



**DEVELOPMENT AND INVESTIGATION OF AN AIR TRANSPORTATION
OPERATIONS SAFETY CLIMATE SCALE**

DISSERTATION

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AFIT-ENS-DS-17-S-042

**DEPARTMENT OF THE AIR FORCE
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DISSERTATION

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Abstract

Safety is of critical importance in many industries, and the US Air Force is no exception. Since 2005, the US Air Force has experienced more than 119 on-duty air and ground fatalities as well as 520 off-duty ground fatalities. One of the more dangerous environments in the U.S. Air Force and the civilian industry is air transportation operations where the fatal injury rate is higher than the national average. However, peer-reviewed safety research focusing on air transportation operations is practically non-existent, both in the military and civilian context. Therefore, safety research that helps us better understand how to shape safety behaviors and predict or prevent mishaps must be undertaken. Furthermore, the relationship between safety and operational outcomes is not fully understood, and research efforts to gain a better understanding of the inherent safety-operations tradeoff are long overdue.

To address these concerns, this dissertation 1) develops and validates an air transportation operations-specific safety climate scale capable of capturing organization and group-level safety climate, 2) investigates safety climate's relationship with organizational citizenship behaviors and individual operational performance, and 3) examines the role a joint management system plays in translating safety climate into simultaneous increases in safety behaviors and individual operational performance.

To my wife and daughter.

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Matthew D. Roberts

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DEVELOPMENT AND INVESTIGATION OF AN AIR TRANSPORTATION OPERATIONS SAFETY CLIMATE SCALE

I. Introduction

Undeniably, safety is of critical importance in many industries, and the US Air Force is no exception. Since 2005, the US Air Force has experienced more than 119 on-duty air and ground fatalities as well as 520 off-duty ground fatalities (Air Force Safety Center, 2015; Headquarters U.S. Air Force, 2015). One such instance occurred on February 17, 2013 when a US Air Force air transportation specialist lost his life in a workplace accident on Joint Base Andrews. While backing up a vehicle, the vehicle operator lost sight of the air transportation specialist and pinned him between the vehicle and a warehouse wall, leading to his death (USAF Ground AIB Report, 2013). The investigation concluded that improper spotting procedures were the primary cause of the accident, as the vehicle operator is required to stop the vehicle any time he or she loses sight of the spotter. As described above, a lapse in following safety procedures can have catastrophic results; however, safety incidents can have harmful consequences in other ways as well. In addition to loss of life, injuries can have a detrimental impact in the form of lost workdays. From 1993–2002 alone, on-duty injuries resulted in more than 3,300 lost workdays for Air Force active duty personnel (Copley et al., 2010). One of the more dangerous environments in the U.S. Air Force is air transportation operations, where the fatal injury rate is higher than the national average for all industries (United States Department of Labor, 2004). However, peer-reviewed safety research focusing on air transportation operations is practically non-existent, both in the military and civilian

context. Therefore, safety research that helps us better understand how to shape safety behaviors and predict or prevent mishaps must be undertaken.

An important construct from the safety literature that has proven effective in predicting safety behaviors and safety incidents across a variety of industries is safety climate (de Koster et al., 2011; Kelloway et al., 2006; Podsakoff et al., 1990; Zohar, 2010; Zohar & Luria, 2005). Safety climate refers to the perceptions employees have of the importance their organization places on safety, and these perceptions help employees understand which types of behaviors are rewarded and supported in their organization (Zohar, 2010). When an organization shuns safety procedures in favor of operational outcomes, this sends a signal to the employees that safe behaviors may not be as important to their organization. However, when safety outcomes are rewarded over operational outcomes, employees get the sense that the organization cares about safety, and a higher level of safety climate is attained. This potential conflict between safety procedures and operational objectives serves as the basis for the safety climate construct (Zohar, 2010). Moreover, Zohar (2010) calls for industry-specific safety climate scales to be developed in order to uncover unique and context-specific factors that are important to developing a climate of safety for a respective industry. To date, no safety climate scale has been developed for the air transportation operations industry. Developing an air transportation operations safety climate scale may be pivotal to understanding what shapes the safety behaviors of the employees in this industry.

Furthermore, developing an air transportation operations safety climate scale may provide benefits above and beyond those in the safety realm. Recent related research has uncovered that the inherent tradeoff between safety and operational outcomes may be

able to be overcome in certain situations (Pagell et al., 2015). Instead of favoring operational outcomes over safety outcomes, or vice versa, creating a joint management system (JMS) that simultaneously measures, controls, and continuously improves both safety and operations may help balance the safety versus productivity tradeoff and lead to improved safety and operational outcomes (Pagell et al., 2015). Additionally, creating a climate of safety may enhance employees' sense of belonging to their organization and motivate them to engage in discretionary extra-role behaviors, namely organizational citizenship behaviors (OCBs), that enhance the functioning of the organization (Organ, 1988). By creating an air transportation operations safety climate scale and investigating its interactions with a JMS, this research may provide an avenue to influence employees to simultaneously work more safely and efficiently.

1.1 Research Objective

The objective of this research is to provide actionable safety-related intelligence to air transportation operations leaders that could enhance safety and operational performance of air transportation organizations. Specifically, this research seeks to 1) create and validate an air transportation operations safety climate scale, 2) investigate safety climate's relationship with organizational citizenship behaviors and individual operational performance, and 3) examine the role a JMS plays in the relationship between safety climate, safety behaviors, and individual operational performance.

1.2 Research Contributions

With regards to the targeted research objectives, this dissertation provides the following contributions:

1. *Develops and validates an air transportation operations-specific safety climate scale.* A multi-level framework for safety climate is developed and validated using USAF air transportation specialists as a proxy. Organization and group-level safety climate constructs and their relevant sub-dimensions are identified. This safety climate measurement scale can serve as a leading indicator for safety mishaps in the air transportation operations industry, and the scale may differentiate low from high-performing organizations when it comes to creating a climate of safety. This effort intends to extend safety climate theory to the high-risk industry of air transportation operations and provides strong statistical support for level-adjusted safety climate scales. For managers, this scale can help provide an in depth understanding of the impact an individual's safety climate perceptions may have on his or her safety decision-making process. It was discovered that not only is it important for first-line supervisors to display a sincere commitment to safety and enforce the organization's safety policies, but organizational leaders must examine the formal safety policies to ensure the policies are straight-forward, non-contradictory, and help establish an environment that does not subjugate safety for performance.
2. *Investigates the effects of safety climate on OCBs and individual operational performance.* This research advances the understanding of the role that safety climate may play on non-safety related outcomes in the form of OCBs and individual operational performance. Theoretically, findings support that high levels of safety climate may increase an employee's perceived organizational support and motivate an employee to engage in extra-role commitments that result

in increased operational performance. This is the first known research effort to link a multi-level safety climate framework to operational performance through the mediating effects of OCBs.

3. *Empirically demonstrates the role a JMS plays in the relationship between safety climate, safety behaviors, and individual operational performance.* Results of this research provide evidence that balancing the safety and operational performance tradeoff can result in simultaneous increases in safety behavior and operational performance of high-risk organizations. This study is novel in that it incorporates employee perceptions of the existence of a JMS rather than relying on safety and operational manager's inputs. Additionally, this research demonstrates how safety climate theory and relational coordination theory can complement each other in relating safety climate to operational and safety outcomes. Finally, managers can use employee perceptions of a JMS as a feedback mechanism to determine if a JMS has been effectively implemented in the organization.

1.3 Overview and Organization

The remainder of this dissertation follows a scholarly article format. Chapters II-IV are independent research articles on safety climate in the air transportation operations industry. Each chapter is self-contained in that it contains its own introduction, conceptual development, methodology, analysis, and conclusion sections. Additionally, each chapter contains its own future research recommendations.

Chapter II develops an air transportation operations-specific safety climate scale and validates the scale with an independent sample. This chapter introduces the reader to

the safety climate construct and provides an understanding of the important role safety climate can play in the air transportation operations environment.

Chapter III utilizes the newly developed air transportation operations safety climate scale and investigates its relationship with OCBs and individual operational performance. The intent of this chapter is to gain a better understanding of the relationship between safety and operational performance. Results of the structural equation model analysis support the notion that safety climate may have effects far beyond safety outcomes.

Chapter IV addresses the perceived tradeoff between safety performance and operational performance by investigating the role a JMS plays in the relationship between safety climate, safety behaviors, and operational performance in high-risk organizations. Structural equation modeling was used to analyze these relationships. It was discovered that JMS moderates the relationship between group-level safety climate and operational performance. Although safety climate was positively related to safety behaviors, safety climate was only positively related to operational performance when employees had high perceptions of the existence of a JMS. Findings suggest that JMS may be a mechanism for translating safety climate into simultaneous increases in safety and operational performance in high-risk organizations.

The final chapter provides concluding remarks and summarizes the contributions made by each academic paper. Finally, it closes with suggestions for future research.

II. Development and Validation of an Air Transportation Operations Safety Climate Scale

2.1 Introduction

On August 7, 1997 a Douglas DC-8-61 cargo aircraft crashed after takeoff in Miami, FL due to its center of gravity being altered. The causal factor for this accident was misloaded cargo (NTSB, 2015). Four crew members and a motorist on the ground were killed in this accident. This accident prompted the NTSB to issue safety recommendations to the Federal Aviation Administration to ensure all cargo operators and cargo handling personnel receive standardized instruction on aircraft loading procedures and that proper weight and balance documents were being used. However, these safety recommendations alone were not enough to prevent similar accidents from taking place. A Boeing 747-200 nearly crashed due to cargo breaking free during flight. This incident occurred in Lome, Togo, Africa on February 2, 2008 when an oil well drill broke free from its container and became lodged in the tail section of the aircraft. The crew was able to make an emergency landing with no sustained injuries (NTSB, 2015). Finally, on April 29, 2013, seven crew members were killed when their Boeing 747-400 aircraft crashed shortly after takeoff from Bagram Air Base, Afghanistan. The National Transportation Safety Board (NTSB) concluded that an improperly secured mine resistant, ambush protected all-terrain vehicle weighing more than 12 tons likely broke free from its tie-down straps and crashed into the tail section of the airplane, damaging critical hydraulic systems and ultimately rendering the aircraft uncontrollable (NTSB, 2015). Furthermore, the NTSB found that a lack of standardized cargo handling

procedures, training, and duty hour limitations for personnel who load and secure cargo as well as inadequate training and guidance for cargo handling inspectors contributed to this tragedy. These incidents provide evidence that cargo handling and aircraft loading personnel have the potential to cause injuries and accidents to themselves and others if they improperly perform their jobs.

2.1.1 Air Transportation Operations: Unique Safety Challenges

The United States Office of Personnel Management's (1999) description of the aircraft freight loading occupation includes loading, securing, and unloading air cargo in the air terminal and on aircraft. This occupation is encompassed in the 6900 series of job families, Warehousing and Stock Handling. One of the gravest dangers faced by personnel in this industry is the operation of forklifts and aircraft loading equipment. Across all industries, nearly 100 workers are killed each year while operating forklifts and another 95,000 workers are injured (Lu & Yang, 2010). Further hazards include operating on and around loading docks, failure to use proper personal protective equipment, and injuries from manual lifting (United States Department of Labor, 2004). These dangers are exacerbated when one considers that most of these actions take place on an aircraft flightline or inside tight quarters such as a warehouse. In the United States Air Force (USAF), these duties are performed by air transportation specialists. Duties of the air transportation specialist include planning, scheduling, and processing passengers and cargo for air movement, loading and unloading passengers and cargo, as well as operating forklifts and aircraft loading equipment (Department of the Air Force, 2012).

The dangers of this profession were never more apparent than on February 17, 2013 when a USAF air transportation specialist was killed in a workplace accident on

Joint Base Andrews. According to the official investigation, two air transportation specialists were in the process of moving a piece of equipment into a warehouse storage location. In order to accomplish this, three vehicles had to be moved. One specialist operated the vehicles while the other specialist used spotting procedures to safely guide the vehicle operator. While backing up the third vehicle, the vehicle operator lost sight of the other air transportation specialist and accidentally pinned him between the vehicle and the warehouse wall, leading to his death (USAF Ground AIB Report, 2013). The investigation cited improper spotting procedures as a primary cause of the accident, as the vehicle operator is required to stop the vehicle any time he or she loses sight of the spotter.

The importance of safety cannot be understated in any industry, and the air transportation operations industry is no different, as it is an industry with a fatal injury rate higher than the national average for all industries (United States Department of Labor, 2004). However, peer-reviewed safety research centering on air transportation operations is practically non-existent. Safety research in other industries has also historically been lacking, with less than 1% of organizational research published in top journals focusing on occupational safety (Barling et al., 2002; Neal & Griffin, 2006). When these articles did address occupational safety and the reduction of injuries, their focus was on accident prone individuals, personality traits, design of equipment, and regulatory systems (Barling et al., 2002). However, Barling et al. (2002) informs us that occupational injuries might be reduced through a focus on safety-related events, which are a function of safety climate. Safety climate refers to the shared perceptions that employees have of the value an organization places on safety versus other factors. The

relationship between safety climate and safety-related outcomes is well documented, and research has shown that safety climate is a robust predictor of safety performance (de Koster et al., 2011; Kelloway et al., 2006; Podsakoff et al., 1990; Zohar, 2010; Zohar & Luria, 2005).

2.1.2 Understanding Safety Climate

Dov Zohar launched safety climate research with his seminal article in 1980 titled, “Safety climate in industrial organizations: Theoretical and applied implications” (Zohar, 1980). In this article Zohar sought to describe a particular type of organizational climate, namely one for safety in industrial organizations. Zohar keyed in on Schneider’s (1975) suggestion that organizational climate should be an area of research instead of a specific measure, and that organizational climate can be measured through the perceptions of employees. Furthermore, Zohar asserted that employees’ shared perceptions and expectations drive their behaviors.

Zohar (1980) performed an extensive literature review to develop the relevant dimensions of safety climate, keying in on organizational characteristics that differentiate high and low-accident rate companies. The literature review resulted in the following dimensions of safety climate: management attitudes towards safety, effects of safe conduct on promotion, effects of safe conduct on social status, organizational status of the safety officer, importance and effectiveness of safety training, risk level at work place, and effectiveness of enforcement versus guidance in promoting safety. A pilot sample of 120 production workers in four Israeli factories resulted in an eight-factor solution consisting of 40 items. All eight dimensions were retained and labeled as: importance of safety training programs, management attitudes toward safety, effects of

safe conduct on promotion, level of risk at work place, effects of required work pace on safety, status of safety officer, effects of safe conduct on social status, and status of safety committee. To test 1) if workers in different companies share common perceptions regarding safety in their respective organization, 2) if safety climate can vary from a less favorable to a more favorable one, and 3) if safety climate is correlated with a company's safety record, Zohar surveyed 20 production workers from each of 20 factories. Results of Zohar's analysis confirmed that workers' perceptions of their workplace safety were relatively homogenous within factories and distinctly different than workers' perceptions in other factories. This supported the existence of organizational safety climates. Furthermore, safety climate scores were found to vary from less favorable to more favorable, and the scores were related to the general safety level in the respective organizations. Zohar found that the two most influential dimensions of safety climate were the perceived relevance of safety to job behavior (indicated by safety training and work pace) and management attitude toward safety (as shown by status of the safety officer and safety committee). This article depicts the origin of the safety climate construct that has been heavily researched and refined by numerous researchers in subsequent years.

One of the more noticeable refinements to the safety climate construct came from Zohar himself in 2000 when he empirically tested a group-level model of safety climate, a model that was distinct from the organization-level safety climate model. This model measured perceptions of supervisory safety practices in work groups instead of the enforced company policies and procedures found at the organization-level. Results from this study supported the predictive validity of the new group-level safety climate

measure, as the workgroup safety climate perceptions significantly predicted accident records during a 5-month follow-on period. Zohar combined the group-level and organization-level safety climate constructs into an overarching multi-level safety climate model which depicted that enforced safety policies and supervisory safety practices simultaneously effect safety climate at the organization and group level, which in turn influences safety behaviors and safety outcomes (Zohar, 2003). One of the major strengths of the safety climate concept is that it has been shown to be a robust predictor of safety outcomes across a wide variety of industries (Zohar, 2010). Many researchers have used this construct and found that higher ratings of perceived safety climate result in a positive influence on safety behaviors and a decrease in safety incidents (Barling, et al., 2002; Fogarty & Shaw, 2010; Griffin & Neal, 2000; Huang et al., 2007; Kelloway et al., 2006; Zacharatos et al, 2005; Zohar, 2002; Zohar, 2003; Zohar & Luria, 2005; Zohar et al., 2014). Although a consensus has been reached as to safety climate's predictive ability on safety performance, there remain significant differences of opinion in how safety climate should be measured. Specifically, differences exist as to whether safety climate should be measured at the individual unit of analysis, or if individual perceptions should be aggregated to the group or organizational level of analysis.

The argument for aggregating individual safety climate perceptions to the workgroup or organizational unit of analysis is supported by Zohar (Zohar, 2002; Zohar & Luria, 2005; Zohar, 2008, Zohar, 2010). Before addressing Zohar's justification for this argument, it is first important to understand that organizational climate has long been conceptualized as an aggregated psychological climate (Baer & Frese, 2003). Baer and Frese (2003) highlight previous research by James et al. (1988) and argue that

psychological climate is a set of perceptions reflecting how facets of the environment are cognitively appraised and hold meaning for individuals. When people inside an organization share similar perceptions, these perceptions should be aggregated in order to form indicators of an organizational climate. Zohar and Luria (2005) built on this concept and applied it specifically to the multi-level construct of safety climate consisting of an organization-level and group-level climate. Zohar and Luria (2005) argue that convergent measures of employees' perceptions should be aggregated to the unit of analysis of theoretical interest, namely the organization and sub-groups within the organization. This is because in the multi-level safety climate model, top management is concerned with making and enforcing policies and procedures, whereas group-level supervisors are tasked with executing those procedures. This gives rise to the possibility of employees forming sub-climates within an organization.

To understand why this can happen, Zohar (2008) lists three assumptions that have to be made. First, since policies and procedures established by top management are enacted by group-level supervisors, there is a potential for a discrepancy between formal and executed policy. Second, supervisors have discretion when it comes to implementing these policies during day-to-day activities. This discretion arises due to the fact that procedures cannot cover every situation that will be encountered, and supervisors must make choices as to how they will react to new situations or situations that have conflicting guidance. Individual differences between group-level supervisors can lead to different actions when it comes to implementing the top-level policies, which can result in between-group variation within the same organization. Finally, Zohar (2008) states that employees must be able to differentiate between procedures instituted by top

management and procedures executed by group-level supervisors. Essentially, distinct organization-level and group-level safety climates are likely to be formed. This is the driving force behind aggregating individual-level perceptions of safety climate to the group and organization level. Research results indicate that organization-level and group-level safety climates are aligned and that group-level safety climate may mediate the relationship between organization-level safety climate and safety related outcomes (Zohar & Luria, 2005). Thus, by aggregating individual-level perceptions of safety climate to the group and organization-level, true shared perceptions can be assessed, sub-climates can be identified, and the effects of these levels of safety climate can be investigated.

2.1.3 Purpose

Air transportation operations safety research is currently unexplored territory. Although much research has been done areas such as warehouse safety and transportation safety, no research articles have been found that address air transportation operations safety. Additionally, there is no published research on safety in USAF air transportation operations. Although consensus has been reached as to safety climate's relationship with safety performance, Zohar (2010) stresses the need for creating industry-specific safety climate scales in order to capture context-dependent perceptions of safety climate. Generic safety climate scales should not be used because factors that are important for safety in one industry, such as nursing, may be completely different from factors in other industries such as air transportation operations. Although safety in air transportation operations is of critical importance, no air transportation operations-specific safety climate scale has been developed. Therefore, the purpose of this research is to develop

an air transportation operations-specific safety climate scale, using the USAF air transportation specialist as a proxy, and lay the foundation for future safety research in this industry.

