an extensive civilian background in air shows mentioned:

> I would say that the safety culture is much stronger than it used to be that air shows are safer than they used to be. And I do not think that if you just separate the bottom third, it is not that much less entertaining of a product.

The last statement illustrates that in recent years, changes have occurred in the air show community, and numerous countries have established a safety culture. However, various countries might have different approaches to sustaining a proactive safety culture. A European air show performer reported that:

> The existing safety culture varies extremely, from Germany to Romania, Hungary, Greece, France. In some places, it is almost nonexisting, everybody is doing what they want, and in some places, I think it is almost perfect. The solution for a pilot is that you define your margin before, and then if there are different margins in the safety culture at one place, you can adapt to their laws.

Another air show performer with substantial civilian air show experience corroborated the opinions of the previous air show performer by stating that national culture influences overall safety culture:

> I think that it is very much a question of culture. The most interesting people are the Latin culture: the Spanish, the Italians. Italians are very clear, and when you see the way a military demonstration team is flying, they know the international rules, but they do not seem to stick to the rules. They consider that they have a

specific culture, which is not according to the rules. In Italy, nobody is sticking to the rules. (...) I think where there is a great maturity in the air show attitude is in England. I very rarely saw unacceptable things in England. (...) In the US, you had very few performers: You have, in fact, guys that you see very often. Otherwise, most of the time, the guys with even warbirds just do flybys, they do not do full displays, and they do not try aerobatics. So, you have a limited number of performers, and those guys are very disciplined. Sometimes what they do, especially the night shows, can be at a high altitude. But they fly in a standard way, in a standard manner, by the rules.

One interviewee described an inherent institutional culture that prevailed in the air show community some years ago:

> There was an antiauthority culture, a subculture that was a part of it that people could participate in. There was that you get more notoriety if you behave in an unsafe way; frankly, if you do not die, it might be a better air show. If you are flying recklessly and you have managed not to die, then to most people, that is a more interesting thing.

The same interviewee also acknowledged a different approach to mentoring new air show performers from past years, adding, "People are interested in that [mentoring new pilots], where they were not really interested in before, which was a type of approach 'New guy; great, welcome, try not to hit the ground.'"

Three other components of safety culture explored among interviewees were based on Reason's (1997) reporting culture, learning culture, and informed culture. According to the majority of interviewees, the current reporting culture in the air show community is built on peer-to-peer interactions and the resolution of safety concerns due to the relatively small and tight-knit size of the air show community. An interviewee from Africa stated, “The community was just too small, and if you ever had a bad attitude, you get worked out relatively quickly there.”

Another interviewee from Australia reported that:

> I think that there are not that many of those pilots, particularly in my country, and the reason is that we all know each other very well, (...) we have got a very small community anyway, so most of us know each other.

Existing formal reporting systems in the international air show community also differ by country. According to a North American interviewee, “There is no formal way; it is always, if you see something, you say something.” While another air show performer from Europe reported, “[UK] CAA points the responsibility of air show safety to the flight safety committee, display director, and pilots.” At the same time, another air show performer from Africa stated that:

> There is not a laid down safety system on paper with forms and processes there to follow, no. If the safety director red-cards an event because somebody made a mistake and went too low or breached the rules, intentionally or unintentionally, a red card is given, or the instruction to land is given, and then, of course, there would be a fight about it, maybe or maybe not depending on if the guy accepts it. But the feedback is instantaneous; the feedback is known by the whole fraternity; if someone screws up, then everyone knows about it. So, this information is floating in a melting pot that’s communal, but it is not on paper anyway.

The same interviewee then discussed the advantages and disadvantages of having an anonymous reporting system:

> I would like to see an airline-style documentary anonymous reporting system, but the implementation there would be quite a challenge because of the very varied backgrounds, activities, types of aircraft, and flying. It is quite a challenge. While maybe in an airline, the aircraft types are limited, everyone has the same goal; it is the same company. At an air show, it is different companies, different teams, it is very scattered, it is very fragmented, so it makes that kind of thing quite difficult. Is it possible? Absolutely. I just do not want to give a display pilot more paperwork to fill in. There is so much to do already.

Then, another air show performer with decades of experience as both a pilot and a flying display director emphasized the importance of institutional memory and experience transference in the air show community. This statement highlights the point:

> I am coming to the end of my career not just as a pilot but as a display organizer as well. And one of the legacies I might be able to leave is the thought of better transmissivity of experience and encouraging that exchange of experiences and ideas such that we carry things forward. I have had a great deal of fun out of my flying and a great deal of fun out of my display life, and anybody has the opportunity to do it or to be encouraged to have a go.

This experience could be passed on in a range of methods, but numerous interviewees emphasized the value of their instructor not just during training but also during the mentoring process throughout the first years of their display pilot career. According to one interviewee:

> That was a huge tip I got from my original ACE (…); my ACE sent me this paper, and it has the process to go through to get to that level of what is a professional air show pilot.

Another interviewee stated that additional ways of disseminating knowledge, such as those listed below, could be employed in the future: "There are educational tracks that should be made available online to people that can refer if they want to be an air show pilot."

In terms of informed culture, two air show performers with substantial experience in the air show industry agreed on the importance of communication and information exchange among all stakeholders in the air show community. According to the first interviewee:

> The most important thing to safety culture is that you can communicate with each other. The best safety advice comes from another performer in the air show that comes up to you and says, "You know you want to move that up, or your snap rolls are too low, or that looked really good, but you might want to think about this." And so, you get the experienced pilots helping the less experienced pilots and so on.

While the second interviewee reported that:

> First probably is communication; being able to talk to each other, to meet each other, and that is typically what EAC is designed for and useful. I think workshops at the convention can be even better than those self-presentations and what some of the guys are doing because it is not interactive enough. I think that workshops are more interactive, and people have to explain their problems to each

> of the parties: Regulators, organizers, performers, and even sponsors; so we understand better each other, the problems, and the challenges of each other. That is why communication and education are probably a way to improve the situation.

Then an interviewee who is under training to become a fast jet display pilot expressed their appreciation of having safety workshops where air show performers can talk about safety and share their experiences.

Interviewees also stated that there seems to be a culture of excellence prevalent in the current air show community, which is manifested by operators with high standards. According to one interviewee:

> The system I come from was quite of a high standard. In general, what I have seen clearly are the individuals I have flown with, the organizers I have flown under, and the team members that I have flown with are of the highest caliber- an incredible thing to have experienced.

Another interviewee stated that there is a continuing effort to increase standards within the air show community, as highlighted below: "So, there is a little bit higher bar now than there was before some years." They added that one reason that might have affected the reduction of accidents for the last couple of years in the air show community in their country is, "It is way safer now than it was: Airplanes are better, there is less tolerance for average pilots, the ACEs are held up to a standard—a lot of the ACEs that were terrible are gone."

Another air show performer stated that it is not only the air show performers who have changed their minds about operational risk and the culture of excellence but also display evaluators and ACEs who have embraced this culture of excellence and have raised the authorization standards by increasing the stringency requirements when giving display authorizations to pilots to protect not only the pilots or the air show industry but also to save the lives of those who enjoy watching air shows.

The interviewees then discussed the importance of encouraging excellence within the air show community. One interviewee highlighted the importance of sharing all the good practices and promoting safety and excellence across the air show performers, organizers, and air bosses: “I think it is really important to look at what people are doing good and why things are going well.” Another interviewee with extensive expertise in air displays and air races over the last three decades stated:

> What you seek is a positive way to move on it, not always to show the negative side, but the positive side, how to behave in the right way. With always pointing the negative side, this has been tried out, and we are actually at a standstill. But we might improve it if we go to the positive way with a good example, then the behavior could change slowly.

Another interviewee then added to that notion by stating, “There is a positive reinforcement of something done well, or you made the right decision. I am sick of negative stuff. I think it just reinforces the things to do better.”

Additionally, an interviewee with vast experience in air show flying emphasized the need for a transition in the mentality of air show performers from a safety culture to a culture of excellence, as well as the reinforcement of positive practices, as stated below:

> That is maybe not a culture of safety; it is a culture of excellence and that you can go to an air show. You can put a sticker, a patch on your flight suit that says we are a culture of excellence.

Numerous interviewees emphasized the importance of developing a culture of professional culture. More specifically, several interviewees raised the issue of normalization of deviance and its possible impact on flight safety. One of the interviewees commented:

> You need to build a culture of discipline, and you need to build a discipline within the community that they do not accept variation; they do not accept the normalization of deviance. You cannot have that; it has got to be stamped out as 'if there is any deviation, will you start progressing beyond what would be accepted? Then it is over and done with; you need to hit it until knocked off,' so it is about managing that.

Another interviewee noted the implications of normalization of deviance: "We are letting this guy slide when we should not have, and he killed people at an air show; he flew into people." Then an experienced air show performer addressed the importance of following the rules and implementing a zero-tolerance policy not just by air show performers but also by air bosses. An air show performer noted the need for change in the existing safety culture of the air show community by stating, "What has to be done is to change the culture inside the people with constant work, not with paper; it does not work with paper." Another respondent added that the way to change is to adopt a "flag behavior," as mentioned below:

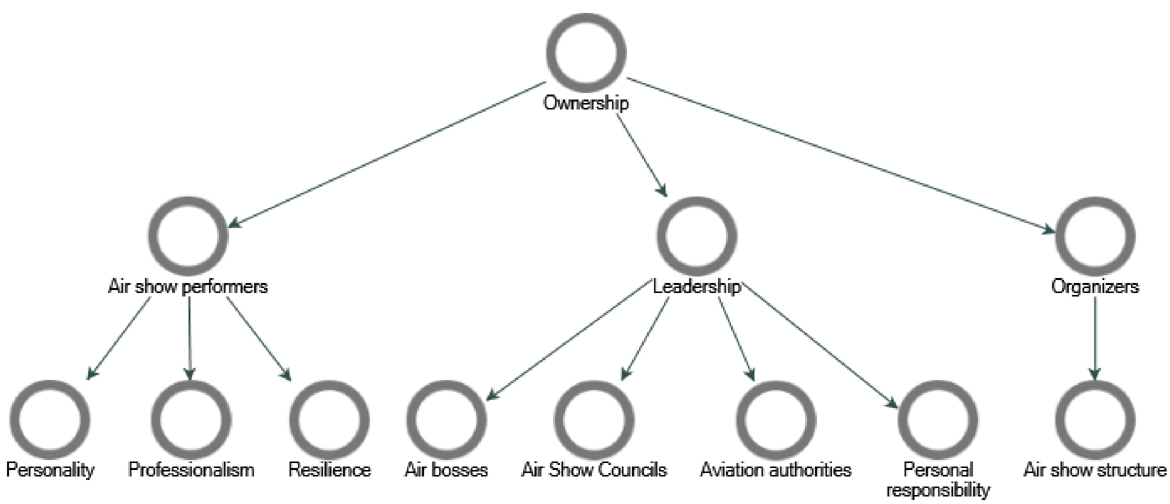
> We have to change. What we need, I call it "Flag behavior." It is like the old times with a flag falling into an instrument, but now this "Flag" has to be in the brain. This flag has to come and say, you do something I do not like – something is wrong with it. This is a culture I would like to go to – that would be my aim if I

had changed something. Also in myself, I always tried to use this flag and advised myself, "Oops, something wrong, one notchback – first, look what is happening." Some people do not have it; they think that "It is an air show now where everybody wants to be lower." It is human, but we have to make it clear in our brains and change our behavior patterns.

Ownership. The ownership issue emerged through the interviewee's discussion of the air show community's existing safety culture (see Figure 50). The ownership theme provided a better understanding of the critical need for the accountability required of air show performers, air show organizers, and the senior leadership within the entire air show community.

Figure 50

Ownership Theme, Codes, and Subcodes Map



According to interviewees, air show performers require a type of personality that enables professionalism and resilience throughout their careers in the air show community. Several interviewees indicated professional discipline as the most desirable air show performer's personality trait. An interviewee with extensive experience as both an air show performer and an air boss noted:

> In my country, pilots that have grown up in the military or been in the airlines which have had structure around the way that they go flying and how they prepare themselves to go fly, are generally the ones I had the least concern about on an air show weekend because I know that they have structure, and they have discipline in the way in which they prepare themselves and how they fly.

Another desirable personality trait highlighted by an interviewee was humility which can be critical for safety-critical stand-downs to be made despite the mission-oriented urge to proceed when the risk is highly intolerable. This statement highlights the point:

> All the pilots from Blue Angels, the Thunderbirds, Snowbirds, and many display pilots I know were very simple, humble, kind people to deal with, and I think it is very much a matter of quality.

Then, as part of the professionalism demanded of air show performers, they must be receptive to constructive criticism, as a civilian air show performer described:

> Everything is criticized. There are like 100 things that the competition pilot gets marked for, and he knows this before. So, to be critiqued and to fly correctly is just like DNA. I think that is the way for a pilot to grow.

The desirable personality trait of resilience was highlighted as part of the interviews. According to an interviewee with substantial military demonstration team flying experience, air show performers must learn to anticipate and respond to the unexpected, as stated below:

> A couple of years ago, I had an accident, but I always thought that something like that could happen to me. So, I always say to other pilots that if they think that they are exceptional ones, they should always think that they will make some mistake, which is normal.

The ability of air show performers to adapt to unexpected situations is critical, as reported by another air show performer.

The interviewees shared their opinions on the existing leadership in the air show community, including the roles of air bosses, air show councils, and aviation authorities, as well as the personal responsibility that everyone bears. According to an interviewee, an air boss must exhibit certain traits to foster a safety culture and the effective performance of an air show, as outlined below:

> I feel that the starting point for that at every air show is the air boss. So, if the air boss has a strict way of managing that show, the show goes smoothly. If he is confident, if he has a good plan, if the schedule is well thought out, if he is good at controlling the acts and keeping everything ticking along, and having a high capacity, high-level situational awareness to know what is happening around the show, they go on clockwork, and it works out really well…they will set the tone for that weekend.

Another interviewee with extensive experience flying in air shows stated that certain air bosses' behavior toward air show performers needed to be addressed:

> We go to briefings every week, every air show, and they are the same thing. If you see the same old thing, it is like, in a way, they talk down to the performer a lot, "Okay, do not do anything stupid." They are always saying stuff like; do I

really need this guy to tell me not to do anything stupid. Is it really going to make a difference on Saturday morning? If I had not figured that out before I got here, then I am in deep trouble. They should not be talking to me like this, and that is somebody who has never flown an airplane down low or done aerobatics, an air traffic controller, let us say; that is great, but do not tell me not to do anything stupid, "Do not do nothing dumb," is how they treat it, and they yell at you if you ask a question, they get mad, it is terrible.

The interviewees also discussed the importance of air show councils, particularly the EAC and ICAS. One European interviewee stated that:

> What EAC should be able to promote is not to be a regulator but to educate people; I think it is very important. Education, education, education, education (…) it is not EAC's role to train the guys but educate them to point out the safe attitudes for pilots, display directors, as well as all the regulators.

A North American air show performer emphasized the essential role that ICAS played in creating the ACE system for granting display licenses to air show performers by noting that:

> The people involved in ICAS started saying this [high accident rate] is bad for business. Furthermore, the ACE committee got a little tougher, and it started to get a little bit better, and then a couple of people that were notorious for being scary died.

Additionally, the same interviewee acknowledged ICAS's philanthropic role.

Nonetheless, one of the most crucial functions of air show councils is to organize their annual convention, which provides significant benefits to air show performers and offers an opportunity for them to network and share experiences, as one experienced air show performer highlighted.

Another interviewee stated that air show councils could do more to promote a safety culture within the air show community by stating, “But you cannot just come out once a year at a convention and say we are going to have a safety culture; there has to be a lot more.”

Numerous interviewees emphasized the aviation authorities’ role in facilitating the air show community, particularly in terms of display permit rules and processes. According to a performer at a European air show, “If you consider the UK, Switzerland, all Scandinavian countries, even Netherlands, there is a display authorization process. This means that you need an evaluator to authorize you to fly a specific display.” This was buttressed by another air show performer who added that: “The Americans try a little bit by the ACE system with the evaluators, but often the evaluator himself is too good, or he gives his buddy a low-level waiver.”

The same issue concerning the ACE system in North America was also brought to the attention of several other air show performers, both Americans and people from other countries. One air show performer from the United States claimed similar behavior from now-defunct ACEs, “It was friends, good old boys kind of network. It was friends ACEing friends, and that was prevalent.”

Interviewees also highlighted the critical role and function of leadership in aviation authorities, both civilian and military, in selecting air show pilots. An air show performer with military demo team experience, when discussing pilot’s selection criteria, stated:

> Using our selection criteria to make sure that we are picking the top performers in the communities that come to us. We mitigate it based on our entry requirements; usually, one needs to have a fighter or ejection seat background. A lot of our pilots now for the Team will come from an instructional background; so that is one way that will mitigate that just by the selection criteria of making sure that people have at least the most amount of high performance, high speed, ejection seat time as possible as we can.

An interviewee with a civilian background also stated, "Talking about safety culture and procedure starts with the recruitment of the pilots, then with the training, the good living, sleeping conditions, and lastly, how you set up a display."

In terms of the need for personal responsibility and leadership skills as enduring attributes for air show performers, there seems to be a consensus among interviewees. According to one interviewee, "Unfortunately, it comes down to the individual pilots to execute on the day. The air show fraternity can only do so much, but it is an incredibly high-risk environment." Likewise, another interviewee emphasized the significance of recognizing the potential threat of not performing safely during an air show by adding, "The reputational and the financial damage of not doing it safely and having an outcome where it can come back on the pilot or back on the organizer, it is just not worth it."

It is noteworthy that the majority of interviewees confirmed that all air show community stakeholders share duty and accountability for establishing an effective safety culture in the air show community. According to one North American air show performer:

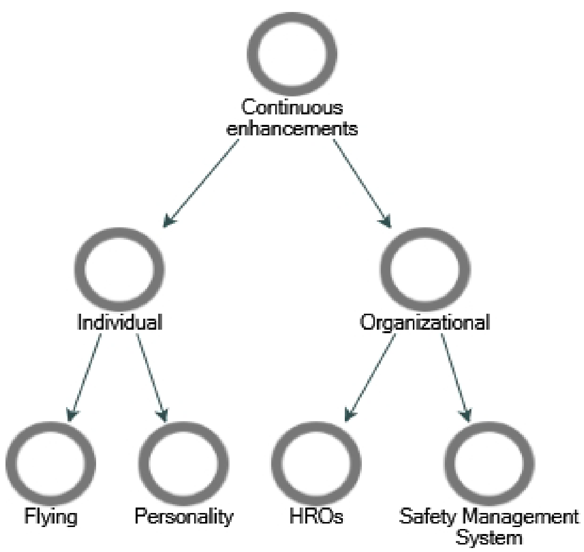
> These shows over here are very structured. There is a tremendous amount of security; it is very regimented. It is not a flying circus; everything is always overstructured, but in the interest of the air show and the safety of the people is very structured. So, the hot ramp is a sterile area, and everything is thought about, how fuel trucks are going in, where they are going in. So, I think it is pretty good.

In addition, the same air show performer stated that regardless of the size of the air show, air shows in their country follow standardized safety requirements.

Continuous Enhancements. During the interview coding process, the themes of continuous enhancements were explored as a component of safety culture (see Figure 51). According to Hollnagel (2010), continual improvement of safety is part of a robust, resilient safety culture.

Figure 51

Continuous Enhancements Theme, Codes, and Subcodes Map



Several interviewees agreed that air show performers should enhance their flying abilities as well as their behavior. A few interviewees indicated that air show performers should consider including altitude margins to improve their flying, as one interviewee put it:

> No one talks about [altitude] margins now. We forced the conversation now, sort of like a buzzword that everybody is accepting, but no one talked about margins until about five years ago. And so, you got minimums, but that is your minimum not to die. What is your margin for an air show so that you do not even think about it, and a lot of people do not have those.

Another interviewee added, commenting:

> Just because you are clear to 100 feet or 250 feet for rolling maneuvers – it does not mean to say you have to fly at that height; it is the basic rule below which you must not come. So why fly at it because any minor distraction could put you underneath that height. So, it is always best to leave a little bit of a cushion. But you do get these pilots who determinedly fly down to the limit because they can, and they are the guys I worry about.

Another interviewee noted that air show performers should constantly consider creating margins for error so that they can react if any distraction or unforeseen event happens during their demonstration in the high threat low-level aerobatic environment.

Individual air show performers' performance enhancement should be centered on monitoring ego, according to some interviewees. A characteristic statement by one interviewee was, "You cannot have so many pilots—with individual goals and individual egos—egos are checked at the door."

At the organizational level, several interviewees cited the four pillars of the safety management system (FAA, 2020b) as a way to improve the international air show community further. Several interviewees expressed concern about the safety policy and objectives component of an SMS, pointing out that overregulation exists in their nation's air show sectors. One interviewee with vast experience as an air show performer, air boss, and part of their country's regulatory team stated:

> One of the offshoots, of course, of regulating or overregulating is the paperwork that's demanded each and every show, and pilots and paperwork do not mix well. The danger about insisting on minutiae in the paperwork is that the guys will gloss over it.

Then another air show performer added, "What we are doing now is just filling out more papers and more papers, and they think it would make it better. It does not work with paper. It has to be here [brain] and here [heart]."

At the organizational level, interviewees suggested that the air show community might learn from other high-risk aviation activities such as Red Bull air races, as mentioned in several interviews. One interviewee emphasized the level of safety attained in this specific type of air race: "Almost 100 [Red Bull air] races without an accident; it is quite an achievement. There were hairy situations, but luckily no one died."

Then, another interviewee who has vast expertise in aerobatic competition and air show flying noted that rigorous restrictions applied in aerobatic competitions had improved the operational safety records. An air show performer with substantial aerobatic competition experience explained, "In competitions, you get criticism for everything you do. You have to take a lot of it. Every flight is critiqued, and all other pilots are watching you; it is very difficult."

Another organization that was not tied to the aviation sector but rather to motorsports, notably Formula 1 racing, was identified by an air show performer who highlighted Formula 1's remarkable safety records, pointing out:

> When you see today's Formula 1, which is by definition a dangerous business, they managed to achieve an unbelievable level of safety. We saw that they use new safety technologies, such as the halo [safety device] that they have included on the cockpits and how they stay safe. (...) Today, they managed to get a secure record, which is quite high if you consider the level of risk or potential risk their activity has.

In summary, the interviewee suggested that the air show community could learn from and emulate Formula 1's successful safety record advancements to enhance the driver's protection through the use of modern technology such as the halo system (Rosalie & Malone, 2018). Another rule regulated by Formula 1, which may be valuable to enhancing the air show performers' safety, is driver protection equipment, such as fire-resistant coveralls and crash-resistant helmets (Mellor, 2002).

Documentary Analysis

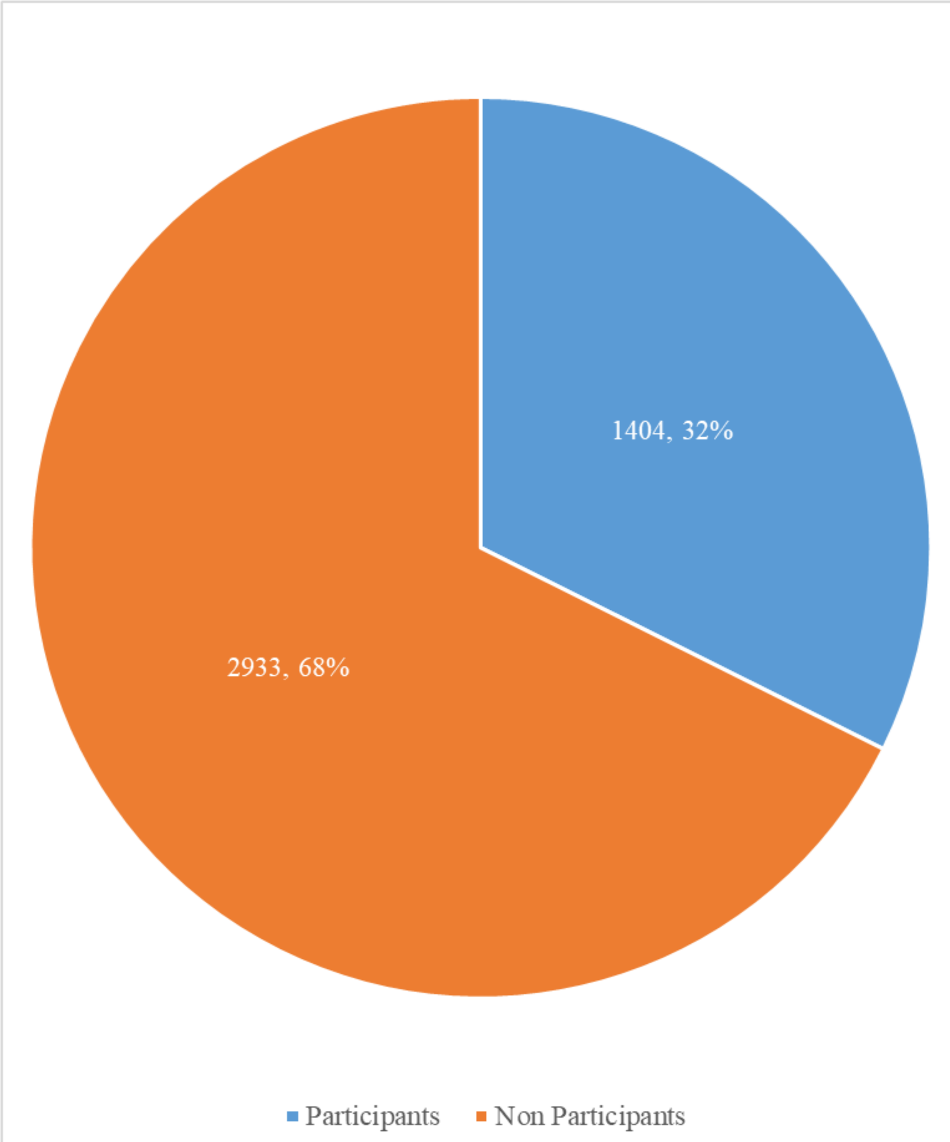
As part of the overall research objective of data triangulation, a comprehensive documentary analysis was performed, as suggested by Maxwell (2012). On top of the documents analyzed in the literature review chapter, the material analyzed included numerous international air show rules and regulations, both from civilian and military organizations, presentations, and newsletters from the ICAS and the EAC.

Factual Air Show Data

A descriptive analysis of documentary data of air show safety events compiled by Barker (2003, 2020b) was conducted to provide context to the state of safety within the air show industry. The findings suggest a total of 1,380 accidents and incidents were recorded over the 111-year period from 1908 to 2019, which included 4,337 casualties. The fatalities and injuries sustained during air show events are depicted in Figure 52. The findings suggest a worrisome trend in the excessive number of spectators, passengers, and nonparticipants killed or injured.

Figure 52

Air Show Casualties, 1908 to 2019



Air Show Accident and Incident Causal Factors

According to air show accident data compiled by Barker (2020a), the primary causal factors of air show accidents and incidents were the human factor, the machine, and then the medium. The respective involvement in accidents and incidents was 69% (n = 949) for humans, while the machine contributed 24% (n = 325), and the medium in 7% (n = 104) of the accidents and incidents (see Appendix K, Figure 76).

Human. The human factor contributed to air show accidents and incidents in such a way that caused an aerial vehicle to a flight into terrain (FIT), loss of control (LOC), midair collision (MAC), or a flight into an object (FIO). Pilot error has contributed to accidents and incidents due to negligence, poor oversight, noncompliance with standard operating procedures, or not operating the aircraft under the manufacturer's instructions. In addition, the pilot's incapacitation during display flying may arise from either a specific medical condition or from G-induced loss of consciousness (G-LOC). The human contribution to accidents and incidents is shown in Appendix K, Figure 77.

Machine. Machine, comprising both mechanical and structural failure, contributed to accidents and incidents to a total of 24% (n = 325; see Appendix K, Figure 78 and Figure 79).

Medium. One hundred four (n = 104) accidents and incidents occurred due to the medium factor at air shows worldwide over the period 1908 to 2019, resulting in 204 casualties. Bird strikes imposed the most significant risk at 28% (n = 28; see Appendix K, Figure 80).