2.1.4 *Present Study*

An exploratory sequential mixed methods research design in three phases was used to develop the air transportation operations safety climate scales. A qualitative inquiry was performed first, and Creswell's (2014) six-step process for qualitative data analysis was used to guide this inquiry. This consisted of a review of the relevant literature, semi-structured interviews, and site visits to gather raw data. Once completed, interviews were transcribed and coded to uncover relevant safety climate themes. These themes were interpreted and used to develop a series of survey instruments. Air transportation specialists residing in USAF organizations were the target participants for this research effort. This research and research procedures were reviewed and approved by an Institutional Review Board and the Air Force Survey Control Office. In the first study, 4 site visits and 23 semi-structured interviews were conducted and analyzed to develop an initial set of 62 items for organization safety climate and 76 items for group safety climate. In the second study, the safety climate scales were further reduced to 14 items for organizational safety climate and 10 items for group safety climate by analyzing the inter-item correlations and performing an exploratory factor analysis. Finally, a third study was conducted using confirmatory factor analysis and inter-item correlations to validate the proposed air transportation operations safety climate scales (Campbell & Fiske, 1959; Hinkin, 1998; Schwab, 1980).

2.2 Study 1: Instrument Development

2.2.1 Phase 1: Item Generation

Phase 1 was conducted to generate an initial pool of organization and group safety climate measurement scale items relevant to the air transportation operations domain. The scale items were developed through a combination of an extensive literature review, site visits, and semi-structured interviews. Previous research and theory were first examined to identify potential dimensions of safety climate for the air transportation operations environment. This review resulted in 10 possible safety climate dimensions and served as the basis for the interview protocol. The start list for safety climate dimensions can be found in Appendix A.1, and the interview protocol can be found in Appendix A.2.

Procedure. A total of 23 air transportation operations subject matter experts were interviewed from 3 large USAF aerial port squadrons (APS): two east coast APS (n = 6; n = 8) and one west coast APS (n = 9). Informed consent was received from each interviewee, and all interviews were recorded. Interviewees included organization leaders, first-line supervisors, safety managers, and line workers. Each interviewee was asked to provide information regarding safety-related decisions they make, disconnects encountered between making safe decisions and performing operational tasks, consequences of making safe or unsafe decisions, safety policies that help or hurt one's ability to make safe decisions, supervisor and leadership practices regarding safe behavior, etc. Once data saturation was reached, no additional interviews were conducted (Miles et al., 2014). The interviews were then transcribed using a professional

transcription service and analyzed to identify the dimensions of safety climate for air transportation operations.

Analysis of the interviews was conducted in two cycles. For the first cycle, provisional coding was selected and began with the predetermined start list of 10 potential safety climate dimensions. The provisional list was generated from the literature review, safety climate theory, and field notes from the site visits. Elaborative coding was used for the second cycle. In elaborative coding, the goal is to refine theoretical constructs from previous studies (Saldaña, 2012). The analysis resulted in multi-dimensional organization and group safety climate constructs. For organization safety climate, the potential sub-dimensions were management commitment to safety, safety policies and procedures, safety training, and vehicles and equipment. For group safety climate, the potential sub-dimensions identified were management commitment to safety, work pressure, safety briefings, safety communication, and coworker support. Coded text from each dimension and previous safety climate measurement scales were then used to develop a pool of 138 potential scale items. After eliminating redundant items, 107 scale items survived. This resulted in a total of 49 items for organization safety climate: 21 items for management commitment to safety, 9 items for safety policies and procedures, 9 items for safety training, and 10 items for vehicles and equipment. A total of 58 items remained for group safety climate: 24 items for management commitment to safety, 10 items for work pressure, 6 items for safety briefings, 7 items for safety communication, and 11 items for coworker support.

2.2.2 Phase 2: Item Review

Sample. The 107 scale items were reviewed by 13 judges with varying backgrounds but related areas of expertise including aircraft maintenance, logistics readiness, cargo movement, passenger movement, and air transportation operations safety. This review served two purposes: 1) maximize content validity of the scale and 2) evaluate the items' clarity and conciseness (DeVellis, 2010). Three of the judges were professors with doctoral degrees related to logistics and supply chain management, two of the judges were doctoral candidates in a logistics program, and one of the judges was a master's student in logistics and supply chain management. The remaining judges were practicing managers of different levels in air transportation operations.

Procedure. A preliminary survey was sent to each judge to review. The survey included each safety climate scale item organized by construct and dimension (e.g., organization safety climate – management commitment to safety). The judges were instructed to provide feedback on whether the questions were clear, whether the questions were reflective of the dimensions they were intended to measure, and whether the questions were relevant to air transportation operations. As a result of the feedback, 34 items were removed. These items were removed due to several factors: 1) repetitiveness, 2) difficult to understand, 3) and not relevant. The 31 remaining scale items for organization safety climate consisted of: 11 items for management commitment to safety, 6 items for safety policies and procedures, 7 items for safety training, and 7 items for vehicles and equipment. The 42 remaining scale items for group safety climate were broken down as: 12 items for management commitment to safety, 7 items for work

pressure, 5 items for safety communication, 10 items for safety briefings, and 8 items for coworker support.

2.3 Study 2: Instrument Refinement – Pilot Survey

Sample. Invitations went out to 723 air transportation specialists from three large continental USAF APS's to participate in the pilot survey. A total of 168 responses were received (response rate of 23.2%). The average age of the respondents was 28.7 years (SD = 6.8) and the average years of work experience was 10.1 years (SD = 8.9). To assess the characteristics of the sample relative to the population, a comparison was made with regards to rank and age distribution (see Table 1). A difference of proportions test was conducted, and no significant difference was found between the sample and population rank proportions. Because the responses by rank and age compare favorably to that of the air transportation specialist population, it was concluded that a representative sample was achieved.

Table 1: USAF air transportation specialist sample and population comparison

	Population	Sample
#	4530	168
Age	27.6	28.7
SD	6.4	6.8
	Population	Sample
E-1	0.6%	0.9%
E-2	3.1%	2.6%
E-3	24.7%	18.8%
E-4	22.9%	23.9%
E-5	25.6%	24.8%
E-6	13.8%	17.1%
E-7	7.4%	8.5%
E-8	1.3%	2.6%
E-9	0.7%	0.9%

Procedure. The pilot survey was composed of the 31-item organization safety climate scale, the 42-item group safety climate scale, and demographic questions. For the safety climate scales, respondents were asked to indicate on a 7-point Likert scale the extent to which they agreed or disagreed with the statements. This scale was anchored at 1 (strongly disagree) and 7 (strongly agree).

All air transportation specialists assigned to the three APSs involved in this study were invited to participate in this survey on a voluntary and confidential basis. Each air transportation specialist was sent an introductory email explaining the research, and that email was followed up with an official survey invitation email that included a web link to the online survey. A reminder email was sent out one week after the official survey invitation email, and a final email was sent one week later in accordance with accepted survey protocol (Fink, 2012; Neuman, 2011; Salant & Dillman, 1994). No individual identifier was collected for this study to help provide anonymity to respondents. It has been shown that anonymous surveys aid in lowering social desirability bias (Joinson, 1999). The average time of completion of the survey was approximately 25 minutes. Furthermore, each respondent had the opportunity to be entered into a drawing for a \$50 gift card upon completion of the survey. Although 168 responses were received, any survey with more than 50% missing values in either of the safety climate scales were excluded from the analysis. This resulted in a final sample of 165 responses for organization safety climate (22.8% response rate) and 150 responses for group safety climate (21.4% response rate). A non-response bias test was conducted to compare responses of early and late respondents. Groups were separated into those that responded to the first email versus those that responded to follow-up emails. A t-test analysis was

used to determine if there were statistically significant differences between responses of the two groups. Results showed that there was a significant difference in responses for three of the 73 variables (GSB5, $p = .016$; GSB6, $p = .004$; GCS7, $p = .022$) for early versus late respondents. Based on the above results, it was concluded that non-response bias was not a major concern in this study.

2.3.1 Phase 1: Item Selection Process

Prior to conducting the factor analysis, interitem correlations of the safety climate scale items were examined and problem variables were removed (Hinkin, 1998). Measurement scales should be comprised of highly correlated items because low correlations indicate items may not be measuring the same construct (Churchill, 1979; DeVellis, 2010). Therefore, any organization safety climate item that correlated less than 0.4 with all other organization safety climate scale items was deleted from the analysis (Kim & Mueller, 1978). The same procedure was used for the group safety climate scale items. This process resulted in the removal of 6 organization safety climate scale items and 4 group safety climate items, leaving 25 and 38 items per scale, respectively.

2.3.2 Phase 2: Preliminary Factor Analysis

Because of the exploratory nature of this study, and because safety climate theory suggests organization safety climate, group safety climate, and their sub-dimensions are related, principle axis factoring with an oblique rotation was used (Fabrigar et al., 1999). Furthermore, because organization safety climate and group safety climate are expected to be related, a separate factor analysis was performed for each construct. The exploratory factor analysis was used as an item-reduction technique and to address the dimensionality of the organization and group-level safety climate scales. Rules used for

the factor analysis were: factors with eigenvalues greater than 1 were retained, items with loadings less than 0.40 or cross-loadings within 0.20 of a significant loading were removed from the analysis, and items with communalities less than 0.50 were removed from the analysis (Hinkin, 1998). This process was repeated until a clear factor structure matrix was obtained. The factor loadings, eigenvalues for the factors, percentage of explained variance by the factors, and internal reliability statistics are shown in Tables 2 and 3. This process resulted in a 14-item, four-factor solution for organization safety climate (management commitment to safety, safety policies and procedures, safety training, and vehicles and equipment). A 10-item, three-factor solution was obtained for group safety climate (commitment and support, work pressure, and safety briefings). A list of the organization and group-level safety climate items can be found in Appendix A.3. All factors for organization and group safety climate's displayed adequate internal reliability with Cronbach's α scores above 0.7 (Nunnally & Bernstein, 1994).

Table 2: EFA results for organization-level safety climate scale

	Factor			
	F1	F2	F3	F4
F1: Safety training (CA = 0.885)				
OT1	0.87	-	-	-
OT2	0.73	-	-	-
OT3	0.65	-	-	-
OT4	0.74	-	-	-
OT5	0.72	-	-	-
F2: Management commitment to safety (CA = 0.875)				
OMC1	-	0.73	-	-
OMC2	-	0.94	-	-
OMC3	-	0.78	-	-
F3: Vehicles and Equipment (CA = 0.859)				
OVE1	-	-	0.86	-
OVE2	-	-	0.55	-
OVE3	-	-	0.75	-
F4: Safety policies and procedures (CA = 0.815)				
OSP1	-	-	-	0.72
OSP2	-	-	-	0.84
OSP3	-	-	-	0.66
Eigenvalues	6.84	1.54	1.25	1.01
Percentage Variance	48.83	10.97	8.95	7.18
Cumulative Variance	48.83	59.80	68.74	75.92

Notes. Numbers in boldface indicate dominant factor loadings.
Only factor loadings over .3 are shown.

Table 3: EFA results for group-level safety climate scale

	Factor		
	F1	F2	F3
F1: Commitment and support (CA = 0.886)			
GMCS1	0.80	-	-
GMCS2	0.77	-	-
GMCS3	0.79	-	-
GMCS4	0.80	-	-
F2: Work pressure (CA = 0.815)			
GWP1	-	0.90	-
GWP2	-	0.76	-
GWP3	-	0.61	-
F3: Safety briefings (CA = 0.868)			
GSB1	-	-	0.79
GSB2	-	-	0.80
GSB3	-	-	0.78
Eigenvalues	5.12	1.53	1.00
Percentage Variance	51.24	15.31	10.00
Cumulative Variance	51.24	66.55	76.55

Notes. Numbers in boldface indicate dominant factor loadings.
Only factor loadings above .3 are shown

2.4 Study 3: Instrument Validation – Validation Survey

Sample. To validate the new safety climate scales, we invoked an independent sample from 19 USAF organizations. These organizations consisted of five continental United States (CONUS) and six overseas USAF APS's, as well as eight CONUS USAF logistics readiness squadrons (LRS) in which air transportation specialists are employed. None of the organizations in the pilot study were included in the validation study. In total 1,733 air transportation specialists were invited to participate in the web based survey, and 260 responses were received (15.0% response rate). The average age of the

respondents was 28.7 years (SD = 6.3), and the average years of work experience was 10.98 years (SD = 8.07). To assess the characteristics of the sample relative to the population, a comparison was made with regards to rank and age distribution (see Table 4). The sample was overrepresented by air transportation specialists in the non-commissioned officer (NCO) ranks of E-5 through E-6, and underrepresented in the Airman (Amn) ranks of E-1 through E-4. One possible explanation for this could be due to only including operational organizations in this study. The air transportation specialist technical training school was not included in the survey sample. All new air transportation specialists attend this training school, and it consists of primarily personnel in the Amn ranks. Because of the difference between sample and population respondent rank, caution should be used when generalizing findings of this study beyond the current sample.

Table 4: USAF air transportation specialist sample and population comparison

	Population	Sample
#	4,530	260
Age	27.6	28.8
SD	6.4	6.0
	Population	Sample
E-1	0.6%	1.1%
E-2	3.1%	1.1%
E-3	24.7%	15.5%
E-4	22.9%	18.7%
E-5	25.6%	33.7%
E-6	13.8%	19.8%
E-7	7.4%	9.6%
E-8	1.3%	0.5%
E-9	0.7%	0.0%

A non-response bias test was conducted to compare responses of early and late respondents. Groups were separated into those that responded to the first email versus those that responded to follow-up emails. A t-test analysis was used to determine if there were statistically significant differences between responses of the two groups. Results showed that there was a significant difference in responses of to three variables (GSB1, $p = .016$; GSB2, $p = .004$; GMCS4, $p = .022$) for early versus late respondents. Based on the above results, it was concluded that non-response bias was not a major concern in this study.

Procedure. All air transportation specialists included in this study were invited to participate in this survey on a voluntary and confidential basis. The same procedures used in the pilot study were once again used for the validation study. Each air transportation specialist was sent an introductory email explaining the research, and that email was followed up with an official survey invitation email that included a web link to the online survey. A reminder email was sent out one week after the official survey invitation email, and a final email was sent one week later in accordance with accepted survey protocol (Fink, 2012; Neuman, 2011; Salant & Dillman, 1994). No individual identifiers were collected for this study. The average time of completion of the survey was approximately 21 minutes. Furthermore, each respondent had the opportunity to be entered into a drawing for a \$50 gift card upon completion of the survey. Although 260 responses were received, 13 responses were deleted due to unengaged respondents. The unengaged respondents were identified due to answering all Likert questions as a “7”. No issues were found with missing responses in this study. This resulted in a final sample of 247 responses (14.3% response rate). A non-response bias test was conducted

to compare responses of early and late respondents and APS versus LRS respondents. Once again, groups were separated into early and last responders based on those that responded to the first email versus those that responded to follow-up emails. Independent sample t-tests were performed to determine if significant differences existed between the two groups. The type I error rate was set to .05 for this analysis. For the early versus late respondents, results showed that there was a significant difference in responses for only one variable (OVE2, $p = .009$). When comparing APS responses to LRS responses, a significant difference was found between three variables (OT6, $p = .040$; OVE2, $p = .020$; SB5, $p = .044$). Based on the above results, it was determined that non-response bias was not a significant concern in this study.

The survey was composed of the 15-item organization safety climate scale, the 10-item group safety climate scale, a 5-item self-reported safety behavior scale (Mearns et al., 2003; Mearns et al., 2010; Rundmo, 1996; Rundmo, 2000), two questions addressing the frequency of injuries (Goldenhar et al., 2003; Iverson & Erwin, 1997), and demographic questions. Although the pilot study resulted in a 14 item organization safety climate scale, one of the items was found to be a double barreled question. This item, OT1, was divided into two questions (see Appendix A.3) which resulted in the 15-item organizational safety climate scale. For the safety climate and safety behavior scales, respondents were asked to indicate on a 7-point Likert scale the extent to which they agreed or disagreed with the statements. These scales were anchored at 1 (strongly disagree) and 7 (strongly agree). For the frequency of injuries, respondents were asked to indicate how many times a major body part (e.g., head, neck, eyes, shoulder, arms, wrist, hand, back, legs, ankles, feet) was injured over the past year. The responses for injuries

were then trichotomized into: none, one, or two or more. This method of grouping self-reported injury has been used in previous studies that model direct relationships between predictor variables and injury outcomes (Goldenhar et al., 2003; Iverson & Erwin, 1997).

To validate the safety climate measurement scales, several approaches were used. First, a series of confirmatory factor analyses (CFA) were performed to assure factor structure validity of the newly developed safety climate scales. Separate CFAs were performed and interpreted for both the pilot survey and validation survey data. In addition to the χ^2 test statistic, the quality of model fit was assessed using the standardized root mean square residual (SRMR), comparative fit index (CFI), goodness of fit index (GFI), normed fit index (NFI), and root mean square error of approximation (RMSEA). For CFI, .95 or greater is evidence of approximate fit (Bentler & Bonnet, 1980; Hu & Bentler, 1999). For GFI and NFI, .90 or greater is evidence of approximate fit (Bentler & Bonnet, 1980; Joreskog & Sorbom, 1982; Kline, 2011). An SRMR under .08 signifies an acceptable fit (Hooper et al., 2008; Kline, 2011). Finally, an RMSEA < .05 is evidence of a good model fit; .05 < RMSEA < .08 indicates a reasonable model fit; and an RMSEA > .10 indicates a poor model fit (Browne & Cudeck, 1993; Hair et al., 2010). Next, discriminant validity is demonstrated performing the Fornell and Larcker (1981) test. Finally, criterion-related validity is analyzed by assessing the safety climate scales' relationship with its theoretical effects of safety behaviors and workplace injuries.

2.4.1 Phase 1: Dimensionality

A series of CFAs via AMOS 18 using maximum likelihood estimation was performed to cross-validate the organization and group-level safety climate scales that were obtained through the pilot study EFA. Separate CFAs were performed on the pilot

study data (n = 165 for organization-level safety climate; n = 150 for group-level safety climate) and on the validation study data (n = 247 for both organization and group-level safety climate). For both the pilot study data and validation data, three models were assessed with each level of safety climate, and the results are displayed in Table 5. First, a correlated four-factor organization-level safety climate model (and three-factor group-level safety climate model) based off the pilot study EFA was assessed. Next, a one-factor, unidimensional model was assessed for both the organization and group-level safety climate scales to determine if single latent variables would be best in analyzing the new safety climate scales. Finally, 2nd order hierarchical models were assessed in which the factors found during the pilot study EFAs were modeled as indicators for the higher-order safety climate scales.

For organization-level safety climate, all three models fit the data reasonably well with GFIs and NFIs near or above the .90 threshold, CFIs near or above the 0.95 threshold, SRMRs under .08, and RMSEAs showing good or reasonable model fit. However, the 2nd order hierarchical model consistently had the better model fit across all fit indices, while the unidimensional model failed to meet the minimum fit indices threshold for GFI and CFI. For group-level safety climate, once again all three models fit the data reasonably well with GFIs and NFIs well above the .90 threshold, CFIs well above the .95 threshold, and SRMRs well below acceptable levels of fit thresholds. Once again, the 2nd order hierarchical model consistently displayed the best model fit ($\chi^2 = 41.20$, $df = 30$, $p\text{-value} = .08$; GFI = .97; CFI = .99; NFI = .97; SRMR = .04; RMSEA = .04, 90% CI (.00, .07)). These findings were consistent across both the pilot and validation studies. Based both on the results of the CFAs and the theoretical

underpinnings that safety climate should be represented by various sub-dimensions, the 2nd order hierarchical model was deemed to be most appropriate for capturing the air transportation safety climate scales, similar to findings by Huang et al. (2013). These findings offer support for the construct validity and dimensionality of the safety climate scales created during the pilot study. Models of the organization and group-level safety climate scales are shown in Figures 1 and 2.

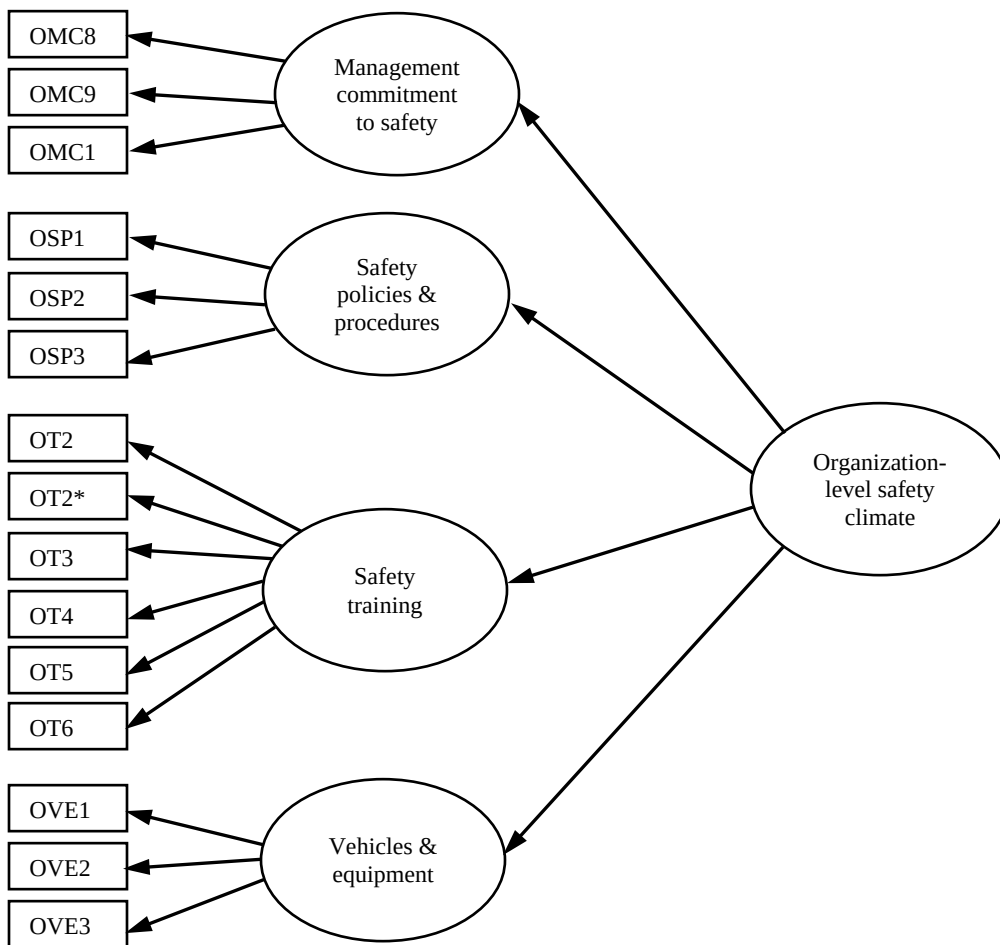


Figure 1. Organization-level safety climate dimensions and indicators

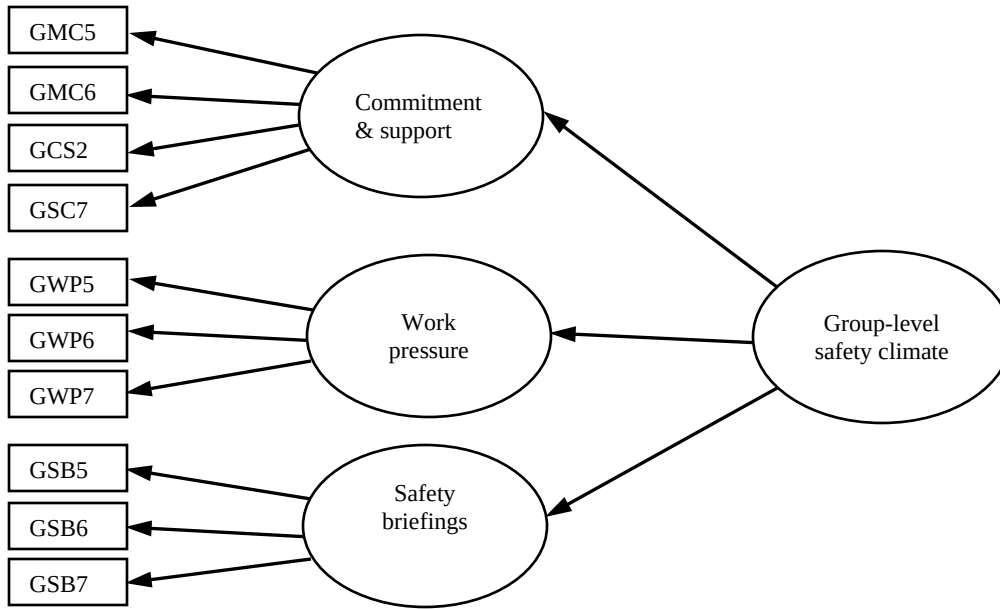


Figure 2. Group-level safety climate dimensions and indicators

Table 5: CFA results for organization and group-level safety climate

Models	Fit indexes							
	χ^2 (df)	P CMIN /DF	p-value	GFI	CFI	NFI	SRMR	RMSEA (90% CI)
A. Org-level safety climate								
Pilot study (n = 165)								
Model 1: Four-factor	139.44 (71)	1.96	***	.89	.95	.91	.053	.08 (.06, .10)
Model 2: Single-factor	157.54 (67)	2.35	***	.88	.93	.89	.069	.09 (.07, .11)
Model 3: 2nd order hierarchical	128.84 (72)	1.79	***	.90	.96	.91	.054	.07 (.05, .09)
Validation study (n = 247)								
Model 1: Four-factor	198.78 (82)	2.62	***	.90	.95	.91	.06	.08 (.06, .09)
Model 2: Single-factor	229.94 (83)	2.77	***	.88	.93	.90	.06	.09 (.07, .10)
Model 3: 2nd order hierarchical	194.77 (83)	2.347	***	.90	.95	.92	.06	.07 (.06, .09)
B. Grp-level safety climate								
Pilot study (n = 150)								
Model 1: Three-factor	59.05 (31)	1.91	***	.93	.97	.94	.05	.08 (.05, .11)
Model 2: Single-factor	43.33 (26)	1.74	.01	.94	.98	.95	.04	.07 (.03, .10)
Model 3: 2nd order hierarchical	55.64 (30)	1.86	***	.94	.97	.94	.04	.08 (.04, .11)
Validation study (n = 247)								
Model 1: Three-factor	41.20 (30)	1.37	.08	.97	.99	.97	.04	.04 (.00, .07)
Model 2: Single-factor	55.75 (29)	1.92	.02	.96	.98	.95	.04	.06 (.04, .09)
Model 3: 2nd order hierarchical	41.20 (30)	1.37	.08	.97	.99	.97	.04	.04 (.00, .07)

Note: *** $p < .001$

2.4.2 Phase 2: Criterion-Related and Discriminant Validity Assessment

Criterion-related validity, the extent to which a measure correlates with another theoretically related measure, was examined by investigating the correlations between the air transportation operations safety climate scales and self-reported safety behaviors and self-reported injuries (Leedy & Ormrod, 2014). Safety research has shown that safety climate is an antecedent of safety performance across a wide range of industries and has been implicated as a key factor in promotion of injury-reducing behavior (Barling et al., 2002; Fogarty & Shaw, 2010; Griffin & Neal, 2000; Huang et al., 2007; Huang et al., 2013; Kelloway et al., 2006; Zohar, 2002). Therefore, evidence of criterion-related validity would be demonstrated if there is a positive relationship between the safety climate scales and safety behaviors, and an inverse relationship between the safety climate scales and the frequency of injuries.

Discriminant validity, the extent to which a measure does not correlate with an unrelated measure, was investigated by performing the Fornell and Larcker (1981) test. Discriminant validity is supported if the square root of a constructs average variance extracted (AVE) is greater than the correlations between that construct and other constructs under investigation.

The individual safety behaviors construct was used in this study because it provides a measurable criterion for researchers, and it is more closely related to psychological factors than actual accidents or injuries (Christian et al., 2009). Safety behavior was measured using a five-item scale intended to assess behavioral patterns that involve breaking rules and taking chances in core activities (Mearns et al., 2010). This scale has been found to be reliable across different industries with a Cronbach's α

ranging from .74 - .86 (Mearns et al., 2003; Mearns et al., 2010; Rundmo, 1996; Rundmo, 2000). This scale includes questions such as “I ignore safety regulations to get the job done” and “I take shortcuts which involve little or no risk.” Frequency of injuries was assessed by asking respondents how many times they have experienced an injury over the past year. Since these outcomes reflect counts that are trichotomized into groups, calculating Cronbach’s α is not appropriate (Goldenhar et al., 2003).

Means, standard deviations, Cronbach’s α ’s, and Pearson correlation coefficients were calculated using SPSS and individual-level data. As shown in Table 6, all constructs display sufficient internal reliability with Cronbach’s α ’s above .70 (Nunnally & Bernstein, 1994). Furthermore, results of correlating the safety climate scales with self-reported safety behavior and frequency of injuries confirm the expected relationships because all dimensions of the organization and group-level safety climate scales were positively correlated to safety behaviors and negatively correlated to frequency of injuries. These strong relationships provide evidence of criterion-related validity. Results of the Fornell and Larcker (1981) test show that the square root of all constructs’ AVEs were greater than any correlation between constructs. This result provides evidence of discriminant validity of the scales.

The results from the reliability estimates, pilot study EFAs, CFA comparisons, and correlations with related and unrelated constructs suggest that the air transportation operations safety climate scales are internally consistent and valid.

Table 6: Means, Standard Deviations, Cronbach's α 's, and Correlations

Construct	<i>M</i>	<i>SD</i>	α	AVE	1	2	3	4	5	6	7	8	9
1. Mgmt commitment	5.77	1.13	.80	.58	.76								
2. Safety policies & procedures	5.57	1.20	.78	.57	.52	.75							
3. Safety training	5.26	1.25	.91	.63	.45	.62	.79						
4. Vehicles & equipment	4.99	1.47	.83	.62	.47	.49	.61	.79					
5. Commitment & support	6.01	0.90	.89	.61	.40	.47	.58	.47	.78				
6. Work pressure	4.78	1.45	.79	.58	.52	.35	.40	.36	.44	.76			
7. Safety briefings	5.58	1.07	.72	.50	.40	.44	.58	.40	.62	.31	.71		
8. Safety Behaviors	5.49	1.26	.91	.67	.39	.53	.40	.35	.48	.44	.38	.82	
9. Injuries	.30	.62	n/a	n/a	-.17**	-.14*	-.25	-.28	-.18**	-.17**	.18**	-.14*	n/a

Notes. Org-level safety climate consists of mgmt commitment, safety policies & procedures, safety training, and vehicles & equipment.

Grp-level safety climate consists of commitment & support, work pressure, and safety briefings.

Square root of AVE shown on diagonal.

$p < .001$ unless otherwise noted; * $p < .05$. ** $p < .01$.

2.5 Discussion

The purpose of this study was to develop a valid and reliable air transportation operations-specific safety climate scale using the USAF air transportation specialist as a proxy. The newly developed scale uses a multi-level framework by separating the safety climate scale into perceptions of organization and group-level constructs, as recommended by Zohar (2010). Results provide initial evidence of the reliability and validity of the newly developed safety climate measure. A series of EFAs and CFAs confirmed the construct validity of the 15-item, four-factor solution for organization-level safety climate and the 10-item, three-factor solution for group-level safety climate. Organization-level safety climate was encompassed by the sub-dimensions of management commitment to safety, safety policies and procedures, safety training, and vehicles and equipment. Group-level safety climate was comprised by the sub-dimensions of commitment and support, work pressure, and safety briefings. Evidence of criterion-related validity was supported due to the strong relationship between the organization and group-level safety climate scales and the theoretically related measures of self-reported safety behaviors and frequency of injuries. These findings were consistent with many previous studies including Barling et al. (2002), Fogarty and Shaw, (2010), Huang et al. (2013), and Zohar (2002). Finally, discriminant validity was demonstrated by performing the Fornell and Larcker (1981) test.

2.5.1 Value of the Air Transportation Operations Safety Climate Construct

The value of an air transportation operations safety climate construct cannot be understated. First and foremost, it can serve as a leading indicator for safety mishaps in

the air transportation operations industry. And as previously mentioned, the consequences of these safety mishaps may reach far beyond the air transportation specialists themselves. As such, being able to identify which organization may be at risk for a mishap can help leaders institute proactive mechanisms to mitigate such mishaps. Next, the new safety climate construct may be able to help differentiate between low and high-performing organizations when it comes to creating a climate of safety. Leaders can look to the high-performing organizations to discover potential best practices that can be instituted throughout the industry. Also, the safety climate scale can help diagnose organizations with low perceived safety climate and identify ways to help improve this climate. For instance, one can look to see which dimension of organization or group-level safety climate needs improvement, and a plan can be tailored specifically for that organization to address its issue(s). Finally, the air transportation operations safety climate scale can be used to identify disconnects between the organization-level safety climate and group-level safety climate. Since supervisors may have discretion in how they implement top management's safety policies, and because individual differences between group-level supervisors exist, organization's safety policies may be executed differently by each workgroup (Zohar, 2008). So if the organization-level safety climate is found to be much higher than the group-level safety climate in an organization, it could be indicative of the group-level managers not fostering the same level of commitment to safety as the organization's leaders. It could also signify that safety policies and procedures have been misunderstood by group-level supervisors. This scenario could signal the need for leadership at all levels to come together and ensure unity of effort throughout the organization.

2.5.2 Theoretical Implications

This research makes several important contributions to safety climate theory. First, although current safety climate theory and research is robust, it is not adequate to explain safety climate in the context of the air transportation operations industry. This industry is characterized by dangerous work where accidents can have far-reaching implications, and safety issues in this arena need to be addressed. This paper addresses Zohar's (2010) call for industry-specific safety climate scales and serves as the initial study on the predictors of safety performance in air transportation operations industry. Several safety climate dimensions (i.e., management commitment to safety, safety policies and procedures, training) that were found to be important in this industry are also routinely found across most industries (Flin et al., 2000). However, the safety briefings dimension, a dimension primarily found in the healthcare industry), was found to be instrumental in measuring group safety climate for air transportation operations personnel. It was discovered during the interview portion of this research that safety briefings are given frequently throughout the day in the air transportation industry. Safety briefings are given at the beginning of each shift and prior to loading cargo on an aircraft, at a minimum. In industries where safety briefings are mandated prior to performing work, the safety briefing dimension may be of upmost importance. Although no unique safety climate dimension was found, it may be possible to identify safety climate dimensions that are important to industries with similar characteristics. Furthermore, even though no unique safety climate dimensions were discovered in this research effort, 16 out of the 25 scale items used in this study included context-specific language for the air transportation operations industry.

Next, this research provides strong statistical and theoretical support for level-adjusted safety climate scales in the air transportation operations industry. Policies and procedures are instituted at the organization-level; however, group-level managers may have the authority to use discretion in implementing these policies and procedures. Individual employees are able to discriminate between these and they form their different perceptions between organization and group-level safety climate (Zohar, 2008). The safety climate scales developed in this research are able to capture these perceptions.

2.5.3 Managerial Implications

In addition to the theoretical contributions mentioned above, this research also has important managerial implications. From the beginning, it has been shown that improvement in management attitudes and commitment towards safety are mandatory prerequisites for improving safety in an organization (Zohar, 1980). By including the management commitment to safety sub-dimension for organization-level safety climate and the commitment and support sub-dimension for group-level safety climate, leaders can assess employee perceptions of leadership commitment to safety at the current time and in the future. Safety climate scores can be compared over time to determine if actual improvement or deterioration is occurring and adjust accordingly. The safety climate scores can serve as a gauge to see if safety climate improvement initiatives are being successful or not.

Also, the air transportation operations safety climate scale can help managers gain an in depth understanding of the impact an individual's safety climate perceptions may have on his or her safety decision-making process. Results of this study can be used to see which safety climate sub-dimension plays the largest role in influencing employee

safety behaviors. This could allow managers to target specific areas of improvement in safety climate to have the biggest impact on safety behaviors.

Finally, it was found that organization and group-level safety climate perceptions exist for air transportations operations personnel, and that these different levels were both related to safety behaviors and frequency of injury. This signals that it is not only important for supervisors to be better leaders that display a sincere commitment to safety and provide necessary safety equipment and training, but that organizations themselves may have to examine formal policies to ensure they are straight-forward, non-contradictory, and help establish an environment that does not subjugate safety for performance.

2.5.4 Limitations and Future Research

Although this research provides numerous contributions to theory and practice, it is not without key limitations that must be acknowledged. First, USAF air transportation specialists were used as a proxy for this study, and this may hurt the generalizability of the findings. It was discovered that there was a statistically significant difference between sample and population respondent rank in the validation study, and caution was recommended when generalizing findings of this study beyond the current sample. However, the CFAs between the pilot and validation studies garnered nearly identical results. This provides evidence that the newly developed safety climate scales are robust for studying the safety climate of USAF air transportation specialists. However, the intent of this research was to create an air transportation operations industry-specific safety climate scale, and this must be addressed. The tasks required of USAF air transportation specialists were identified and compared to the same occupation within the

Air Reserve Component (e.g. Air National Guard and Air Force Reserve) and civilian air transportation operation companies, and these duties were found to be similar.

Additionally, many organizational features in our sample are not exclusive to the military. Many organizations share a similar hierarchical structure, have employees that must engage in high-risk and stressful activities, and have employees that must work directly with others in a team setting (Dvir et al., 2002). Furthermore, safety is of vital importance to both military and civilian organizations, and previous safety and leadership research in both military and civilian contexts suggests no threat to external validity exists (Zohar & Luria, 2004; Zohar & Tenne-Gazit, 2008). Even so, a follow-up study including civilian air transportation operations personnel should be conducted.

A second limitation of this study arises due to using self-reported measurement scales in the survey. By using self-reported measurement scales, common method bias may be a concern, and some have noted that it may be a major threat to reliability and validity (Roxas & Lindsay, 2012). To address this potential limitation, this study used several common method and social desirability bias minimization and detection techniques. First, an anonymous, web-based survey was chosen for this research because research shows they may result in lower social desirability (Joinson, 1999). A non-response bias test was also performed. Finally, Harmon's one factor test was performed to determine if common method variance was an issue in the study (Podsakoff & Organ, 1986). If common method variance were a serious issue, one would expect a single factor to emerge from a factor analysis. The test led to six factors with eigenvalues greater than one being extracted with factor 1 accounting for 38% of the variance. Although results of these analyses suggest that common method bias was not a concern in

this study, future studies should incorporate operational safety metrics and observed safety practices as outcomes.

The creation of the air transportation operations safety climate scale also has important implications for future research. First, using the newly created scale, studies can be undertaken to determine how safety climate is created within the air transportation operations environment. In addition to how safety climate is created in this industry, boundary conditions can be examined to discover what variables play a role in translating safety climate to safety behaviors. Furthermore, Brown (1996) called for researchers to include safety as a central theme in future operations management research. It is now twenty years later; however, safety and operational outcomes have still been largely examined in isolation of each other (Das et al., 2008, Pagell et al., 2014, Pagell et al., 2015). It is evident that safety and operations are often studied in a vacuum, and this research sets the stage for incorporating both in future air transportation operations research.

In conclusion, the air transportation operations industry is a high-risk environment with unique safety challenges. As researchers and practitioners, it is our duty to develop better methods to help reduce the chances of safety incidents throughout the industry. It has been shown that relying on safety recommendations is not enough to prevent future accidents (NTSB, 2015), and that a climate of safety can help reduce accidents and injuries (Zohar, 2010). The goal of this research was to develop and validate an air transportation operations-specific safety climate scale that encompasses both the organization and group level in order to better understand how safety climate is created in

this environment. Although more research is required, this study provides a solid foundation for future safety research in the air transportation operations industry.

III. The Effects of Safety Climate and OCBs on Operational Performance

3.1 Introduction

Safety climate has been studied extensively across many different industries to better understand safety performance of employees and to help develop methods to reduce workplace accidents. However, the relationship between safety and operational performance is still not fully understood. Researchers believe that safety climate, the perceptions employees have of the importance their organization places on safety, often competes with rules and procedures of other domains such as productivity and efficiency (Neal & Griffin, 2006; Zohar, 2010; Zohar & Luria, 2005); however, this idea has rarely been investigated. The lack of integrated safety and operational performance research was first highlighted by Brown (1996) when she mentioned that despite workplace safety being a growing concern for operations managers, safety was practically non-existent in the operations literature. Brown (1996) called for researchers to include safety as a central theme in future operations management research. It is now twenty one years later; however, safety and operational outcomes have still been largely examined in isolation of each other (Das et al., 2008; Pagell et al., 2014; Pagell et al., 2015). The purpose of this research is to investigate the effects of safety climate on organizational citizenship behaviors (OCBs) and operational performance of air transportation operations personnel.