Air Show Accidents and Incidents by Event Categories

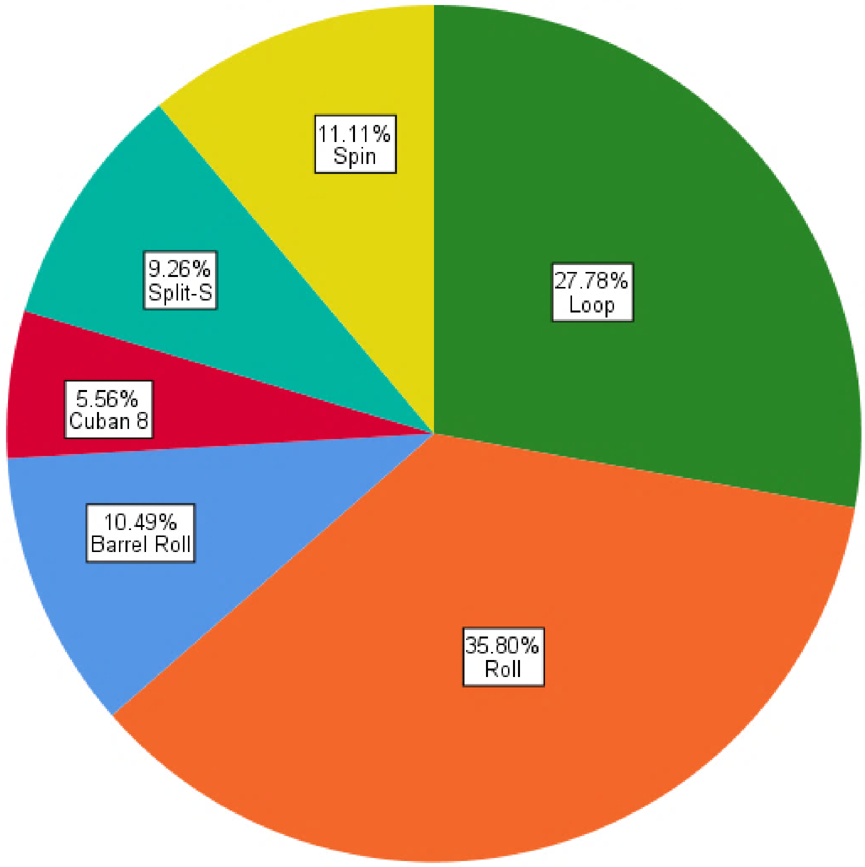
Accidents and incidents occurred in 73% (n = 1,005) of cases during the actual event, compared to 27% (n = 375) during practices or rehearsals (see Appendix K, Figure 81).

Display Profile Maneuvering

More than 20 different maneuvers contributed to an accident or incident in an accident database compiled by Barker (2003, 2020b). The distribution of aerobatic maneuvers with a high propensity to trigger air show accidents or incidents with fatal outcomes were the roll, the loop, the spin, the barrel roll, the Spilt S, and the Cuban 8 (see Figure 53).

Figure 53

Air Show Accidents and Incidents, Aerobatic Maneuvers



Qualitative Research Questions

Answers to the qualitative research questions are provided below based on the validation process of the acquired qualitative data from air show observation, semi-structured interviews, focus group, documentary analysis, and factual air show data.

Research Question 3

What forms of mindfulness strategies do air show performers employ preflight?

As revealed by the themes that emerged from the qualitative data analysis, mindfulness strategies employed preflight started days before the air show. To achieve the consistency specified by the interviewees, preshow preparation for the required mission planning and practice is essential.

The most profound and common method for air show performers was revealed to be the visualization of the display flight, which began during the air show safety briefing, was followed by the self-briefing or team briefing, and was then concluded by a chair-flying or walkthrough of the display in an isolated area away from the crowd and the media.

Numerous mindfulness practices are used throughout the air show performers' flying training. The majority of military organizations provide simulator training to display pilots to mentally prepare them for normal and abnormal flight scenarios. Additionally, it was reported that a typical practice among both civilian and military air show performers is for beginner pilots to fly in the back seat to appreciate the presence of the crowd throughout the air show, gaining experience and strengthening their emotional resilience. This type of training provides air show performers with the essential abilities to manage exogenous factors such as crowd distractions and pressures, as well as time constraints imposed by event organizers during the demonstration. Isolation from the crowd prior to the display was also critical for air show performers to maintain their focus and awareness both before and during the demonstration.

Additionally, air show performers utilized several methods to mentally prepare for an air show. First, to monitor their inflight performance, air show performers reviewed videos of their recorded flights. Then, automatically filled-in grade sheets for individual maneuvers were used by several military single-ship demonstration teams.

Research Question 4

How do air show performers perceive and tolerate risk preflight?

The findings suggested that as part of preflight, air show performers conduct a thorough risk assessment of the human factor, the aircraft they are flying, display management, and risks related to the physical and societal medium they are operating at, as well as the mission profile they perform themselves.

Results suggest that air show performers should accept the risks that are tolerable based on their training, experiences, and contextual complexities such as weather during displays to ensure the safety of themselves, audiences, and the industry. It is critical that the entire air show industry functions as a system to assist air show performers in identifying unanticipated threats during their demonstration by providing standardized risk assessment matrices for displays to air bosses and encouraging voluntary safety reporting of identified or anticipated threats to aviation authorities or air show councils.

These risk assessment matrices, either on paper or by utilizing a personal checklist, can help to detect threats related to physiological, psychological, and display execution. Other proactive risk mitigation measures, such as the adoption of preflight safety buffers, namely the FAA's (2016) IMSAFE strategy, by air show performers are strongly encouraged whenever their fitness for flight is in doubt.

The use of safety observers on the ground is highly recommended, especially for military operators. The duties of safety observers are similar to those of a wingman in that they provide mutual support by keeping an eye on the air show performer's airspace, having extra eyes on the ground, and performing an additional cross-check to verify that they fly an exact display while entering their energy gates safely.

The responsibility and accountability for flying display-related safety risks were discussed, and differences between the military and civilian performers were intuitive. In terms of the military, generally, risk tolerability and approval for higher levels of risk for any display followed an authority hierarchy. The final decision to accept any escalated form of risk associated with the air show is approved by a senior officer or a supervisor in the next higher chain of command. On the contrary, risk acceptance for civilian air show performers lies on the individual air show performer or each member of the team in case of a formation flying activity.

Research Question 5

How do air show performers perceive and tolerate risk inflight?

In summary, the interviewees suggested that air show performers concentrate on their display and keep on their flow as soon as they are airborne, avoiding anticipated threats or adequately prepared to deal with the challenges associated with such threats. In the air, the primary threats faced are distraction or disruption that may derail them from their display flow, such as unplanned traffic entering the display area, which can lead to immediate cessation of displays in line with safety,

If there is any aircraft malfunction during their display, air show performers prioritize personal and audience safety by landing as soon as practicable at the nearest suitable airfield. Threats and associated risk of the medium (environmental) factor, like density altitude, are normally identified and mitigated through meticulous preflight preparation and rehearsal at the air show site. That allows show performers to develop the necessary flow and capabilities to anticipate variations in both human and aircraft performance.

Another inflight threat with significant risk consideration was identified as changes in the cloud base, especially when adverse weather was approaching the air show site. For air show performers, one means of coping with such a threat is a preflight commitment to a low cloud base show, which allows them to maintain clearance from the clouds while remaining in visual meteorological conditions. Then the wind was identified as another risk factor, especially if it created turbulence in the air show site, that mainly affected air show performers executing formation aerobatics. Some of the mitigation strategies for these environmental threats and associated risks were to widen up the formation and raise the minimum altitude for the display or move their display line further away from the crowd.

Overwater display was perceived as having a considerable risk for air show performers due to the effects on the pilot's visual and depth perception. Again, this threat and risk associated with it are typically identified during the planning phase before the air show, and if it became a factor during the actual flight, air show performers would raise their minimum display altitude to prevent any potential risk for a CFIT.

The crowd at the air show could be a distraction for air show performers, particularly those with little expertise flying in air shows. A strategy for air show performers to cope with the presence of a crowd while in flight is to stay focused on the mission flow and avoid looking at the crowd during the display.

Risks related to the display's execution and the maneuvers to be practiced are already identified and mitigated with repetitive and correct practices before the air show. Furthermore, in most countries, performers must define a specific profile routine to regulators and the air boss on the day of the demonstration and adhere to that profile during their flying. Adhering to their schedule and avoiding any impromptu or unplanned maneuvers inflight might be a method to accept the risk associated with the maneuvers and the display profile.

Research Question 6

What are the most common hazardous attitudes observed among air show performers?

Generally, there seems to be an agreement among most respondents that currently, the number of air show performers with demonstrable hazardous attitudes seems to be dwindling as compared to previous years. However, there are occasional incidents and accidents that suggest that these attitudes were contributory factors. These hazardous attitudes suggested by FAA, such as invulnerability, impulsivity, machismo, and antiauthority, can still be identified among some performers and the data suggest that invulnerability seems more prominent among performers. Interestingly, minimal mention was made about the identification of resignation among air show performers.

Concealed hazardous attitudes, differentiated from those suggested by the FAA, were also suggested by research participants. Ego as an attitude was highlighted, and egocentric air show performers were characterized as ones who looked out for only themselves, were apt to show off to their peers, family, and friends, and put at risk the rest of the air show community.

Interviewees suggested that deficient technical knowledge and “stick-rudder” skills imperiled the operational environment for both individual air show operators and the entire community. Some of these deficient air show performers include those who lack air show operational experiences, professional discipline, flying skills, and preparation before the flight. The findings also suggest that air show performers that lacked financial resources, could accept significant risks and dangerously conduct flight displays.

Distraction during air show performances was identified and discussed. This is the air show performer who becomes easily distracted by emotional and family issues, the crowd, social media and is not focused on being a safe and efficient air show performer.

Being unorganized was a concealed attitude for air show performers. Individuals who are not methodically organized in their preparation and execution of the display, behaving, and flying sloppy could be dangerous personalities in the air show community.

Efforts should be made by all stakeholders in the air show community to identify and adopt mitigation strategies that will minimize the adverse effects of these listed hazardous attitudes. Some of the effective efforts include mentoring by show instructors and evaluators, recurrent or continuous education programs for air show performers, and informal hangar sessions facilitated by peers. That can bring nonconforming air show operators up to the required standards of the international air show community, or if they do not transform, remove them from membership of the air show community.

Research Question 7

How does air show performers' operational experience influence their perception of resilient safety culture?

Regardless of their operational experience in the air show community, the sustenance of resilient safety culture could be a key to high-reliability continuous enhancement of safety in the air show industry. The interviewees intimated that the higher the experience and exposure of an air show performer, the higher their expectations in terms of safety from the air show community. Experienced air show performers expect high standards from the rest of the display pilots and the management of air shows, specifically from the air bosses.

Highly experienced air show performers have built-in resilience skills that help them anticipate the unexpected and manage any distractions and interruptions before and during the display. Paradoxically, some of these highly experienced pilots, especially those who fly solo twice or three times per day in air shows, could end up being complacent and conduct hazardous display profiles that could harm themselves and the entire air show community.

Inexperienced air show performers could sometimes overestimate their skills and capabilities, which is an intrinsic threat with safety risk (Dunning, 2011), and in the strive to ensure a culture of excellence and resilience, it is these novices air show performers must be mentored by more experienced and safety-conscious display performers. Experienced, respected, and safety-conscious mentors should be willing to share their experiences and learning outcomes accrued over the years in the air show display business with others to engender the transfer and retention of organizational knowledge.

Irrespective of the level of air show flying experience, the findings suggested that most air show performers are inclined to accept and embrace a resilient safety culture that emphasizes best practices across the international air show community. It will be expedient for the more experienced air show performers with leadership or supervisory roles such as instructors, mentors, subject matter experts, and evaluators to spearhead the culture of proactive and resilient safety in the air show community.

Data Triangulation Using Correlation Heatmaps

The first research question focuses on the strength of relationships between resilient safety culture, safety risk parameters, and mindfulness in the international air show community. The five qualitative research questions focused on air show performers' mindfulness strategies, risk perceptions and tolerance pre and inflight, observed hazardous attitudes, and perceptions within a resilient safety culture.

A correlation heatmap (see Figure 54) visualized the comprehensive association of the research variables that were derived after the quantitative and qualitative data had been triangulated into a mixed data set, generating acceptable and relevant inferences in mixed-methods studies (Younas et al., 2021). The 30 correlations between the research variables were displayed as a matrix of color tiles, where each tile represented a correlation derived by the quantitative (Quant), qualitative (Qual.), and final mixed result (Mix.) resulted after the data triangulation/synthesis (Heyvaert et al., 2011; Younas et al., 2021).

Figure 54

Correlation Heatmap: Joint Display of Findings for Research Variables, Total Triangulated Association, Pre-Data Analysis

RT												
HA												
MF												
RSC												
	Quant.	Qual.	Mix.	Quant.	Qual.	Mix.	Quant.	Qual.	Mix.	Quant.	Qual.	Mix.
	RP			RT			HA			MF		

Correlation

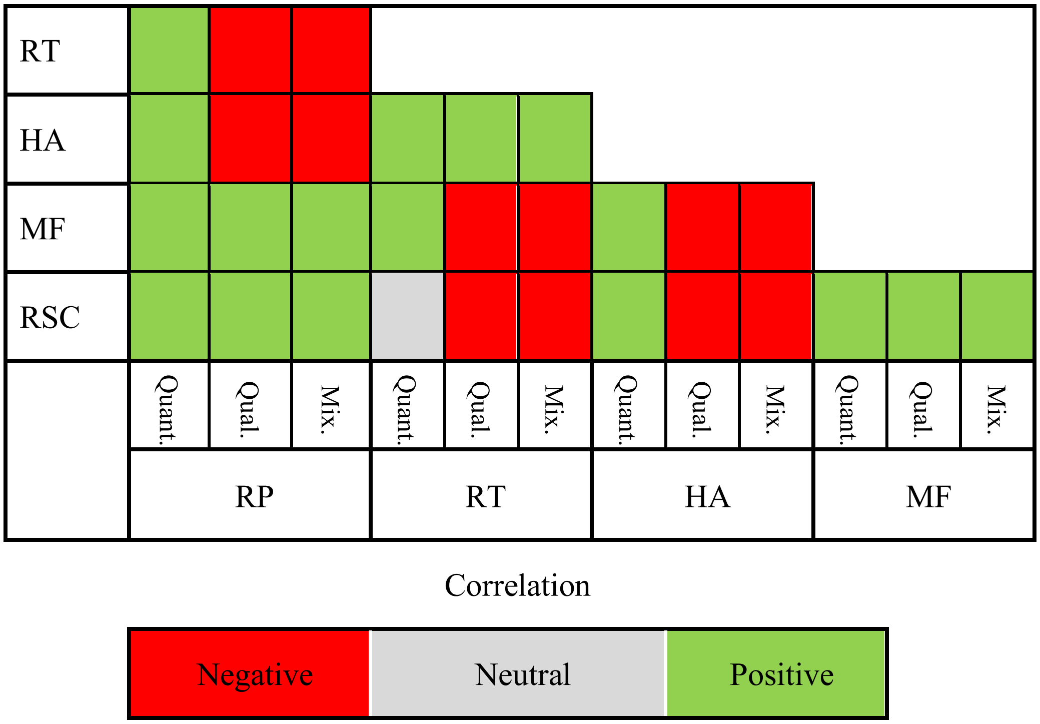
Negative	Neutral	Positive

To ensure the correlation heatmap was intuitive to the reader, vivid colors were selected, as suggested by Wilke (2019). Light grey color represented that there was no correlation among a set of two variables; red color represented a negative correlation among a set of two variables; green color represented a positive correlation among a set of two variables.

The correlation heatmap shown in Figure 55 depicts the comprehensive association of the research variables that were derived after the quantitative and qualitative data had been triangulated into a mixed data set.

Figure 55

Correlation Heatmap: Joint Display of Findings for Research Variables, Total Triangulated Association



Every research variable is discussed here as a combination of data from the two different types of research questions: Quantitative (Research Question 1) and qualitative (Research Questions 3, 4, 5, 6, and 7).

Risk Perception

The quantitative findings show that risk perception had no significant predictive relationship with resilient safety culture. Moreover, the quantitative results indicate a moderate positive correlation between risk perception and risk tolerance, hazardous attitudes, and mindfulness. Thus, when respondents' risk perception increases, they become more risk-averse, and their hazardous behaviors gradually increase. This finding could be the result of complacency introduced by overconfidence in past outstanding performances (Dekker & Woods, 2010).

The qualitative findings, on the other hand, reveal that air show performers' risk perception has a negative relationship with risk tolerance and hazardous attitudes. The findings support previous research that found a negative relationship between risk perceptions and higher risk-taking behaviors (Drinkwater & Molesworth, 2010; Ji et al., 2011; Joseph & Reddy, 2013; You et al., 2013).

Furthermore, the qualitative findings reveal a favorable association between risk perception, mindfulness, and resilient safety culture, confirming the observation that insufficient risk assessment can lead to poor decision-making, culminating in catastrophic aircraft accidents (AAIB, 2017).

Risk Tolerance

The quantitative findings show that risk tolerance had a significant predictive relationship with mindfulness among respondents. Moreover, the quantitative results indicate a significant positive correlation between risk tolerance and hazardous attitudes, as well as risk perception.

The qualitative findings, on the other hand, reveal a negative relationship between risk tolerance, mindfulness, and resilient safety culture among the interviewees. In addition, risk tolerance is positively connected to hazardous attitudes, contradicting Hunter's (2002) claim that there is no substantial relationship between risk tolerance and aviation incidents related to hazardous attitudes.

Even though there has been a strong focus on safety in the air show community in the past years, unfortunately, fatal accidents still happen, and people lose their lives every year (Barker, 2020a). The high level of risk involved in air show flying requires an appropriate and relevant level of professionalism and risk management at all levels of administration, from the aviation authorities to the air show organizers, air bosses, and ultimately the air show performers themselves. As suggested by several interviewees, in line with the literature (Barker, 2020a; Chen & Chen, 2014; Schopf et al., 2021), air bosses have the main responsibility to demonstrate effective leadership in managing risks during the planning and execution phase of an aerial event, eliminating the likelihood and severity of any potential risks, while minimizing or zeroing the adverse effects to the public and to the air show industry itself.

Hazardous Attitudes

The quantitative findings show that hazardous attitudes have a significant predictive relationship with resilient safety culture among respondents. Also, mindfulness as a mediator improves the total effect of hazardous attitudes on resilient safety culture. Lastly, the quantitative results indicate a significant positive correlation between hazardous attitudes and both risk perception and tolerance, as well as mindfulness.

The qualitative findings reveal that the hazardous attitudes of air show performers are associated with a negative relationship with risk perception, mindfulness, and resilient safety culture, confirming previous research that suggests that hazardous attitudes contribute to poor pilot decision-making (Hunter, 2005; Ji et al., 2011).

Furthermore, hazardous attitudes are found to be positively related to risk tolerance, confirming the findings of Martinussen and Hunter (2018), who state that hazardous attitudes are one of the numerous psychological constructs identified as a potential factor influencing decision-making and impacting the likelihood of being involved in an accident.

The results reveal that display pilots may behave dangerously without any prior signs of hazardous attitudes, which supports Papadakis' (2008) suggestion that display pilots may act unsafely due to latent factors without any earlier signals of hazardous attitudes. Moreover, the findings of the interviews reveal hazardous attitudes that may explain the differences in attitudes among air show performers and highlight endogenous personality traits, such as egotism.

Mindfulness

The quantitative findings show that mindfulness has significant predictive power for risk perception, risk tolerance, resilient safety culture, and hazardous attitudes among respondents. Also, mindfulness as a mediator improves the total effect of hazardous attitudes, risk perception, and risk tolerance on resilient safety culture.

The qualitative findings indicate that the mindfulness of air show performers is negatively associated with risk tolerance and hazardous attitudes. Additionally, mindfulness is associated with more favorable risk perception and resilient safety culture.

Mindfulness strategies may aid air show performers in decreasing their risk tolerance, which is consistent with the suggestion of Meland et al. (2015) that the effects of mindfulness training on elite individuals working in high-performance environments demonstrate a more resilient safety culture and a greater appreciation for lower levels of risk.

Additionally, the findings corroborate previous research indicating that mindfulness promotes effective decision-making (Gautam & Mathur, 2018) and has a negative correlation with pilot anxiety (Li et al., 2020). Additionally, the primary methods for improving mindfulness mentioned by interviewees corroborate the literature, which suggests that air show performers mentally prepare for their performance by using visualization techniques and adhering to the "30-minute bubble" rule (Barker, 2020a) or the "sacred 60-minute" policy (Hollowell, 2012). Nonetheless, each air show performer stated that they employ their unique methods of mindfulness that are tailored to their own needs.

Furthermore, interviewees reported that they mentally prepare for their flying display by establishing go-no-go weather criteria, energy gates, and decision-making nodes in case of an emergency. These methods concur with Martinussen and Hunter's (2018, p. 305) suggestion that another generalized approach to improving aeronautical decision making would be to create packages of predetermined decisions for various situations that may be encountered; these packages would include specific triggers for action.

Resilient Safety Culture

The quantitative findings show that resilient safety culture has a significant predictive relationship with hazardous attitudes and mindfulness and a non-significant predictive relationship with risk perception among respondents. Also, mindfulness as a mediator significantly improved the total effect of hazardous attitudes on resilient safety culture.

The qualitative findings indicate that the resilient safety culture of air show performers has a negative correlation with risk tolerance and hazardous attitudes.

Additionally, resilient safety culture is associated with increased risk perception and mindfulness.

The research findings suggest that the air show community may have the desired attributes of resilient safety culture, as suggested earlier by Akselsson et al. (2009), by emphasizing a learning culture and striving for resilience. The community has developed and utilizes forward feed control such as training and effective standard operating procedures to keep processes within safe limits. Moreover, the international air show community strives for efficiency in safety management and the integration of safety as a core business function. Finally, the findings suggest a mindful community that is cognizant of the need for high reliability, in line with the recommendations of Weick and Sutcliffe (2001, 2009).

Furthermore, the findings confirm that the air show industry is aware of cultural gaps and works to settle them - it has a systematic approach to identifying and controlling system vulnerabilities by applying effective risk management and controls. Furthermore, the air show industry is actively emulating other HROs, such as space organizations (Casler, 2014), in terms of safety culture development and risk management efficacy for complex operations (ICAS, 2016). In addition, it emphasizes efficient change management and designs for safety, and it employs a continuous improvement philosophy (Adjekum & Fernandez-Tous, 2020b; Stolzer & Goglia, 2016; Teske & Adjekum, 2022).

The findings also corroborate Hollnagel's (2014) observation that even when incidents do occur, the air show community's resilient safety culture allows the organization to adapt, recover, and operate efficiently within the margins of safety. Thus, enhancing a strong safety culture with a proactive resilient safety culture could assist an organization not only in improving its safety performance but also recovering from an upheaval (Shirali et al., 2016). Finally, the findings further support previous research (Adjekum & Fernandez-Tous, 2020b; Heese et al., 2014; Hollnagel, 2014; Hollnagel et al., 2011; Reason, 2016), which advocate for the importance of a resilient safety culture in fostering an organizational safety culture that promotes safe practices.

Demographics Analysis

The second research question examined the relationships between resilient safety culture, safety risk parameters, and mindfulness in the international air show community using air show flying experience, military or civilian flying experience, age, educational background, and marital status as demographic variables.

A correlation heatmap (Figure 56) visualized the comprehensive association of the research variables with the demographic groups that were derived after the quantitative and qualitative data had been triangulated into a mixed data set, generating acceptable and relevant inferences in mixed-methods studies (Younas et al., 2021). The 75 correlations between the research variables with the demographic groups were displayed as a matrix of color tiles, where each tile represented one correlation coefficient derived by the quantitative (Quant), qualitative (Qual.), and final mixed result (Mix.) resulted after the data triangulation/synthesis (Heyvaert et al., 2011; Younas et al., 2021).

Figure 56

Correlation Heatmap: Joint Display of Findings for Research Variables With the Demographic Groups, Total Triangulated Association, Pre-Data Analysis

	Air show flying experience			Flying experience (military)			Age			Educational background			Marital status (married)		
	Quant.	Qual.	Mix.	Quant.	Qual.	Mix.	Quant.	Qual.	Mix.	Quant.	Qual.	Mix.	Quant.	Qual.	Mix.
RP															
RT															
HA															
MF															
RSC															

Correlation

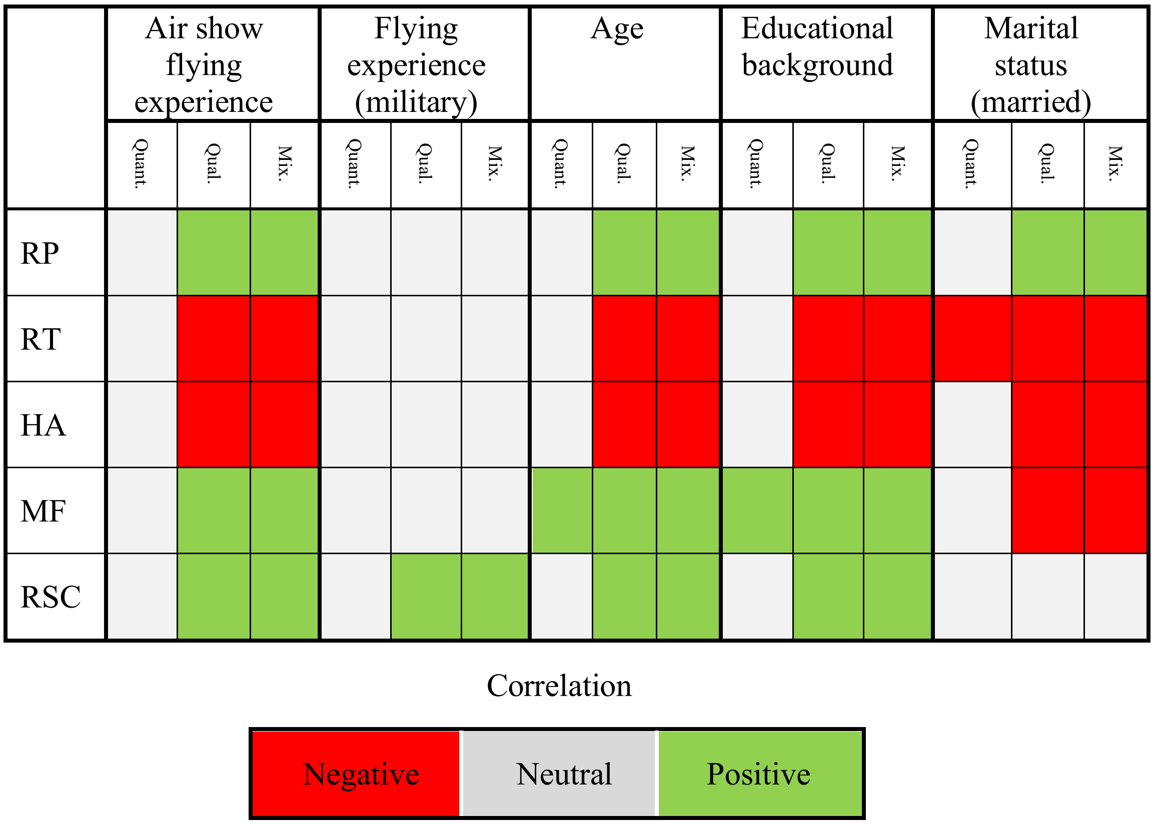
Negative	Neutral	Positive

To ensure the correlation heatmap was intuitive to the reader, vivid colors were selected, as suggested by Wilke (2019). Light grey color represented that there was no correlation among a set of two variables; red color represented a negative correlation among a set of two variables; green color represented a positive correlation among a set of two variables.

After triangulating the quantitative and qualitative data into a mixed data set, a correlation heatmap (see Figure 57) was created that depicts a comprehensive association of the research variables with the demographic groups.

Figure 57

Correlation Heatmap: Joint Display of Findings for Research Variables With the Demographic Groups, Total Triangulated Association



Air Show Flying Experience

The findings indicate that air show flying experience is positively correlated with risk perception, mindfulness, and resilient safety culture, confirming previous research indicating that experience, whether flying or performing other acts, has a definite positive association with risk perception (Crundall et al., 2013; Ferraro et al., 2015; Joseph & Reddy, 2013; Winter et al., 2019; You et al., 2013).

More specifically, the findings suggest that the more flying experience these airshow pilots have, the more training they may have gained and the more understanding they could have of the airplane's dynamics and energy management. A display pilot performing their first air show has a limited understanding of unexpected risks; their risk perception is entirely focused on the risks they have acquired through studying their training manuals, via lessons learned shared by their mentors and instructors, and during their limited exposure to low-level aerobatic environments.