Although the literature investigating the links between safety and productivity are minimal, theoretical and empirical evidence does exist that shows a positive relationship may in fact exist. For instance, Michael et al. (2005) invoke social exchange theory and

organizational support theory to link perceptions of management commitment to safety to individual employee performance in the wood manufacturing industry. The authors concluded that a strong commitment to safety by management may result in better operational performance by individual employees. Das et al. (2008) use cognitive dissonance theory and found that safety disconnects, defined as the difference in manager and worker perceptions regarding safety, may result in lower worker effectiveness and quality of work. Additionally, Pagell et al. (2014) conducted a series of 10 case studies on production and distribution facilities in Ontario, Canada to determine if it is possible to concurrently create a safe and productive workplace. The authors found that productivity and safety were in conflict in organizations that displayed a day-to-day output-oriented culture. However, the authors also found that when a supportive culture and joint management systems were employed, organizations were able to be safe and productive. Finally, Pagell et al. (2015) surveyed 198 manufacturing facilities throughout Ontario, Canada in order to assess whether or not safety and operational effectiveness were contradictory or complementary to one another. The authors found that when an organization chooses to implement a joint management system, managing safety and operations in a coordinated fashion, safety and operations were complementary. Results of the previous two studies suggest that the long-held belief of safety and productivity being incongruent may be inaccurate. Rather, safety and productivity may in fact be complementary and dependent upon an organizational culture that is simultaneously supportive of safety and operations.

Organizational citizenship behaviors (OCBs) may play a key role in the relationship between safety climate and operational performance. OCBs have been

shown to contribute to organizational success by enhancing coworker and managerial productivity, freeing up resources, and by helping coordinate activities within and across work groups (Organ, 1988). OCBs are discretionary, extra-role behaviors that promote the effective functioning of the organization (Organ, 1988). Furthermore, OCBs have been shown to be influenced by work environmental factors such as safety (Somech & Drach-Zahavy, 2004). Lee et al. (2007), through the lens of organizational support theory, linked safety climate to work attitudes whereas Michael et al. (2005) and Podsakoff et al. (2000) used organizational support theory to link OCBs to performance outcomes. While the aforementioned studies link safety climate to OCBs and OCBs to operational performance, no such studies exist that tie these three concepts together in one consolidated effort. The current research proposes that higher levels of safety climate will be associated with higher levels of OCBs, and in turn, higher levels of operational performance. In the following section, theoretical support is provided for the hypotheses.

3.2 Conceptual Background

3.2.1 Safety Climate and Organizational Citizenship Behaviors

Safety climate, the measurable aspect of safety culture, has been shown to be shaped by the safety policies, practices, and supported behaviors of the organization (Huang et al., 2013; Zohar, 2010). For instance, if productivity is perceived to be favored over safety, and safety policies, procedures, and practices are routinely subjugated, the perceived safety climate of the organization will be lower than that of an organization that does not favor productivity to the detriment of safety. Safety climate exists at both

the organization and group level, with organization-level safety climate being shaped by perceptions of enforced company policies and procedures, while group-level safety climate is shaped by perceptions of supervisory safety practices (Zohar, 2000; Zohar, 2003). Because of the multi-level safety climate framework, separate constructs should be used for each level when examining safety climate. Furthermore, safety climate has been found to be a robust predictor of safety performance with lower safety climate leading to higher accident rates, and vice versa (Barling et al., 2002; Fogarty & Shaw, 2010; Griffin & Neal, 2000; Huang et al., 2007; Kelloway et al., 2006; Zohar, 2002). It is believed this occurs due to employees using their perceptions of safety climate to drive their own safety behaviors (Zohar, 1980). Interestingly, there is increasing evidence that safety climate may influence non-safety related behaviors as well. Recently safety climate has been found to be positively related to job satisfaction, organizational commitment, and intent to stay (Clarke, 2010; Huang et al., 2015; Kath et al., 2010; Mearns et al., 2010; Michael et al., 2005; Nahrgang et al., 2011; Swartz et al., 2017).

Yet another type of behavior that safety climate may influence is called OCB. OCBs are discretionary, extra-role behaviors that promote the effective functioning of the organization (Organ, 1988). These behaviors have been shown to be influenced by work environmental factors such as safety (Somech & Drach-Zahavy, 2004). OCBs have been found to be multi-dimensional in nature, and include sub-dimensions such as helping behavior, sportsmanship, and civic virtue (Podsakoff, 2000). Helping behavior is characterized by an individual voluntarily helping others with work related issues. Sportsmanship is described as being willing to sacrifice one's own personal interests for the good of the work group and as not complaining when work circumstances are less

than ideal (Podsakoff, 2000). Finally, Podsakoff (2000) defines civic virtue as an employee participating in and being concerned about the life of the company. OCBs have been shown to contribute to organizational success by enhancing coworker and managerial productivity, freeing up resources, and by helping coordinate activities within and across work groups (Organ, 1988).

Organizational support theory offers insight into how safety climate may influence OCBs. Organizational support theory is an extension of social exchange theory, and both include the idea of reciprocity as a central theme. Social exchange theory describes these exchanges as interactions in which employees trade effort and loyalty for benefits such as a safe work environment (Williams et al., 2011).

Organizational support theory extends this relationship to say that employees use these social exchanges to form opinions on how much the employer values their contributions and well-being (Michael et al., 2005). Michael et al. (2005) further state that these opinions are used to form an employee attitude called perceived organizational support (POS), which corresponds to how employees feel about their employer fairly compensating them, whether their employer helps them when in need, and whether or not they are provided good working conditions (Eisenberger et al., 1986). When an employee works in a high-risk environment where safety mishaps can have catastrophic effects on themselves or others, providing safe working conditions may take on even more importance when it comes to increasing POS. Thus, increases in perceived safety climate in high-risk industries may increase an employee's POS.

It has been discovered that increases in POS motivate employees to work harder for three reasons: 1) POS produces an obligation to care about the organization and help

it reach its objectives, 2) the approval and respect conveyed by POS fills an employee's socioemotional need and leads to the employee incorporating the organization into part of their social identity, and 3) POS strengthens the employee's belief that the organization rewards increased performance (Rhoades & Eisenberger, 2002). Therefore, when the organization values the safety of an employee and provides a safe working environment, the employee feels more of a sense of belonging to the organization and may engage in extra-role commitments such as OCBs that will mutually benefit the employee and the organization. This phenomenon may be particularly salient in high risk environments whereby employees must protect themselves and external stakeholders from harm. Hence, the following relationship is hypothesized between organization-level safety climate and OCBs:

H1a. *Organization-level safety climate is positively related to organizational citizenship behaviors.*

In addition to employees forming opinions on how much the organization values their contributions, they also form opinions on how much their supervisors value their contributions and well-being (Rhoades & Eisenberger, 2002). Rhoades and Eisenberger (2002) go on to state that supervisors act as agents of the organization, and therefore employees use the actions of supervisors as indicators of organizational support. When supervisors in high-risk environments value the safety of the employee, the employee may have a higher sense of POS and thus engage in OCBs as a result. Therefore, the following relationship is hypothesized between group-level safety climate and OCBs:

H1b. *Group-level safety climate is positively related to organizational citizenship behaviors.*

Furthermore, safety policies and procedures are created by organizational leadership to help achieve strategic objectives. First line supervisors must interpret, implement, and execute these safety policies and procedures. Since these group-level supervisors are bounded by the organization-level safety policies and procedures, it is expected that organization-level safety climate will be positively related to group-level safety climate (Zohar & Luria, 2005), and that group-level safety climate will mediate the relationship between organization-level safety climate and organizational citizenship behaviors.

H1c. *Organization-level safety is positively related to group-level safety climate.*

H1d. *Group-level safety climate mediates the positive relationship between organization-level safety climate and organizational citizenship behaviors.*

3.2.2 Organizational Citizenship Behaviors and Operational Performance

Organizational support theory offers a valuable lens when understanding how OCBs and its dimensions of helping behavior, sportsmanship, and civic virtue may impact operational performance. Rhoades and Eisenberger (2002) explain that perceived organizational support should increase an employee's job performance and lead to extra-role activities such as helping other employees and offering suggestions for the organization to be more effective. These benefits coincide with Organ's (1988) explanation of OCBs contributing to organizational success by enhancing coworker and

managerial productivity, freeing up resources, and helping coordinate activities within and across work groups.

The helping behavior dimension is characterized by experienced employees helping newer or less experienced employees solve work-related problems and perform their jobs more efficiently (Podsakoff et al., 1997). This can contribute to organizational performance by improving overall employee performance and by freeing up managerial resources. Instead of a manager having to spend more time with the new employee, he or she can focus on other important tasks since established employees have gone out of their way to help the newer employee.

A similar result may also be seen with sportsmanship. When high levels of sportsmanship are present, employees keep good attitudes and remain in high spirits even when conditions at work are less than ideal. Furthermore, employees put the organization's interests above their own. This may lead to a positive work environment and gain more cooperation from other employees (Podsakoff et al., 1997). This would free up managers from having to spend time calming down frustrated employees, allowing the managers to focus on other tasks.

Civic virtue may have a positive effect on operational performance. When employees display civic virtue, they are more active in work meetings and offer suggestions on how the organization can improve overall (Podsakoff et al., 1997). These meetings often include people from multiple work groups; therefore, the information shared during these meetings can benefit multiple departments throughout an organization. Updates to policies, suggested improvements to policies and procedures,

and best practices are among some of the topics that could be discussed during these meetings that could help an organization be more productive.

There are multiple studies that empirically link OCBs to operational performance. Podsakoff et al. (1997) studied the effects of OCBs on the quantity and quality of the performance of 218 people in 40 work groups in the paper mill industry. They found that helping behavior and sportsmanship had significant effects on performance quantity and that helping behavior had a significant impact on performance quality. Wang et al. (2005) surveyed supervisors and subordinates from multiple organizations in China to analyze the effects of transformational leadership, leader-member exchange, OCBs and task performance. They found that employee OCBs were positively related to supervisory ratings of employee task performance. Finally, Walz and Niehoff (2000) researched the link between OCBs and organizational effectiveness in limited-menu restaurants. They found that OCBs were associated with lower costs, increased revenues, increased perceived company quality, increased operating efficiency, increased customer satisfaction, and fewer customer complaints. Walz and Niehoff (2000) concluded that developing an environment that promotes OCBs may enhance management's productivity and organizational effectiveness. Based on the above, the following hypothesis is proposed:

H2. Organizational citizenship behaviors are positively related to perceptions of individual operational performance.

3.3.3 Indirect Effects of Safety Climate on Operational Performance

In the previous sections, it was explained why organization and group-level safety climate would be related to OCBs, and why OCBs would be related to operational performance. Therefore, it is also expected that organization and group-level safety climate would be related to operational performance through the mediating effect of OCBs. However, OCBs may not be able to fully explain safety climate's relationship with operational performance. There may be other factors to consider when explaining the expected relationship between safety climate and operational performance such as safety disconnects, perceptions of management commitment to safety, and the presence of a joint management system for safety and production (Das et al., 2008; Michael et al., 2005; Pagell et al., 2014; Pagell et al., 2015). Therefore, the following hypotheses are proposed for the relationship between safety climate and perceptions of individual operational performance.

H3a. Organizational citizenship behaviors will partially mediate the relationship between organization-level safety climate and perceptions of individual operational performance.

H3b. Organizational citizenship behaviors will partially mediate the relationship between group-level safety climate and perceptions of individual operational performance.

The conceptual model and hypotheses are depicted in Figure 3.

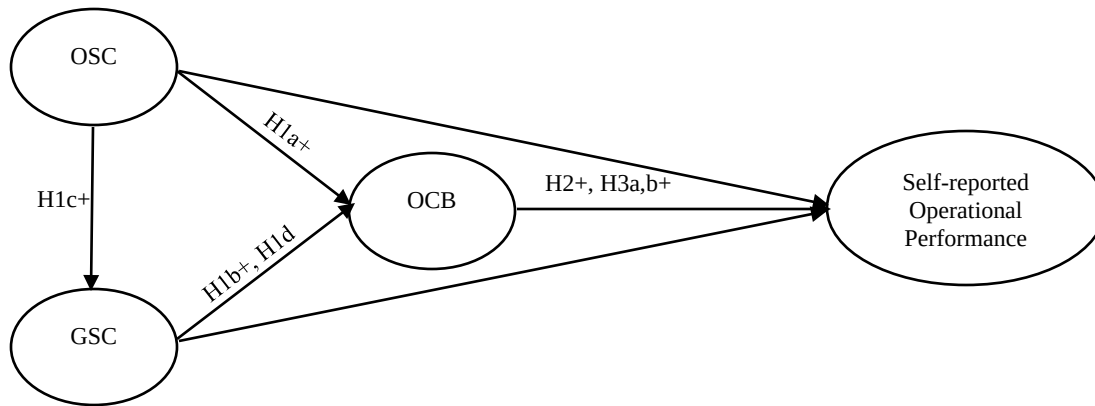


Figure 3. Proposed Structural Equation Model

3.4 Methodology

3.4.1 Data Collection

The study was conducted using survey data collected from air transportation specialists assigned to 22 United States Air Force (USAF) organizations. These organizations consisted of eight continental and six overseas USAF aerial port squadrons (APS) as well as eight continental USAF logistics readiness squadrons (LRS) in which air transportation specialists are assigned. A list of current USAF APS's were provided by the sponsor of the research, the USAF Air Mobility Command Director of Logistics (AMC/A4). A total of 16 USAF APS's were identified and invited to participate in the research. Each USAF APS commander was contacted via telephone and email in order to communicate the nature of the research and gain approval, and approval was obtained from 14 commanders. The commanders of the remaining two organizations did not respond to the request; therefore, those organizations were not included in the research. To obtain a list of USAF LRS's to include in the research, the logistics support branch of the USAF Installation and Mission Support Center (IMSC) was contacted. The USAF

IMSC provided a list of eight USAF LRS's to include in the research. These organizations were selected due to them having at least five air transportation specialists assigned. Each of the organization's commanders was contacted via telephone and email to gain approval for their personnel to participate in the research, and all commanders agreed to let their personnel participate.

All 2,456 air transportation specialists assigned to the 22 USAF organizations previously mentioned were invited to participate in this survey on a voluntary and confidential basis. Each individual was sent an introductory email explaining the research followed up with an official survey invitation email that included a web link to the online survey. A reminder email was sent out one week after the official survey invitation, and a final reminder email was sent one week later in accordance with accepted survey protocol with accepted survey protocol (Fink, 2012; Neuman, 2011; Salant & Dillman, 1994). No individual identifiers were collected for this study. The average time of completion of the survey was approximately 21 minutes. Furthermore, each respondent had the opportunity to be entered into a drawing for a \$50 gift card upon completion of the survey.

Completed surveys were received from 340 air transportation specialists for a response rate of 13.8%; however, 22 responses were deleted due to unengaged respondents. The unengaged respondents were identified due to answering all Likert questions as a "7", including the items that had to be reverse coded. No issues were found with missing responses in this study. This resulted in a final sample of 318 responses (13% response rate). A comparison was made with regard to rank and age distribution to assess the characteristics of the sample relative to the population (see

Table 7). The sample was overrepresented by air transportation specialists in the non-commissioned officer (NCO) ranks of E-5 through E-6, and underrepresented in the Airman (Amn) ranks of E-1 through E-4. One reason for these results may be due to the fact that the air transportation specialist technical school was not included in the survey sample. All new air transportation specialist Amn attend this technical school, and it consists primarily of personnel in the Amn ranks. The technical school was not included because it is not an operational organization. Because of this, and because there was no difference in age between the sample and population, it was concluded that the research sample was representative of the air transportation specialist population.

Table 7: USAF air transportation specialist sample and population comparison

	Population	Sample
#	4530	318
Age	27.6	29.0
SD	6.4	6.2
	Population	Sample
E-1	0.6%	0.8%
E-2	3.1%	1.7%
E-3	24.7%	14.7%
E-4	22.9%	20.1%
E-5	25.6%	30.5%
E-6	13.8%	22.2%
E-7	7.4%	9.2%
E-8	1.3%	0.8%
E-9	0.7%	0.0%

3.4.2 Variables

The key constructs included in this research are organization-level safety climate (OSC), group-level safety climate (GSC), OCB, and self-reported operational performance. The OSC and GSC measurement scales were recently developed by the

researcher and are specific to the air transportation operations industry. These measurement scales were developed using an exploratory sequential mixed methods research design. A qualitative inquiry was performed first, and Creswell's (2014) six-step process for qualitative data analysis was used to guide this inquiry. This consisted of a review of the relevant literature, semi-structured interviews, and site visits in order to gather raw data. Once completed, interviews were transcribed and coded in order to uncover relevant safety climate themes (Saldaña, 2012). These themes were interpreted and used to develop a series of survey instruments. Air transportation specialists residing in USAF organizations were the target participants for this research effort. This research and research procedures were reviewed and approved by an Institutional Review Board and the Air Force Survey Control Office. In the first study, 4 site visits and 23 semi-structured interviews were conducted and analyzed in order to develop an initial set of 62 items for organization safety climate and 76 items for group safety climate. In the second study, the safety climate scales were further reduced to 14 items for organizational safety climate and 10 items for group safety climate by analyzing the inter-item correlations and performing an exploratory factor analysis. Finally, a third study was conducted using confirmatory factor analysis and inter-item correlations to validate the proposed air transportation operations safety climate scales (Campbell & Fiske, 1959; Hinkin, 1998; Schwab, 1980). The OSC and GSC measurement scales were found to be valid and reliable in the previous studies.

OSC was measured by a second-order, four-factor, 15-item scale asking respondents to assess the extent to which they agree or disagree with statements concerning the OSC dimensions of management commitment to safety, safety policies

and procedures, safety training, and vehicles and equipment. The OSC items were intended to capture perceptions of safety related to organizational leadership. GSC was measured by a second-order, three-factor, 10-item scale asking respondents to assess the extent to which they agree or disagree with statements concerning the GSC dimensions of commitment and support, work pressure, and safety briefings. The GSC items were intended to capture perceptions of safety related to one's immediate work group. OCB was measured using a three-factor, 13-item scale developed by Podsakoff et al. (1997). This scale has been found reliable across a variety of industries with Cronbach α 's ranging from .67 to .96 (Deckop et al., 2003; Podsakoff et al., 1997; Robinson & Morrison, 1995). The OCB scale asked respondents to assess the extent to which they agree or disagree with statements concerning whether or not they engage in the OCB dimensions of helping behavior, civic virtue, and sportsmanship. Finally, self-reported operational performance was measured with a 7-item in-role performance scale developed by Williams and Anderson (1991) that has been found reliable across a variety of industries with Cronbach α 's ranging from .72 to .93 (Deckop et al., 2003; Hui & Law, 1999; Meyerson & Kline, 2008; Williams & Anderson, 1991). The operational performance scale asked respondents to assess the extent to which they agree or disagree with statements concerning how well they perform their assigned duties. All items were measured on a 7-point scale and can be found in Appendix B.1.

The Cronbach α 's for the included constructs ranged from .73 to .92, which was beyond the recommended level of .70 for general research (Nunnally & Bernstein, 1994). To investigate the presence of common method bias, Harmon's one-factor test was used (Podsakoff & Organ, 1986). This test resulted in ten factors accounting for 68% of the

variance, with the first factor accounting for 29.7%. No single factor emerged, and no factor accounted for most of the variance, which leads to the conclusion that common method bias was not a concern with this data (Podsakoff et al., 2003). Finally, a non-response bias test was conducted to compare the responses of early and late respondents and to compare the results of APS versus LRS respondents. For the early versus late respondents, groups were separated into those that responded to the first email versus those that responded to follow-up emails. A t-test analysis was used to determine if there were statistically significant differences between responses of the two groups. Results showed that there was a significant difference in responses to only three variables when comparing APS versus LRS responses (see Table 8). No statistically significant difference was found for any variable when comparing early versus late respondents. It was concluded that non-response bias was not a major concern in this study.