These novice performers may still be unaware of additional hazards and risks that have played a role in previous air show mishaps; as Bob Hoover (Barker, 2020b) stated, "There are no new accidents, only new pilots causing old accidents."

Therefore, continuous education via mentoring may help air show performers compensate for their experience gaps, as suggested by ICAS (2018) and the UK CAA (2022). Nonetheless, the findings indicate that air show flying experience is negatively correlated with risk tolerance and hazardous attitudes, supporting Barker's (2003, 2020a) assertion that, in contrast to general aviation, air show performers' flying experience is not a guarantee of an uneventful flying display.

Additionally, several accident investigations have reported that highly experienced air show performers, particularly when performing solo, may push themselves and the aircraft to the limits, leaving no margin for error (AAIB, 2017; NTSB, 2012).

Military or Civilian Flying Experience

This study's findings reveal no significant relationship between military or civilian background and risk perception, risk tolerance, hazardous attitudes, or mindfulness. Nonetheless, the qualitative data reveal a favorable association between resilient safety cultures and air show performers with a military flying experience, owing to the introduction of SMS programs, the size of the organizations, and the control provided at all levels of risk management.

This finding may also be confirmed by Barker's (2020a) statistical data, which indicate a larger number of air show accidents between 2000 and 2020 involving civilian air show performers (n = 354) as opposed to military air show performers (n = 169).

Substantial aviation experience is required for military display pilots. Among the requirements are having previous experience in ejection seat or a fast jet, G-lab training, upset recovery training, operational risk management, and crew resource management courses, as well as significant aerobatic training over several years and in a variety of aircraft types. On the contrary, the standards for becoming an air show performer for a civilian pilot are less stringent.

Furthermore, military air show performers are part of structured organizations, which are resourceful, and have integrated SMS programs. The majority of the military organizations have already adopted safety management systems, with defined processes for safety policies, safety risk management, safety assurance, and safety promotion. Especially, operational risk assessment matrices, as a strategy for detecting hazards and risks before an air show, have been implemented with clearly identified risks and levels of accountability to accept risks before an air show.

Nevertheless, there is a dichotomy in the utility of safety risk matrices between military and civilian air show performers. According to the majority of civilian air show performers who participated in semi-structured interviews, risk assessment matrices do not provide value to the air show performer because they are viewed as a means of a bureaucratic process. Given that the bulk of air show performers fly solo and are a one-person organization responsible for everything from administration to display training and aircraft maintenance, they may view an SMS or risk matrix as unnecessary paperwork that distracts them from accomplishing their objective. However, given the scalability of SMS, as recommended by the FAA (2020b), civilian air show performers might select specific sections of an SMS and tailor them to their nature of operations, ultimately enhancing the safety of their air displays.

Age

Age was positively associated with risk perception, mindfulness, and resilient safety culture, according to the data analysis. However, the data indicate a negative correlation between age and hazardous attitudes and risk tolerance, correlating with previous research (Gibson et al., 2013; Hallahan et al., 2004), suggesting that age has an inverse relationship with risk tolerance.

The older a pilot becomes, the more mature he or she becomes in most aspects of life, and the more aware they become of the inherent daily risks they face, not just in flying but in life in general. As a result, they may be willing to accept less risk.

However, physiological factors of age, for example, heart diseases, which are addressed in medical certification for pilots (NTSB, 2012), could also affect air show performers' physiological state and overall risk assessment; yet the analysis of this risk factor was beyond the scope of this study.

Educational Background

The findings establish a positive correlation between educational background and risk perception, mindfulness, and resilient safety culture. Moreover, findings indicate a negative correlation between educational background and hazardous attitudes and risk tolerance, corroborating Chionis and Karanikas' (2018) argument that postgraduate aviation professionals are less risk-averse than their colleagues with a bachelor's degree or less.

Air show performers with a master's degree or higher have been exposed to a higher level of education and knowledge, which may contribute not only to a better understanding of risk assessment processes and theoretical implications of safety but also provides them with the analogous maturity to understand accountability against aviation authorities, but most importantly, the air show community itself.

Nevertheless, this does not imply that air show performers with lower education levels are not acceptable in the air community because they may be more risk-averse; rather, pilots with lower educational backgrounds may require more attention from regulators, mentors, and the rest of their peers to ensure that they have the appropriate risk management skills.

Extra educational activities at air show conventions, such as workshops, seminars, or webinars, as well as mentoring from more experienced display pilots, could help these pilots with less educational background.

Marital Status

The findings suggest that marital status and specifically being married, correlates positively with risk perception. By contrast, marital status negatively correlates with hazardous attitudes, mindfulness, and risk tolerance, consistent with literature findings (Hallahan et al., 2004; Aumeboonsuke & Caplanova, 2021) that indicate marital status as a key factor affecting risk tolerance scores. Finally, no association was discovered between marital status and resilient safety culture.

Considering the correlation of marital status with risk factors, mindfulness, and hazardous attitudes, emphasis should be placed on mental preparedness training (Andersen et al., 2016) for air show performers whose marital status may be a factor (Williams et al., 2010).

Consequently, lessons learned from air show performers who were preoccupied with family concerns might be discussed during the annual ICAS and EAC air show safety workshops, and mitigation methods could be provided. Also, based on the findings, groups consisting of not married, i.e., single, air show performers, could be created to provide support in lowering their risk tolerance and enhancing their risk perception (Nosita et al., 2020).

Married pilots' preoccupation with family issues may affect their mindfulness and increase their risk tolerance. Even though married airshow performers may have a more stable life than single performers, they may be preoccupied with issues involving family members, finances, and other concerns that could distract them preflight. It's worth noting that the ICAS risk assessment matrix (Appendix J, Figure 73) already includes as a risk criterion for air show performers to report how many months until they're expecting a child. This demonstrates that the air show community has already identified and addressed family-related risk factors.

CHAPTER 5. CONCLUSIONS AND RESEARCH IMPLICATIONS

A mixed-methods approach with integrated data triangulation was used to assess the strength of relationships between operational risk factors, hazardous attitude, and resilient safety culture when mediated by mindfulness in the international air show community. The quantitative approach (*n* = 156) comprised an anonymous online survey of the perceptions of respondents from the international air show community.

The qualitative approach included semi-structured interviews (*n* = 12) with a sample of SMEs in the air show community, a focus-group session (*n* = 8) with a sample of air show performers, a field observation at an air show event, and a documents analysis of historical air show safety events data.

After the collected data were triangulated, the findings suggested that resilient safety culture is significantly correlated with risk perception and mindfulness; mindfulness was strongly correlated to risk perception, meaning that the more someone is present in the air show activity, the more they can perceive potential risks.

Additionally, findings suggested that hazardous attitudes are strongly correlated with risk tolerance for the air show performers, meaning that the more someone is susceptible to a hazardous attitude, they are willing to tolerate higher risk during the air show. Mindfulness significantly mediated the relationship between hazardous attitudes, risk perception, risk tolerance, and resilient safety culture.

In terms of the demographic groups examined in the current study, it was found that air show experience enhances risk perception, mindfulness, and the overall resilient safety culture. Military air show background was strongly correlated with resilient safety culture perception, mindfulness, and a negative correlation to hazardous attitudes.

The demographic variables age and educational background strongly correlated with risk perception, mindfulness, and the overall resilient safety culture. Lastly, being married had a positive correlation with risk perception and a negative correlation with risk tolerance, mindfulness, and hazardous attitudes.

This study was conducted during a challenging period for the international air show community due to the COVID-19 pandemic. The results of this study provided a data-driven and validated measurement model to assess the relationships between the study variables in the international air show community while adding to the current paucity of literature about this sector of the aviation community.

Theoretical and practical implications from this study could shift the paradigm of a resilient safety culture that promotes safety excellence, organizational mindfulness, continuous improvements of safety, sharing of lessons learned, and retention of knowledge.

The study findings provide effective tools for threat identifications and safety risk controls during air show displays by facilitating an operational environment where risk is reduced to a level that is low as practicable (ALARP), as suggested by the ICAO's safety management manual (ICAO, 2018).

Theoretical Implications

The findings of this study provide a novel theoretical foundation for assessing the strength of relationships between risk perceptions, risk tolerance, hazardous attitudes, mindfulness, and resilient safety culture in the international air show community. Furthermore, air bosses should play an essential role in promoting safety and ensuring effective risk management.

Given their crucial position in advising the air show performers and managing the entire air show, air bosses should pay special attention to promoting safety. Because passive safety measures, such as people not following safety standards, have been demonstrated to have negative impacts, a proactive approach to safety should be considered (Olsen et al., 2021).

The findings recognize the significance of a resilient safety culture in the air show community that supports excellence, best practices, and continuous enhancements. The high degree of standards imposed in recent years demonstrates that a culture of excellence might be adopted by the air show community, as safety appears to be assured.

The findings of this study can also be utilized as a theoretical baseline to assess the study variables for other high-performance, high-risk activities, such as military combat flying, aerial vehicle testing, and other high-performance activity participants with a high level of risk and reward, such as Formula 1 drivers, MotoGP drivers, solo climbers, and circus performers, could learn strategies to enhance their performance.

Lastly, findings from this study could provide a theoretical foundation to further study the relationships between resilient safety culture, mindfulness strategies, risk management, and operational performance among personnel involved in a task that requires high reliability, such as surgeons, air-traffic operators, and nuclear plant operators.

Practical Implications

The study's findings could serve as a basis and blueprint for new training programs and could be implemented into the certification and currency courses for air show performers and air bosses. First, as Hunter (2002, p. 21) suggests, risk recognition training might be included in the training of air show performers in an attempt to improve a pilot's risk tolerance. Then, as Meland et al.(2015) recommended, mindfulness training or briefings could be included in air show performers' training, seminars, re-currencies, or display assessments to foster a more robust, resilient safety culture and tolerance for lower levels of risk.

Mindfulness training also could be beneficial for pilots and air bosses to control their egos by completing self-reflection activities and recognizing that they are part of the overall air show community, and as such, all their actions should be taken in respect to the lives of others. Additionally, Gautam and Mathur's (2020) recommendation to incorporate ego resiliency training into pilot training might be applied similarly to air show performers' training to assist in predicting and reducing hazardous attitudes, such as egocentric, impulsive, and macho attitudes.

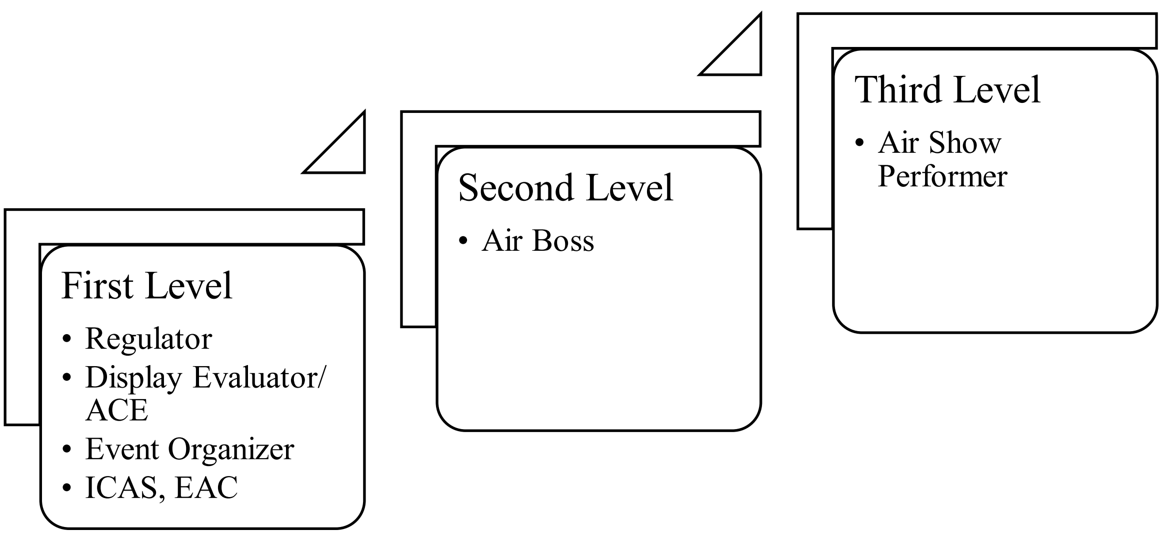
Operating in a sterile and completely safe environment precludes the knowledge and experience received when frequently exposed to unstable operating conditions (Weick, 1987). Therefore, realistic training should simulate random perturbations during the display pilot's flight preparation.

Overall, air show performers and air bosses may require a more practical approach to safety education, which may be achieved if more emphasis is placed on personnel-centric safety education, as proposed by Klockner et al. (2021). Methods to promote best practices for safety and excellence include, but are not limited to, workshops, webinars, safety surveys, anonymous reporting systems with the engagement of aviation authorities, and air show councils.

The importance of air bosses was highlighted in the study's findings. Air bosses serve as risk management intermediaries in air shows, bridging the gap between the regulators and the air show performers (see Figure 58). As such, they are held accountable for the safe execution of an air show. Overall, air bosses set the tone of the air show during the display safety briefing, and they must maintain the rhythm of the air show choreography until the end of the event.

Figure 58

Levels of Risk Management in Air Shows



In addition, the air show community could use a "dynamic risk assessment," which might include physiological information, such as the air show performer's heart rate, as a stress signal supplied to the air boss. This form of bio-data could help the air boss detect any unusual stress that the pilot is experiencing and adjust for the risk of the pilot's incapacitation.

Marital status was identified as a factor impacting air show performers' risk tolerance. Therefore, during the yearly conventions of ICAS and EAC, as well as the symposiums arranged by BADA and FSA for air show performers and air bosses, lessons learned from air show performers who were preoccupied with family concerns might be discussed, and then mitigation methods could be proposed.

Additionally, the ICAS risk assessment worksheet could be supplemented with the air show performer's marital status, with an appropriate weighting on the overall risk score. Also, based on the findings, groups consisting of not married, i.e., single, air show performers could be created to provide support in controlling their risk tolerance and enhancing their risk perception.

Finally, a widely agreed-upon risk matrix might aid in the adoption of an air show risk level (ASRL), an indicator that could be included in the pilots' briefing and other services involved in the event's air operations. The air show risk level might be based on the same principles as the pilots' weather categories, i.e., VFR, SVFR, and IFR; it could be used to make judgments on who is flying, what type of profile, and so on, depending on the pilot's experience, qualifications, and weather circumstances, i.e., wind, sun, visibility, clouds, and density altitude. Such a widely recognized risk indicator may benefit air show performers since it provides a centralized management technique to the air boss, who has a holistic situational awareness of the air show's execution.

Limitations

The survey was designed to elicit individuals' attitudes and beliefs, which makes them more susceptible to response bias, self-serving bias, framing effects, response bias, and social desirability bias (Grimm, 2010). It is believed that the responses accurately reflect what these individuals thought at the time and place they provided them.

Additionally, researcher bias may have influenced the interpretation of the findings due to the researcher's active involvement in the air show community in a variety of leadership roles. Therefore, to minimize the researcher-induced bias and subjectivity, a semi-structured question format was used, and after completing the qualitative data collection, an independent audit of codes and transcripts was done by an air show SME and a doctoral advisory committee using selected portions of the interview and focus group sessions transcripts. Member checking of codes and themes was also used to minimize potential researcher's biases in the findings.

Due to the study's international focus on the air show community, language barriers and national culture may have limited or skewed participant responses, given the study's enrollment of 22 different nationalities, the majority of which did not have English as the first language. There is the possibility that some respondents may have challenges with comprehending scale items that were in English but had a Qualtrics option for rudimentary translation into other languages. Also, during an interview session, a facilitator who spoke English and Spanish fluently assisted the researcher in interpreting questions posed to the interviewee and responses provided by the interviewee.

Iterative modification of the conceptual measurement model for this study was used to obtain a good fit for estimating the strengths of relationships between the constructs, culminating in a final measurement model that adequately depicts the constructs under consideration.

The concept of resilient safety culture is subjective and quantified through the respondents' perceptions. Neither the instrument nor the study made distinctions between different levels of air show operational expertise or between different countries, as the majority of international air shows follow common basic flight safety guidelines.

Additionally, Charness et al. (2019) assert that risk attitude assessments are unrelated to risk-taking in the field, doubting commonly used methodologies for assessing actual risk preferences. Researchers conclude that, while the external validity of risk attitude assessments is maintained in closely related contexts, it may be jeopardized in more remote situations.

While the researcher identified a purposeful sample of respondents from the international air show community, there were still difficulties with the survey's unequal sample sizes. This resulted in greater representations of respondents from the U.S and U.K as compared to South Africa and the U.A.E.

The effect of national culture on perceptions when dealing with such an unequal sample must be considered. It is worth noting that the researcher attempted to contact several air show performers through various methods or in person, but the response rate to emails or messages requesting participation in the online survey or semi-structured interviews was weak.

Moreover, it was impossible to elicit responses from respondents living in countries with a negligible air show community. Therefore, the study's scope was limited to the countries and air show communities where respondents could participate. Additionally, military demonstration teams and performers, in particular, were unable to interact or were restricted from participating in this study due to the clearances required from their military top hierarchy. Moreover, most of the air show performers in India and the Far East were unable to participate in this study due to a lack of direct communication with them by the researcher.

Additionally, the contemporaneous triangulation approach was confined to a snapshot of resilient safety culture perceptions during the study period and may not reflect the long-term trend. The dynamic nature of flight operations and the occurrence of a safety-related event in real-time throughout the study period may have affected respondents' assessments.

Furthermore, the survey data reflect a specific snapshot of the air show community's status. Thus, the researcher postulated that because of the survey's timing, i.e., when the world is still coping with the impacts of the COVID-19 pandemic, there may be a bias in air show performers' perceptions of safety, which may distort participants' responses.

First, air shows have been operationally scaled back during the COVID-19 pandemic, with the majority of the large air shows being canceled or postponed during the 2020 and 2021 display seasons while this study was being conducted. Air displays, as well as other outdoor gatherings classified as mass gatherings, were restricted during the COVID-19 pandemic by various government policies aimed at reducing the virus's impact on health services and preserving lives (Flightline UK, 2020).

As a result, air show performers' interest in flying activities such as airshows may have been adversely affected, which can also have an impact on their safety perceptions. It may also have resulted in the sense of detachment of some individual airshow pilots from the air show community. Such a scenario can have an effect on perceptions and invariably influence responses in this research.

According to some extant research, the COVID-19 pandemic's social isolation has had an effect on mental health, social participation, life satisfaction, and lifestyle choices (Ammar et al., 2020, 2021). Air show performers and air bosses may have been influenced by this upheaval as well, resulting in distancing themselves and declining to participate in the study.

In addition, none of the interviewees were present in person due to COVID-19 travel constraints. In remote communication via online interviews, the inability to use body language may have also kept respondents from connecting completely with the researcher (Creswell & Creswell, 2018).

Lastly, some of the scales incorporated into the final survey instrument were designed and validated using general aviation pilots. Even though the instrument items were modified to capture perceptual trends and nuances of the air show community, it is possible that such modifications may have limited survey participants' clear understanding of the items.

Recommendations for Future Study

This study has established a benchmark for assessing the relationships between risk perceptions, risk tolerance, mindfulness, and resilient safety culture in the international air show community. Future research may be based on a longitudinal study that will examine how the predictive capabilities of exogenous variables such as risk perception, risk tolerance, and hazardous attitudes affect resilient safety culture over time by sampling a cohort of international air show performers who perform individually as well as those who perform as part of a demonstration team.

Another possible area of study would be a comparative evaluation of air show performers at various levels of experience to get insight into some trends and predictive relationships between exogenous variables, safety behavior, and safety-related occurrences.

Additionally, a comparative examination of air show performers' resilient safety culture based on nationality can be conducted to gain insight into the strength of relationships between exogenous variables studied in this research and resilient safety culture. When analyzing the perceptions of air show performers from different nations, a survey that employs photos instead of text to describe the scale items could be used to limit any language barrier constraints (Leutner et al., 2017).

A study based on the methods applied by Saposnik and Johnston (2014) that uses game concepts to assess risk tolerance, such as poker, may also be tested. This type of research could benefit the annual training or recurrence of air show performers and air bosses.

Based on the current study's findings and suggested by Adjekum (2014), the lack of SMS implementation in the majority of air show entities presents an opportunity for formal adoption and implementation of SMS by various air show associations and event organizers to further improve the safety culture.

Then, as part of the continual development of the international air show community's resilient safety culture, a study could be conducted to investigate the efficacy of automatically filled-in maneuver evaluation reports based on aerobatics competition standard rules of critique (Commission Internationale de Voltige Arienne, 2019), as a method used by air show performers to assess their inflight performance and their resilient safety skills. Having measurable safety performance indicators could raise pilots' awareness and encourage them to strive for excellence.

Furthermore, a quasi-experiment that investigates the physiological effects of high altitudes, accompanied by minimal oxygen saturation, provides valuable insight into its effect on air show performers' cognitive ability and decision-making skills and become a performance indicator for resilience. A comparable investigation may examine air show performers' cognitive performance during low-level aerobatic flight using biometrics such as heart rate variability (Luft et al., 2009).

Air show performers are exposed to distractions and interruptions during their display. Another quasi-experiment could examine methods to monitor air show pilot's visual attention during inflight distractions and interruptions (Loukopoulos et al., 2001, 2016) with the use of sensors such as eye-tracking devices (Chen et al., 2019; Ziv, 2016) and virtual reality (VR) flight simulation technology (Harris et al., 2022).

Air show performers' risk tolerance was found to be influenced by their marital status. In order to further examine other marital status-related variables, additional studies could be conducted to elucidate a relationship between parental status and risk tolerance of air show performers (Nosita et al., 2020).

Also, financial pressures were identified as a factor affecting the risk tolerance and operational decision-making of air show performers. Thus, additional research is recommended to elaborate on the relationship between financial pressures and air show performers’ risk tolerance and decision making (Aalberg et al., 2020; Causse et al., 2011).

Finally, future research could help the air show community collect further data from scientific studies. Therefore, an ongoing effort is needed to promote flight safety-related surveys administered in the air show community to enhance the community’s resilient safety culture and foster an evidence-based learning culture.

Data-driven research on aviation safety, such as the current study, will enable the air show leadership to make evidence-based decisions vital for continuous monitoring and improvements of operational safety in the industry to meet the desired benchmark of zero air show accident vision espoused by Des Barker.

APPENDIX A. UND's Institutional Review Board Approval

Division of Research & Economic Development
Office of Research Compliance & Ethics

Principal Investigator: Dr. Daniel Kwasi Adjekum
Project Title: AN EVALUATION OF THE RELATIONSHIPS BETWEEN RESILIENT SAFETY CULTURE, SAFETY RISK PARAMETERS, AND MINDFULNESS IN THE INTERNATIONAL AIRSHOW COMMUNITY
IRB Project Number: IRB0003717
Project Review Level: Expedited 6, 7
Approval Date: 08/23/2021
Expiration Date: 08/22/2022
Consent Form Approval Date: 08/23/2021

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

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

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

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

Sincerely,

Michelle L. Bowles, M.P.A., CIP
she/her/hers
Director of Research Assurance & Ethics
Office of Research Compliance & Ethics
Division of Research & Economic Development
University of North Dakota
Technology Accelerator, Suite 2050
4201 James Ray Drive Stop 7134
Grand Forks, ND 58202-7134
O: 701.777.4279
D: 701.777.4079
F: 701.777.2193
Michelle.Bowles@UND.edu
https://und.edu/research/resources/index.html

APPENDIX B. Survey Instrument Outline

D–1. Age

- ◯ 18 - 24– (1)
- ◯ 25 - 34 (2)
- ◯ 35 - 44 (3)
- ◯ 45 - 54 (4)
- ◯ 55 - 64 (5)
- ◯ 65 or older `6)

D.2. Gender

- ◯ Male (1)
- ◯ Female (2)

D.3. Country of origin

- ◯ Canada (1)
- ◯ France (2)
- ◯ United Kingdom (3)
- ◯ United States (4)
- ◯ Other (Please specify) (5)

D.4. Marital status

- ◯ Single (1)
- ◯ Married (2)
- ◯ Widowed (3)
- ◯ Divorced (4)
- ◯ Separated (5)
- ◯ Registered partnership (6)
- ◯ Prefer not to answer (7)

D.5. Educational background

- ◯ High School (1)
- ◯ Bachelor's Degree (2)
- ◯ Master's Degree (3)
- ◯ PhD or higher (4)

D.6. Current role in the air show community

- ◯ Air show performer (1)
- ◯ Air boss (2)
- ◯ Other (Please specify) (3)

D.7. Total air show flying experience

- ◯ < 1 year (1)
- ◯ 1-3 years (2)
- ◯ 4-6 years (3)
- ◯ 7-10 years (4)
- ◯ 10+ years (5)

D.8. Aerobatics background

- ◯ Civilian (1)
- ◯ Military (2)
- ◯ None (3)

HA. Please provide your degree of agreement regarding the following statements about yourself:

	Strongly disagree (1)	Somewhat disagree (2)	Neither agree nor disagree (3)	Somewhat agree (4)	Strongly agree (5)
I am a display pilot due entirely to my hard work and ability. (1)	○	○	○	○	○
I can learn any flying skill if I put my mind to it. (2)	○	○	○	○	○
I really hate being delayed on the ground when I am ready for the display. (3)	○	○	○	○	○
I feel like yelling at people who do not clear the display box fast enough when I am ready for my display. (4)	○	○	○	○	○

RSC. Please provide your degree of agreement regarding the following statements about resilient safety culture in the air show community:

	Strongly disagree (1)	Somewhat disagree (2)	Neither agree nor disagree (3)	Somewhat agree (4)	Strongly agree (5)
Safety is recognized as being everyone's responsibility, not just that of the air boss. (1)	○	○	○	○	○
Policies are in place to reduce potential sources of nonoperational distraction during air shows (ATC/flight deck). (2)	○	○	○	○	○
Air show performers hardly use training to recognize high-risk situations. (3)	○	○	○	○	○
There are SOPs for recovery from errors identified by air show performers, which are reinforced by training. (4)	○	○	○	○	○

RT. Please provide your degree of agreement regarding the following statements about risk tolerance during an air show event:

	Strongly disagree (1)	Somewhat disagree (2)	Neither agree nor disagree (3)	Somewhat agree (4)	Strongly agree (5)
With 4 miles of visibility and haze, a demo team leader decides to do a high/ full show. (1)	○	○	○	○	○
Low ceilings obscure the tops of the mountains. As a display pilot pulls for a loop, he finds himself suddenly in the clouds. He keeps his heading and backpressure on the stick and hopes for the best. (2)	○	○	○	○	○
While on a fly-past flight, a display pilot notices that the weather is deteriorating to the west. A line of clouds is moving in his direction, but he is still over 20 miles away. He decides to cancel his flight and turns to return to his home airfield about 25 miles east of his present position. (3)	○	○	○	○	○
A demo pilot has enjoyed flying a spectacular sunset show over the sea with 25 miles of visibility, wind calm conditions, and no wave waters. As he pulls up for a barrel roll, at about 1,500 feet, he loses sight of the horizon, and the sea water seems to be indistinguishable from the sky. He keeps the backpressure on the stick and continues the maneuver. (4)	○	○	○	○	○

RP. Please rate the level of risk present if you were to experience the situation tomorrow.

	1 (Low risk) (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7 (7)	8 (8)	9 (High risk) (9)
Fly a display over a large lake or sea at 300 feet above ground level. (1)	○	○	○	○	○	○	○	○	○
Conduct a fly-past over a hilly populated area at 3,000 above ground level. (2)	○	○	○	○	○	○	○	○	○
Fly a display over water at 500 feet above ground level. (3)	○	○	○	○	○	○	○	○	○
Fly a display over water at 1,000 feet above ground level. (4)	○	○	○	○	○	○	○	○	○

MF. Please indicate how frequently or infrequently you currently have each experience:

	Almost always (1)	Very frequently (2)	Somewhat frequently (3)	Somewhat infrequently (4)	Very infrequently (5)	Almost never (6)
It seems I am flying my display routine “on autopilot” without much awareness of what I am doing. (1)						
I rush through the maneuvers without being really attentive to them. (2)						
I do tasks in the cockpit automatically, without being aware of what I am doing. (3)						
I have trouble staying focused on my display routine and am easily sidetracked. (4)						

APPENDIX C. Survey Instrument Codebook

Code	Instrument	Scale	Construct	Item number	Question
DEMOGRAPHIC DETAILS					
D.1	-	-	(Demographics)	D1	What is your age?
D.2				D2	What is your gender?
D.3				D3	What is your country of origin?
D.4				D4	What is your marital status?
D.5				D5	What is your educational background?
D.6				D6	What is your current role in the air show community?
D.7				D7	What is your total air show flying experience in years?
D.8				D8	What is your aerobatics background, civilian or military?
PART 1. HAZARDOUS ATTITUDES					
HA.1	Hazardous Attitude Scale (Ji et al., 2011)	1 – 5 (Strongly Disagree-Strongly Agree)	Hazardous Attitudes	HA1	I am a display pilot due entirely to my hard work and ability.
HA.2				HA5	I can learn any flying skill if I put my mind to it.
HA.3				HA16	I really hate being delayed on the ground when I am ready for the display.
HA.4				HA17	I feel like yelling at people who do not clear the display box fast enough when I am ready for my display.
PART 2. RESILIENT SAFETY CULTURE					
RSC.1	Resilient Safety Culture (Adjekum & Fernandez-Tous, 2020b)	1 – 5 (Strongly Disagree-Strongly Agree)	Resilient Safety Culture	RSC1 (Pri3)	Safety is recognized as being everyone's responsibility, not just that of the air boss.
RSC.2				RSC3 (Pol5)	Policies are in place to reduce potential sources of nonoperational distraction during air shows (ATC/flight deck).
RSC.3				RSC6 (Pra5R)	Air show performers hardly use training to recognize high-risk situations.
RSC.4				RSC7 (Pro4)	There are SOPs for recovery from errors identified by air show performers, which are reinforced by training.
PART 3. RISK TOLERANCE					
RT.1	Risk Tolerance (Ji et al., 2011)	1 – 5 (Strongly Disagree-Strongly Agree)	Risk Tolerance	RT3	With 4 miles of visibility and haze, a demo team leader decides to do a high/ full show.
RT.2				RT7	Low ceilings obscure the tops of the mountains. As a display pilot pulls for a loop, he finds himself suddenly in the clouds. He keeps his heading and backpressure on the stick and hopes for the best.
RT.3				RT10	While on a fly-past flight, a display pilot notices that the weather is deteriorating to the west. A line of clouds is moving in his direction, but he is still over 20 miles away. He decides to cancel his flight and turns to return to his home airfield about 25 miles east of his present position.
RT.4				RT15	A demo pilot has enjoyed flying a spectacular sunset show over the sea with 25 miles of visibility, wind calm conditions, and no wave waters. As he pulls up for a barrel roll, at about 1,500 feet, he loses sight of the horizon, and the sea water seems to be indistinguishable from the sky. He keeps the

					backpressure on the stick and continues the maneuver.
PART 4. RISK PERCEPTION Please rate the level of risk present in the situation if YOU were to experience the situation tomorrow. Responses are provided on a scale from 1 (Low Risk) to 9 (High Risk).					
RP.1	Flight Risk Perception Scale (FPRS) (Winter et al. 2019)	1 – 9 (Low Risk-High Risk)	Risk Perception	RP9 (Altitude Risk)	Fly a display over a large lake or sea at 300 feet above ground level.
RP.2				RP10	Conduct a fly-past over a hilly populated area at 3,000 above ground level.
RP.3				RP11	Fly a display over water at 500 feet above ground level.
RP.4				RP13	Fly a display over water at 1,000 feet above ground level.
PART 5. MINDFULNESS					
MF.1	Mindful Attention Awareness Scale (MAAS) (Brown & Ryan, 2003)	1 – 6 (Almost Always-Almost Never)	Mindfulness	MF7	It seems I am flying my display routine "on autopilot" without much awareness of what I am doing.
MF.2				MF8	I rush through the maneuvers without being really attentive to them.
MF.3				MF10	I do tasks in the cockpit automatically, without being aware of what I am doing.
MF.4				MF14	I have trouble staying focused on my display routine and am easily sidetracked.

APPENDIX D. Semi-Structured and Focus Group Interview Session Guide

Parts of the Interview	Interview Questions
Introduction	Hello, my name is Manolis Karachalios, and I am this study's primary investigator. Thank you so much for consenting to take part in this interview. As stated in the invitation email, the objective of this interview is to gather your perspectives on the resilient safety culture within the air show community, as well as how risk perception and mindfulness have influenced that perspective. This interview should last approximately one hour. Please be aware that this session will be recorded and that contemporaneous notes will be taken. Following the interview, I will organize and transcribe your comments, which will be categorized and themed for our research. Please be aware that the researchers will make every effort to guarantee that no personally identifying information about you, such as your name, is unintentionally disclosed during the session and is not utilized in our final report. All audio recordings from this session will be deleted once the transcription process has been completed and you have had the opportunity to confirm the contents of the transcript that will be sent to answer any questions you are concerned with. I want to remind you once again that this interview will be audio recorded for transcription reasons. Before we begin the interview, you must also read and sign the informed consent statement document.
Part A	**Biographic Data (Taken for each participant)**
	Age: Sex: Status (Military/ Civilian/ Ex-Military, currently civilian): Number of Years at the Air Show Community: Role (Display Pilot/ Air Boss):
Part B	**Risk Perception**
	1. What are the most significant risks you anticipate during a flying display? 2. What kinds of risks are you willing to accept when flying in an actual air show?
Part C	**Hazardous Attitudes**
	3. Which types of display pilots do you think are the most dangerous? 4. Have you ever seen a display pilot whose manner deviated from the norm in the air show community?

Part D	Mindfulness
	5. What kinds of mental preparation techniques do you do before a flight? 6. How do you manage the external pressures caused by the public, your peers, or any other distractions during an air show?
Part E	**Resilient Safety Culture**
	7. In your own words, how would you describe the existing safety culture in the air show community? 8. How do you believe a resilient safety culture can enhance the overall safety operations for air show performers?
Part F	**Close**
	9. Is there anything more you would like to say? 10. Have you got any questions for me? Thank you for your time, and we will provide you with the transcript for your approval before data analysis. Goodbye.

APPENDIX E. Goodness-of-Fit Tests With the Use of G*Power

Figure 59

*G*Power Curves for Goodness-of-Fit Tests*

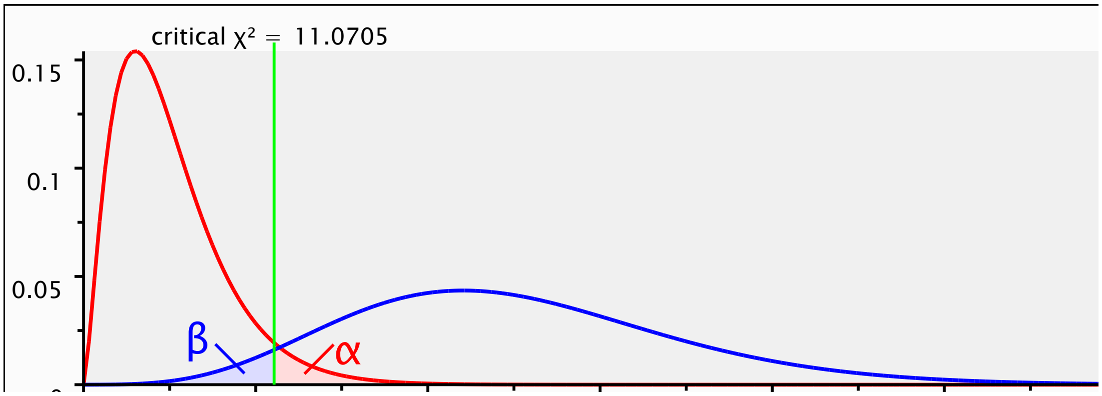


Figure 60

χ^2 Tests - Goodness-of-Fit Tests: Contingency Table

Analysis:	A priori: Compute required sample size		
Input:	Effect size w	=	0.5
	α err prob	=	0.05
	Power (1−β err prob)	=	0.95
	Df	=	5
Output:	Noncentrality parameter λ	=	20.0000000
	Critical χ²	=	11.0704977
	Total sample size	=	80
	Actual power	=	0.9523388

APPENDIX F. ANOVA Tables

Table 24

ANOVA, Age

Variable		*SS*	*df*	*MS*	*F*	Sig.
RT	Between groups	2.24	4	.56	1.02	.40
	Within groups	52.14	95	.55		
	Total	54.38	99			
RSC	Between groups	.27	4	.07	.17	.95
	Within groups	40.68	102	.40		
	Total	40.95	106			
RP	Between groups	10.31	4	2.58	.92	.46
	Within groups	277.05	99	2.80		
	Total	287.35	103			
MF	Between groups	5.21	4	1.30	3.48	.01
	Within groups	37.04	99	.37		
	Total	42.25	103			
HA	Between groups	1.00	4	.25	.73	.58
	Within groups	34.46	100	.35		
	Total	35.46	104			

Table 25

ANOVA, Marital Status

Variable		*SS*	*df*	*MS*	*F*	Sig.
RT	Between groups	6.24	5	1.25	2.316	.050
	Within groups	52.27	97	.54		
	Total	58.51	102			
RSC	Between groups	2.39	6	.40	1.018	.42
	Within groups	40.22	103	.39		
	Total	42.60	109			
RP	Between groups	23.72	5	4.74	1.761	.13
	Within groups	269.33	100	2.69		
	Total	293.05	105			
MF	Between groups	6.72	5	1.34	3.771	.01
	Within groups	35.61	100	.36		
	Total	42.33	105			
HA	Between groups	1.40	6	.23	.667	.68
	Within groups	35.36	101	.35		
	Total	36.76	107			

Table 26

ANOVA, Educational Background

Variable		*SS*	*df*	*MS*	*F*	Sig.
RT	Between groups	4.51	3	1.50	2.76	.05
	Within groups	54.00	99	.55		
	Total	58.51	102			
RSC	Between groups	2.54	3	.85	2.24	.09
	Within groups	40.06	106	.38		
	Total	42.60	109			
RP	Between groups	17.91	3	5.97	2.21	.09
	Within groups	275.14	102	2.70		
	Total	293.05	105			
MF	Between groups	3.81	3	1.27	3.36	.02
	Within groups	38.52	102	.38		
	Total	42.33	105			
HA	Between groups	.42	3	.14	.40	.75
	Within groups	36.34	104	.35		
	Total	36.76	107			

Table 27

ANOVA, Air Show Flying Experience

Variable		*SS*	*df*	*MS*	*F*	Sig.
RT	Between groups	.82	4	.22	.35	.84
	Within groups	57.69	98	.59		
	Total	58.51	102			
RSC	Between groups	1.02	4	.26	.65	.63
	Within groups	41.58	105	.40		
	Total	42.60	109			
RP	Between groups	21.52	4	5.38	2.00	.10
	Within groups	271.53	101	2.69		
	Total	293.05	105			
MF	Between groups	1.93	4	.48	1.21	.31
	Within groups	40.40	101	.40		
	Total	42.33	105			
HA	Between groups	.16	4	.04	.11	.98
	Within groups	36.59	103	.36		
	Total	36.76	107			

Table 28

ANOVA, Aerobatics Experience

Variable		*SS*	*df*	*MS*	*F*	Sig.
RT	Between groups	1.72	1	1.72	3.06	.08
	Within groups	56.79	101	.56		
	Total	58.51	102			
RSC	Between groups	.44	1	.44	1.12	.29
	Within groups	42.17	108	.39		
	Total	42.60	109			
RP	Between groups	.081	1	.08	.03	.87
	Within groups	292.97	104	2.82		
	Total	293.05	105			
MF	Between groups	.32	1	.32	.79	.38
	Within groups	42.01	104	.40		
	Total	42.33	105			
HA	Between groups	.62	1	.62	1.81	.18
	Within groups	36.14	106	.34		
	Total	36.76	107			

APPENDIX G. Word Cloud

Figure 61

Word Cloud, Semi-Structured and Focus Group Interview Sessions

APPENDIX H. Themes, Codes, References

Figure 62

Themes and Codes, Number of References in Qualitative Data, HA

Name	Files	References
Hazardous Attitudes	0	0
Hazardous Attitudes\Concealed hazardous attitude	1	1
Hazardous Attitudes\Concealed hazardous attitude\Deficient	0	0
Hazardous Attitudes\Concealed hazardous attitude\Deficient\Lack of discipline	1	2
Hazardous Attitudes\Concealed hazardous attitude\Deficient\Lack of discipline\Discipline control	1	1
Hazardous Attitudes\Concealed hazardous attitude\Deficient\Lack of discipline\Instill discipline	1	2
Hazardous Attitudes\Concealed hazardous attitude\Deficient\Lack of discipline\Use of checklist	1	1
Hazardous Attitudes\Concealed hazardous attitude\Deficient\Lack of experience	3	4
Hazardous Attitudes\Concealed hazardous attitude\Deficient\Lack of experience\New performer	0	0
Hazardous Attitudes\Concealed hazardous attitude\Deficient\Lack of experience\Regulatory-driven risks	1	1
Hazardous Attitudes\Concealed hazardous attitude\Deficient\Lack of financial resources	2	2
Hazardous Attitudes\Concealed hazardous attitude\Deficient\Lack of financial resources\Financial pressure	1	1
Hazardous Attitudes\Concealed hazardous attitude\Deficient\Lack of flying skills	4	5
Hazardous Attitudes\Concealed hazardous attitude\Deficient\Lack of flying skills\Inconsistent	1	1
Hazardous Attitudes\Concealed hazardous attitude\Deficient\Lack of flying skills\Inconsistent\Inconsistent flying	1	1
Hazardous Attitudes\Concealed hazardous attitude\Deficient\Lack of flying skills\Underconfident	1	1
Hazardous Attitudes\Concealed hazardous attitude\Deficient\Lack of preparation	1	1
Hazardous Attitudes\Concealed hazardous attitude\Deficient\Lack of preparation\Lack of mental preparation	1	1
Hazardous Attitudes\Concealed hazardous attitude\Deficient\Lack of training	3	3
Hazardous Attitudes\Concealed hazardous attitude\Distracted	2	2
Hazardous Attitudes\Concealed hazardous attitude\Distracted\Distracted from family issues	2	2
Hazardous Attitudes\Concealed hazardous attitude\Distracted\Hiring pressure	0	0
Hazardous Attitudes\Concealed hazardous attitude\ Egocentric	4	6
Hazardous Attitudes\Concealed hazardous attitude\ Egocentric\Arrogance	2	2
Hazardous Attitudes\Concealed hazardous attitude\ Egocentric\Entitlements	2	8
Hazardous Attitudes\Concealed hazardous attitude\ Egocentric\Glory	1	2
Hazardous Attitudes\Concealed hazardous attitude\ Egocentric\Show-off	7	14
Hazardous Attitudes\Concealed hazardous attitude\Part timer	1	1
Hazardous Attitudes\Concealed hazardous attitude\Part timer\Hobbyist	2	3
Hazardous Attitudes\Concealed hazardous attitude\Part timer\Weekend warbird pilot	1	2
Hazardous Attitudes\Concealed hazardous attitude\Wrong attitude	1	1
Hazardous Attitudes\Concealed hazardous attitude\Wrong attitude\Dude look	1	1
Hazardous Attitudes\FAA reccomended hazardous attitudes	0	0
Hazardous Attitudes\FAA reccomended hazardous attitudes\Anti-authority	4	6
Hazardous Attitudes\FAA reccomended hazardous attitudes\Impulsivity	1	1
Hazardous Attitudes\FAA reccomended hazardous attitudes\Impulsivity\Continuation bias	1	1
Hazardous Attitudes\FAA reccomended hazardous attitudes\Impulsivity\Ignorance	2	3
Hazardous Attitudes\FAA reccomended hazardous attitudes\Impulsivity\Immaturity	1	1
Hazardous Attitudes\FAA reccomended hazardous attitudes\Invulnerability	4	6
Hazardous Attitudes\FAA reccomended hazardous attitudes\Invulnerability\Complacency	3	3
Hazardous Attitudes\FAA reccomended hazardous attitudes\Invulnerability\Overconfident	3	4
Hazardous Attitudes\FAA reccomended hazardous attitudes\Invulnerability\Overconfident\Overestimation	2	2
Hazardous Attitudes\FAA reccomended hazardous attitudes\Invulnerability\Overconfident\Overmotivation	1	3
Hazardous Attitudes\FAA reccomended hazardous attitudes\Invulnerability\Pushing the limits	1	1
Hazardous Attitudes\FAA reccomended hazardous attitudes\Invulnerability\Risky display profile	1	1
Hazardous Attitudes\FAA reccomended hazardous attitudes\Machismo	2	3
Hazardous Attitudes\FAA reccomended hazardous attitudes\Machismo\Competitive	1	1
Hazardous Attitudes\FAA reccomended hazardous attitudes\Machismo\Parachute jumpers	2	2
Hazardous Attitudes\FAA reccomended hazardous attitudes\Mix of hazardous attitudes	2	3
Hazardous Attitudes\FAA reccomended hazardous attitudes\Resignation	0	0

Figure 63

Themes and Codes, Number of References in Qualitative Data, MF

Name	Files	References
Mindfulness	0	0
Mindfulness\Consistency	4	4
Mindfulness\Consistency\Checklist	2	2
Mindfulness\Consistency\Importance of Practice	2	4
Mindfulness\Consistency\Importance of Practice\Realistic practice	0	0
Mindfulness\Consistency\Methodical	1	1
Mindfulness\Consistency\Precision flying	1	1
Mindfulness\Consistency\Repetition	1	1
Mindfulness\Consistency\Resetting	1	1
Mindfulness\Exogenous factors control	0	0
Mindfulness\Exogenous factors control\Distractions	4	6
Mindfulness\Exogenous factors control\Distractions\Distraction management	6	8
Mindfulness\Exogenous factors control\Distractions\Distraction management\Competition flying	1	1
Mindfulness\Exogenous factors control\Distractions\Distraction management\External pressure control	4	6
Mindfulness\Exogenous factors control\Distractions\Distraction management\Focus	4	6
Mindfulness\Exogenous factors control\Distractions\Distraction management\Training	1	1
Mindfulness\Exogenous factors control\Distractions\Self isolation	2	3
Mindfulness\Exogenous factors control\Distractions\Self isolation\30 minute rule	4	6
Mindfulness\Exogenous factors control\Distractions\Self isolation\60-minute rule	3	6
Mindfulness\Exogenous factors control\Distractions\Self isolation\Before takeoff	2	2
Mindfulness\Exogenous factors control\Distractions\Self isolation\Crowd distancing	5	7
Mindfulness\Exogenous factors control\Distractions\Self isolation\Relax	1	1
Mindfulness\Exogenous factors control\Distractions\Self isolation\Social events withdrawal	1	1
Mindfulness\Exogenous factors control\Distractions\Self isolation\Tranquil thinking	1	1
Mindfulness\Exogenous factors control\Distractions\Type of distractions	0	0
Mindfulness\Exogenous factors control\Distractions\Type of distractions\Air Boss-induced	2	4
Mindfulness\Exogenous factors control\Distractions\Type of distractions\Announcers	1	1
Mindfulness\Exogenous factors control\Distractions\Type of distractions\ATC-induced	2	4
Mindfulness\Exogenous factors control\Distractions\Type of distractions\Family	1	1
Mindfulness\Exogenous factors control\Distractions\Type of distractions\Fatigue	0	0
Mindfulness\Exogenous factors control\Distractions\Type of distractions\Phone calls	3	4
Mindfulness\Exogenous factors control\Distractions\Type of distractions\Public	0	0
Mindfulness\Exogenous factors control\Distractions\Type of distractions\Sel-induced pressure	1	1
Mindfulness\Exogenous factors control\Distractions\Type of distractions\Social media	1	1
Mindfulness\Exogenous factors control\Pressures	1	1
Mindfulness\Exogenous factors control\Pressures\Social facilitation	1	2
Mindfulness\Exogenous factors control\Pressures\Social facilitation\Sterile area	2	2
Mindfulness\Exogenous factors control\Pressures\Time management	3	4
Mindfulness\Exogenous factors control\Pressures\Time management\Time buffer	2	2
Mindfulness\Exogenous factors control\Pressures\Unbiased opinion of oneself	1	1
Mindfulness\Pre-show preparation	5	8
Mindfulness\Pre-show preparation\Contingency planning	2	2
Mindfulness\Pre-show preparation\Environmental conditions	3	5
Mindfulness\Pre-show preparation\Environmental conditions\Density altitude	1	1
Mindfulness\Pre-show preparation\Rest	1	1
Mindfulness\Visualization	4	5
Mindfulness\Visualization\Affirmations	1	1
Mindfulness\Visualization\Briefing	6	13
Mindfulness\Visualization\Briefing\Debriefing	2	6

Figure 64

Themes and Codes, Number of References in Qualitative Data, MF and RSC

Name	Files	References
Mindfulness\Visualization\Briefing\Self-briefing	1	1
Mindfulness\Visualization\Chair flying	5	9
Mindfulness\Visualization\Concentration	3	7
Mindfulness\Visualization\Flow	1	1
Mindfulness\Visualization\Flow\Compartmentalization	1	1
Mindfulness\Visualization\Other high-performance activities	2	2
Mindfulness\Visualization\Pre-shot routine	1	1
Mindfulness\Visualization\Rehearsal	1	1
Mindfulness\Visualization\Video review	3	7
Mindfulness\Visualization\Walk through	4	5
Resilient Safety Culture	0	0
Resilient Safety Culture\Air show performers	0	0
Resilient Safety Culture\Air show performers\Financial background	1	1
Resilient Safety Culture\Air show performers\Personality	0	0
Resilient Safety Culture\Air show performers\Personality\Calm	2	2
Resilient Safety Culture\Air show performers\Personality\Conservative mindset	1	1
Resilient Safety Culture\Air show performers\Personality\Discipline	3	4
Resilient Safety Culture\Air show performers\Personality\Fastidious	1	1
Resilient Safety Culture\Air show performers\Personality\Humble	3	3
Resilient Safety Culture\Air show performers\Personality\Passion	1	1
Resilient Safety Culture\Air show performers\Personality\Stable extrovert	3	3
Resilient Safety Culture\Air show performers\Personality\Well-mannered	1	1
Resilient Safety Culture\Air show performers\Personality\Willingness to listen	1	3
Resilient Safety Culture\Air show performers\Professional maturity	1	1
Resilient Safety Culture\Air show performers\Professional maturity\Judgement	1	1
Resilient Safety Culture\Air show performers\Professional maturity\Prepared	2	2
Resilient Safety Culture\Air show performers\Professional maturity\Procedures adherence	2	2
Resilient Safety Culture\Air show performers\Professional maturity\Standardised performance	0	0
Resilient Safety Culture\Air show performers\Professional maturity\Theoretical knowledge	1	1
Resilient Safety Culture\Air show performers\Resilience	1	1
Resilient Safety Culture\Air show performers\Resilience\Expect the unexpected	1	1
Resilient Safety Culture\Air show performers\Resilience\Resilience development	1	1
Resilient Safety Culture\Air show performers\Skills	0	0
Resilient Safety Culture\Air show performers\Skills\Competition aerobatics	2	3
Resilient Safety Culture\Air show performers\Skills\Competition aerobatics\Familirization to social anxiety	1	1
Resilient Safety Culture\Air show performers\Skills\Competition aerobatics\Openness to criticism	2	4
Resilient Safety Culture\Air show performers\Skills\Competition aerobatics\Precision	1	1
Resilient Safety Culture\Air show performers\Skills\Consistent	1	2
Resilient Safety Culture\Air show performers\Skills\Desire to fly well	0	0
Resilient Safety Culture\Air show performers\Skills\Desire to fly well\Self-competition	1	1
Resilient Safety Culture\Air show performers\Skills\Desire to fly well\Self-trust	1	1
Resilient Safety Culture\Air show performers\Skills\Energy management awareness	2	3
Resilient Safety Culture\Air show performers\Skills\Situational awareness	1	1
Resilient Safety Culture\Air show performers\Skills\Superior flying skills	2	2
Resilient Safety Culture\Air show performers\Skills\Training	1	5
Resilient Safety Culture\Attributes	0	0
Resilient Safety Culture\Attributes\Adaptable	1	1
Resilient Safety Culture\Attributes\Collaborative	1	1
Resilient Safety Culture\Attributes\Inherent	1	1
Resilient Safety Culture\Attributes\Robust	2	2

Figure 65

Themes and Codes, Number of References in Qualitative Data, RSC

Name	Files	References
Resilient Safety Culture\Attributes\Self-sustaining	2	2
Resilient Safety Culture\Attributes\Shared values	2	2
Resilient Safety Culture\Attributes\Shared values\Air show family	1	1
Resilient Safety Culture\Attributes\Shared values\Air show family\Family environment	1	1
Resilient Safety Culture\Attributes\Shared values\Pride	1	1
Resilient Safety Culture\Attributes\Shared values\Professionalism	2	2
Resilient Safety Culture\Attributes\Shared values\Trust	3	5
Resilient Safety Culture\Attributes\Shared values\Trust\Friendship	2	2
Resilient Safety Culture\Attributes\Structured air shows	1	2
Resilient Safety Culture\Attributes\Structured air shows\Size of air show	1	1
Resilient Safety Culture\Continuous enhancements	3	5
Resilient Safety Culture\Continuous enhancements\Air race and Aerobatic competition paradigms	2	8
Resilient Safety Culture\Continuous enhancements\Bifurcated	1	1
Resilient Safety Culture\Continuous enhancements\Continuous improvement	1	2
Resilient Safety Culture\Continuous enhancements\Ego management	2	2
Resilient Safety Culture\Continuous enhancements\HROs	1	2
Resilient Safety Culture\Continuous enhancements\Indicators	1	1
Resilient Safety Culture\Continuous enhancements\Margins	2	2
Resilient Safety Culture\Continuous enhancements\Negative issues	0	0
Resilient Safety Culture\Continuous enhancements\Negative issues\Competitiveness	2	4
Resilient Safety Culture\Continuous enhancements\Negative issues\Deviation from safety culture	2	2
Resilient Safety Culture\Continuous enhancements\Negative issues\Financial competition	3	6
Resilient Safety Culture\Continuous enhancements\Negative issues\Implications	1	1
Resilient Safety Culture\Continuous enhancements\Negative issues\Implications\Effect of accidents	2	2
Resilient Safety Culture\Continuous enhancements\Negative issues\Implications\Inevitable accidents	1	1
Resilient Safety Culture\Continuous enhancements\Negative issues\Insufficient safety culture	1	3
Resilient Safety Culture\Continuous enhancements\Negative issues\Lack of common goals	1	1
Resilient Safety Culture\Continuous enhancements\Negative issues\Low standards	1	2
Resilient Safety Culture\Continuous enhancements\Negative issues\Mediocrity	1	1
Resilient Safety Culture\Continuous enhancements\Negative issues\Micromanaging	1	1
Resilient Safety Culture\Continuous enhancements\Negative issues\Organizational hypocricy	1	1
Resilient Safety Culture\Culture	0	0
Resilient Safety Culture\Culture\Change of culture	0	0
Resilient Safety Culture\Culture\Change of culture\Flag behavior	1	1
Resilient Safety Culture\Culture\Culture of discipline	2	2
Resilient Safety Culture\Culture\Culture of discipline\Normalization of deviance	4	5
Resilient Safety Culture\Culture\Excellence culture	1	2
Resilient Safety Culture\Culture\Excellence culture\Excellence	4	5
Resilient Safety Culture\Culture\Excellence culture\High standards	2	6
Resilient Safety Culture\Culture\Excellence culture\Positivism	5	8
Resilient Safety Culture\Culture\Informed culture	0	0
Resilient Safety Culture\Culture\Informed culture\Communication	2	2
Resilient Safety Culture\Culture\Learning culture	4	5
Resilient Safety Culture\Culture\Learning culture\Coaching	1	1
Resilient Safety Culture\Culture\Learning culture\Dissemination of information	1	1
Resilient Safety Culture\Culture\Learning culture\Education	2	2
Resilient Safety Culture\Culture\Learning culture\Experience of tragedies	1	1
Resilient Safety Culture\Culture\Learning culture\Expert advice	1	1
Resilient Safety Culture\Culture\Learning culture\Feedback	1	1
Resilient Safety Culture\Culture\Learning culture\Group development	1	1