Table 8: Differences between APS versus LRS responses

Variable	Group	n	Mean	SD	<i>p</i> -value
OVE1	APS	241	4.27	1.64	0.001
	LRS	77	5.00	1.73	
OVE2	APS	241	4.84	1.80	0.001
	LRS	77	5.56	1.52	
GSB1	APS	241	6.10	0.99	0.015
	LRS	77	5.75	1.37	

3.5 Analysis and Results

A combination of SPSS and AMOS 18.0, using the maximum likelihood estimation method, was used for the analysis. A two-step procedure was used to test the proposed model, as recommended by Anderson and Gerbing (1988). First, a

confirmatory factor analysis (CFA) was conducted using the measurement model to assess construct and discriminant validity. Next, the structural model was used to test the proposed hypotheses

3.5.1 Measurement Model Results

To assess construct and discriminant validity, a CFA was performed using AMOS 18.0. The constructs representing OSC, GSC, OCBHB, OCBCV, OCBS, and OP were included in the CFA. The measurement model resulted in the following fit indices: χ^2 (1001.57, df = 642, p-value < .001); comparative fit index (CFI) (.95); incremental fit index (IFI) (.95); standardized root mean residual (SRMR) (.048); and root mean square error of approximation (RMSEA) (.042, 90% CI (.037, .047)). The fit indices indicate an adequate model fit with the exception of the χ^2 statistic (Hu & Bentler, 1999). Although a significant χ^2 statistic was obtained, the normed χ^2 statistic was 1.56 which fell well below the recommended maximum of 3.0 (Kline, 2011).

To test for convergent validity, factor loadings were assessed along with the average variance extracted (AVE) for each construct. Standardized factor loadings and AVEs are shown in Table 9. All items loaded onto their corresponding constructs with p < .001, and all but five variables had factor loadings exceeding the recommended 0.6 threshold recommended by Hair et al. (2010). The OCB sub-dimensions of helping behavior, civic virtue, and sportsmanship had two, one, and one item respectively that was below the threshold. Individual operational performance had one item that was significantly lower than the 0.60 threshold. The rule of thumb for using AVE to assess convergent validity is 0.5 which means that the variance explained by the construct is greater than what is due to measurement error (Hair et al., 2010). All constructs with the

exception of helping behavior, civic virtue, and sportsmanship had AVEs above the 0.50 threshold. Coincidentally, these represent the dimensions of OCB in this study. Helping behavior and sportsmanship fell just below the recommended level with AVEs of 0.48, and civic virtue had an AVE of 0.42. Due to these constructs having low AVEs and variables with factor loadings below the recommended 0.6 threshold, remedial measures were taken. Items HB1, HB3, CV3, and OCBS1 were subsequently removed from the analysis. Adjustments to these scales have had to be made in previous research due to significant cross loadings and Cronbach's α levels below the recommended threshold (Podsakoff et al., 1997). Removal of these variables resulted in AVEs above .5 for all constructs. The updated factor loadings and AVEs are shown in Table 10. These results provide evidence of convergent validity.

Discriminant validity was assessed by performing the Fornell and Larcker (1981) test. According to this test, discriminant validity is supported if the square root of a construct's AVE is greater than the correlations between that construct and other constructs used in the model. As shown in Table 11, all constructs passed this test, which provides evidence of discriminant validity. Internal consistency was examined using Cronbach's α . All constructs with the exception of civic virtue had alpha levels at or above the recommended minimum level of 0.70 (Nunnally & Bernstein, 1994). Civic virtue's alpha was just under the recommended level at 0.65. Results for the structural model follow.

Table 9: Results of CFA

Constructs and scale items	Factor loadings	Constructs and scale items	Factor loadings
Management commitment to safety (AVE = 0.60)		Safety briefings (AVE = 0.53)	
OMC1	0.65	GSB1	0.64
OMC2	0.79	GSB2	0.79
OMC3	0.87	GSB3	0.75
Safety policies and procedures (AVE = 0.57)		Helping behavior (AVE = 0.48)	
OSP1	0.81	HB1*	0.58
OSP2	0.76	HB2	0.72
OSP3	0.69	HB3*	0.57
Safety training (AVE = 0.64)		HB4	0.63
OT1	0.82	HB5	0.82
OT2	0.79	HB6	0.74
OT3	0.85	HB7	0.76
OT4	0.78	Civic Virtue (AVE = 0.42)	
OT5	0.83	CV1	0.79
OT6	0.73	CV2	0.60
Vehicles and equipment (AVE = 0.60)		CV3*	0.53
OVE1	0.71	Sportsmanship (AVE = 0.49)	
OVE2	0.58	OCBS1*	0.47
OVE3	0.98	OCBS2	0.71
Management commitment and coworker support (AVE = 0.60)		OCBS3	0.84
GMCS1	0.80	Individual operational performance (AVE = 0.54)	
GMCS2	0.79	IP1	0.54
GMCS3	0.79	IP2	0.87
GMCS4	0.74	IP3	0.89
Work pressure (AVE = 0.55)		IP4	0.88
GWP1	0.76	IP5	0.29
GWP2	0.75		
GWP3	0.72		

Notes: All t-values were significant with $p < .001$.

* indicates item was subsequently removed from the analysis

The OSC construct consists of management commitment to safety, safety policies and procedures, safety training, and vehicles and equipment. The GSC construct consists of management commitment and coworker support, work pressure, and safety briefings. The OCB construct consists of helping behavior, civic virtue, and sportsmanship.

Table 10: Results of CFA after HB1, HB3, CV3, and OCBS1 were removed

Constructs and scale items	Factor loadings	Constructs and scale items	Factor loadings
Management commitment to safety (AVE = 0.60)		Safety briefings (AVE = 0.53)	
OMC1	0.65	GSB1	0.64
OMC2	0.79	GSB2	0.79
OMC3	0.87	GSB3	0.75
Safety policies and procedures (AVE = 0.57)		Helping behavior (AVE = 0.55)	
OSP1	0.82	HB2	0.71
OSP2	0.76	HB4	0.63
OSP3	0.69	HB5	0.83
Safety training (AVE = 0.64)		HB6	0.75
OT1	0.82	HB7	0.76
OT2	0.79	Civic Virtue (AVE = 0.54)	
OT3	0.85	CV1	0.88
OT4	0.78	CV2	0.55
OT5	0.83	Sportsmanship (AVE = 0.61)	
OT6	0.73	OCBS2	0.72
Vehicles and equipment (AVE = 0.60)		OCBS3	0.84
OVE1	0.71	Individual operational performance (AVE = 0.54)	
OVE2	0.53	IP1	0.54
OVE3	0.98	IP2	0.87
Management commitment and coworker support (AVE = 0.60)		IP3	0.89
GMCS1	0.79	IP4	0.88
GMCS2	0.78	IP5	0.29
GMCS3	0.79		
GMCS4	0.74		
Work pressure (AVE = 0.56)			
GWP1	0.77		
GWP2	0.75		
GWP3	0.72		

Notes: All t-values were significant with $p < .001$.

The OSC construct consists of management commitment to safety, safety policies and procedures, safety training, and vehicles and equipment. The GSC construct consists of management commitment and coworker support, work pressure, and safety briefings. The OCB construct consists of helping behavior, civic virtue, and sportsmanship..

Table 11: Means, standard deviations, reliability, AVE, and correlations

Construct	Mean	SD	CA	AVE	OMC	OSP	OT	OVE	GMCS	GWP	GSB	OCBHB	OCBCV	OCBS	OP
OMC	5.77	1.14	0.81	0.60	0.77										
OSP	5.63	1.17	0.79	0.57	0.53†	0.75									
OT	5.29	1.28	0.92	0.64	0.48†	0.60†	0.80								
OVE	5.14	1.45	0.84	0.60	0.48†	0.48†	0.60†	0.77							
GMCS	6.04	0.90	0.88	0.60	0.40†	0.47†	0.59†	0.48†	0.77						
GWP	4.75	1.45	0.78	0.56	0.50†	0.31†	0.36†	0.30†	0.39†	0.75					
GSB	5.56	1.13	0.76	0.53	0.41†	0.44†	0.59†	0.39†	0.62†	0.29†	0.73				
OCBHB	6.20	0.64	0.85	0.55	0.34†	0.32†	0.39†	0.30†	0.44†	0.32†	0.41†	0.74			
OCBCV	5.87	0.91	0.65	0.54	0.27†	0.20†	0.30†	0.14*	0.26†	0.27†	0.35†	0.61†	0.73		
OCBS	4.89	1.20	0.76	0.61	0.20†	0.13*	0.24†	0.20†	0.21†	0.35†	0.10 ^{ns}	0.25†	0.11*	0.78	
OP	6.25	0.62	0.73	0.54	0.25†	0.23†	0.25†	0.22†	0.19†	0.20†	0.15**	0.40†	0.36†	0.17**	0.73

Notes: † $p < .001$; ** $p < .01$; * $p < .05$

Square root of AVE shown on diagonal

3.5.2 Structural Model Results

Next, all hypotheses were tested via structural equation modeling using the maximum likelihood method in Amos 18. Mediation hypotheses were evaluated using the bootstrap test of indirect effects as suggested by Zhao et al. (2010). This was accomplished using 5,000 re-samples with replacement using Shrout and Bolger's (2002) bias-corrected bootstrap method to determine the product of the mediation pathway with a 95% confidence interval. The structural model provided acceptable fit ($\chi^2 = 1158.319$; $df = 682$; normed $\chi^2 = 1.70$; $p < .001$; CFI = 0.93; IFI = 0.93; SRMR = .061; RMSEA = .047 with a 90% CI of (0.42, 0.52)) and was deemed acceptable for hypothesis testing. Both direct and mediated effects were predicted and tested between exogenous and endogenous variables. Results are presented in Table 12 and Figure 4.

H1a predicted a positive relationship between OSC and OCB. However, results of the model suggest OSC is not significantly related to OCB ($\gamma = -.35$, $z = .140$, $p = .77$), which leads to H1a being rejected. H1b predicted a positive relationship would exist between GSC and OCB, and this hypothesis was confirmed ($\beta = .453$, $z = .140$, $p = .001$). As expected, a statistically significant positive relationship was found between OSC and GSC ($\gamma = .761$, $z = .080$, $p < .001$), lending support to H1c. Although H1a was rejected, a significant indirect effect was found between OSC and OCB through the mediated effect of GSC ($\gamma = .345$, 95%CI (.105, .779), $p = .02$). According to Zhao et al. (2010), a significant indirect effect is all that is required to establish mediation. Thus, the path between OSC and OCB was fully mediated by GSC, and H1d was supported.

Hypotheses H2, H3a and H3b postulated that OCB would be positively related to OP and that OCB would partially mediate the relationships between the safety climate

constructs and OP. Specifically, H2 predicted that OCB would be positively related to OP. A significant positive effect was found between these two variables, lending support for the hypothesis ($\beta = .386$, $z = .07$, $p < .001$). Furthermore, H3a proposed that OCB would partially mediate the positive relationship between OSC and OP. However, Shrout and Bolger's (2002) bias-corrected bootstrap method resulted in a non-significant mediation path, leading to a rejection of H3a ($\gamma = -.019$, 95% CI $(-.268, .116)$, $p = .859$). Interestingly, a significant direct path was found between OSC and OP ($\gamma = .171$, $z = .074$, $p = .02$), and this may be an indication of missing variables in the model. For H3b, which proposed that OCB would partially mediate the positive relationship between GSC and OP, a significant mediated path was found ($\beta = .175$, 95%CI $(.052, .486)$, $p = .017$). However, the direct effect of GSC on OP was non-significant ($\beta = -.182$, $z = .094$, $p = .053$). This resulted in a fully mediated relationship between GSC and OP through OCB, lending partial support for H3b.

Table 12: Structural Equation Model Results

Structural path	Hypothesis	Effect	SE	t-value	p-value	LCL	UCL	Supported
OSC → OCB	H1a	-0.035	0.14	-0.3	0.77	---	---	No
GSC → OCB	H1b	0.453	0.14	3.18	0.001	---	---	Yes
OSC → GSC	H1c	0.761	0.08	9.48	0.001	---	---	Yes
OSC → GSC → OCB	H1d	0.345	0.241	---	0.02	0.105	0.779	Yes
OCB → OP	H2	0.386	0.07	5.76	0.001	---	---	Yes
OSC → OCB → OP	H3a	-0.019	0.186	---	0.859	-0.268	0.116	No
GSC → OCB → OP	H3b	0.175	0.225	---	0.017	0.052	0.486	Yes

Note: *Bootstrap upper and lower confidence intervals for the indirect effects



Figure 4. Final SEM model based on significant direct paths
 *** $p < .001$; $p < .05$; SMC = squared multiple correlation

3.6 Discussion

Typically, safety climate is studied solely in the realm of safety and safety outcomes. However, the purpose of this research was to expand the safety climate research horizons and investigate its effects on organizational citizenship behaviors and operational performance of air transportation operations personnel. Although researchers believe safety climate may compete with productivity and efficiency (Neal & Griffin, 2006; Zohar, 2010; Zohar & Luria, 2005), results of this study provide evidence that safety climate may be able to enhance operational performance of air transportation operations personnel. Organization-level safety climate was found to positively influence group-level safety climate, which in turn, positively influenced organizational citizenship behaviors. As expected, organizational citizenship behaviors positively influenced self-reported operational performance. And although no direct link was found between group-level safety climate and operational performance, a significant and positive indirect link was found between group safety climate and operational performance, which was mediated by organizational citizenship behaviors. Interestingly, organization-level safety climate was found to be positively related to operational performance. This

warrants further investigation, as this relationship may be further explained by other constructs such as a joint management system. Maybe just as important, no negative influence was found between safety climate and operational performance, which is contradictory to the widely-held belief that safety climate and operational performance may compete with each other (Neal & Griffin, 2006; Zohar, 2010; Zohar & Luria, 2005).

Although the results are promising, it was surprising that organization-level safety climate had no direct relationship with organizational citizenship behaviors. This may be due to the hierarchical structure of the organizations involved in this study. Group-level supervisors work alongside the employees on a daily basis, whereas organizational leaders have much less contact with the employees. This separation between employees and organizational leadership was mentioned in survey comments. Even so, organization-level safety climate explained 75% of the variance in group-level safety climate, which is evidence of its powerful overall effect. This could be due to the high-risk environment the participants of the study operate in. When mishaps can result in millions of dollars in damages or loss of life, group-level supervisors may not have a lot of variance in the way they interpret, implement, and execute the organization's safety policies and procedures. It would be interesting to investigate whether this strong a relationship is present in other industries where there is much less risk of injury or death. Overall, these results help advance the understanding of the relationship between safety and operational performance

3.6.1 Theoretical Implications

Results of this study show how organizational support theory can be used to explain the relationship between safety climate, organizational citizenship behaviors, and

operational performance. This research extends previous efforts of Lee et al. (2007), Michael et al. (2005), Podsakoff et al. (2000), and Somech and Drach-Zahavy (2004) by investigating the relationships between safety climate, organizational citizenship behaviors, and operational performance in one, concerted effort. At the organizational level, having leaders that place safety over mission accomplishment and are firmly committed to providing a safe working environment, provide adequate safety training to all employees, and ensure safe and well-maintained vehicles and equipment are always available may help enhance employees' perceived organizational support. Furthermore, at the group level, having direct supervisors and coworkers that always enforce safety rules and set expectations that everyone must always be safe regardless of the workload may also help increase perceived organizational support. The aforementioned aspects of organization and group-level safety climate lets the employees know that the organization genuinely cares about their well-being, and in turn, the employees may reciprocate by caring about the organization. Organizational support theory informs us that an increase in perceived organizational support can lead to the employee incorporating the organization into their social identity, thus motivating the employees to work harder in order to help the organization meet its objectives. Results of this research provide evidence of this through the relationship between safety climate and organizational citizenship behaviors.

Findings from this research also support Rhoades and Eisenberger's (2002) belief that organizational support theory can be used to explain how perceived organizational support leads to increased employee job performance. The organizational citizenship behavior dimensions of sportsmanship, civic virtue, and helping behavior were found to

be positively associated with self-reported operational performance of air transportation operations personnel in this study. Although there are multiple studies that link safety climate to organizational citizenship behaviors and organizational citizenship behaviors to operational performance outcomes, no such study has been found that simultaneously links all of these constructs together. Furthermore, no study has been found that investigates the relationship of multiple levels of safety climate with organizational citizenship behaviors. Results point to a “safety chain” in which the organization’s safety policies and procedures have a large direct impact on group-level safety climate which, in turn, influences employee citizenship behavior. As such, this research effort provides the first glimpse of how safety climate, through the lens of organizational support theory and the mediating effects of organizational citizenship behaviors, may actually enhance operational performance of employees in high-risk environments.

3.6.2 Managerial Implications

From a managerial standpoint, this research helps leaders and first-line supervisors understand how their actions with regard to creating a climate of safety can enhance employee operational performance. For organizational leaders, it is not enough to simply tell employees that you care about their safety. Employee perceptions of OSC are formed through what the employee experiences. Leaders must “walk-the-walk” and show through their actions that safety is more important than even mission accomplishment. If employees are punished for delaying an aircraft due to a safety concern, this would send a mixed signal to the employee and possibly lead to a lower level of OSC. Similarly, if organizational leadership fails to provide safe and appropriate vehicles or equipment, it could send a signal to the employees that safety is not a major

concern of the organization. Once again, this could lead to lower levels of OSC which, as this research has shown, could lead to lower levels of GSC. On the other hand, if employees believe organizational leaders are sincere in their commitment to safety, higher levels of OSC and GSC result, and this is associated with higher levels of OCBs and self-reported operational performance.

In similar fashion, first-line supervisors need to understand their daily actions influence GSC and impact OCB and self-reported operational performance as well. By enforcing all safety rules and correcting unsafe behaviors even when injury or an accident has not occurred, first-line supervisors send a signal to employees that they are truly committed to safety. But it is not only supervisors that can benefit from this research. It was shown that coworkers play an important role in creating GSC as well. When coworkers expect everyone to behave safely, when they ensure everyone uses the appropriate safety equipment for the job, and when they give impactful safety briefings to their workgroup, GSC is increased. Results of this research showed that GSC was directly related to OCBs and indirectly influenced self-reported operational behaviors. By understanding that their attitudes towards being safe have impacts far beyond safety outcomes, leaders at all levels can see just how valuable creating a climate of safety can be.

3.6.3 Limitations and Future Research

Some important limitations to this study and opportunities for future research must be addressed. First, this study only included USAF air transportation specialists and the generalizability of results could be in question. The tasks required of USAF air transportation specialists were identified and compared to the same occupation within the

US Air Reserve Component (Air National Guard and Air Force Reserve) and civilian air transportation operation companies, and these duties were found to be similar. Although USAF air transportation specialists may be a proxy for the air transportation operations industry, replication of this study in other industries should be undertaken in order to enhance the generalizability of the findings.

Further limitations to this research are the sole reliance on self-reported measures and the single method of data collection used. Common method bias and social desirability may be a concern because of this. To help address these potential limitations, an anonymous, web-based survey was chosen because research shows they may result in lower social desirability (Joinson, 1999). Next, a short form of Hart et al.'s (2015) BIDR-16 social desirability scale was used to detect potential social desirability. Specifically, the impression management subscale was used. The impression management subscale was modeled as a latent construct while letting the indicators of the OSC, GSC, OCB, and self-reported operational performance constructs to load onto it as well as their hypothesized constructs. There are three advantages to using this type of analysis: "1) allows measurement error in the factor to be estimated, 2) models the effects of the biasing factor on the measures themselves, and 3) does not constrain the effects of the methods factor on the individual measures to be equal" (Podsakoff et al., 2003; 893-894). No issues with social desirability were found with this analysis. Additionally, Harmon's one-factor test was conducted with results pointing to a single method of data collection being an acceptable risk (Podsakoff et al., 2003). Future research should incorporate objective performance data in the analysis to help triangulate results.

In addition to replicating this study in other industries, future research should be conducted to identify other variables, both mediators and moderators, that may play a role in the relationship between safety climate and operational performance.

Furthermore, the opportunity exists to simultaneously investigate the effect that safety climate its potential mediators/moderators have on both safety and operational performance to gain a more complete picture of the relationship between safety and operations.

In conclusion, the goal of this research was to investigate the effects of safety climate and OCBs on operational performance of air transportation operations personnel. It was found that safety climate did in fact influence OCBs, which in turn had a positive relationship with operational performance. These promising results may help debunk the often-viewed idea that safety climate is in competition with productivity and provide the impetus for more research in this area.