Figure 66

Themes and Codes, Number of References in Qualitative Data, RSC and RP

Name	Files	References
Resilient Safety Culture\Culture\Learning culture\Information flow	3	3
Resilient Safety Culture\Culture\Learning culture\Maturity to share information	2	2
Resilient Safety Culture\Culture\Learning culture\Mentoring	4	9
Resilient Safety Culture\Culture\Learning culture\Mentoring\Mentored by a Friend	1	1
Resilient Safety Culture\Culture\Learning culture\Mentoring\Professional mentor program	3	5
Resilient Safety Culture\Culture\Learning culture\Mentoring\Role of instructors	4	4
Resilient Safety Culture\Culture\Learning culture\Sharing lessons learned	4	7
Resilient Safety Culture\Culture\Learning culture\Transmissivity of experience	1	1
Resilient Safety Culture\Culture\National culture	3	8
Resilient Safety Culture\Culture\Outdated culture	1	3
Resilient Safety Culture\Culture\Reporting culture	6	9
Resilient Safety Culture\Culture\Reporting culture\Constructive criticism	2	4
Resilient Safety Culture\Culture\Reporting culture\Peer reviewed community	7	14
Resilient Safety Culture\Culture\Reporting culture\Peer reviewed community\Small community	1	1
Resilient Safety Culture\Culture\Reporting culture\Reporting occurence	2	2
Resilient Safety Culture\Culture\Reporting culture\Reporting system	7	10
Resilient Safety Culture\Culture\Safety Culture	5	10
Resilient Safety Culture\Culture\Safety Culture\Safety Management System	1	1
Resilient Safety Culture\Culture\Safety Culture\Safety Management System\Risk assessment	0	0
Resilient Safety Culture\Culture\Safety Culture\Safety Management System\Safety barriers	2	2
Resilient Safety Culture\Culture\Safety Culture\Safety Management System\Safety motivation	1	1
Resilient Safety Culture\Culture\Safety Culture\Safety Management System\Safety policy	3	4
Resilient Safety Culture\Culture\Safety Culture\Safety Management System\Safety policy\Extra paperwork	2	5
Resilient Safety Culture\Culture\Safety Culture\Safety Management System\Safety policy\Ineffective	1	1
Resilient Safety Culture\Culture\Safety Culture\Safety Management System\Safety policy\Rules	1	1
Resilient Safety Culture\Culture\Safety Culture\Safety Management System\Safety promotion	1	1
Resilient Safety Culture\Culture\Safety Culture\Safety Management System\Safety records	1	1
Resilient Safety Culture\Leadership	4	4
Resilient Safety Culture\Leadership\Air bosses	5	9
Resilient Safety Culture\Leadership\Air bosses\Air boss network	1	1
Resilient Safety Culture\Leadership\Air bosses\Dreaded Briefing	1	2
Resilient Safety Culture\Leadership\Aviation authorities	1	1
Resilient Safety Culture\Leadership\Aviation authorities\Display authorisation process	1	1
Resilient Safety Culture\Leadership\Aviation authorities\Display authorisation process\ACE system	5	8
Resilient Safety Culture\Leadership\Aviation authorities\Display authorisation process\ACE system\Fraternity ACEing	1	4
Resilient Safety Culture\Leadership\Aviation authorities\Display authorisation process\Display approval	3	4
Resilient Safety Culture\Leadership\Aviation authorities\Display authorisation process\Display pilot selection	4	6
Resilient Safety Culture\Leadership\Aviation authorities\Display authorisation process\Evaluation card	2	2
Resilient Safety Culture\Leadership\Aviation authorities\Display authorisation process\Retention Vs Recruitement	1	2
Resilient Safety Culture\Leadership\Aviation authorities\Oversight	1	1
Resilient Safety Culture\Leadership\Personal responsibility	1	1
Resilient Safety Culture\Leadership\Role of Air Show Councils	4	10
Resilient Safety Culture\Leadership\Role of Air Show Councils\ACEs	1	1
Resilient Safety Culture\Leadership\Role of Air Show Councils\ACEs\ACE authorization	1	1
Resilient Safety Culture\Leadership\Role of Air Show Councils\ACEs\Ace committee	1	1
Resilient Safety Culture\Leadership\Role of Air Show Councils\Role of conventions	3	3
Risk Perception	0	0
Risk Perception\Financial risk	1	1
Risk Perception\Financial risk\Budget restrictions	1	2
Risk Perception\Financial risk\Financial damage	1	1

Figure 67

Themes and Codes, Number of References in Qualitative Data, RP

Name	Files	References
Risk Perception\Financial risk\Financial pressures	3	4
Risk Perception\Financial risk\Financial problems	3	4
Risk Perception\Financial risk\Lack of Financial Resources	3	5
Risk Perception\Financial risk\Reputational risk	1	1
Risk Perception\Financial risk\Sponsorship	1	1
Risk Perception\HuMan	0	0
Risk Perception\HuMan\Confidense	2	3
Risk Perception\HuMan\Human error	2	3
Risk Perception\HuMan\Human error\Pilot error	2	2
Risk Perception\HuMan\Physiological risks	0	0
Risk Perception\HuMan\Physiological risks\Emotional risk	1	1
Risk Perception\HuMan\Physiological risks\Fatigue	4	9
Risk Perception\HuMan\Physiological risks\Fatigue\Fatigue risk management	3	6
Risk Perception\HuMan\Physiological risks\Fatigue\Latent stress	2	2
Risk Perception\HuMan\Physiological risks\G-LOC	2	2
Risk Perception\HuMan\Physiological risks\Sleep	1	1
Risk Perception\HuMan\Psychological risk	1	1
Risk Perception\HuMan\Psychological risk\Indecision	1	1
Risk Perception\HuMan\Psychological risk\Loss of Situational Awareness	1	1
Risk Perception\HuMan\Psychological risk\Overconfidense	1	2
Risk Perception\HuMan\Psychological risk\Social desirability	2	2
Risk Perception\HuMan\Seasoned performers	0	0
Risk Perception\HuMan\Seasoned performers\Nervousness	1	1
Risk Perception\HuMan\Skill risk	1	1
Risk Perception\HuMan\Skill risk\Continuity	1	2
Risk Perception\HuMan\Skill risk\Currency	1	1
Risk Perception\HuMan\Skill risk\Lack of air show experience	2	2
Risk Perception\HuMan\Skill risk\Lack of aircraft type experience	2	3
Risk Perception\HuMan\Skill risk\Lack of practice	1	1
Risk Perception\HuMan\Skill risk\Lack of preparedness	2	2
Risk Perception\HuMan\Unconcentrated flying	1	1
Risk Perception\Level of risk	5	9
Risk Perception\Machine	0	0
Risk Perception\Machine\Age of aircraft	1	2
Risk Perception\Machine\Aircraft Malfunction	1	1
Risk Perception\Machine\Aircraft Malfunction\Engine failure	3	4
Risk Perception\Machine\Aircraft Malfunction\Flight controls	1	2
Risk Perception\Machine\Aircraft Malfunction\Maintenance safety standards	2	2
Risk Perception\Machine\Aircraft Malfunction\Structural damage	4	4
Risk Perception\Machine\Aircraft turn-around	1	1
Risk Perception\Machine\Aircraft type	1	1
Risk Perception\Machine\Maximum gross weight to start a display	1	2
Risk Perception\Machine\Twin engine aircraft risks	2	2
Risk Perception\Management	0	0
Risk Perception\Management\Air bosses	1	1
Risk Perception\Management\Air show management	1	3
Risk Perception\Management\Poor event organization	3	3
Risk Perception\Medium	0	0
Risk Perception\Medium\Physical medium	0	0
Risk Perception\Medium\Physical medium\Air show site	0	0

Figure 68

Themes and Codes, Number of References in Qualitative Data, RP

Name	Files	References
Risk Perception\Medium\Physical medium\Air show site\Airshow box size	1	1
Risk Perception\Medium\Physical medium\Air show site\Airspace structure	1	1
Risk Perception\Medium\Physical medium\Air show site\Crowd control	1	1
Risk Perception\Medium\Physical medium\Bird strike	3	3
Risk Perception\Medium\Physical medium\Drones	1	1
Risk Perception\Medium\Physical medium\Environment	0	0
Risk Perception\Medium\Physical medium\Environment\Density altitude	3	6
Risk Perception\Medium\Physical medium\Environment\Over water display	1	2
Risk Perception\Medium\Physical medium\Environment\Sun position	1	1
Risk Perception\Medium\Physical medium\Environment\Weather	1	1
Risk Perception\Medium\Physical medium\Environment\Weather\Poor visibility	1	1
Risk Perception\Medium\Physical medium\Environment\Weather\Turbulence	1	1
Risk Perception\Medium\Physical medium\Environment\Weather\Visibility	1	2
Risk Perception\Medium\Physical medium\Environment\Weather\Winds	1	2
Risk Perception\Medium\Physical medium\Obstacles	1	1
Risk Perception\Medium\Societal medium	0	0
Risk Perception\Mission	0	0
Risk Perception\Mission\CFIT	1	1
Risk Perception\Mission\CFIT\Altitude factor	3	4
Risk Perception\Mission\CFIT\Hitting	1	1
Risk Perception\Mission\Circling the jumpers	2	2
Risk Perception\Mission\Display profile	0	0
Risk Perception\Mission\Display profile\Complexity of display	2	4
Risk Perception\Mission\Display profile\Display variation	1	1
Risk Perception\Mission\Display profile\Roll	1	1
Risk Perception\Mission\Display profile\Roll\Downline roll	1	2
Risk Perception\Mission\Ferry flight	3	5
Risk Perception\Mission\Formation flying	1	1
Risk Perception\Mission\Formation flying\Formation aerobatics	1	1
Risk Perception\Mission\Formation flying\Mid-air collision	3	4
Risk Perception\Mission\Formation flying\Team leader	2	5
Risk Perception\Mission\Formation flying\Team wingman	2	4
Risk Perception\Mission\Formation flying\Team-related risks	2	3
Risk Perception\Mission\Social obligations	1	1
Risk Perception\Unexpected situation	1	1
Risk Perception\Unexpected situation\Distractions	1	1
Risk Perception\Unexpected situation\Distractions\Crowd facilitation	2	2
Risk Perception\Unexpected situation\Distractions\Environmental	1	1
Risk Perception\Unexpected situation\Distractions\Family issues	2	2
Risk Perception\Unexpected situation\Distractions\Family issues\Marital problems	1	1
Risk Perception\Unexpected situation\Distractions\GoPro Cameras	1	1
Risk Perception\Unexpected situation\Distractions\Radio chatter	3	4
Risk Perception\Unexpected situation\Distractions\Rushed	1	2
Risk Perception\Unexpected situation\Luck	1	2
Risk Perception\Unexpected situation\Pressures	1	1
Risk Perception\Unexpected situation\Pressures\Refueling between the shows	1	1
Risk Perception\Unexpected situation\Pressures\Regulatory-induced pressure	1	1
Risk Perception\Unexpected situation\Pressures\Time pressure	4	10
Risk Perception\Unexpected situation\Pressures\Time pressure\Time management	2	2
Risk Perception\Unexpected situation\Unexpected traffic	3	3

Figure 69

Themes and Codes, Number of References in Qualitative Data, RT

Name	Files	References
Risk Tolerance	0	0
Risk Tolerance\HuMan	0	0
Risk Tolerance\HuMan\Fatigue	2	3
Risk Tolerance\HuMan\G-tolerance	1	1
Risk Tolerance\HuMan\Physiological issues	1	3
Risk Tolerance\HuMan\Pilot Emotions	1	2
Risk Tolerance\HuMan\Self preservation	1	2
Risk Tolerance\HuMan\Team leader	1	1
Risk Tolerance\Machine	0	0
Risk Tolerance\Machine\Maintenance	2	3
Risk Tolerance\Machine\Maintenance\Mechanical issues	1	1
Risk Tolerance\Machine\System malfunction	1	2
Risk Tolerance\Management	0	0
Risk Tolerance\Management\Air bosses	3	3
Risk Tolerance\Management\Crash and rescue	1	1
Risk Tolerance\Management\Discrete frequency	3	3
Risk Tolerance\Management\Regulators	1	1
Risk Tolerance\Medium	1	1
Risk Tolerance\Medium\Air show facilitation	1	2
Risk Tolerance\Medium\Over water	2	2
Risk Tolerance\Medium\Overland displays	1	1
Risk Tolerance\Medium\Overwater display	1	2
Risk Tolerance\Medium\Restricted visibility	1	1
Risk Tolerance\Medium\Social engagement	1	1
Risk Tolerance\Medium\Social facilitation	1	2
Risk Tolerance\Medium\Weather	3	7
Risk Tolerance\Medium\Weather\Cloud ceiling	1	1
Risk Tolerance\Medium\Weather\High Density Altitude	2	2
Risk Tolerance\Medium\Weather\Winds	1	1
Risk Tolerance\Mission	0	0
Risk Tolerance\Mission\Circle the jumpers	1	1
Risk Tolerance\Mission\Competition flying	0	0
Risk Tolerance\Mission\Formation flying	1	1
Risk Tolerance\Mission\Incentive rides	1	1
Risk Tolerance\Risk management	3	3
Risk Tolerance\Risk management\Judgement	1	1
Risk Tolerance\Risk management\Knock it off	1	1
Risk Tolerance\Risk management\Priorities	2	3
Risk Tolerance\Risk management\Proactive risk management	1	1
Risk Tolerance\Risk management\Risk matrix	5	7
Risk Tolerance\Risk management\Risk mitigation	5	9
Risk Tolerance\Risk management\Risk mitigation\Rehearsal	1	1
Risk Tolerance\Risk management\Risk mitigation\Training as risk mitigator	2	3
Risk Tolerance\Risk management\Risk mitigation\What-ifs	1	1
Risk Tolerance\Risk management\Routine changes	1	1
Risk Tolerance\Risk management\Routine changes\Change of display program or sequence	3	7
Risk Tolerance\Risk management\Safety buffer	3	3
Risk Tolerance\Risk management\Safety buffer\Margin for error	1	1
Risk Tolerance\Risk management\Standard Operating Procedures	1	4
Risk Tolerance\Risk management\Standard Operating Procedures\Contracts	1	3
Risk Tolerance\Risk management\Standard Operating Procedures\Go-no go criteria	1	1
Risk Tolerance\Risk management\Sterile environment	2	2
Risk Tolerance\Zero tolerance	6	7
Risk Tolerance\Zero tolerance\Unexpected risk	4	9
Risk Tolerance\Zero tolerance\Unexpected risk\Bird strike	3	3
Risk Tolerance\Zero tolerance\Unexpected risk\Engine failure	2	2
Risk Tolerance\Zero tolerance\Unexpected risk\Structural damage	1	1
Risk Tolerance\Zero tolerance\Unnecessary risks	2	3

APPENDIX I. Themes: Triangulation and Interrater Agreement

Table 29

Themes Identified in Qualitative Data Sources, Triangulation

Study area	Theme	Qualitative data source		
		Semi-structured interviews and focus group	Observation	Air show-related documents
Risk perception and tolerance	Financial risk	X		
	Level of air show display flying risk	X		
	Risk management	X	X	X
	Unexpected situation	X	X	X
	Zero-tolerance	X	X	X
	5Ms	X	X	X
Hazardous attitudes	Concealed hazardous attitudes	X	X	
	FAA recommended hazardous attitudes	X	X	X
Mindfulness	Consistency	X	X	X
	Exogenous factors control	X	X	X
	Preshow preparation	X	X	X
	Visualization	X	X	X
Resilient safety culture	Continuous enhancements	X	X	X
	Culture	X	X	X
	Ownership	X	X	X

Table 30

Themes Identified in Qualitative Data Sources, Interrater Agreement

Study area	Theme	Level of interrater agreement
Risk perception and tolerance	Financial risk	Excellent
	Level of air show display flying risk	Excellent
	Risk management	Excellent
	Unexpected situation	Excellent
	Zero-tolerance	Excellent
	5Ms	Excellent
Hazardous attitudes	Concealed hazardous attitudes	Excellent
	FAA recommended hazardous attitudes	Excellent
Mindfulness	Consistency	Excellent
	Exogenous factors control	Excellent
	Preshow preparation	Excellent
	Visualization	Excellent
Resilient safety culture	Continuous enhancements	Excellent
	Culture	Excellent
	Ownership	Excellent

APPENDIX J. Air Show Site Observation Data

Figure 70

Air Show Site Observation Field Notes, Personal Notebook

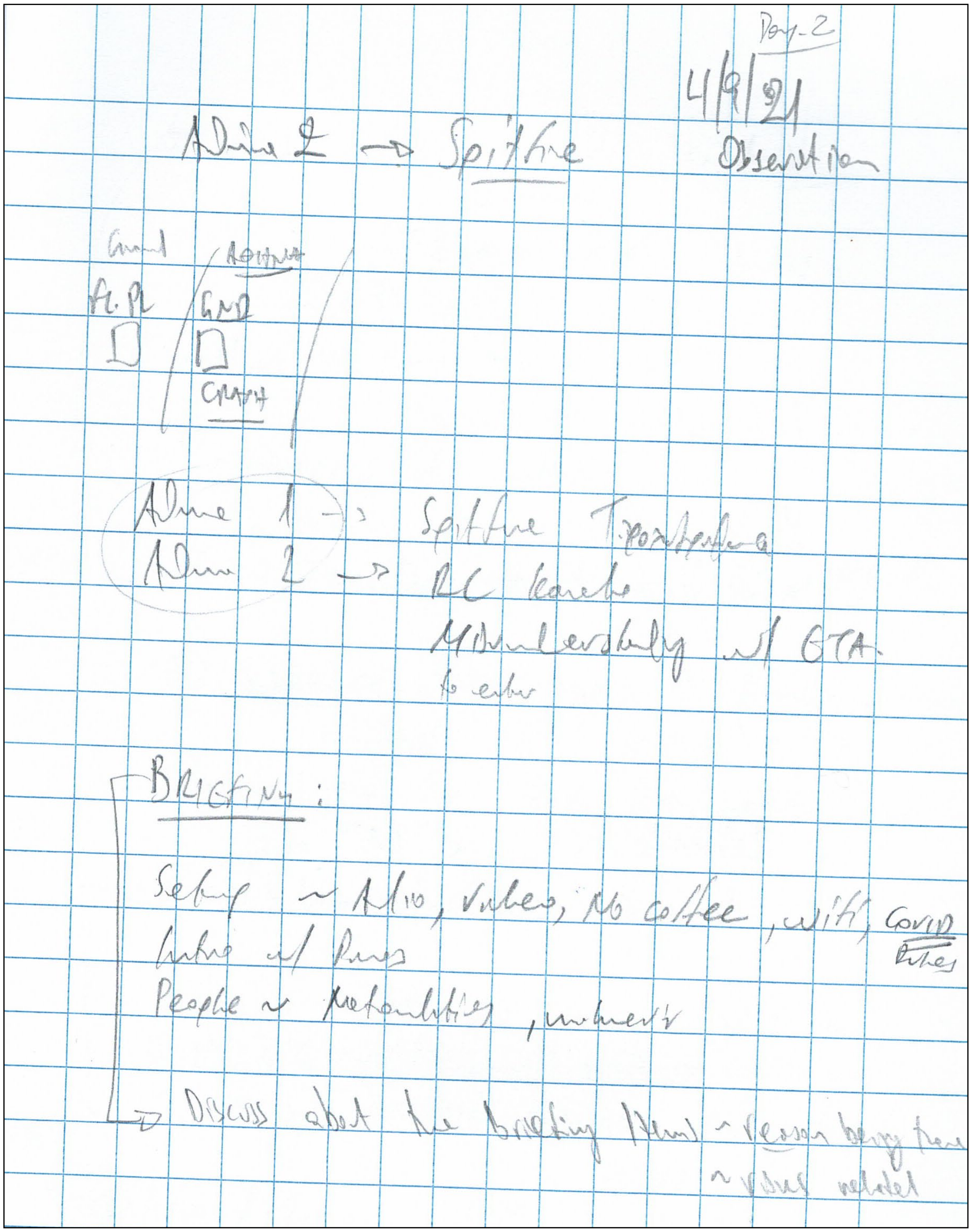


Figure 71

Air Show Site Observation, Example of Notes by ATC (In the Greek Language)

1.ποια στιγμή εξυπηρετεί να μπορούν για τη σημαία-σημαδι τούς οι αλεξιπτωτιστές (διάρκεια διαδικασίας 4:30)
2.[redacted] δεν είχαν επαφή στην προσέγγιση, (πιθανόν ήταν σε manual),αν το επιθυμούν να ενημερώσουν ότι θα καλεί μόνο ο ένας από όλα τα ελικόπτερα.
3.να ξέρουμε,αν είναι εφικτό τον αριθμό αλεξιπτωτιστών από πριν
4.να ορίσουμε ένα στάνταρ (σημείο και ύψος)κράτησης μέσα από τα [redacted] μίλια ώστε να γνωρίζουν όλοι πως εκεί υπάρχει κυκλοφορία (πιθανόν νότια στον [redacted] 7000')
5.διαρκεια σκουπισματος [redacted]
6.διαρκεια ανασχετηρων [redacted]
7.αν είναι εφικτό να απογειωνουμε με συρματόσχοινο κάτω ([redacted])
[redacted])

Figure 72

Air Show Planning Material, Example of Timetable

- Sunday 05 September -			
TIME SLOT	**THEME**	**PARTICIPANT**	**AERIAL EVENT**
1205	General Aviation	RC KAVALA ACRO TEAM (GR)	FLYING DISPLAY
1215		LUCA BERTOSSIO (IT)	FLYING DISPLAY
1228		KIOWA + AH64A (HELLENIC ARMY)	TAKEOFF - HOLD
1230	Hellenic Air Force	TECNAM P-2002JF (HELLENIC AIR FORCE)	FLYBY
1235		CL-415 (HELLENIC AIR FORCE)	WATER DROP (SUBJECT TO OPERATIONAL NEEDS)
1240	Hellenic Army	CH-47 + KIOWA + AH64A + HUEY (HELLENIC ARMY)	PARADROP - CAS EVAC
1300		APACHE AH-64 (HELLENIC ARMY)	FLYING DISPLAY
1310	Hellenic Navy	S-70B AEGEAN HAWK (HELLENIC NAVY)	FLYING DISPLAY
1340	Hellenic Air Force	MIRAGE 2000 (HELLENIC AIR FORCE)	SCRAMBLE
1347		F-4, F-16, MIRAGE 2000 (HELLENIC AIR FORCE)	FLYBY
1350	Show Of Force	MIRAGE 2000 Vs F-16 (HELLENIC AIR FORCE)	DOGFIGHT
1400		SUPER PUMA (HELLENIC AIR FORCE)	COMBAT SEARCH AND RESCUE
1400		PHANTOM F-4 (HELLENIC AIR FORCE)	AIRFIELD ATTACK
1410	Spitfire	SPITFIRE (HELLENIC AIR FORCE)	TAKEOFF
1411		SKYVAN (BE)	TAKEOFF
1412		F-15 (UNITED STATES AIR FORCE)	TAKEOFF
1414	Spitfire	SPITFIRE (HELLENIC AIR FORCE)	FLYING DISPLAY
1425	International Teams	PATROUILLE DE FRANCE (FRENCH AIR FORCE)	FLYING DISPLAY
1500		RAFALE SOLO DISPLAY TEAM (FRENCH AIR FORCE)	FLYING DISPLAY
1515		F-16 DISPLAY TEAM (ROYAL DANISH AIR FORCE)	FLYING DISPLAY
1530		F-15 (UNITED STATES AIR FORCE)	FLYBY
1535		SKYVAN (BE)	LAND
1540	200 Years	ZEUS DEMO TEAM (HELLENIC AIR FORCE)	FLYING DISPLAY
1555		ZEUS DEMO TEAM (HELLENIC AIR FORCE) + AEGEAN AIRLINES (GR)	FLYBY - LAND
1605	Saudi Hawks	SAUDI HAWKS (ROYAL SAUDI AIR FORCE)	FLYING DISPLAY
1650	Saudi Hawks & Aegean Airlines	SAUDI HAWKS (ROYAL SAUDI AIR FORCE) + AEGEAN AIRLINES (GR)	FLYBY

** Schedule might be subject to change due to the availability of air show participants, inclement weather, or other operational factors.*

Figure 73

Air Show Planning Material, Example of Risk Assessment Worksheet

[redacted]

ICAS Individual Risk Management/Assessment Worksheet

Show Location: [redacted] Date: 5 Sept 2011

- Enter a "1" in the Tally column for each applicable item
- Add Tally scores to obtain final IRM score
- Compare final score to the IRM index to determine assessed risk for the day's scheduled performance.

SCHEDULING ASSESSMENT

CREWMEMBER FACTORS	Tally
"I'M SAFE"	
Illness	
Medication	
Stress	
Alcohol	
Fatigue	
Environment	
Scheduling Total:	0

PRE-PERFORMANCE ASSESSMENT

ENVIRONMENTAL FACTORS	Tally
Cold Weather Ops (< 0 C/ 32 F)	
Hot Weather Ops (>35 C/ 95 F)	
Density Altitude	
Field Elevation	
Crosswinds > 10 kts	1
Ceilings < 3000 ft	
Visibility < 5 SM	
Moderate Turbulence Forecast	
Overwater	
Thunderstorms Forecast	
Bird / AHAS Activity ≥ Moderate	
EXECUTION FACTORS	
Scheduled number of performances per day	1
Night Show	
Aircraft/Vehicle Maintenance Issues	1
Participate in Media Flights	
Pre-Performance Total:	3

Scheduling + Pre-Performance = Final IRM Score

INDIVIDUAL RISK MANAGEMENT INDEX		
0 - 5	Low	Total: 3 (low)
6 - 10	Moderate	
11 - 15	High	
16+	Extreme	

RISK ASSESSMENT CRITERIA

How Do You Feel?	> 90% 0	80-90% 2	< 80% 4
Quality of Crew Rest	GOOD 0	FAIR 4	POOR 8
Consecutive Airshows	≤ Three 0	Four 2	≥ Five 4
Days Since Last Show	< 15 0	15-30 2	> 30 4
Work Stress Level	Low 0	Mod 2	High 4
Months Since Last Practice or Routine	No / >3 4	1-3 2	< 1 0
Months Until Expecting Child	No 0	2-9 2	< 2 4
Relationship Issues	No 0	Minor 4	Major 8
Financial Issues	No 0	Minor 4	Major 8
Additional Distractions	No 0	Minor 4	Major 8

INDIVIDUAL RISK ASSESSMENT

		CREW INSTRUCTIONS
1		• Use risk assessment criteria above to assess personal risk
2		• Record individual score in corresponding box to the left
3		• Compare individual scores to personal risk index below
4		• Record number of personal scores in the personal risk assessment matrix below
5		
6		
7		
8		
9		
10		

PERSONAL RISK ASSESSMENT INDEX		
0 - 5	Low	Total:
6 - 10	Moderate	
11 - 15	High	
16+	Extreme	

Figure 74

Air Crew Safety Briefing, Example of Briefed Items

[redacted]

1 ☐

2 ☐ **AIRCREW BRIEFING**

3 ☐ **The Team**

- Flying Display Director [redacted]
- Flying Display Director Assistant [redacted]
- Flying Display Director Assistant [redacted]
- Flying Display Director Assistant [redacted]

- Aishow CC: to solve (almost) all your problems
  - [redacted]

4 ☐ **Attendance Check/ Roll Call**

-
-

5 ☐ **Time Check**

- Use Local Time (UTC+3)

6 ☐ **WEATHER BRIEFING**

CURRENT CONDITIONS
FORECAST CONDITIONS
WEATHER MINIMA

7 ☐ **Weather Briefing**

- Current Conditions
-

8 ☐ **Weather Briefing**

Current / Forecast Conditions

-

9 ☐ **Weather Briefing**

Any local weather conditions/effects

-

10 ☐ **Weather Briefing**

Weather minima for the display

-

11 ☐ **DISPLAY ORDER**

UPDATE

12 ☐ **Display Order / Pilot's Guide**

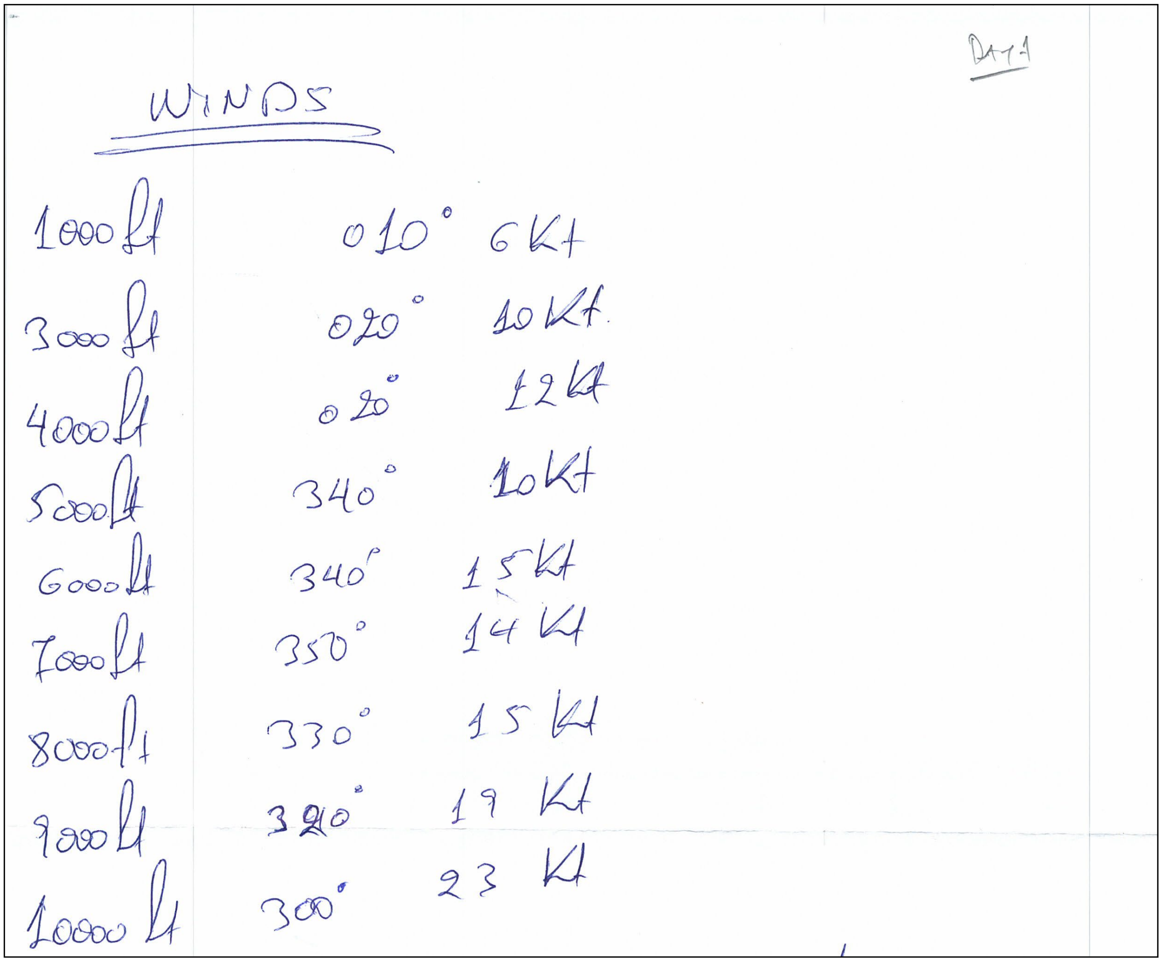
Version #3

13 ☐ **ATC BRIEFING**

1

Figure 75

Air Show Planning Material, Example of Upper Winds



DAY 1

WINDS

1000 ft	010°	6 Kt
3000 ft	020°	10 Kt.
4000 ft	020°	12 Kt
5000 ft	340°	10 Kt
6000 ft	340°	15 Kt
7000 ft	350°	14 Kt
8000 ft	330°	15 Kt
9000 ft	320°	19 Kt
10000 ft	300°	23 Kt

APPENDIX K. Factual Air Show Data Charts

Figure 76

Air Show Accident and Incidents, Contributory Factors

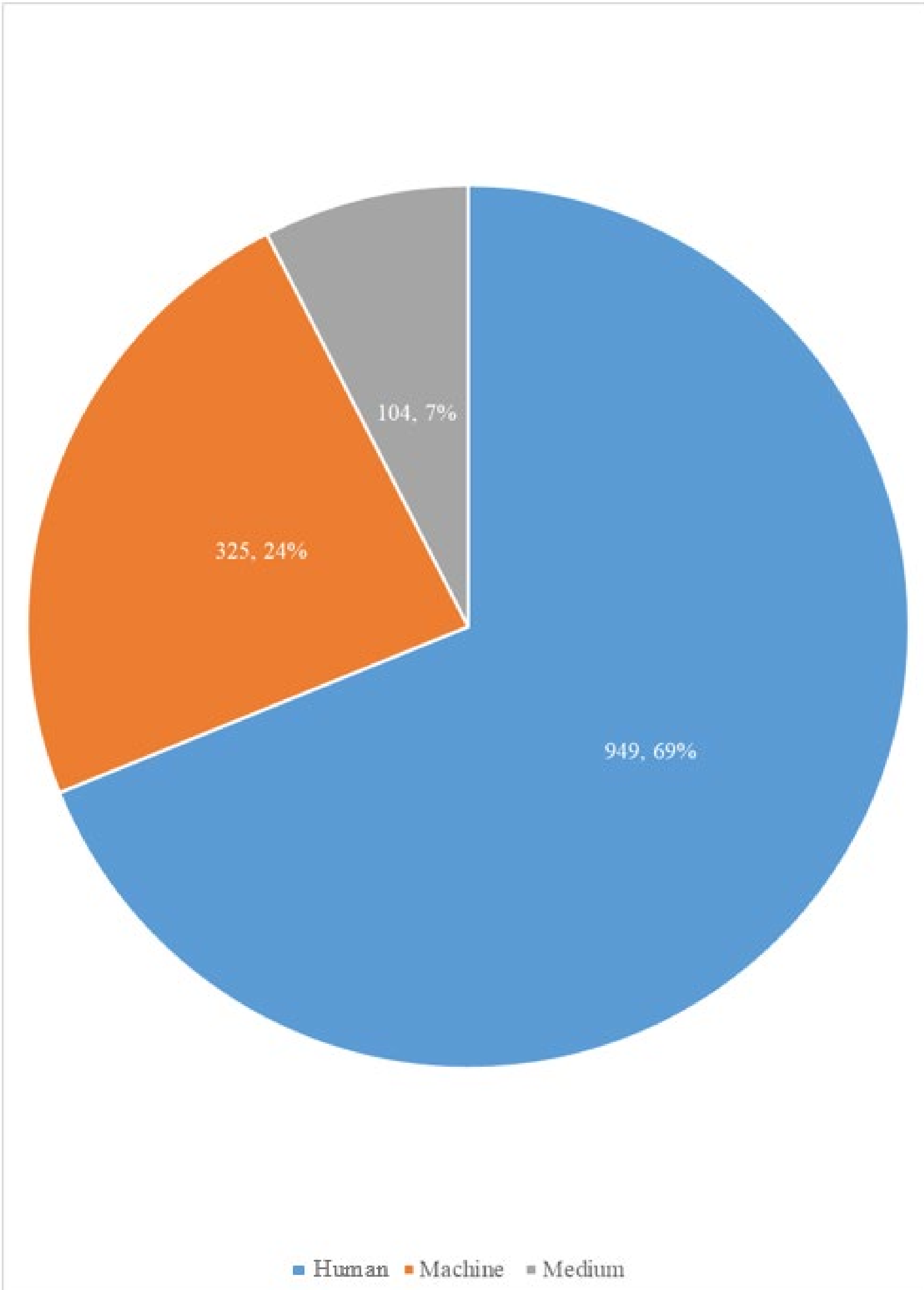


Figure 77

Air Show Accident and Incidents, Human Factor

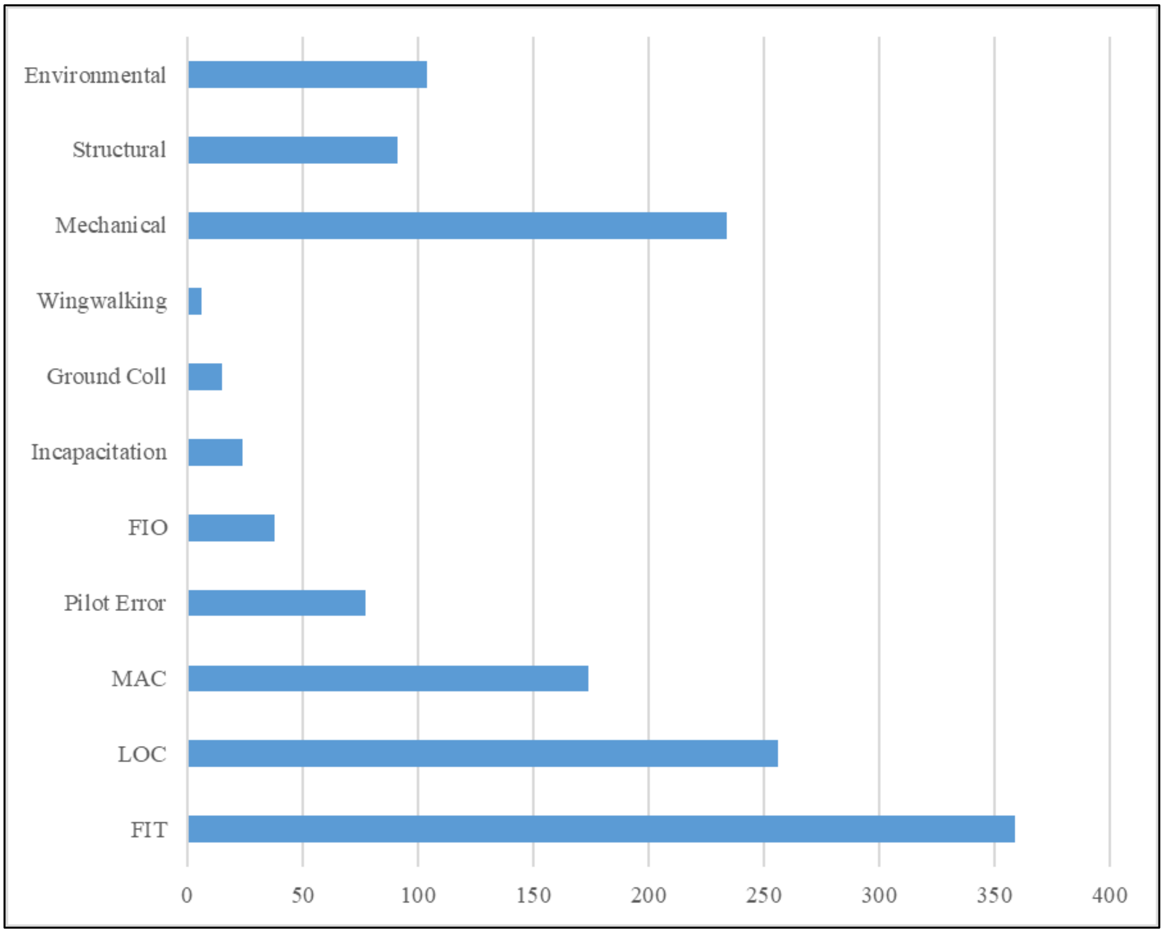


Figure 78

Air Show Accident and Incidents, Machine (Mechanical) Factor

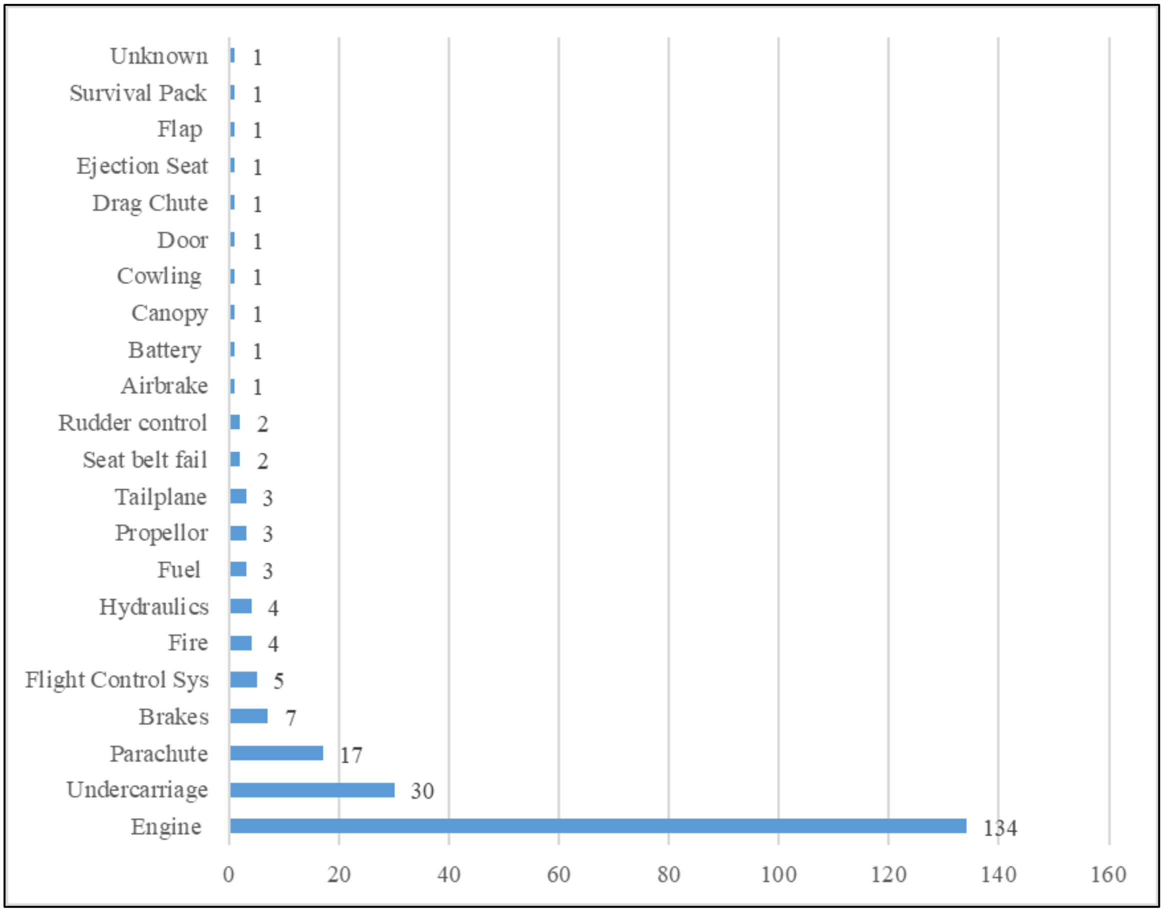


Figure 79

Air Show Accident and Incidents, Machine (Structural) Factor

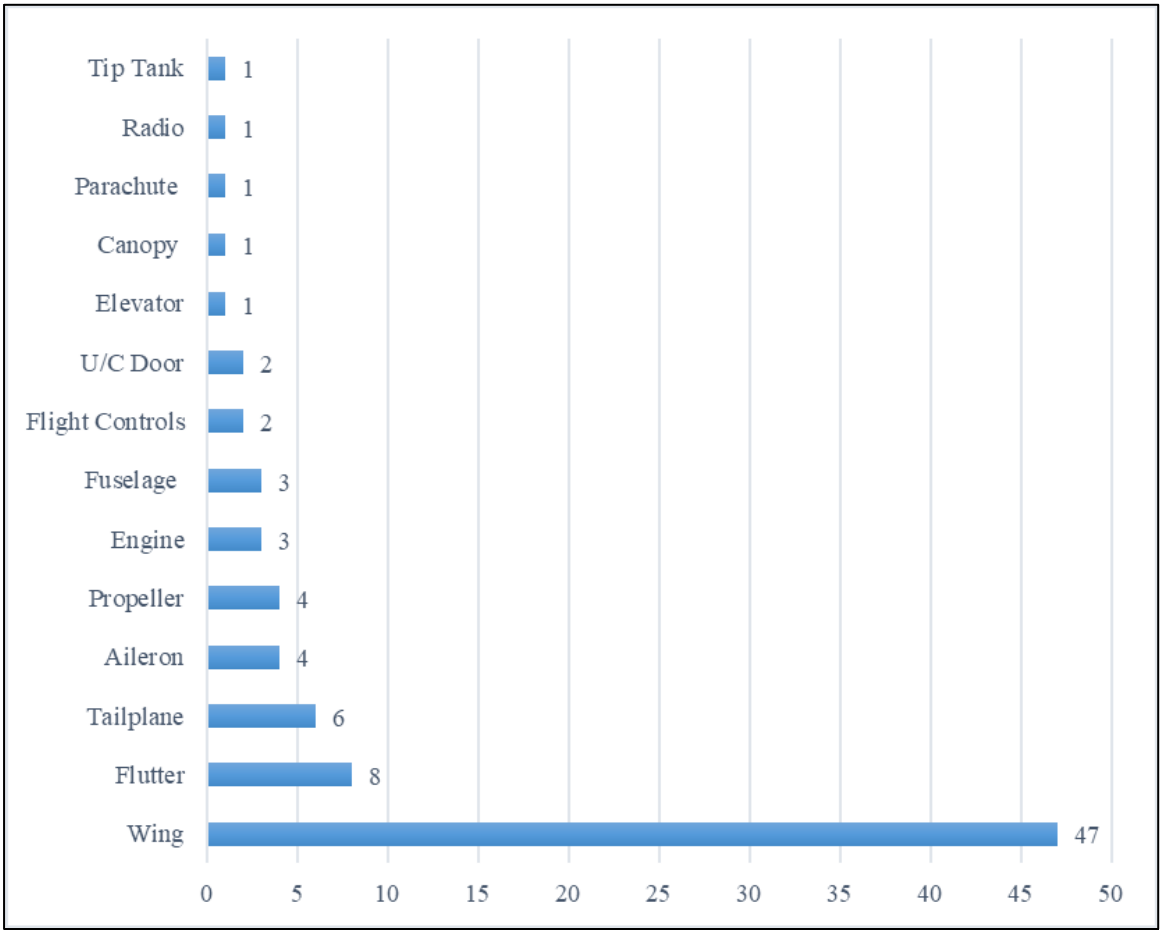


Figure 80

Air Show Accident and Incidents, Medium Factor

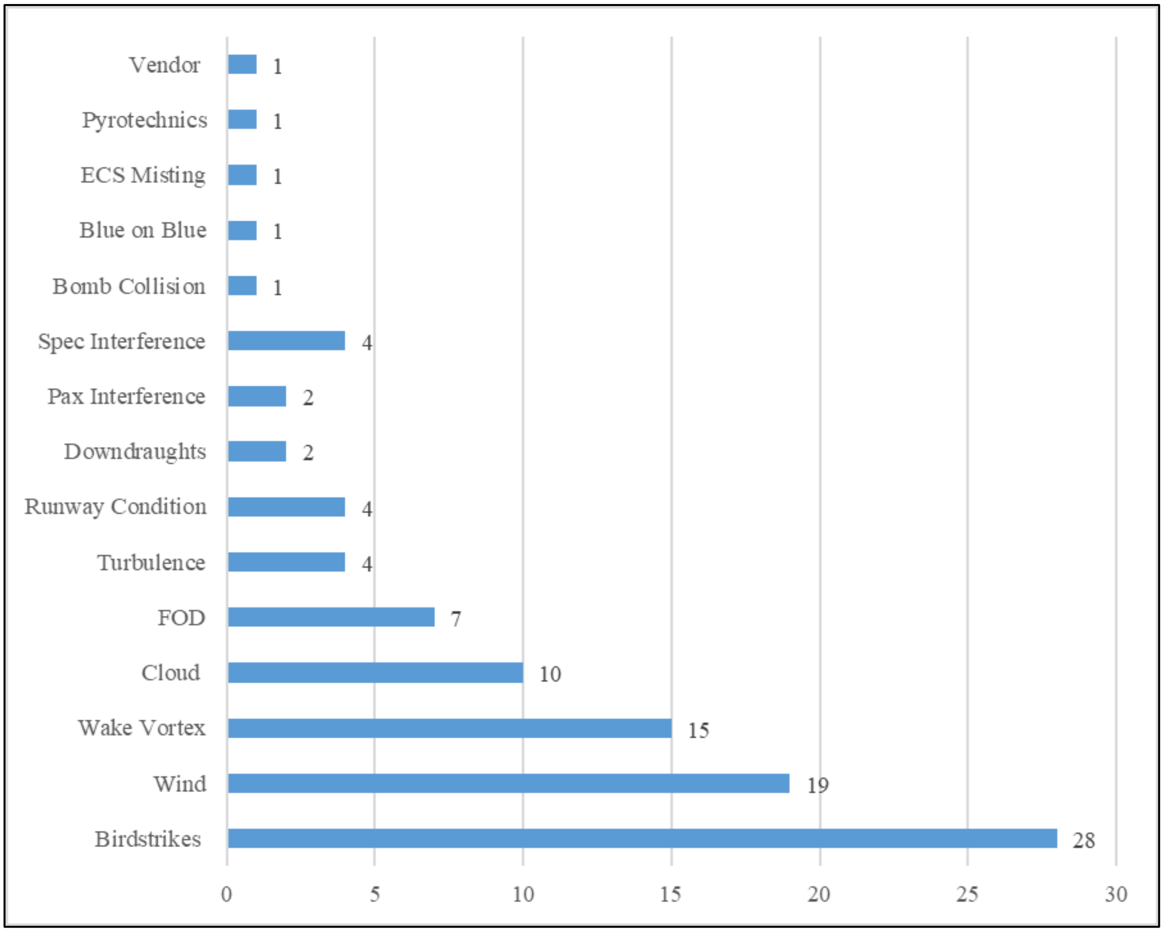
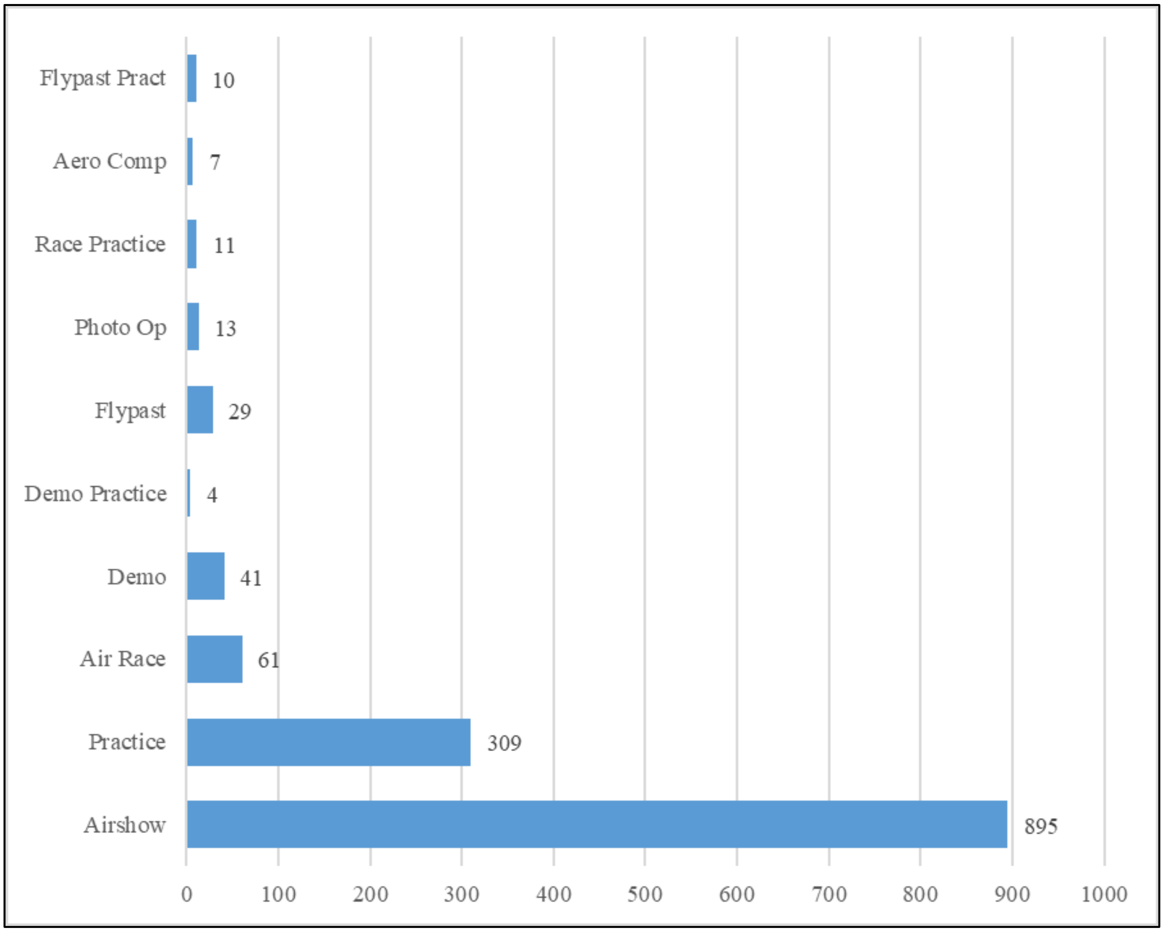


Figure 81

Air Show Accident and Incidents, Event Category



REFERENCES

Aalberg, A. L., Bye, R. J., Kråkenes, T., & Evjemo, T. E. (2020). *Perceived pressure to fly predicts whether inland helicopter pilots have experienced accidents or events with high potential*. [Paper Presentation] Proceedings of the 30th European Safety and Reliability Conference and the 15th Probabilistic Safety Assessment and Management Conference. Retrieved April 7, 2022, from https://www.researchgate.net/profile/Rolf-Bye/publication/342465952_Perceived_Pressure_to_Fly_Predicts_Whether_Inland_Helicopter_Pilots_have_Experienced_Accidents_or_Events_with_High_Potential/links/5ef5a4e192851c52d6fdd689/Perceived-Pressure-to-Fly-Predicts-Whether-Inland-Helicopter-Pilots-have-Experienced-Accidents-or-Events-with-High-Potential.pdf

Abu-Bader, S., & Jones, T. V. (2021). Statistical mediation analysis using the Sobel test and Hayes SPSS process macro. *International Journal of Quantitative and Qualitative Research Methods, (9)*1, 42-61. https://ssrn.com/abstract=3799204

Adjekum, D. K. (2014). Safety culture perceptions in a collegiate aviation program: A systematic assessment. *Journal of Aviation Technology and Engineering*, *3*(2), 44. https://doi.org/10.7771/2159-6670.1086

Adjekum, D. K., & Fernandez-Tous, M. (2020a). Assessing cultural drivers of safety resilience in a collegiate aviation program. *Collegiate Aviation Review*, *38*, 122. https://doi.org/10.22488/okstate.20.100208

Adjekum, D. K., & Fernandez-Tous, M. (2020b). Assessing the relationship between organizational management factors and resilient safety culture in a collegiate aviation program with safety management systems (SMS). *Safety Science*, *131*, 104909. https://doi.org/10.1016/j.ssci.2020.104909

Adjekum, D. K., Keller, J., Walala, M., Young, J., Christensen, C., & DeMik, R. (2015). Cross-sectional assessment of safety culture perceptions and safety behavior in collegiate aviation programs in the United States. *International Journal of Aviation, Aeronautics, And Aerospace*. https://doi.org/10.15394/ijaaa.2015.1074

Air Accidents Investigation Branch. (2017). *Report on the accident to Hawker Hunter T7, G-BXFI near Shoreham Airport on 22 August 2015* (Aircraft Accident Report No. 1/2017). Department of Transport, United Kingdom. https://assets.publishing.service.gov.uk/media/58b9247740f0b67ec80000fc/AAR_1-2017_G-BXFI.pdf

Air Combat Command. (2021a). *ACC Aerial Events 2021, demo team, and heritage flight support manual*. Air Combat Command. https://www.acc.af.mil/Portals/92/2021%20Demo%20Team%20and%20HF%20Support%20Manual%202_1.pdf

Air Combat Command. (2021b). *ACC Airshow risk assessment guide* (Vol. 1). Air Combat Command. https://www.acc.af.mil/Portals/92/ACC%20Airshow%20Risk%20Assessment%20Guide-v1_0.pdf

Akselsson, R., Koornneef, F., Stewart, S., & Ward, M. (2009). Resilience safety culture in aviation organisations. *HILAS (Human Integration into the Lifecycle of Aviation Systems) 2009: Chapter 2; Draft Version.*

American Psychological Association. (2012). The road to resilience. *American Psychological Association*, 7. https://www.uis.edu/counselingcenter/wp-content/uploads/sites/87/2013/04/the_road_to_resilience.pdf

Ammar, A., Chtourou, H., Boukhris, O., Trabelsi, K., Masmoudi, L., Brach, M., Bouaziz, B., Bentlage, E., How, D., Ahmed, M., Mueller, P., Mueller, N., Hsouna, H., Aloui, A., Hammouda, O., Paineiras-Domingos, L. L., Braakman-Jansen, A., Wrede, C., Bastoni, S., … Hoekelmann, A. (2020). COVID-19 Home confinement negatively impacts social participation and life satisfaction: a worldwide multicenter study. *International Journal of Environmental Research and Public Health*, *17*(17), E6237. https://doi.org/10.3390/ijerph17176237

Ammar, A., Trabelsi, K., Brach, M., Chtourou, H., Boukhris, O., Masmoudi, L., Bouaziz, B., Bentlage, E., How, D., Ahmed, M., Mueller, P., Mueller, N., Hammouda, O., Paineiras-Domingos, L. L., Braakman-jansen, A., Wrede, C., Bastoni, S., Pernambuco, C. S., Mataruna, L., … Hoekelmann, A. (2021). Effects of home confinement on mental health and lifestyle behaviours during the COVID-19 outbreak: Insights from the ECLB-COVID19 multicentre study. *Biology of Sport*, *38*(1), 9–21. https://doi.org/10.5114/biolsport.2020.96857

Andersen, J. P., Papazoglou, K., Gustafsberg, H., Collins, P., & Arnetz, B. B. (2016). Mental preparedness training. *FBI Law Enforcement Bulletin.* https://leb.fbi.gov/2016/march/mental-preparedness-training

Arnett, J. J., Offer, D., & Fine, M. A. (1997). Reckless driving in adolescence: “state” and “trait” factors. *Accident Analysis and Prevention*, *29*(1), 57–63. https://doi.org/10.1016/s0001-4575(97)87007-8

Aumeboonsuke, V., & Caplanova, A. (2021). An analysis of impact of personality traits and mindfulness on risk aversion of individual investors. *Current Psychology*, 1-18. https://doi.org/10.1007/s12144-021-02015-9

Australian Transport Safety Bureau. (2005). *An examination of accidents and incidents involving pilot distraction in Australia between 1997 and 2004*. Australian Transport Safety Bureau. https://www.atsb.gov.au/media/36244/distraction_report.pdf

Ballard, S. B., & Osorio, V. B. (2015). U.S. civil air show crashes, 1993 to 2013. *Transportation Research Record*, *2471*, 1–9. https://doi.org/10.3141/2471-01

Baltzell, A., & Akhtar, V. L. (2014). Mindfulness meditation training for sport (MMTS) intervention: Impact of MMTS with division I female athletes. *The Journal of Happiness & Well-Being*, *2*(2), 160–173.