IV. The Moderating Effect of Employee Perceptions of a Joint Management System on Safety Climate and Performance

4.1 Introduction

Past researchers have argued that a basic tradeoff exists between safety performance and competing priorities, such as productivity (Janssens et al., 1995; Wallace & Chen, 2006). Researchers have also argued that this tradeoff may stem from a conflict between an organization's safety rules and procedures and its productivity and efficiency objectives (Zohar, 2010). These competing rules and objectives must be internalized by employees in order to determine which type of behaviors will get rewarded or supported in an organization. This gives rise to the concept of safety climate, which can be defined as the perceptions employees have of the importance their organization places on safety (Zohar, 2010; Zohar & Luria, 2005). Safety behaviors have a significant impact on safety performance and have been found to be significantly associated with actual safety mishaps (Griffin & Neal, 2000; Mearns et al., 2001; Mearns et al., 2003; Mearns et al., 2010). Perceptions of safety climate have been shown to be a robust predictor of safety behaviors (Zohar, 2010). Wallace and Chen (2006) argued that when employees hold perceptions of high levels of safety climate, they are less likely to be focused on accomplishing work objectives quickly and more focused on following the rules and regulations. This focus can lead to workers behaving more safely but hindering production performance. This coincides with Zohar and Luria's (2005) conclusion that a fundamental conflict exists between production speed and safety precautions.

Although some researchers believe there is a negative relationship between productivity and safety performance, few studies exist that examine this phenomenon. The lack of integrated research was first highlighted by Brown (1996) when she mentioned that despite workplace safety being a growing concern for operations managers, safety was practically non-existent in the operations literature. Brown (1996) called for researchers to include safety as a central theme in future operations management research. It is now more than twenty years later; however, safety and operational outcomes have still been largely examined in isolation of each other (Das et al., 2008, Pagell et al., 2014, Pagell et al., 2015). Even so, theoretical and empirical evidence does exist that shows safety performance and productivity can coexist in an organization in such a manner that safe organizations can be more productive than unsafe organizations (Pagell et al., 2014, Pagell et al., 2015, Tompa et al., 2016).

The idea that safe organizations can be more productive than unsafe organizations may especially hold true in high-risk industries in which safety mishaps could have catastrophic consequences. In these types of industries, organizational outcomes are increasingly dependent upon highly interdependent sets of tasks which are performed under conditions of uncertainty and time constraints (Gittell, 2006). One such high-risk industry in which safety and productivity may be able to coexist is the airline industry. A successful flight depends on the safe and effective coordination between multiple groups such as pilots, aircraft mechanics, ramp agents, and cargo handlers (Gittell, 2006). An operational or safety failure by any one of these stakeholders could lead to an aircraft delay, unsatisfied customers, or a flight mishap. For instance, the National Transportation Safety Board concluded that improperly secured cargo broke free from its

restraints during flight and caused the crash of a National Air Cargo, Inc.-operated Boeing 747-400 aircraft on April 29, 2013, killing seven crew members (NTSB, 2015). A lack of standardized cargo handling procedures and inadequate training for cargo loaders and cargo handling inspectors contributed to this tragedy (NTSB, 2015). As a result of the incident, National Air Cargo, Inc. was fined \$77,000 by the Federal Aviation Administration and ordered by a jury to pay more than \$115 million to the families of deceased crew members (Bilyk, 2017; Page, 2015). Furthermore, the company filed for bankruptcy protection in October 2014 (Air Cargo News, 2014). It is not a far reach to conclude that if the cargo were safely loaded onto the aircraft, the aircraft might have successfully performed its operational mission and averted a great tragedy. Results of the aforementioned situations suggest that the long-held belief of safety and productivity being incongruent may be inaccurate. Rather, safety and productivity in high-risk organizations may in fact be complementary and dependent upon an organizational culture that is simultaneously supportive of both safety and operational performance. Specifically, when these high-risk industries are characterized by multiple groups with interdependent tasks, the existence of a joint management system (JMS) may hold the key to simultaneously achieving safe and effective operations. This is because a JMS is a system that simultaneously measures, controls, and continuously improves both safety and operations (Pagell et al., 2015). Whereas safety climate survey measure employee perceptions of the importance an organization places on safety versus competing factors such as productivity, safety climate surveys do not capture the relative importance an organization places on safety versus production. However, the perceptions of the

presence of a JMS could indicate whether an employee believes a balance exists between safety and productivity in an organization.

Therefore, through the lens of relational coordination theory, this research seeks to evaluate the influence of a JMS on both safety and operational performance.

Specifically, we investigate the moderating effect of a JMS on the relationship between employee perceptions of safety climate, their safety behaviors, and individual operational performance. The current study adds to the body of knowledge in multiple ways. First, previous JMS research relied on safety and operational managers' opinions on whether or not a JMS existed in the organization. Using employees' perceptions of whether or not a JMS exists has yet to be studied. Pagell et al. (2015) state that the only way to truly assess if a JMS exists would be to collect data from the operational workers themselves. After all, it has been found that employee perceptions of the environment, rather than the environment itself, is what affects behavioral responses (James & Jones, 1974; James et al., 1978). Next, Pagell et al. (2015) have called for future JMS research to incorporate leading indicators of safety due to incident data being incomplete and lagging. Lagging indicators are reactionary in nature and, therefore, can be a poor gauge of prevention. Leading indicators, on the other hand, are measures that precede or indicate a future event. Safety climate has been found to be a robust predictor of safety incidents across a wide variety of industries and is a strong leading indicator of safety behavior and performance (Barling et al., 2002; Fogarty & Shaw, 2010; Griffin & Neal, 2000; Huang et al., 2007; Kelloway et al., 2006; Zohar, 2000; Zohar, 2002). Utilizing safety climate in JMS research can help shed light on the importance of JMS in regards to preventing adverse safety behaviors and simultaneously improving operational performance. This

study will also extend safety climate theory, in that some theorists still purport a tradeoff between safety and operational performance (Zohar, 2010). This study proposes that when safety and operational objectives are given equal importance through the use of a JMS, the safety-productivity tradeoff can be balanced.

4.2 Conceptual Background

4.2.1 Safety Climate and Safety Behaviors

Safety climate has been shown to be a robust predictor of safety outcomes across a wide variety of industries (Zohar, 2010). Safety climate theory has been developed and refined over the last 37 years and posits that employees, through the daily interactions and social exchanges with leadership and managers, can gain a sense of the importance the organization places on safety behaviors over other factors (Williams, Garver, & Stephen Taylor, 2011). For instance, Kath et al. (2010) state that perceived management attitudes about safety, a key component of safety climate, can be considered a signal to employees that safe behaviors at work are an obligation and an employee citizenship behavior. Therefore, if the worker feels supported and cared for by the organization, he or she may feel obliged to reciprocate by behaving safely. In other words, when an employee feels the organization places a high value on safety, a higher safety climate is achieved. This higher safety climate results in safer behavior and a decrease in safety incidents (Barling, et al., 2002; Fogarty & Shaw, 2010; Griffin & Neal, 2000; Huang et al., 2007; Kelloway et al., 2006; Zacharatos et al, 2005; Zohar, 2002; Zohar, 2003; Zohar & Luria, 2005; Zohar et al., 2014).

One of the more important refinements to safety climate theory came from Zohar (2000) when he empirically tested a group-level model of safety climate, a model that was distinct from the organization-level safety climate model. This model measured perceptions of supervisory safety practices in work groups instead of the enforced company policies and procedures found at the organization-level. Results from this study supported the predictive validity of the new group-level safety climate measure, as the safety climate perceptions significantly predicted accident records during a 5-month follow-on period. Zohar combined the group-level and organization-level safety climate constructs into an overarching multi-level safety climate model to depict that enforced safety policies and supervisory safety practices simultaneously effect safety climate at the organization and group level, which in turn influences safety behaviors and safety outcomes (Zohar, 2003). More recently, Huang et al. (2013) developed a multi-level safety climate scale for truck drivers and found that organization and group-level safety climate were both significantly related to self-reported driving safety behaviors and actual injuries. In the multi-level safety climate framework, top managers in the organization develop safety policies and procedures to achieve strategic objectives, and lower level supervisors are tasked with interpreting, implementing, and executing these safety procedures. Since group-level supervisors are bound by the organization-level safety policies and procedures, it is expected that organization-level safety climate will be positively related to group-level safety climate (Zohar & Luria, 2005). Based on the above discussion, the following relationships are hypothesized between organization and group-level safety climate and safety behaviors.

H1a. *Organizational-level safety climate is positively related to group-level safety climate.*

H1b. *Organizational-level safety climate is positively related to safety behaviors.*

H1c. *Group-level safety climate is positively related to safety behaviors.*

H1d. *Group-level safety climate will mediate the positive relationship between organization-level safety climate and safety behaviors.*

4.2.2 Safety Climate and Individual Operational Performance

Although investigating the link between safety and operational performance is in its relative infancy, several theories have been used in recent literature to help explain the possible relationship between safety and productivity, namely social exchange theory, organizational support theory, and cognitive dissonance theory. Michael et al. (2005) used social exchange theory and organizational support theory to link perceptions of management commitment to safety to individual employee performance in the wood manufacturing industry. Michael et al. (2005) argued that employees will display positive behaviors such as improved performance in order to reciprocate the favorable treatment they receive from their employers. The idea of reciprocity is a central theme to both social exchange and organizational support theory. Social exchange theory describes the employee/employer relationship as a series of ongoing exchanges in which employees trade effort and loyalty for benefits such as a safe work environment (Williams et al., 2011). Organizational support theory extends this relationship to say that employees use these social exchanges to form opinions on how much the employer values their contributions and well-being (Michael et al., 2005). Michael et al. (2005) further state that these opinions are used to form an employee attitude called perceived

organizational support (POS), and that increases in POS motivate employees to work harder. Thus, when the organization values the safety of an employee, the employee is driven to work harder for the organization which can lead to increased performance. To test this relationship, Michael et al. (2005) surveyed 641 employees at three wood product manufacturing facilities to determine if there was a relationship between management commitment to safety and non-safety related outcomes such as job-related performance. To assess performance, supervisors rated each of their subordinates on a number of performance measures such as “This employee completes all assigned duties”. Overall, the authors found that management commitment to safety and job-related performance were positively related.

Das et al. (2008) used cognitive dissonance theory to explain the relationship between safety and quality, which is an important indicator of operational performance. More specifically, the authors assessed the relationship between safety disconnect and quality. Safety disconnect is defined by Das et al. (2008) as the difference in manager and worker perceptions regarding safety, and the authors note that disconnects, in general, have been associated with performance outcomes in numerous studies. Cognitive dissonance is the state of having inconsistent thoughts or opinions which result in an uncomfortable motivating feeling (Festinger, 1962). These uncomfortable feelings will push individuals to act in ways to reduce the disconnect. Das et al. (2008) believed employees would choose to ignore the managerial opinion and act on their own due to having a high stake in ensuring their own safety. The authors further explained that when the safety disconnect is large, employees do not feel safe and they feel management is not addressing safety concerns. This in turn leads to an employee losing motivation to be

involved in quality improvement activities and may result in lower worker effectiveness and quality of work. This research sheds light on how disconnects between employee and managerial perceptions of safety can influence quality outcomes. To test their hypotheses, Das et al. (2008) surveyed 144 workers from 19 manufacturing firms across the U.S. to test whether or not safety disconnects were related to the quality outcomes of scrap/rework and reliability/durability. The authors found a significant negative relationship between safety disconnect and both quality indicators. Based upon the above discussion, the following hypotheses are proposed:

H2a. *Organizational-level safety climate is positively related to individual operational performance.*

H2b. *Group-level safety climate is positively related to individual operational performance.*

H2c. *Group-level safety climate will mediate the positive relationship between organization-level safety climate and individual operational performance.*

4.2.3 Moderating Effects of a Joint Management System

JMS is linked in previous research to safety and operational performance, but its interaction effect with the relationship between safety climate and both safety behaviors and individual operational performance is currently unknown. The theory of relational coordination (Gittell, 2002) provides the framework for understanding how a JMS can amplify safety climate's effect on safety behaviors and individual operational performance. This theory is centered on the belief that effective coordination occurs through relational and communication ties between workers with interdependent tasks, and that shared goals, shared knowledge, and mutual respect underlie the effective

coordination of work (Gittell, 2002). In organizations where a JMS is present, employees work towards interdependent safety and operational goals rather than trying to optimize their own functional silos. One of the main characteristics of a JMS is that safety and operational objectives are managed as an integrated process with no tension between the two, and this should lead to safe behaviors and effective operations. Organizations with a high safety climate are characterized by having managers and coworkers that are committed to safety. The managers do not subjugate safety to mission accomplishment, regardless of whether or not the workers are behind schedule. Therefore, the expected outcomes on safety behaviors and operational performance for organizations with a high safety climate should be strengthened when that organization also has a JMS.

Shared knowledge is also a necessary condition for effective coordination to occur (Gittell, 2006). Shared knowledge enables employees to understand how their tasks interrelate with the entire production system and how the safety rules and procedures can help enhance organizational outcomes. In organizations with a JMS, safety and operational knowledge are shared freely and both treated as knowledge of the production system (Pagell et al., 2015). Each employee understands the overall work process and how their actions, with regard to safety and operations, can have an impact on employees in other functions. In organizations with a high safety climate, employees should have a thorough knowledge of applicable safety policies and procedures, the employees receive comprehensive training on the vehicles and/or equipment they use to perform their jobs, and safety communication (i.e., safety briefings) occurs between the employees. Consequently, the effects of these characteristics on safety behaviors and individual operational performance should be enhanced in the presence of a JMS.

Finally, mutual respect plays an important role in relational coordination theory because status boundaries can pose a threat to effective performance (Gittell, 2006). Gittell (2006) mentions that when members of different workgroups or occupations feel that they are more important or better than those of other workgroups or occupations, divisive relationships can form where coordination can be undermined. Workgroups may focus on local optimization rather than the operational performance of the entire organization. Pagell et al. (2015) explain that when a JMS is present, employees communicate more effectively with each other regardless of their status, and that mutual respect also means employees are less likely to take shortcuts to avoid causing instability in the production system. When an organization has a high safety climate, employees work safely even when they may be behind schedule. Mutual respect is shown because supervisors and coworkers do not put added pressure on the employee to rush through his or her job. Furthermore, supervisors and coworkers expect everyone to work safely and correct any and all unsafe behavior regardless of status or position in the organization. In an organization in which a high JMS is present, the beneficial effects of a high safety climate should be strengthened. Therefore, the following hypotheses are proposed:

H3a. JMS will moderate the relationship between organization-level safety climate and safety behaviors (i.e., stronger positive relationship under high JMS).

H3b. JMS will moderate the relationship between group-level safety climate and safety behaviors (i.e., stronger positive relationship under high JMS).

H4a. JMS will moderate the relationship between organization-level safety climate and individual operational performance (i.e., stronger positive relationship under high JMS).

H4b. JMS will moderate the relationship between group-level safety climate and individual operational performance (i.e., stronger positive relationship under high JMS).

The conceptual model for this research is shown in Figure 5.

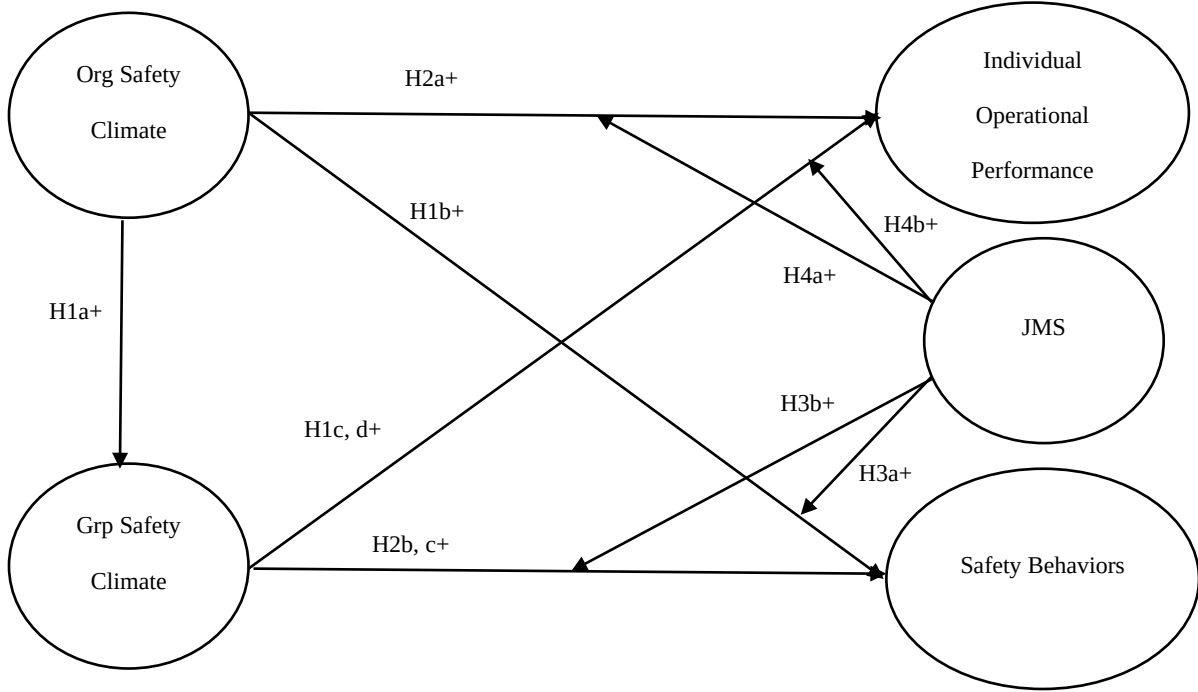


Figure 5. Proposed theoretical model

4.3 Methodology

4.3.1 Data Collection

This research was conducted using survey data collected from air transportation specialists assigned to 22 United States Air Force (USAF) organizations. These organizations consisted of eight continental and six overseas USAF aerial port squadrons (APS) as well as eight continental USAF logistics readiness squadrons (LRS) in which air transportation specialists are assigned. A list of current USAF APS's was provided by the sponsor of the research, the USAF Air Mobility Command director of logistics (AMC/A4). A total of 16 USAF APS's were identified and invited to participate in the research. Each USAF APS commander was contacted via telephone and email to

communicate the nature of the research and gain approval. Approval was obtained from 14 commanders. The commanders of the remaining two organizations did not respond to the request; therefore, those organizations were not included in the research. To obtain a list of USAF LRS's to include in the research, the logistics support branch of the USAF Installation and Mission Support Center (IMSC) was contacted. The USAF IMSC provided a list of eight USAF LRS's to include in the research. These organizations were selected due to them having at least five air transportation specialists assigned. Each of the organization's commanders was contacted via telephone and email to gain approval for their personnel to participate in the research, and all commanders agreed to let their personnel participate.

All 2,456 air transportation specialists assigned to the 22 USAF organizations previously mentioned were invited to participate in this survey on a voluntary and confidential basis. Each individual was sent an introductory email explaining the research followed up with an official survey invitation email that included a web link to the online survey. A reminder email was sent out one week after the official survey invitation, and a final reminder email was sent one week later in accordance with accepted survey protocol (Fink, 2012; Neuman, 2011; Salant & Dillman, 1994). No individual identifiers were collected for this study. The average time of completion of the survey was approximately 21 minutes. Furthermore, each respondent had the opportunity to be entered into a drawing for a \$50 gift card upon completion of the survey.

Completed surveys were received from 340 air transportation specialists for a response rate of 13.8%; however, 22 responses were deemed unengaged respondents and

deleted. The unengaged respondents were identified due to answering all Likert questions as a “7”. No issues were found with missing responses in this study. This resulted in a final sample of 318 responses (a 13% response rate). To assess the characteristics of the sample relative to the population of air transportation specialists in the USAF, a comparison was made with regards to rank and age distribution (see Table 13). Results of a one sample proportion test showed that the sample was overrepresented by air transportation specialists in the non-commissioned officer (NCO) ranks of E-5 through E-6 and underrepresented in the Airman (Amn) ranks of E-1 through E-4. One reason for these results may be the fact that the air transportation specialist technical school was not included in the survey sample. All new air transportation specialist Amn attend this technical school, and it consists primarily of personnel in the Amn ranks. This organization was not included because it was not an operational organization. Because of the differences between the sample and population, caution must be taken when generalizing the findings of this study beyond the current sample.

Table 13: USAF air transportation specialist sample and population comparison

	Population	Sample
#	4530	318
Age	27.6	29.0
SD	6.4	6.2
	Population	Sample
E-1	0.6%	0.8%
E-2	3.1%	1.7%
E-3	24.7%	14.7%
E-4	22.9%	20.1%
E-5	25.6%	30.5%
E-6	13.8%	22.2%
E-7	7.4%	9.2%
E-8	1.3%	0.8%
E-9	0.7%	0.0%

4.3.2 Variables

To determine the role JMS plays with regard to safety climate's effect on safety behaviors and individual operational performance, the following constructs were included in this research: organization-level safety climate (OSC), group-level safety climate (GSC), JMS, self-reported safety behaviors, and self-reported operational performance. To measure OSC and GSC, air transportation operations-specific measurement scales recently developed and validated by the researcher were used.