Baretta, D., Greco, A., & Steca, P. (2017). Understanding performance in risky sport: The role of self-efficacy beliefs and sensation seeking in competitive freediving. *Personality and Individual Differences*, *117*, 161–165. https://doi.org/10.1016/j.paid.2017.06.006

Barker, D. (2003). *Zero error margin—Airshow display flying analysed.* https://www.researchgate.net/publication/261136368_Zero_Error_Margin_-_Airshow_Display_Flying_Analysed

Barker, D. (2020a). *Anatomy of airshow accidents* (1st ed., Vol. 1). International Council of Air Shows, International Air Show Safety Team.

Barker, D. (2020b). *Air show accidents: A statistical and preventative perspective*. International Council of Air Shows 2020 Convention. https://www.youtube.com/watch?v=29zT0edEAUQ&t=877s

Bauranov, A., Parks, S., Jiang, X., Rakas, J., & González, M. C. (2021). Quantifying the resilience of the U.S. domestic aviation network during the COVID-19 pandemic. *Frontiers in Built Environment,* 7. https://doi.org/10.3389/fbuil.2021.642295

Bell, G. J. (2020). *The organizational resilience handbook : a practical guide to achieving greater resilience.* Kogan Page Limited.

Bentler, P., & Bonett, D. (1980). Significance tests and goodness-of-fit in analysis of covariance structures. *Psychological Bulletin*, *88*, 588–606. https://doi.org/10.1037/0033-2909.88.3.588

Bento, F., Mercado, M. P., & Garotti, L. (2021). Organizational resilience in the oil and gas industry: A scoping review. *Safety Science.* https://doi.org/10.1016/j.ssci.2020.105036

Birrer, D., Röthlin, P., & Morgan, G. (2012). Mindfulness to enhance athletic performance: theoretical considerations and possible impact mechanisms. *Mindfulness*, *3* (3), 235–246. https://doi.org/10.1007/s12671-012-0109-2

Blackburn, E., & Epel, E. (2018). *The telomere effect: A revolutionary approach to living younger, healthier, longer* (2nd ed.). Orion Spring.

Brennan, T. (2005). *The stress first aid kit: Meditations for transforming your mental and emotional state* [Audiobook]. Bolinda Publishing Pty Ltd.

Brintz, C., Miller, S., Olmsted, K. R., Bartoszek, M., Cartwright, J., Kizakevich, P., Butler, M., Asefnia, N., Buben, A., & Gaylord, S. (2019). Adapting mindfulness training for military service members with chronic pain. *Military Medicine*, *185*. https://doi.org/10.1093/milmed/usz312

British Air Display Association. (2022). *To encourage, promote and advance safety and standards in British air displays.* British Air Display Association. https://www.bada-uk.com/

Brown, K. W., & Ryan, R. M. (2003). The benefits of being present: Mindfulness and its role in psychological well-being. *Journal of Personality and Social Psychology*, *84*(4), 822–848. https://doi.org/10.1037/0022-3514.84.4.822

Brown, K. W., Ryan, R. M., & Creswell, J. (2007). Mindfulness: Theoretical foundations and evidence for its salutary effects. *Psychological Inquiry*, *18*, 211–237. https://doi.org/10.1080/10478400701598298

Brown, T. A. (2015). *Confirmatory factor analysis for applied research* (2nd ed.). Guilford publications.

Brugnara, R. L., de Souza Fontes, R., de Andrade, D., & Leão, M. S. (2022). Interaction of aeronautical decision-making and organizational safety-II in the context of airline transport pilot training. *Education Journal, 11*(1), 12-25. https://doi.org/10.11648/j.edu.20221101.12

Brymer, E., & Mackenzie, S. H. (2017). Psychology and the extreme sport experience. *Extreme Sports Medicine*, *1*, 3–13. https://doi.org/10.1007/978-3-319-28265-7_1

Brymer, G. E. (2005). *Extreme dude! A phenomenological perspective on the extreme sport experience* [Thesis, University of Wollongong]. https://ro.uow.edu.au/theses/379

Byrnes, K., P., Rhoades, D. L., Williams, M. J., Arnaud, A. U., & Schneider, A. H. (2022). The effect of a safety crisis on safety culture and safety climate: The resilience of a flight training organization during COVID-19. *Transport Policy*, 117, 181–191. https://doi.org/10.1016/j.tranpol.2021.11.009

Cairns, J., Adie, W., & Osman, L. (2008). Measurement of risk perception in the offshore oil and gas industry. *Risk Management*, *10*(3), 205–217. https://doi.org/10.1057/rm.2008.4

Callari, T. C., McDonald, N., Kirwan, B., & Cartmale, K. (2019). Investigating and operationalising the mindful organising construct in an air traffic control organisation. *Safety Science, 120*, 838-849. https://doi.org/10.1016/j.ssci.2019.08.027.

Cantu, J., Tolk, J., Fritts, S., & Gharehyakheh, A. (2020). High reliability organization (HRO) systematic literature review: Discovery of culture as a foundational hallmark. *Journal of Contingencies and Crisis Management*, 28(4), 399-410. https://doi.org/10.1111/1468-5973.12293

Carthey, J., de Leval, M. R., Wright, D. J., Farewell, V. T., & Reason, J. T. (2003). Behavioral markers of surgical excellence. *Safety Science, 41*(5), 409-425. https://doi.org/10.1016/S0925-7535(01)00076-5

Casler, J. G. (2014). Revisiting NASA as a high reliability organization. *Public Organization Review, 14*(2), 229-244. https://doi.org/10.1007/s11115-012-0216-5

Causse, M., Baracat, B., & Pastor, J. et al. (2011). Reward and uncertainty favor risky decision-making in pilots: evidence from cardiovascular and oculometric measurements. *Applied Psychophysiology and Biofeedback 36* (4), 231–242 (2011). https://doi.org/10.1007/s10484-011-9163-0

Charness, G., Garcia, T., Offerman, T., & Villeval, M. (2019). Do measures of risk attitude in the laboratory predict behavior under risk in and outside of the laboratory? *HAL Open Science*, 58. https://doi.org/halshs-02146618v2

Chen, C. F., & Chen, S. C. (2014). Measuring the effects of safety management system practices, morality leadership and self-efficacy on pilots' safety behaviors: Safety motivation as a mediator. *Safety Science, 62*, 376-385. https://doi.org/10.1016/j.ssci.2013.09.013

Chen, J., Zhang, Q., An, R., & Lei, T. (2019, February). A sensitivity analysis method of human factors measurement tools in pilot distraction. In *2019 2nd International Conference on Intelligent Autonomous Systems (ICoIAS)* (pp. 47-52). IEEE. https://doi.org/10.1109/ICoIAS.2019.00015.

Chiesa, A., & Serretti, A. (2009). Mindfulness-based stress reduction for stress management in healthy people: A review and meta-analysis. *Journal of*

Alternative and Complementary Medicine (New York, N.Y.), *15*(5), 593–600. https://doi.org/10.1089/acm.2008.0495

Chionis, D., & Karanikas, N. (2018). Differences in risk perception factors and behaviours amongst and within professionals and trainees in the aviation engineering domain. *Aerospace*, *5*, 62. https://doi.org/10.3390/aerospace5020062

Christian, M. S., Bradley, J. C., Wallace, J. C., & Burke, M. J. (2009). Workplace safety: A meta-analysis of the roles of person and situation factors. *Journal of Applied Psychology*, *94*(5), 1103–1127. https://doi.org/10.1037/a0016172

Clarke, S. (2000). Safety culture: Under-specified and overrated? *International Journal of Management Reviews*, *2*(1), 65–90. https://doi.org/10.1111/1468-2370.00031

Cole, N. N., Nonterah, C. W., Utsey, S. O., Hook, J. N., Hubbard, R. R., Opare-Henaku, A., & Fischer, N. L. (2015). Predictor and moderator effects of ego resilience and mindfulness on the relationship between academic stress and psychological well-being in a sample of Ghanaian college students. *Journal of Black Psychology*, *41*(4), 340–357. https://doi.org/10.1177/0095798414537939

Comcare. (2008). *Working well, an organisational approach to preventing psychological injury*. Commonwealth of Australia. https://www.comcare.gov.au/about/forms-publications/documents/publications/safety/working-well-guide.pdf

Commission Internationale de Voltige Arienne. (2019). *The CIVA judging tutorial for 2019 (Revision 7)*. Commission Internationale de Voltige Arienne. Retrieved March 25, 2022, from https://www.civanews.com/wp-content/uploads/historical-images/media/2019-01/CIVA-Judging-Tutorial-2019-pdfaeaa8a872d9de96a7c8f7f1014fd6e4b1185f1d7.pdf

Conner, D. (1993). *Managing at the speed of change*. Random House.

Convertino V. A. (1998). High sustained +Gz acceleration: physiological adaptation to high-G tolerance. *Journal of Gravitational Physiology: A Journal of the International Society for Gravitational Physiology, 5*(1), P51–P54.

Creswell, J. W., & Creswell, J. D. (2018). *Research design—qualitative, quantitative, and mixed methods approaches* (5th ed.). SAGE Publications Ltd.

Crundall, D., van Loon, E., Stedmon, A. W., & Crundall, E. (2013). Motorcycling experience and hazard perception. *Accident Analysis & Prevention*, *50*, 456–464. https://doi.org/10.1016/j.aap.2012.05.021

Csikszentmihalyi, M. (2008). *Flow: The psychology of optimal experience* (3rd ed.). Harper Perennial.

Cudahy, J. (2019, August 19). Air shows as aviation work force development events. *Air Show Digest*. International Council of Air Shows.

de Voogt, A. J., & van Doorn, R. R. A. (2009). Accidents associated with aerobatic maneuvers in U.S. aviation, *Aviation, Space, and Environmental Medicine, 80* (8), 732-733. Aerospace Medical Association. https://doi.org/10.3357/ASEM.2521.2009

Defense Safety Authority. (2019). *Service Inquiry HAWK T Mkl A XX204 RAF Valley, 20 March 2018*. Defense Safety Authority. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attac hment_data/file/837526/20191007-HAWK_T_Mk1a_XX204_SI_Redacted-Final.pdf

Dekker, S. W. A. (2004). The hindsight bias is not a bias and not about history. *Human Factors and Aerospace Safety, 4*(2), 87-99.

Dekker, S. W. A. (2014). *Safety differently: Human factors for a new era* (2nd ed.). CRC Press.

Dekker, S. W. A. (2020). Safety after neoliberalism. *Safety Science*, 125, 104630. https://doi.org/10.1016/j.ssci.2020.104630

Dekker, S. W. A., & Woods, D. D. (2010). Chapter 5 - The high reliability organization perspective. In Salas, E. &Maurino, D., (Eds.), *Human Factors in Aviation (*2nd ed., pp. 123-143). Academic Press. https://doi.org/10.1016/B978-0-12-374518-7.00005-5

Demir, A. E., & Aydın, E. (2021). Vestibular illusions and alterations in aerospace environment. *Turkish Archives of Otorhinolaryngology, 59*(2), 139–149. https://doi.org/10.4274/tao.2021.2021-3-3

Denkova, E., Zanesco, A. P., Rogers, S. L., & Jha, A. P. (2020). Is resilience trainable? An initial study comparing mindfulness and relaxation training in firefighters. *Psychiatry Research*, 285, 112794–. https://doi.org/10.1016/j.psychres.2020.112794

Department of the Navy. (2016). *Command investigation into the circumstances surrounding the navy flight demonstration squadron class an aviation mishap in Smyrna, Tennessee, on 2 June 2016* (Investigation Report No. 00/0412, p. 46).

Department of the Navy. https://s3.documentcloud.org/documents/3109500/JAGMAN-and-First-Endorsement.pdf

Diehl, A. E. (2002). *Silent knights: Blowing the whistle on military accidents.* Brassey's Inc.

Dillman, B. G., Voges, J., & Robertson, M. (2010). Safety occurrences student perceptions regarding failures to report. *Journal of Aviation Management and Education*, 14. http://www.aabri.com/manuscripts/09261.pdf

Doerr, A. J. (2020). When and how personality predicts workplace safety: Evaluating a moderated mediation model. *Journal of Safety Research, 75*, 275-283. https://doi.org/10.1016/j.jsr.2020.09.008

Drinkwater, J., & Molesworth, B. (2010). Pilot see pilot do: Examining the predictors of pilots' risk management behaviour. *Safety Science*, *48*(10), 1445–1451. https://doi.org/10.1016/j.ssci.2010.07.001

Dunning, D. (2011). The Dunning–Kruger effect: On being ignorant of one's own ignorance. In J. M. Olson & M. P. Zanna (Eds.), *Advances in Experimental Social Psychology* (Vol. 44, pp. 247–296). Academic Press. https://doi.org/10.1016/B978-0-12-385522-0.00005-6

European Airshow Council. (2020). *Airshow manual* (5.1). European Airshow Council.

European Airshow Council. (2022a). *Personal communication of author with EAC: Number of air show performers and flying display directors in Europe* [Personal communication].

European Airshow Council. (2022b). *Open discussion during the European Airshow Convention 2022*. European Airshow Council.

Fasey, K. J., Sarkar, M., Wagstaff, C. R. ., & Johnston, J. (2021). Defining and characterizing organizational resilience in elite sport. *Psychology of Sport and Exercise*, 52. https://doi.org/10.1016/j.psychsport.2020.101834

Federal Aviation Administration. (2001). *A human error analysis of commercial aviation accidents using the human factors analysis and classification system (HFACS)*. Federal Aviation Administration.

Federal Aviation Administration. (2016). *Pilot's handbook of aeronautical knowledge, FAA-H-8083-25B*. Federal Aviation Administration.

Federal Aviation Administration. (2020a). Chapter 6: Issue a certificate of waiver or authorization for an aviation event. In *Flight Standards Information Management System* (pp. 3-141 - 3-160). Federal Aviation Administration.

Federal Aviation Administration. (2020b). *8000.369C - Safety management system*. Federal Aviation Administration.

Ferraro, R., VanDyke, D., Zander, M., Anderson, K., & Kuehlen, B. (2015). Risk perception in aviation students: Weather matters. *International Journal of Aviation, Aeronautics, and Aerospace*, *2*(1). https://doi.org/10.15394/ijaaa.2015.1044

Field, A. (2018). *Discovering statistics using IBM SPSS statistics* (5th ed.). SAGE Publications Ltd.

Filho, E., Aubertin, P., & Petiot, B. (2016). The making of expert performers at Cirque du Soleil and the National Circus School: A performance enhancement outlook. *Journal of Sport Psychology in Action*, *7*(2), 68–79. https://doi.org/10.1080/21520704.2016.1138266

Flightline UK. (2020). *Future air displays: A public perspective results from an online survey 30th May – 1st July 2020*. Flightline UK.

Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research*, *18*(1), 39–50. https://doi.org/10.2307/3151312

France Spectacle Aérien. (2022). *Encourage and promote airshows*. France Spectacle Aérien. https://france-spectacle-aerien.com/

Francis, K. B., Gummerum, M., Ganis, G., Howard, I. S., & Terbeck, S. (2018). Virtual morality in the helping professions: Simulated action and resilience. *The British Journal of Psychology,* 109(3), 442–465. https://doi.org/10.1111/bjop.12276

Fredrickson, B. L. (2001). The role of positive emotions in positive psychology. *The American Psychologist*, *56*(3), 218–226. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3122271/pdf/nihms-305177.pdf

Fusco, P. (2018). *The crowd pleasers: A history of airshow misfortunes from 1910 to the present*. Skyhorse Publishing.

Galloway, S. M. (2012). Standing side by side: Principles of effective leadership. *Professional Safety, 57*(7), 26–.

Gautam, A., & Mathur, R. (2018). Influence of mindfulness on decision making and psychological flexibility among aircrew. *Journal of Psychosocial Research*, *13*(1), 199–207.

Gautam, A., & Mathur, R. (2020). The impact of ego resiliency on hazardous attitude of pilots. *Shodh Sarita: Quarterly bi-lingual research journal, 7*(21), 62-66.

Gethin, R. (2011). On some definitions of mindfulness. *Contemporary Buddhism*, *12*(1), 263–279. https://doi.org/10.1080/14639947.2011.564843

Gibson, R. J., Michayluk, D., & Van de Venter, G. (2013). Financial risk tolerance: An analysis of unexplored factors. *Financial Services Review*, *22*, 23–50. https://opus.lib.uts.edu.au/handle/10453/23532

Glendon, I., & Stanton, N. (2000). Perspectives on safety culture. *Safety Science*, *34*(1–3), 193–214. https://doi.org/10.1016/S0925-7535(00)00013-8

Gössling, S., (2020). Risks, resilience, and pathways to sustainable aviation: A COVID-19 perspective, *Journal of Air Transport Management*, Volume 89, 101933, https://doi.org/10.1016/j.jairtraman.2020.101933.

Granath, B. (2017, November 10). *Members of Apollo 13 team reflect on NASA's finest hour*. National Aeronautics and Space Administration. http://www.nasa.gov/content/members-of-apollo-13-team-reflect-on-nasas-finest-hour

Grimm, P. (2010). Social desirability bias. In *Wiley International Encyclopedia of Marketing*. Wiley Online Library. https://doi.org/10.1002/9781444316568.wiem02057

Hallahan, T. A., Faff, R. W., & McKenzie, M. D. (2004). An empirical investigation of personal financial risk tolerance. *Financial Services Review*, *13* (1), 57–78.

Han, Y., Yun, J.-A., Jeong, K. S., Ahn, Y.-S., & Choi, K.-S. (2021). Posttraumatic stress disorder symptoms and neurocognitive functioning in fire fighters: The mediating role of sleep problems and resilience. *Comprehensive Psychiatry*, 109, 152250–152250. https://doi.org/10.1016/j.comppsych.2021.152250

Harrell, M. C., & Bradley, M. A. (2009). *Data collection methods: Semi-structured interviews and focus groups* (p. 148). RAND Corporation. https://www.rand.org/content/dam/rand/pubs/technical_reports/2009/RAND_TR718.pdf

Harris, D. (2011). *Human performance in the flight deck*. CRC Press.

Harris, D., Arthur, T., de Burgh, T., Duxbury, M., Lockett-Kirk, R., McBarnett, W., & Vine, S. J. (2022, January 10). Assessing expertise using eye tracking in a virtual reality flight simulation. https://doi.org/10.31234/osf.io/ue58a

Hayes, A. F. (2017). *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach*. Guilford Publications.

Heyvaert, M., Maes, B. & Onghena, P. (2011). Mixed methods research synthesis: definition, framework, and potential. *Qual Quant 47*, 659–676 (2013). https://doi.org/10.1007/s11135-011-9538-6

Heese, M., Kallus, W., & Kolodej, C. (2014). *Assessing behaviour towards organizational resilience in aviation*. [Paper Presentation] Proceedings of the 5th Resilience Engineering Association Symposium, 67–73.

Hofmann, S. G., Sawyer, A. T., Witt, A. A., & Oh, D. (2010). The effect of mindfulness-based therapy on anxiety and depression: A meta-analytic review. *Journal of Consulting and Clinical Psychology*, *78*(2), 169–183. https://doi.org/10.1037/a0018555

Hofstede, G. (1984). *Culture's consequences: International differences in work-related values*. SAGE Publications Ltd.

Hofstede, G. (2001). *Culture's consequences: Comparing values, behaviors, institutions, and organizations across nations* (Vol. 41). SAGE Publications Ltd.

Hofstede, G., Hofstede, G. J., & Minkov, M. (2010). *Cultures and organizations: Software of the mind; intercultural cooperation and its importance for survival* (3rd ed.). McGraw-Hill.

Holas, P., & Jankowski, T. (2013). A cognitive perspective on mindfulness. *International Journal of Psychology*, *48*(3), 232–243. https://doi.org/10.1080/00207594.2012.658056

Hollnagel, E. (2006). Resilience: The challenge of the unstable. In Hollnagel, E., Woods, D. D. & Leveson, N. C. (Eds.), *Resilience engineering: Concepts and precepts* (p. 9-18). Aldershot, UK: Ashgate.

Hollnagel, E. (2010). How resilient is your organisation? An introduction to the Resilience Analysis Grid (RAG). *Sustainable Transformation: Building a Resilient Organization*. https://hal-mines-paristech.archives-ouvertes.fr/hal-00613986

Hollnagel, E. (2014). *Safety-I and safety-II: The past and future of safety management*. CRC Press.

Hollnagel, E. (2018). *Safety-II in practice: Developing the resilience potentials*. Routledge.

Hollnagel, E., Pariès, J., Woods, D. D., & Wreathall, J. (2011). *Resilience engineering in practice: A guidebook*. Ashgate Publishing, Ltd.

Hollowell, D. (2012, August 1). Putting accident/incident analysis to work for our air show family. *Air Show Digest*. International Council of Air Shows.

Holzel, B., Lazar, S., Gard, T., Schuman-Olivier, Z., Vago, D., & Ott, U. (2011). How does mindfulness meditation work? Proposing mechanisms of action from a conceptual and neural perspective. *Perspectives on Psychological Science*, *6*(6), 537–559. https://doi.org/10.1177/1745691611419671

Hoover, R. A. "Bob." (2014). *Forever flying: Fifty years of high-flying adventures, from barnstorming in prop planes to dogfighting germans to testing supersonic jets*. Atria Paperback.

Hu, L., & Bentler, P. M. (2009). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal*, *6*(1), 1–55. https://doi.org/10.1080/10705519909540118

Hunter, D. R. (2002). *Risk perception and risk tolerance in aircraft pilots* (Technical Report DOT/FAA/AM-02/17, p. 26). Office of Aerospace Medicine, Federal Aviation Administration.

Hunter, D. R. (2005). Measurement of hazardous attitudes among pilots. *The International Journal of Aviation Psychology*, *15*(1), 23–43. https://doi.org/10.1207/s15327108ijap1501_2

Hunter, D. R. (2006a). *Risk perception: Self scale*. Retrieved March 25, 2022, from https://web.archive.org/web/20190514032417/http://avhf.com/html/Researcher/Risk_Perception_Self.asp

Hunter, D. R. (2006b). Risk perception among general aviation pilots. *International Journal of Aviation Psychology*, *16*(2), 135–144. https://doi.org/10.1207/s15327108ijap1602_1

International Civil Aviation Organization. (1993). *Investigation of human factors in accidents and incidents* (Human Factors Digest No. 240-AN/144, 7, p. 66). International Civil Aviation Organization. https://skybrary.aero/sites/default/files/bookshelf/2037.pdf

International Civil Aviation Organization. (2011). *Part I: Operation of aircraft.* In Annex 6. International Civil Aviation Organization.

International Civil Aviation Organization. (2016). *Manual for the oversight of fatigue management approaches (Doc 9966).* (2nd ed.). International Civil Aviation Organization.

International Civil Aviation Organization. (2018). *Safety management manual (Doc 9859).* (4th ed.). International Civil Aviation Organization.

International Council of Air Shows. (2008, July 28). Who is responsible? *ICAS Operations Bulletin*. International Council of Air Shows.

International Council of Air Shows. (2012, October 1). Sacred sixty minutes: An update from the field. *ICAS Operations Bulletin*, *5*(11). International Council of Air Shows.

International Council of Air Shows. (2016, September 9). *ICAS confirms 2016 convention keynote speakers.* International Council of Air Shows. Retrieved March 30, 2022, from https://airshows.aero/News/ID/487

International Council of Air Shows. (2018). *Air show performers safety manual.* International Council of Air Shows.

International Council of Air Shows. (2021). *Principles of conduct and professional ethics*. International Council of Air Shows.

International Council of Air Shows. (2022). *Personal communication with ICAS: Number of air show performers and air bosses in North America* [Personal communication].

Jarvis, S. (2009, December). *Human factors—Performer safety debrief*. ICAS Convention 2009, Las Vegas.

Jensen, R. S., & Benel, R. A. (1977). *Judgment evaluation and instruction in civil pilot training* (No. FAA-RD-78-24 Final Rpt.). https://trid.trb.org/view/75609

Ji, M., Yang, C., Li, Y., Xu, Q., & He, R. (2018). The influence of trait mindfulness on incident involvement among Chinese airline pilots: The role of risk perception and flight experience. *Journal of Safety Research, 66*, 161-168. https://doi.org/10.1016/j.jsr.2018.07.005

Ji, M., You, X., Lan, J., & Yang, S. (2011). The impact of risk tolerance, risk perception and hazardous attitude on safety operation among airline pilots in China. *Safety Science*, *49*(10), 1412–1420. https://doi.org/10.1016/j.ssci.2011.06.007

Jin, J., & Tang, J. (2021). Exploring the effect of perceived organizational support and resilience on Chinese pharmacists' engagement in stressful and competitive pharmaceutical work at hospitals. *Saudi Pharmaceutical Journal*, 29(9), 931–938. https://doi.org/10.1016/j.jsps.2021.08.003

Joseph, C., & Reddy, S. (2013). Risk perception and safety attitudes in Indian army aviators. *The International Journal of Aviation Psychology*, *23*(1), 49–62. https://doi.org/10.1080/10508414.2013.746531

Kabat-Zinn, J. (1994). *Wherever you go, there you are: Mindfulness meditation in everyday life* (10th Anniversary). First Hachette Books.