OSC was measured by a second-order, four-factor, 15-item scale that specifically measured the organization-level safety climate dimensions of management commitment to safety, safety policies and procedures, safety training, and vehicles and equipment. OSC measurement items were intended to capture perceptions of safety related to organizational leadership. GSC was measured by a second-order, three-factor, 10-item scale that assessed the extent to which air transportation specialists agreed or disagreed

with statements concerning the GSC dimensions of commitment and support, work pressure, and safety briefings. GSC measurement items were intended to capture perceptions of safety related to one's immediate work group supervisor. Both OSC and GSC were measured on a 7-point scale and can be found in Appendix C.1.

Self-reported operational performance was measured using five items from Williams and Anderson's (1991) in-role performance scale. This scale has previously been used in a variety of industries with Cronbach's α ranging from .72 to .93 (Deckop et al., 2003; Hui & Law, 1999; Meyerson & Kline, 2008; Williams & Anderson, 1991). This measurement scale asked respondents to assess the extent to which they agreed or disagreed with statements concerning how well they perform their assigned duties. Sample items include "I fulfill responsibilities specified in my job description" and "I meet formal performance requirements of the job." The construct self-reported safety behaviors was measured using a 5-item scale intended to assess behavioral patterns that involve breaking rules and taking chances in core activities (Mearns et al., 2010). These behaviors have been demonstrated to be significantly associated with safety violations and actual accident involvement at the individual and workgroup level (Mearns et al., 2001; Mearns et al., 2003). Therefore, safety behaviors is used a surrogate for safety performance in this study. As was found with the operational performance scale, the safety behavior scale has been found to be reliable across many different industries with a Cronbach's α ranging from .74 to .86 (Mearns et al., 2003; Mearns et al., 2010; Rundmo, 1996; Rundmo, 2000). A sample item from this scale includes "I get the job done better by ignoring some rules." Both operational and safety performance were measured on a

7-point scale, and a complete list of the measurement items can be found in Appendix C.1.

Finally, JMS was measured using Tompa et al.'s (2016) four-factor, 13-item JMS scale. Tompa et al.'s (2016) scale was based on Pagell et al.'s (2015) JMS scale and was intended to be administered to an organization's operations manager and safety manager. The intent of the current research was to assess employee perceptions of the existence of a JMS; therefore, Dr. Mark Pagell reviewed each JMS scale item prior to it being used. This resulted in a five-factor, 15-item JMS scale with the factors consisting of process focus, monitoring of operations, monitoring of safety, design of work/hazard control, and frequency of communication of safety. These factors previously resulted in Cronbach's α ranging from .76 to .96 (Tompa et al., 2016). An exploratory factor analysis (EFA) using principal axis factoring with direct oblimin rotation was performed to assess the dimensionality of the JMS construct since this is the first time JMS has been assessed at the employee level. This resulted in a two-factor, 12-item JMS scale with the factors consisting of process focus and monitoring/hazard control/communication. Results of the EFA are shown in Table 14. The JMS items were measured using a 7-point scale and can be found in Appendix C.1. Next, a cluster analysis was performed to identify the degree to which individuals perceived their organization had a JMS. Overall JMS scores were standardized and then centroid-based clustering with a k-means algorithm was performed in SPSS (Hair et al., 2010). To determine the appropriate number of clusters for the analysis, silhouette distance metrics were compared (Everitt et al., 2001). Silhouette distances range from -1, indicating a very poor model, to 1, indicating an excellent model. A silhouette distance metric of 0.5 or above indicates reasonable partitioning of

the data (Kaufman & Rousseeuw, 1990). The silhouette distance metric declined from .68, to .52, to .24 as the number of clusters increased from two to four. Thus, a two-cluster solution was justified with individuals having either a high (219) or low (99) perception of the existence of a JMS.

Internal reliability of the scales was assessed using Cronbach's α , and scores ranged from .73 to .92 (shown in Table 16), which is beyond the recommended level of 0.70 for general research (Nunnally & Bernstein, 1994). To investigate the presence of common method bias, Harmon's one-factor test was used (Podsakoff & Organ, 1986). This test resulted in nine factors accounting for 68.3% of the variance, with the first factor accounting for 36.0%. No single factor emerged, and no factor accounted for most of the variance, which leads to the conclusion that common method bias was not a major concern with this data (Podsakoff et al., 2003). Finally, a non-response bias test was conducted to compare the responses of early and late respondents and to compare the results of APS versus LRS respondents. For the early versus late respondents, groups were separated into those that responded to the first email versus those that responded to follow-up emails. An independent t-test analysis, with the type I error rate for analysis set to 0.50, was used to determine if there were statistically significant differences between responses of the two groups. Results showed that there was a significant difference in responses to only one out of 50 items (JMSHC1, $p = .017$) for early versus late respondents. When comparing APS responses to LRS responses, a significant difference was found for five out of 50 items (GSB1, $p = .015$; OVE1, $p = .001$; OVE2, $p = .001$; SB4, $p = .019$; SB5, $p = .007$). Based on the above results, it was concluded that non-response bias was not a significant concern in this study.

Table 14: EFA results for JMS

	Factor	
	F1	F2
F1: Process focus (CA = 0.76)		
JMSPF1	-	0.61
JMSPF2	-	0.50
JMSPF3	-	0.56
JMSPF4	-	0.76
F2: Monitoring, hazard control and communication (CA = 0.93)		
JMSHC1	0.54	-
JMSHC2	0.79	-
JMSHC3	0.78	-
JMSHC4	0.85	-
JMSHC5	0.91	-
JMSHC6	0.77	-
JMSHC7	0.75	-
JMSHC8	0.77	-
Eigenvalues	6.69	1.30
Percentage Variance	55.77	10.87
Cumulative Variance	55.77	66.64

Note: Numbers in boldface indicate dominant factor loadings.

4.4 Analysis and Results

A combination of SPSS and AMOS 18.0, using the maximum likelihood estimation method, was used for the analysis. The type I error rate for analyses was set to 0.05 for this research. Anderson and Gerbing's (1988) two-step procedure was used to test the proposed model. A confirmatory factor analysis (CFA) was performed first to assess convergent and discriminant validity. Next, the structural model was analyzed to test the proposed hypotheses.

4.4.1 Measurement Model Results

To assess convergent and discriminant validity, a CFA was performed using AMOS 18.0. The constructs representing OSC, GSC, IP and SB were included in the CFA. The measurement model resulted in the following fit indices: χ^2 (1047.86, df = 543, p -value < .001); comparative fit index (CFI) (.93); incremental fit index (IFI) (.93); standardized root mean residual (SRMR) (.06); and root mean square error of approximation (RMSEA) (.054, 90% CI (.049, .059)). The fit indices indicate an adequate model fit with the exception of the χ^2 statistic (Hu & Bentler, 1999). Although a significant χ^2 statistic was obtained, the normed χ^2 statistic was 1.93 which fell well below the recommended maximum of 3.0 (Kline, 2011).

To test for convergent validity, factor loadings were assessed along with the average variance extracted (AVE) for each construct. Standardized factor loadings and AVEs are shown in Table 15. All items loaded onto their corresponding constructs with $p < .001$, and all but two variables had factor loadings exceeding the recommended 0.6 threshold recommended by Hair et al. (2010). Individual performance had two items out of five that were significantly lower than the 0.60 threshold (OP1 & OP5). No remedial measures were taken for these items. The rule of thumb for using AVE to assess convergent validity is 0.5 which means that the variance explained by the construct is greater than what is due to measurement error (Hair et al., 2010). All constructs had AVEs above the 0.50 threshold. Results of the above analyses provide evidence that convergent validity was achieved.

Discriminant validity was assessed by performing the Fornell and Larcker (1981) test. According to this test, discriminant validity is supported if the square root of a

construct's AVE is greater than the correlations between that construct and other constructs used in the model. As shown in Table 16, all constructs passed this test, which provides evidence of discriminant validity. In conclusion, the measurement model results give sufficient support to allow for the evaluation of the structural model and detailed hypotheses testing.

Table 15: Results of CFA

Constructs and scale items	Factor loadings	Construct and scale items	Factor loadings
Management commitment to safety (AVE = 0.61)		Work pressure (AVE = 0.56)	
OMC1	0.66	GWP1	0.79
OMC2	0.78	GWP2	0.73
OMC3*	0.88	GWP3*	0.72
Safety policies and procedures (AVE = 0.57)		Safety briefings (AVE = 0.53)	
OSP1	0.80	GSB1	0.62
OSP2	0.76	GSB2	0.78
OSP3*	0.71	GSB3*	0.77
Safety training (AVE = 0.67)		Operational performance (AVE = 0.54)	
OT1	0.90	OP1*	0.54
OT2	0.88	OP2	0.88
OT3*	0.82	OP3	0.89
OT4	0.74	OP4	0.87
OT5	0.84	OP5	0.29
OT6	0.72	Safety behaviors (AVE = 0.66)	
Vehicles and equipment (AVE = 0.63)		SB1*	0.76
OVE1	0.80	SB2	0.79
OVE2	0.70	SB3	0.86
OVE3*	0.87	SB4	0.87
Management commitment and coworker support (AVE = 0.61)		SB5	0.76
GMCS1	0.80		
GMCS2	0.79		
GMCS3*	0.78		
GMCS4	0.74		

Notes: All t-values were significant at the $p < .001$ level

* indicates item was fixed to 1 to set the scale

Table 16: Means, standard deviations, reliability, AVE, and correlations

Construct	Mean	SD	CA	AVE	OMC	OSP	OT	OVE	GMCS	GWP	GSB	OP	SB
OMC	5.77	1.14	0.81	0.61	0.78								
OSP	5.63	1.17	0.79	0.57	0.53	0.75							
OT	5.29	1.28	0.92	0.67	0.48	0.6	0.82						
OVE	5.14	1.45	0.84	0.63	0.48	0.48	0.6	0.79					
GMCS	6.04	0.90	0.89	0.61	0.4	0.47	0.59	0.48	0.78				
GWP	4.76	1.45	0.78	0.56	0.5	0.31	0.36	0.3	0.39	0.75			
GSB	5.56	1.13	0.76	0.53	0.41	0.44	0.59	0.39	0.62	0.29	0.73		
OP	6.25	0.62	0.73	0.54	0.25	0.23	0.25	0.22	0.19	0.2	0.15**	0.73	
SB	5.58	1.22	0.90	0.66	0.4	0.52	0.38	0.37	0.46	0.41	0.35	0.16**	0.81

Notes: $p < .001$ level unless otherwise noted; ** = $p < .01$
square root of AVE shown on diagonal

4.4.2 Structural Model Results

All hypotheses were tested via structural equation modeling using the maximum likelihood method in Amos 18. Mediation hypotheses were evaluated using the bootstrap test of indirect effects as suggested by Zhao et al. (2010). This was accomplished using 5,000 re-samples with replacement using Shrout and Bolger's (2002) bias-corrected bootstrap method to determine the product of the mediation pathway with a 95% confidence interval. Moderation hypotheses were evaluated using Baron and Kenny's (1986) multi-group analysis method in AMOS 18 using the high and low JMS clusters as groups. The structural model presented in Figure 6 provided an overall acceptable fit ($\chi^2 = 998.894$; $df = 546$; $p < .001$; CFI = 0.93; IFI = 0.93; SRMR = .06; RMSEA = .051 with a 90% CI of (0.46, 0.56)). Although a significant χ^2 statistic was obtained, the normed χ^2 statistic was 1.829 which fell below Kline's (2011) recommended maximum level of 3.0. Thus the structural model results were deemed acceptable for hypothesis testing. Results of the hypotheses tests follow and are presented in Tables 17 and 18.

As expected, OSC was significantly related to GSC ($\gamma = .811, z = .086, p < .001$), lending support for H1a. H1b predicted a positive relationship between OSC and safety behaviors. However, results of the model suggest the direct path between OSC and SB is not significant ($\gamma = .386, z = .247, p = .118$), which leads to H1b being rejected. H1c predicted a positive relationship would exist between GSC and safety behaviors, and this hypothesis was supported ($\beta = 1.037, z = .122, p < .001$). It was posited that GSC would mediate the positive relationship between OSC and safety behavior. Although no direct relationship was found between OSC and safety behavior, it was still possible that GSC could fully mediate the relationship between OSC and safety behaviors. According to Zhao et al. (2010), a significant indirect effect is all that is needed to establish mediation. Results of the mediation analysis provided support for H1d, which stated that GSC fully mediates the relationship between OSC and safety behaviors (.807 [.624, 1.154], $p < 0.001$). Although it was hypothesized that GSC would partially mediate the relationship between OSC and safety behaviors, the analysis showed a fully mediated relationship. This fully mediated relationship is similar to results found in previous safety climate research (Zohar & Luria, 2005).

Hypotheses H2a and H2b postulated that OSC and GSC would be positively related to operational performance. The data did not support H2a as OSC was not significantly related to operational performance ($\gamma = .273, z = .145, p < .059$). Conversely, the data did support the theoretical assertion that higher levels of GSC are related to higher levels of operational performance ($\beta = .287, z = .052, p < .001$). To test for the mediated path as hypothesized by H2c, Shrout and Bolger's (2002) bias-corrected bootstrap method was once again performed. This hypothesis was supported as a

statistically significant indirect path was found from OSC to operational performance (.223 [.136, .387], $p < 0.001$). Once again, GSC fully mediated this relationship.

Although H1b, H1c, H2b, and H2c were supported, it is not clear whether these hypotheses hold for different levels of JMS. Specifically, would these relationships hold true for individuals that have high versus low perceptions of the existence of a JMS?

Table 17: Structural Equation Model Results

Structural path	Hypothesis	Effect	SE	<i>p</i> -value	LCL	UCL	Supported
OSC → GSC	H1a	0.811	0.086	0.001	---	---	Yes
OSC → SB	H1b	0.273	0.247	0.118	---	---	No
GSC → SB	H1c	1.037	0.122	0.001	---	---	Yes
OSC → GSC → SB*	H1d	0.841	0.133	0.001	0.624	1.154	Yes
OSC → OP	H2a	0.273	0.145	0.059	---	---	No
GSC → OP	H2b	0.287	0.052	0.001	---	---	Yes
OSC → GSC → OP*	H2c	0.232	0.061	0.001	0.136	0.387	Yes

Note: Bootstrap upper and lower confidence intervals for the indirect effects; * paths were fully mediated

Prior to performing a multi-group analysis, it is necessary to establish configural and metric invariance (Goldsby et al., 2013; Vandenberg & Lance, 2000). This is to ensure that any findings are due to attitudinal differences versus different psychometric responses (Cheung & Rensvold, 2002). Configural invariance is demonstrated through performing a multi-group confirmatory factor analysis (MGCFA). Resultant models from the MGCFA with data split according to JMS group preserved an adequate fit for the data ($\chi^2 = 1800.231$; $df = 1088$; $p < .001$; CFI = 0.88; IFI = 0.88; SRMR = .071; RMSEA = .046 with a 90% CI of (0.42, 0.49)). Evidence of configural invariance was achieved. Metric invariance is demonstrated by performing a χ^2 test between a fully unconstrained model and a model that constrains factor loadings on the constructs to be equal. Metric invariance is achieved if there is no significant difference in the χ^2 test

between the two models. If a significant difference is found between the χ^2 tests, it is an indication that there are differences between the factor loadings for the different groups. The χ^2 (1805.083; df = 1094) of the unconstrained baseline model was significantly different than the χ^2 (1883.384; df = 1120) of the model with constrained factor loadings ($p < .001$) suggesting the estimated parameters are not invariant across the two groups. However, a χ^2 test was then performed constraining one parameter at a time to identify which factor loadings were not invariant. Results indicated that a total of six factor loadings out of 35 were not invariant across the groups (OVE2, GMCS1, GSB3, SB1, OP4, and OP5). Furthermore, every construct had at least one item that was invariant across groups. Thus, partial invariance was established and moderation analysis can proceed because one or more items from each latent construct is metrically invariant (Byrne et al., 1989).

It was hypothesized that the relationship between OSC and safety behaviors would be stronger when employees' perceptions of the existence of a JMS were high (H3a). It was also hypothesized that the relationship between GSC and safety behaviors would be moderated by perceptions of a JMS (H3b). It was posited that the perception of the existence of a JMS would also moderate the relationship between OSC and operational performance (H4a). Finally, H4b hypothesized that the relationship between GSC and operational performance would be moderated by the perception of the existence of a JMS. Since no direct relationship was found between OSC and safety behaviors or operational performance, H3a and H4a were rejected (Baron & Kenny, 1986). To test H3b and H4b, a multi-group analysis was performed. An unconstrained base model was first formed, and then equality constraints were imposed to determine whether

constraining the path coefficients to be equal across the moderator subgroups would have a statistically significant impact on model fit (Jaccard & Wan, 1996; Jöreskog & Sörbom, 1996). A moderation effect is present if there is a significant difference in χ^2 .

The results of the moderation analysis are presented in Table 18. Although the path coefficients differ across JMS groups for GSC to safety behaviors (low JMS: $\beta = .743$, $z = .271$, $p = .006$; high JMS: $\beta = 1.117$, $z = .210$, $p = .001$), there was no significant difference in χ^2 across the groups ($\Delta\chi^2(1) = .954$, $p = .329$). Thus, no moderation effect was found and H3b was rejected. Conversely, the relationship between GSC and operational performance was found to be dependent upon the JMS group ($\Delta\chi^2(1) = 9.103$, $p = .003$). These results indicate that GSC is positively related to operational performance only when a high perception of a JMS exists ($\beta = .452$, $z = .092$, $p < .001$). No statistical relationship exists between GSC and operational performance in the low JMS group ($\beta = -.045$, $z = .120$, $p = .709$). In conclusion, support was found for H4b.

Table 18: Results of multi-group moderation analyses

Hypothesis	Path	Moderator	Model	Level	Path Coefficient (p)	$\Delta\chi^2$ (p)
H3b	GSC --> SB	JMS	Equal across group	Low	1.015 (.001)	Con: 1806.037
				High	1.015 (.001)	Base: 1805.083
			Free across group	Low	.743 (.006)	Diff: .954 (.329)
				High	1.117 (.001)	
H4b	GSC → OP	JMS	Equal across group	Low	.345 (.001)	Con: 1814.186
				High	.345 (.001)	Base: 1805.083
			Free across group	Low	-.045 (.709)	Diff: 9.103 (.003)
				High	.452 (.001)	

Note: GSC = group safety climate; SB = safety behaviors; OP = operational performance; Con = constrained model; Base = unconstrained base model; Diff = difference between models

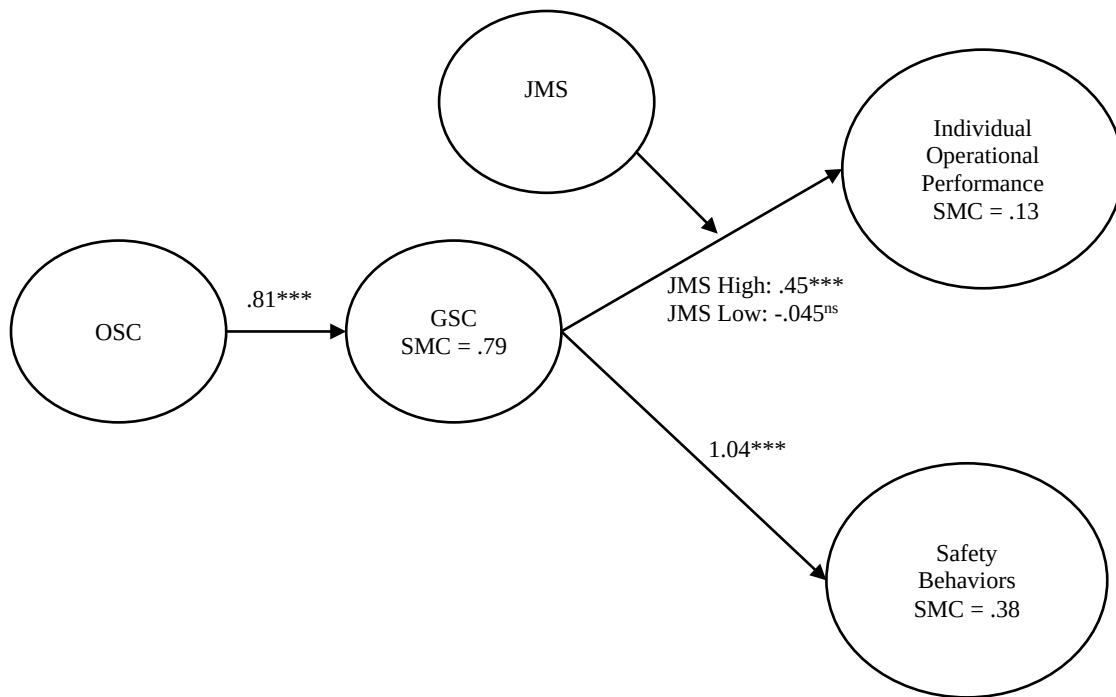


Figure 6. Final SEM model based on significant direct paths
 $*** p < .001$; SMC = squared multiple correlation

4.5 Discussion

Although some researchers have argued that a tradeoff exists between safety and operational performance, there is a lack of integrated research that tests this belief. The purpose of this study was to address the call for simultaneous safety and operations research and investigate whether perceptions of the existence of a JMS could play a role in strengthening the relationship between safety climate and both safety and operational performance. Results presented in this study indicate that organization-level safety climate is significantly related to group-level safety climate, and both levels of safety climate are positively related to safety behaviors. Neither of these relationships differed based on JMS grouping. In the case of organization-level safety climate, the relationship with safety behaviors was fully mediated by group-level safety climate. This fully

mediated path between organization-level safety climate, group-level safety climate, and safety behaviors is consistent with the findings of other safety climate research (Zohar & Luria, 2005). The fully mediated path may be a result of the hierarchical organization structure of the organizations included in this research. Group-level safety climate was assessed by asking employees questions that specifically related to their immediate supervisor and coworkers, whereas organization-level safety climate was assessed by asking employees about their organization-level leaders. Employees noted that they had daily interactions with their immediate supervisors; however, interactions with organization-level leadership were much less frequent. For instance, one respondent commented that they had not seen his organization-level leadership in over two months. This physical separation between employees and organization leadership may help explain why organization-level leadership had no direct effect on safety behaviors. However, organization-level safety climate did explain 79% of the variance in group-level safety climate. This could signify that organization-level leaders are effectively conveying their strategic safety policies and procedures to the first-line supervisors.