Kang, H. (2021). Sample size determination and power analysis using the G* power software. *Journal of Educational Evaluation for Health Professions, 18*. https://doi.org/10.3352/jeehp.2021.18.17

Kao, C. S., Lai, W. H., Chuang, T. F., & Lee, J. C. (2008). Safety culture factors, group differences, and risk perception in five petrochemical plants. *Process Safety Progress*, *27*(2), 145–152. https://doi.org/10.1002/prs.10246

Katz, D., Sarnoff, I., & McClintock, C. (1956). Ego-defense and attitude change. *Human Relations*, *9*(1), 27–45. https://doi.org/10.1177/001872675600900102

Kelly, D., & Efthymiou, M. (2019). An analysis of human factors in fifty controlled flight into terrain aviation accidents from 2007 to 2017. *Journal of Safety Research, 69*, 155-165. https://doi.org/10.1016/j.jsr.2019.03.009

Kern, A. T. (1995). *Darker shades of blue: A case study of failed leadership.* United States Air Force. http://sbfpd.org/uploads/3/0/9/6/3096011/darker_shades_of_blue.pdf

Kirkham, W. R., Wicks, S. M., & Lowrey, D. L. (1982). *G incapacitation in aerobatic pilots: A flight hazard.* Federal Aviation Administration. https://apps.dtic.mil/sti/pdfs/ADA123757.pdf

Kirkman, B., Stoverink, A. C., Mistry, S., & Rosen, B. (2019, July 19). The 4 things resilient teams do. *Harvard Business Review*. https://hbr.org/2019/07/the-4-things-resilient-teams-do

Kline, R. B. (2016). *Principles and practice of structural equation modeling.* (4th ed.). The Guilford Press.

Klockner, K., Shields, P., Pillay, M., & Ames, K. (2021). Pragmatism as a teaching philosophy in the safety sciences: A higher education pedagogy perspective. *Safety Science*, *138*, 105095. https://doi.org/10.1016/j.ssci.2020.105095

Kouzes, J., & Posner, B. (2017). *The leadership challenge* (6th ed.). John Wiley & Sons.

Krieger, J. L. (2005). Shared mindfulness in cockpit crisis situations: An exploratory analysis. *The Journal of Business Communication*, *42*(2), 135–167. https://doi.org/10.1177/0021943605274726

La Porte, T. R. (1996). High reliability organizations: Unlikely, demanding and at risk. *Journal of Contingencies and Crisis Management*, *4*(2), 60–71. https://doi.org/10.1111/j.1468-5973.1996.tb00078.x

Lengnick-Hall, C. A., Beck, T. E., & Lengnick-Hall, M. L. (2011). Developing a capacity for organizational resilience through strategic human resource management. *Human Resource Management Review, 21*(3), 243-255. https://doi.org/10.1016/j.hrmr.2010.07.001

Leutner, F., Yearsley, A., Codreanu, S. C., Borenstein, Y., & Ahmetoglu, G. (2017). From Likert scales to images: Validating a novel creativity measure with image based response scales. *Personality and Individual Differences*, *106*, 36–40. https://doi.org/10.1016/j.paid.2016.10.007

Li, Y., Chen, H., Xin, X., & Ji, M. (2020). The influence of mindfulness on mental state with regard to safety among civil pilots. *Journal of Air Transport Management*, *84*, 101768. https://doi.org/10.1016/j.jairtraman.2020.101768

Liao, M., -Y. (2015). Safety culture in commercial aviation: Differences in perspective between Chinese and Western pilots. *Safety Science*, 79, 193–205. https://doi.org/10.1016/j.ssci.2015.05.011

Loudenslager, L. (2014, August 24). *Leo Loudenslager* [Video]. YouTube. https://www.youtube.com/watch?v=92M2iCD_rQw

Loukopoulos, L. D., Dismukes, R. K., & Barshi, I. (2001, March). *Cockpit interruptions and distractions: A line observation study*. [Paper Presentation] Proceedings of the 11th International Symposium on Aviation Psychology (pp. 1-6). Columbus, OH: The Ohio State University.

Loukopoulos, L. D., Dismukes, R. K., & Barshi, I. (2016). *The multitasking myth: Handling complexity in real-world operations*. Routledge.

Luft, C. D. B., Takase, E., & Darby, D. (2009). Heart rate variability and cognitive function: Effects of physical effort. *Biological Psychology*, *82*(2), 186–191. https://doi.org/10.1016/j.biopsycho.2009.07.007

Macrae, C., & Draycott, T. (2019). Delivering high reliability in maternity care: In situ simulation as a source of organisational resilience. *Safety Science*, 117, 490–500. https://doi.org/10.1016/j.ssci.2016.10.019

Martinussen, M., & Hunter, D. R. (2018). *Aviation psychology and human factors* (2nd ed.). CRC Press.

Maxwell, J. A. (2012). *Qualitative research design: An interactive approach* (3rd ed.). SAGE Publications Ltd.

Mearns, K. J., & Flin, R. (2018). Assessing the state of organizational safety-culture or climate? *Validation in Psychology*, 5–20. https://doi.org/10.4324/9781351300247-1

Meland, A., Fonne, V., Wagstaff, A., & Pensgaard, A. M. (2015). Mindfulness-based mental training in a high-performance combat aviation population: A one-year intervention study and two-year follow-up. *International Journal of Aviation Psychology*, *25*(1), 48–61. https://doi.org/10.1080/10508414.2015.995572

Mellor, A. N. (2002). Impact testing in formula one. *International Journal of Crashworthiness, 7*(4), 475-486. https://doi.org/10.1533/cras.2002.0231

Merritt, A., & Helmreich, R. L. (1996). Creating and sustaining a safety culture: Some practical strategies. *Applied Aviation Psychology*, 20–26.

Mikuliszyn, R., Zebrowski, M., & Kowalczuk, K. (2005). Centrifuge training program with push-pull" elements. *Aviation, Space, and Environmental Medicine, 76*(5), 493–495.

Military Aviation Authority. (2012). *Service inquiry investigation into accident involving Red Arrows Hawk T Mk1 XX179 near Bournemouth on 20 August 2011*. Military Aviation Authority. https://www.gov.uk/government/publications/service-inquiry-report-into-the-accident-involving-red-arrows-hawk-t-mk1-xx179-on-20-august-2011

Ministry of National Defence. (2021). *CT114009 Tutor—Epilogue* (Investigation Report No. CT114009). Government of Canada. https://www.rcaf-arc.forces.gc.ca/en/flight-safety/article-template-flight-safety.page?doc=ct114009-tutor-epilogue/jydwt4nq

Mowbray, D. (2011). *Resilience and strengthening resilience in individuals*. Management Advisory Service. http://www.mas.org.uk

Muller, T. U. (2002). G-induced vestibular dysfunction ("the wobblies") among aerobatic pilots: a case report and review. *Ear, Nose, & Throat Journal, 81*(4), 269–272.

National Academies of Sciences, Engineering, and Medicine. (2009). *Helping airport and air carrier employees cope with traumatic events*. The National Academies Press. https://doi.org/10.17226/14302

National Aeronautics and Space Administration. (2021). *Fly-ins and airshows* (No. 497, Callback). https://asrs.arc.nasa.gov/publications/callback/cb_497.html

National Transportation Safety Board. (2009). *Loss of thrust in both engines, US Airways flight 1549* (Aviation Accident Report AAR-10-03). National Transportation Safety Board. https://www.ntsb.gov/investigations/AccidentReports/Reports/AAR1003.pdf

National Transportation Safety Board. (2012). *Pilot/race 177, The galloping ghost, North American P-51D, N79111, Reno, Nevada, September 16, 2011.* (Aviation Accident Report NTSB/AAB-12/01). National Transportation Safety Board. https://www.ntsb.gov/investigations/AccidentReports/Reports/AAB1201.pdf

Nelson, T. (2007). Commentary: Dress to impress not just overused catch-phrase. *The Colorado Springs Business Journal*, 1–.

Nemeth, C. P., & Hollnagel, E. (2016). *Resilience engineering in practice: Becoming resilient* (Vol. 2). CRC Press.

Nilsson, H., & Kazemi, A. (2016). Reconciling and thematizing definitions of mindfulness: The big five of mindfulness. *Review of General Psychology*, *20*(2), 183–193. https://doi.org/10.1037/gpr0000074

Nosita, F., Pirzada, K., Lestari, T., & Cahyono, R. (2020). Impact of demographic factors on risk tolerance. *Journal of Security & Sustainability Issues, 9*(4). https://doi.org/10.9770/jssi.2020.9.4

Nyklíček, I., & Kuijpers, K. (2008). Effects of mindfulness-based stress reduction intervention on psychological well-being and quality of life: Is increased mindfulness indeed the mechanism? *Annals of Behavioral Medicine*, *35*, 331–340. https://doi.org/10.1007/s12160-008-9030-2

O'Hare, D. (1990). Pilots' perception of risks and hazards in general aviation. *Aviation, Space, and Environmental Medicine*, *61*(7), 599–603.

Oliver, N., Calvard, T., & Potočnik, K. (2019). Safe limits, mindful organizing and loss of control in commercial aviation. *Safety Science, 120*, 772-780. https://doi.org/10.1016/j.ssci.2019.08.018

Olsen, O. K., Hetland, J., Matthiesen, S. B., Hoprekstad, Ø. L., Espevik, R., & Bakker, A. B. (2021). Passive avoidant leadership and safety non-compliance: A 30 days diary study among naval cadets. *Safety Science*, *138*, 105100. https://doi.org/10.1016/j.ssci.2020.105100

Papadakis, M. (2008). *An initial study to discover the human factors underlying air display accidents* [Unpublished Master's Thesis]. Cranfield University.

Pariès, J., Macchi, L., Valot, C., & Deharvengt, S. (2019). Comparing HROs and RE in the light of safety management systems. *Safety Science*, *117*, 501–511. https://doi.org/10.1016/j.ssci.2018.02.026

Parrott, W.G. (Ed.) (2001). *Emotions in social psychology: An essential reading*. Psychology Press.

Patankar, M. S., Brown, J. P., Sabin, E. J., & Bigda-Peyton, T. G. (2012). *Safety culture: Building and sustaining a cultural change in aviation and healthcare*. Ashgate Publishing, Ltd.

Paul, P., & Maiti, J. (2007). The role of behavioral factors on safety management in underground mines. *Safety Science*, *45*, 449–471. https://doi.org/10.1016/j.ssci.2006.07.006

Pauley, K., O'Hare, D., & Wiggins, M. (2008). Risk tolerance and pilot involvement in hazardous events and flight into adverse weather. *Journal of Safety Research*, *39*(4), 403–411. https://doi.org/10.1016/j.jsr.2008.05.009

Pillay, M., Borys, D., Else, D., & Tuck, M. (2010). Safety culture and resilience engineering–exploring theory and application in improving gold mining safety. *Gravity Gold, 21*, e2.

Plutchik, R. (2001). The nature of emotions: Human emotions have deep evolutionary roots. *American Scientist*, *89* (4), 344–350. https://doi.org/10.1511/2001.4.344

Provan, D. J., Woods, D. D., Dekker, S. W. A., & Rae, A. J. (2020). Safety-II professionals: How resilience engineering can transform safety practice. *Reliability Engineering & System Safety*, *195*, 106740. https://doi.org/10.1016/j.ress.2019.106740

Ray, J. L., Baker, L. T., & Plowman, D. A. (2011). Organizational mindfulness in business schools. *Academy of Management Learning & Education, 10*(2), 188-203. https://doi.org/10.5465/amle.10.2.zqr188

Ried, L., Eckerd, S., & Kaufmann, L. (2021). Social desirability bias in PSM surveys and behavioral experiments: Considerations for design development and data collection. *Journal of Purchasing and Supply Management*, 100743. https://doi.org/10.1016/j.pursup.2021.100743

Reason, J. (1990). *Human Error.* Cambridge University Press.

Reason, J. (1997). *Managing the risks of organizational accidents.* (2nd ed.). Routledge.

Reason, J. (2000). Human error: Models and management. *Bmj, 320* (7237), 768-770. https://doi.org/10.1136/bmj.320.7237.768

Reason, J. (2004). Beyond the organisational accident: The need for "error wisdom" on the frontline. *Quality & Safety Health Care*, *13* (Suppl II), ii28–ii33. https://doi.org/10.1136/qshc.2003.009548

Reason, J. (2016). *The human contribution*. Routledge.

Reivich, K., & Shatte, A. (2003). *The Resilience factor: 7 Keys to finding your inner strength and overcoming life's hurdles*. Harmony.

Rhodes, N., & Pivik, K. (2011). Age and gender differences in risky driving: The roles of positive affect and risk perception. *Accident; Analysis and Prevention*, *43*(3), 923–931. https://doi.org/10.1016/j.aap.2010.11.015

Ricard, M., Lutz, A., & Davidson, R. J. (2014). Mind of the meditator. *Scientific American*, *311*(5), 38–45. https://doi.org/10.1038/scientificamerican1114-38

Rickards, C. A., & Newman, D. G. (2005). G-induced visual and cognitive disturbances in a survey of 65 operational fighter pilots. *Aviation, Space, and Environmental Medicine, 76*(5), 496–500.

Richardson, G. E. (2002). The metatheory of resilience and resiliency. *Journal of Clinical Psychology*, *58*(3), 307–321. https://doi.org/10.1002/jclp.10020

Rosalie, S. M., & Malone, J. M. (2018). Effect of a halo-type structure on neck muscle activation of an open-cockpit race car driver training under qualifying conditions. *Case Reports, 2018*, bcr-2017. https://doi.org/10.1136/bcr-2017-224013

Rozenberg, R., Szabo, S., & Šebeščáková, I. (2013). Safety management and formation flying of aerobatic team. *Indian Journal of Applied Research, 5*(4)*,* 317-319. https://doi.org/10.13111/2066-8201.2013.5.4.9

Rozenberg, R., Socha, V., Socha, L., Szabo, S., & Nemec, V. (2016). *Critical elements in piloting techniques in aerobatic teams.* 20th International Scientific Conference: Transport Means, Juodkrante, Lithuania.

Ross, A., & Shapiro, J. (2017). Under the big top: An exploratory analysis of psychological factors influencing circus performers. *Performance Enhancement & Health*, *5*, 115–121. https://doi.org/10.1016/j.peh.2017.03.001

Rotter, J. B. (1954). *Social learning and clinical psychology.* Prentice-Hall, Inc. https://doi.org/10.1037/10788-000

Russ, S. (2015, July 8). Mindfulness-based stress reduction finds a place in the military. *United States Army*. https://www.army.mil/article/151787/mindfulness_based_stress_reduction_finds_a_place_in_the_military

Saposnik, G., & Johnston, S. C. (2014). Decision making in acute stroke care. *Stroke*, *45*(7), 2144–2150. https://doi.org/10.1161/strokeaha.114.005462

Sawyer, K. B., Thoroughgood, C. N., Stillwell, E. E., Duffy, M. K., Scott, K. L., & Adair, E. A. (2022). Being present and thankful: A multi-study investigation of mindfulness, gratitude, and employee helping behavior. *Journal of Applied Psychology, 107*(2), 240–262. https://doi.org/10.1037/apl0000903

Schopf, A. K., Stouten, J., & Schaufeli, W. B. (2021). The role of leadership in air traffic safety employees' safety behavior. *Safety Science, 135*, 105118. https://doi.org/10.1016/j.ssci.2020.105118

Sekiguchi, C., Iwane, M., & Oshibuchi, M. (1986). Anti-G training of Japanese air self defense force fighter pilots. *Aviation, Space, and Environmental Medicine, 57*(11), 1029–1034.

Serfontein, E. & Govender, K. K. (2021). The relationship between resilience and organisational control systems in the South African aviation industry. *Journal of Transport and Supply Chain Management,* 15(771), e1–e11. https://doi.org/10.4102/jtscm.v15i0.598

Seppälä, E. M., Nitschke, J. B., Tudorascu, D. L., Hayes, A., Goldstein, M. R., Nguyen, D. T. H., Perlman, D., & Davidson, R. J. (2014). Breathing-based meditation decreases posttraumatic stress disorder symptoms in U.S. military veterans: A randomized controlled longitudinal study. *Journal of Traumatic Stress*, *27*(4), 397–405. https://doi.org/10.1002/jts.21936

Shirali, Gh. A., Motamedzade, M., Mohammadfam, I., Ebrahimipour, V., & Moghimbeigi, A. (2015). Assessment of resilience engineering factors based on system properties in a process industry. *Cognition, Technology & Work*, *18*. https://doi.org/10.1007/s10111-015-0343-1

Shirali, Gh. A., Shekari, M., & Angali, K. A. (2016). Quantitative assessment of resilience safety culture using principal components analysis and numerical taxonomy: A case study in a petrochemical plant. *Journal of Loss Prevention in the Process Industries*, *40*, 277–284. https://doi.org/10.1016/j.jlp.2016.01.007

Shonin, E., & van Gordon, W. (2015). Practical recommendations for teaching mindfulness effectively. *Mindfulness*, *6*(4), 952–955. https://doi.org/10.1007/s12671-014-0342-y

Şimşekoğlu, Ö., Nordfjærn, T., Zavareh, M. F., Hezaveh, A. M., Mamdoohi, A. R., & Rundmo, T. (2013). Risk perceptions, fatalism and driver behaviors in Turkey and Iran. *Safety Science*, *59*. https://doi.org/10.1016/j.ssci.2013.05.014

Sjoberg, L., Moen, B.-E., & Rundmo, T. (2004). *Explaining risk perception. An evaluation of the psychometric paradigm in risk perception research* (p. 39). Norwegian University of Science and Technology, Department of Psychology.

Smith, A. F., & Arfanis, K. (2013). "Sixth sense" for patient safety. *British Journal of Anaesthesia*, *110*(2), 167–169. https://doi.org/10.1093/bja/aes473

Smith, J., & Smolianov, P. (2016). The high performance management model: From Olympic and professional to university sport in the United States. *The Sport Journal, 4* (0204), 1-19. https://thesportjournal.org/article/the-high-performance-management-model-from-olympic-and-professional-to-university-sport-in-the-united-states/

Sparks, J. R. (2016). *Extreme sports: A study of free-solo rock climbers* [Master's Thesis, Brigham Young University]. https://scholarsarchive.byu.edu/etd/6136

Stocker, E., Englert, C., & Seiler, R. (2017). Mindfulness and self-control in sport. *Journal of Sport & Exercise Psychology*, *39* (Suppl.), S317–S318. https://doi.org/10.7892/boris.112471

Stolzer, A. J., & Goglia, J. J. (2016). *Safety management systems in aviation* (2nd ed.). Routledge.

Sutcliffe, K. M., & Vogus, T. J. (2003). *Organizing for resilience* (Positive Organizational Scholarship, pp. 94–110). University of Michigan.

Sutcliffe, K. M., Vogus, T. J., & Dane, E. (2016). Mindfulness in organizations: A cross-level review. *Annual Review of Organizational Psychology and Organizational Behavior*, *3*, 55–81. https://doi.org/10.1146/annurev-orgpsych-041015-062531

Sujan, M. A., Furniss, D., Anderson, J., Braithwaite, J., & Hollnagel, E. (2019). Resilient health care as the basis for teaching patient safety–A safety-II critique of the World Health Organisation patient safety curriculum. *Safety Science*, *118*, 15-21. https://doi.org/10.1016/j.ssci.2019.04.046

Taherdoost, H. (2020). Sampling methods in research methodology; How to choose a sampling technique for research. *International Journal of Academic Research in Management (IJARM)*, *5*(2), 18–27. https://doi.org/10.2139/ssrn.3205035

Teske, B. E., & Adjekum, D. K. (2022). Understanding the relationship between high-reliability theory (HRT) of mindful organizing and safety management systems (SMS) within the aerospace industry: A cross-sectional quantitative assessment. *Journal of Safety Science and Resilience.* https://doi.org/10.1016/j.jnlssr.2022.01.002

Thompson, M. (1995, May 29). Way, way off in the wild blue yonder - A confidential report details the Air Force's controversial record in flight safety and accident investigation. *Time.* https://content.time.com/time/subscriber/article/0,33009,982358,00.html

Tränkle, U., Gelau, C., & Metker, T. (1990). Risk perception and age-specific accidents of young drivers. *Accident; Analysis and Prevention*, *22*(2), 119–125. https://doi.org/10.1016/0001-4575(90)90063-Q

Tse-Hua, S., & Xitao, F. (2009). Comparing response rates in e-mail and paper surveys: A meta-analysis. *Educational Research Review*, *4*(1), 26–40. https://doi.org/10.1016/j.edurev.2008.01.003

Tu, M. Y., Chu, H., Lin, Y. J., Chiang, K. T., Chen, C. M., Chen, H. H., Yang, C. S., & Lai, C. Y. (2020). Combined effect of heart rate responses and the anti-G straining manoeuvre effectiveness on G tolerance in a human centrifuge. *Scientific Reports, 10*(1), 21611. https://doi.org/10.1038/s41598-020-78687-3

Tulis, D. (2020, January 28). *Airshow community "stunned" by two weekend crashes*. AOPA. https://www.aopa.org/news-and-media/all-news/2020/january/28/airshow-community--stunned-by-two-weekend-crashes

Ungar, M., Brown, M., Liebenberg, L., Othman, R., Kwong, W., Armstrong, M., & Gilgun, J. (2007). Unique pathways to resilience across cultures. *Adolescence*, *42*, 287–310.

United Kingdom Civil Aviation Authority. (2018). *CAP 1694— Human Factors in air displays: Transfer of behaviours and error path study.* (1st ed.). United Kingdom Civil Aviation Authority. https://publicapps.caa.co.uk/docs/33/PE11472_Transfer%20of%20Behaviours%20and%20Error%20Path%20Study_Final%20report_v1.0.pdf

United Kingdom Civil Aviation Authority. (2021). *CAP 1724—Flying display standards document (For consultation)*. United Kingdom Civil Aviation Authority. https://consultations.caa.co.uk/ga/cap-1724-flying-display-standards/user_uploads/cap-1724-consultation-final-2021.pdf

United Kingdom Civil Aviation Authority. (2022). *CAP 403—Flying displays and special events: Safety and administrative requirements and guidance* (19th ed.). United Kingdom Civil Aviation Authority. https://publicapps.caa.co.uk/docs/33/CAP403%20Edition%2019%20Final%20(2022).pdf

United Kingdom Health and Safety Executive. (2002). *Evaluating the effectiveness of the health and safety executive's health and safety climate survey tool.* (Research Report No. 042). Health and Safety Executive.

United Kingdom Royal Air Force. (2010). *Service inquiry report into the Red Arrows accident in Crete on 23 March 2010* (p. 41) [Corporate report]. United Kingdom Royal Air Force. https://www.gov.uk/government/publications/service-inquiry-report-into-the-red-arrows-accident-in-crete-on-23-march-2010

United States Air Force. (1994). *Aircraft accident investigation board report, 24 June 1994, Fairchild AFB, WA* (Aircraft Accident Investigation Report B-52H, S/N 61-002). United States Air Force. https://fairchildhospitalshooting.com/wp-content/uploads/2017/04/1AFD-100510-029regulations.compressed.pdf

United States Air Force. (2018). *Aircraft accident investigation board report: F-16CM, T/N 91-0413, United States Air Force Air Demonstration Squadron, Nevada Test and Training Range, 4 April 2018.* United States Air Force. https://www.acc.af.mil/Portals/92/AIB/180404_ACC_Creech_F16_Thunderbird_AIB_Narrative_Report.pdf?ver=2018-10-16-132501-787

United States Air Force. (2021). *2021 Support manual, air demonstration squadron Thunderbirds*. United States Air Force.

United States Nuclear Regulatory Commission. (2020, June 8). *Safety culture*. United States Nuclear Regulatory Commission. https://www.nrc.gov/about-nrc/safety-culture.html van de Walle, B., & Turoff, M. (2008). Decision support for emergency situations. *Information Systems and e-Business Management*, 6(3), 295–316. https://doi.org/10.1007/s10257-008-0087-z

Vandenberg, R. J. (2006). Statistical and methodological myths and urban legends. *Organizational Research Methods*, *9*(2), 194–201. https://doi.org/10.1177/1094428105285506

Vanlaer, N., Albers, S., Guiette, A., van den Oord, S., & Marynissen, H. (2021). 100% Operational! An organizational resilience perspective on ports as critical infrastructures. *Case Studies on Transport Policy*. https://doi.org/10.1016/j.cstp.2021.11.002

Verney, J. (2009). Mindfulness and the adult ego state. *Transactional Analysis Journal*, *39*(3), 247–255. https://doi.org/10.1177/036215370903900308

Vogus, T. J. (2011). Mindful organizing: Establishing and extending the foundations of highly reliable performance. *Handbook of Positive Organizational Scholarship.* Oxford University Press. https://ssrn.com/abstract=1904613

Vogus, T. J., & Sutcliffe, K. M. (2012). Organizational mindfulness and mindful organizing: A reconciliation and path forward. A*cademy of Management Learning & Education, 11*(4), 722-735. https://doi.org/10.5465/amle.2011.0002c

Wallace, B. A. (2006). Resurgent attention and close attention. In *The attention revolution: Unlocking the power of the focused mind* (1st ed., pp. 43–73). Wisdom Publications.

Webster, N. L. (2007, October 23). *FAA: Civilian air show accident analysis (1997 – 2007)* [PowerPoint slides]. Civil Aerospace Medical Institute Federal Aviation.

Weick, K. E. (1987). Organizational culture as a source of high reliability. *California Management Review*, *29*(2). https://doi.org/10.2307/41165243

Weick, K. E., & Putnam, T. (2006). Organizing for mindfulness: Eastern wisdom and Western knowledge. *Journal of Management Inquiry, 15*(3), 275-287. https://doi.org/10.1177%2F1056492606291202

Weick, K. E., & Sutcliffe, K. M. (1999). Organising for high reliability: processes of collective mindfulness. *Research in Organisational Behaviour, 21*, 100.

Weick, K. E., & Sutcliffe, K. M. (2001). *Managing the unexpected* (Vol. 9). San Francisco: Jossey-Bass.

Weick, K. E., & Sutcliffe, K. M. (2009). Managing the unexpected: Resilient performance in an age of uncertainty. *Personnel Psychology*, *62*(3), 646–652. https://doi.org/10.1111/j.1744-6570.2009.01152_6.x

Weiner, B., & Graham, S. (1984). An attributional approach to emotional development, Emotions. *Cognition and Behaviour,* 167–191.

White, M., Cunningham, L., & Titchener, K. (2011). Young drivers' optimism bias for accident risk and driving skill: Accountability and insight experience manipulations. *Accident; Analysis and Prevention*, *43*, 1309–1315. https://doi.org/10.1016/j.aap.2011.01.013

Wilke, C. O. (2019). *Fundamentals of data visualization: A primer on making informative and compelling figures* (1st ed.). O'Reilly Media.

Williams, K., Frech, A., & Carlson, D. L. (2010). Marital status and mental health. *A Handbook for the Study of Mental Health: Social Contexts, Theories, and Systems*, 306-320. https://www.cambridge.org/9780521491945

Winter, S., Truong, D., & Keebler, J. (2019). The flight risk perception scale (FRPS): A modified risk perception scale for measuring risk of pilots in aviation. *International Journal of Aviation Research*, *11*(1), 57–72. https://doi.org/10.22488/okstate.19.100407

Xu, Q., Wu, Y., Wang, M., Liu, B., Jiang, J., You, X., & Ji, M. (2022). The relationship between sense of calling and safety behavior among airline pilots: The role of harmonious safety passion and safety climate. *Safety Science, 150*, 105718. https://doi.org/10.1016/j.ssci.2022.105718.

Yilmaz, U., Cetinguc, M., & Akin, A. (1999). Visual symptoms and G-LOC in the operational environment and during centrifuge training of Turkish jet pilots. *Aviation, Space, and Environmental Medicine, 70*(7), 709–712. https://pubmed.ncbi.nlm.nih.gov/10417010/

Yorio, P. L., Edwards, J., & Hoeneveld, D. (2019). Safety culture across cultures. *Safety Science*, 120, 402-410. https://doi.org/10.1016/j.ssci.2019.07.021.

You, X., Ji, M., & Han, H. (2013). The effects of risk perception and flight experience on airline pilots' locus of control with regard to safety operation behaviors. *Accident; Analysis and Prevention*, *57C*, 131–139. https://doi.org/10.1016/j.aap.2013.03.036

Younas, A., Inayat, S., & Sundus, A. (2021). Joint displays for qualitative-quantitative synthesis in mixed methods reviews. *Research Methods in Medicine & Health Sciences, 2*(3), 91-101. https://doi.org/10.1177/2632084320984374

Zajonc, R. B. (1965). Social facilitation: A solution is suggested for an old unresolved social psychological problem. *Science, 149*(3681), 269-274. https://doi.org/10.1126/science.149.3681.269

Ziv, G. (2016). Gaze behavior and visual attention: A review of eye tracking studies in aviation. *The International Journal of Aviation Psychology, 26*(3-4), 75-104. https://doi.org/10.1080/10508414.2017.1313096