This research also found that organization and group-level safety climate are positively related to self-reported operational performance. Once again, group-level safety climate fully mediated the relationship between organization-level safety climate and operational performance. However, group-level safety climate was found to be related to operational performance only when employees also had a high perception of the existence of a JMS in their organization. When employees did not have a high perception of the existence of a JMS, there was no significant link between group-level safety climate and operational performance. This finding indicates that when certain

conditions are met in high-risk environments, it is possible for safety climate to be positively related to both safety and operational performance. Thus, the idea of a tradeoff between safety and operations is perhaps negated in this context. This phenomenon may exist because a JMS is characterized as a system that links safety management and operations management together (Pagell et al., 2015). The production system is continuously monitored to ensure risks to both operational effectiveness and safety are identified and controlled. Furthermore, safety and operational objectives are simultaneously monitored. Therefore, in the presence of a JMS, there is no implied conflict between being safe or operationally efficient. Maybe more importantly, in the presence of a JMS, neither safety nor operations is subjugated to the other. They are given equal billing and the result is the ability for safety climate to lead to increased safety and operational performance.

4.5.1 Theoretical Implications

This study advances the understanding of how important a role JMS may play in the relationship between safety climate, safety behaviors, and operational performance of employees in high-risk organizations. Through the lens of relational coordination theory (Gittell, 2002), it was discovered that when employees perceive high levels of a JMS, simultaneous increases in safety behaviors and operational performance can be achieved. Although organizations with a high level of safety climate are characterized by having managers and coworkers that are committed to safety, this alone was not enough to have an impact on operational performance. To translate safety climate into operational performance, employees first had to perceive that there was no conflict between operational and safety objectives. Employees also had to have a firm understanding of

how safety rules and procedures fit into the production system and how the rules and procedures enhance organizational outcomes. Effective communication had to take place in regards to how the organization was meeting its safety and operational goals. Finally, there was no added pressure to work unsafely when work fell behind schedule. These are all aspects of a JMS and are also the foundation of the relational coordination theory concepts of shared goals, shared knowledge, and mutual respect.

Previous JMS research assessed the existence of a JMS through the viewpoint of operations and safety managers and focused on organization-level outcomes (Pagell et al., 2014; Pagell et al., 2015; Tompa et al., 2016). This study adds to the body of knowledge of JMS by incorporating individual employee perceptions of the existence of a JMS. Although managers may believe a JMS is present in an organization, the only way to be sure if the concepts of a JMS are reaching the employees is to ask the employees themselves (Pagell et al., 2015). By using employee perceptions of the existence of a JMS, this study enhances previous JMS research findings and solidifies the link between JMS and both operational and safety outcomes. The findings of this research provide evidence of how safety climate theory and relational coordination theory can complement each other in relating safety climate to operational and safety outcomes.

4.5.2 Managerial Implications

This research also provides important insights for managers of high-risk organizations where accidents can have catastrophic consequences. It was found that safety climate was not necessarily indicative of a conflict between safety and productivity. In other words, managers do not have to be tempted to eschew safety out of fear that productivity will suffer. Instead, through the use of a JMS, simultaneous

increases in safety behavior and operational performance are possible. To achieve this and ensure the individual employee believes a JMS is present, managers should ensure that the jobs the employees perform are well defined and standardized when possible. Also, managers should actively monitor the production system to ensure both safety risk and risks to operational effectiveness are identified and controlled. Both safety and operational objectives should be monitored and both should be given equal billing. Finally, these goals should be frequently communicated to the workers to ensure they understand the importance of both operations and safety to the organization.

Managers could also use employee perceptions of a JMS as a feedback mechanism to determine if a JMS has been effectively implemented in the organization. If the organization believes a JMS is in place, low scores on the JMS scale could indicate that there may be disconnects between organizational policies and actual practice. These disconnects could serve as a signal for organizational leaders to review their operational and safety management policies and help them develop communication and implementation strategies to ensure those policies are being implemented effectively throughout the organization. Overall, adopting a JMS and ensuring it is effectively implemented in the organization may help leaders simultaneously achieve better safety and operational outcomes.

4.5.3 Limitations and Future Research

Although this research may have important theoretical and managerial implications, it is not without limitations. First, responses in this study are limited to organizations in the military air transportation operations environment. Although the duties required of the personnel included in the study are similar to those in the civilian

air transportation operations industry, replication of this study in other high-risk organizations should be undertaken to enhance the generalizability of the research. Also, as previously mentioned, the military organizations included in this study had a hierarchical organization structure, and this structure may have played a role in the fully mediated paths between organization-level safety climate, group-level safety climate, and safety behaviors. It would be interesting to assess whether this relationship would hold for organizations with a flatter organization structure.

Next, future studies should incorporate the entire domain of the JMS construct. Accountability, continuous improvement in operations, and human resource management are dimensions that were not used in the current study. These dimensions were left out of the current study because they were previously found to not be reliable, and including them would have increased the survey instrument by 14 items (Pagell et al., 2015). Although the dimensions were not found to be reliable in a previous study, it would be interesting to discover their applicability to high-risk organizations. Future research should include all potential dimensions of a JMS in order to further our understanding of this important construct.

Another limitation of this study was the reliance on self-reported measures. Self-reported data can lead to threats to reliability and validity due to bias (Roxas & Lindsay, 2012). To address this, Harmon's one-factor test and a non-response bias test were conducted, and it was concluded that neither common method bias nor non-response bias were a concern. Also, although this study focused on individual perceptions and employee outcomes, actual operational data would enhance the findings. Future research should include actual individual operational and safety performance data to determine if

the relationships hold, and to investigate if the hard data are related to employee perceptions of safety and operational performance. Moreover, testing a multi-level model to investigate the effects of a JMS on group and organization-level safety and operational outcomes may reveal some interesting findings.

In conclusion, the goal of this research was to investigate the role a JMS plays in the relationship between safety climate and both safety and operational performance. Although JMS did not have an effect on group safety climate's positive relationship with safety behaviors, it was found that group safety climate was positively related to operational performance, if and only if, employees perceive a high level of JMS exists in the organization. This suggests that JMS may be a mechanism for translating safety climate into simultaneous increases in safety and operational performance in high-risk organizations.

V. Conclusion

The research presented in this dissertation focused on developing an air transportation operations safety climate scale and investigating the construct's relationships with safety and non-safety related outcomes. A multi-level safety climate measurement scale was created that captures perceptions of organization and group-level safety climate. It was discovered that both levels of safety climate play an important role in influencing safety behaviors of air transportation operations personnel. Additionally, it was found that creating a climate of safety and balancing it with operational objectives in high-risk organizations can lead to simultaneous increases in safety behaviors and operational performance. The goal of this research was to provide actionable safety-related intelligence to air transportation leaders. Although a more detailed discussion can be found in each chapter, a summary of original contributions and suggestions for future research follows.

5.1 Original Contributions

Chapter II developed and validated the first known safety climate scale for the air transportation operations industry. Zohar (2010) called for expanding safety climate theory by developing industry specific safety climate scales to uncover context-specific intricacies. This tool may be able to serve as a leading indicator for safety mishaps in the air transportation operations industry. Furthermore, the scale developed in this chapter may help diagnose organizations with perceived safety climate and identify ways to help improve this climate. Chapter II provided strong statistical and theoretical support for level-adjusted safety climate scales in the air transportation operations industry.

Chapter III extended the work accomplished in Chapter II by using the newly developed safety climate scale to investigate the relationship between safety climate and non-safety related outcomes in high-risk environments such as air transportation operations. This is the first known study to investigate a multi-level safety climate framework to operational performance through OCBs. It was found that group-level safety climate was positively related to OCBs, and that OCBs fully mediated the positive relationship between group-level safety climate and individual operational performance. Organization-level safety climate was found to a positive relationship with OCBs through the fully mediated effects of group-safety climate. This research helps organizational leaders and first-line supervisors understand how their actions with regard to creating a climate of safety can enhance employee operational performance.

Chapter IV provided empirical evidence that balancing the safety versus operational performance tradeoff can result in simultaneous increases in safety behavior and operational performance in high-risk organizations. It was discovered that employee perceptions of a JMS moderated the relationship between group-level safety climate and individual operational performance. This is the only known study to use employee perceptions of the existence of a JMS. Previous research relied on inputs from operations and safety managers and conceded that the only way to truly know if a JMS is present was to ask the employees themselves (Pagell et al., 2015). As such, this study advances the understanding of how important a role JMS may play in the relationship between safety climate, safety behaviors, and operational performance of employees in high-risk organizations. Additionally, this research demonstrates how safety climate theory and relational coordination theory can complement each other in relating safety climate to

operational and safety outcomes. Finally, managers can use employee perceptions of a JMS as a feedback mechanism to determine if a JMS has been effectively implemented in the organization.

5.2 Implications for US Air Force Leaders

In addition to the original contributions listed above and managerial implications discussed in each chapter, this research also has important implications for US Air Force leaders. Results of this study may help the Air Force Safety Center transform the way in which it conducts safety climate studies in the future. The newly developed safety climate scale can be utilized by the Air Force Safety Center and pilot tested in future safety climate assessments of US Air Force air transportation operations organizations. From the beginning, it has been shown that improvement in management attitudes and commitment towards safety are mandatory prerequisites for improving the safety in an organization (Zohar, 1980). It has also been demonstrated that safety climate is a multi-level framework that should be measured at the group and organization level. Finally, Zohar (2010) has called for industry specific scales to be developed to better understand context-specific intricacies that may play a role in developing a climate of safety. The scale developed in this study addresses each of these concerns. The air transportation operations-specific safety climate scale is multi-dimensional and includes management attitudes and commitment towards safety at both the organization and group-level. The value of this safety climate scale lies in its ability to assess employee perceptions of leadership commitment to safety at the current time and in the future. And by developing a multi-dimension scale with clear frames of reference for the organization level and

workgroup level, leaders can pinpoint exactly where a deficiency may lie and react accordingly. For instance, if it is found that the group-level safety climate sub-dimension of work pressure is a concern, leaders can take remedial measures to ensure group-level supervisors do not encourage workers to ignore safety rules when the workload builds up. The safety climate scale can be used to create a checklist to help correct any deficiencies that are found. Finally, after validation by the Air Force Safety Center, industry specific safety climate scales can be developed and implemented for other Air Force career fields.

5.3 Suggested Future Work

This research has helped advance the understanding of the relationship that safety climate has with safety behaviors and operational performance of air transportation operations personnel. The benefits of this research can be extended in many ways, and a few suggestions of future research are now presented. First, US Air Force air transportation specialists were used as a proxy for this study, and this may hurt the generalizability of the findings. To address this concern, the new air transportation operations safety climate scale should be validated by conducting a follow-up study that includes civilian air transportation operations personnel.

Also, this research relied solely on self-reported measurement scales for the outcome data. Although common method and social desirability bias minimization and detection techniques were used in this study, future research should incorporate objective operational and safety outcome data to negate any potential common method bias and to triangulate results.

Next, studies should be undertaken to investigate how safety climate is created within the air transportation operations environment. This can be accomplished by including potential antecedents to safety climate in future research. To date, investigating the antecedents of safety climate has not received much attention in the literature (Zohar, 2010). Supervisory leadership and symbolic social interaction are believed to be the two primary antecedents to safety climate, and further research is needed to identify the specific mechanisms in which they promote better safety climate. One way this could be accomplished is by including a leadership measurement scale, such as authentic leadership, and investigating which scale items have the largest impact on each dimension of safety climate. Results of a study such as this could be used to develop a training program for leaders and managers that could potentially help improve safety climate across an organization.

In addition to investigating antecedents of safety climate, introducing potential moderators and mediators that may play a role in the relationship between safety climate, safety behaviors, and operational performance should also be undertaken. For instance, respect may play a significant role in these relationships. During the interview portion of this research, it was mentioned on multiple occasions that an employee may go out of his or her way to behave more safely if that person has a lot of respect for their group and organizational leaders. More interestingly, however, was that it was also said that if there was a lack of respect for leadership, the individual may perform his or her job in whichever way they felt best, even if it was in contrast to safety policies and procedures. The level of respect an employee has for their supervisor may moderate the relationship between safety climate and safety behaviors. By including moderators and mediators in

future research efforts, important boundary conditions may be identified that help translate safety climate to safety behaviors and operational performance.

Finally, future research should further investigate the role a JMS plays in the relationship between safety climate, safety behaviors, and operational performance by including the entire domain of the JMS construct. The dimensions of accountability, continuous improvement for operations, and human resource management were not used in the current study due to them being found unreliable in previous studies. These dimensions should be refined, and the entire JMS construct should be tested in the air transportation operations industry as well as other high-risk industries. It would also be interesting to extend the current research effort by using multi-level modeling techniques to investigate the effects of a JMS on group and organization-level safety and operational outcomes.

Although this research provides important contributions to understanding safety in the air transportation operations industry, there is still much more to be learned. This should only be seen as the first step in air transportation operations safety research. Safety is, and will always remain, important and continued efforts to conduct research in this area should continue.

Appendix

A.1 Potential Safety Climate Dimension Start List

1. Management commitment to safety
2. Safety priority
3. Safety proactivity
4. Work pressure
5. Safety communication
6. Safety systems
7. Safety policies and procedures
8. Worker involvement
9. Competence
10. Risk

A.2 Safety Climate Interview Protocol

Leadership/Safety Officer Interview Script

- 1a. Talk to me about the most common safety-related decisions air transportation specialists make. Are there ever disconnects between what they know is the right thing to do and what they feel they need to do to get the job done?
- 1b. Can you provide me an example of one of those situations in which an air transportation specialist experienced a disconnect and had to make a difficult decision? What was the outcome? How do you think the outcome affected his/her future decision-making?
- 1c. How do you think the air transportation specialist made the decision? In other words, what things did he/she consider when making the decision?
2. What are some of the consequences (positive and negative) you think air transportation specialists consider when determining whether or not to make a safe decision?

- 3a. Think about the daily practices supervisors and leaders use to ensure air transportation specialists perform their duties (i.e., task assignment; allotted time to complete the task; follow-up). What are some issues or things, with respect to those practices, that impact (either help or hurt) their abilities to make safe decisions?
- 3b. Think about the safety policies and procedures air transportation specialists must abide by every day (PPE, HAZMAT use, TO use, etc.). What are some issues or things, with respect to the policies, that impact (either help or hurt) their abilities to make safe decisions?
- 3c. Think about the enforcement of the policies and procedures (leadership presence, QA, inspections, etc.). What are some issues or things, with respect to enforcement, that impact (either help or hurt) air transportation specialists' abilities to make safe decisions?
- 4a. How responsible do you feel an individual is for their safety at work, and in what ways?
- 4b. How responsible do you feel supervisors and leaders are for an individual's safety at work, and in what ways?

Technician Interview Script

- 1a. Talk to me about the most common safety-related decisions you make. Are there ever disconnects between what you know is the right thing to do and what you feel you need to do to get the job done?
- 1b. Can you provide me an example of one of those situations in which you (or a fellow specialist) experienced a disconnect and had to make a difficult decision? What was the outcome? How did the outcome affect your (or the other person's) future decision-making?
- 1c. How did you make your decision? In other words, what things did you consider when making the decision?
- 2a. What are some of the consequences (positive and negative) you consider when determining whether or not to make a safe decision?
- 2b. What are some of the consequences (positive and negative) you consider when determining whether or not to make an unsafe decision?
- 3a. How responsible do you feel for your safety at work, and in what ways are you responsible?

- 3b. How responsible do you feel your supervisors and leaders are for your safety at work, and in what ways?
- 4a. Think about the daily practices supervisors and leaders use to ensure you perform your duties (i.e., task assignment; allotted time to complete the task; follow-up). What are some issues or things, with respect to those practices, that impact (either help or hurt) your ability to make safe decisions?
- 4b. Think about the safety policies and procedures air transportation specialists must abide by every day (wear PPE, HAZMAT use, TO use, etc.). What are some issues or things, with respect to the policies, that impact (either help or hurt) your ability to make safe decisions?
- 4c. Think about the enforcement of the policies and procedures (leadership presence, QA, inspections, etc.). What are some issues or things, with respect to enforcement, that impact (either help or hurt) your ability to make safe decisions?

A.3 Safety Climate Scale Items

Respondents were asked to indicate on a scale from 1-7 the extent to which they agreed or disagreed with the following scale items. The scale anchors were: 1 (strongly disagree), 2 (disagree), 3 (slightly disagree), 4 (neither agree nor disagree), 5 (slightly agree), 6 (agree), and 7 (strongly agree).

Organization-level safety climate (OSC)

Sub-dimension: management commitment to safety

OMC1. Top management in my organization (squadron-level leadership) places safety over mission accomplishment.

OMC2. Top management in my organization (squadron-level leadership) does not mind if an aircraft is delayed if it is due to safety.

OMC3. Top management in my organization (squadron-level leadership) is strict about working safely even if work falls behind schedule.

Sub-dimension: safety policies and procedures

OSP1. Current Safety rules are easy to understand.

OSP2. Current safety rules help keep me safe (e.g., double hearing protection, use of spotters).

OSP3. Current safety procedures reflect how the job is actually performed.

Sub-dimension: safety training

OT1. My organization provides thorough training on every piece of equipment and vehicle we use. *

OT2. Training is received in a timely manner when new procedures are introduced.

OT3. My organization provides realistic training that prepares us for the high-stress environment we operate in.

OT4. Training is received at regular intervals to refresh and update knowledge.

OT5. There is an effective training program for all new employees.

* OT1 was deemed a double barreled question and subsequently broken into separate questions for equipment and vehicles for the validation study.

Sub-dimension: vehicles and equipment

OVE1. The vehicles we are provided are in good working order.

OVE2. We are provided the appropriate vehicles to get the job done in the safest manner.

OVE3. The vehicles we are provided are maintained to the highest safety standards.

Group-level safety climate (GSC)

Sub-dimension: management commitment and coworker support

GMCS1. My work-shift supervisor (e.g., shift foreman, shift lead for flight or section if in an AMS) enforces safety rules and procedures (use of spotters, chocking vehicles, seat belt use, etc.).

GMCS2. My work-shift supervisor (e.g., shift foreman, shift lead for flight or section if in an AMS) quickly corrects any unsafe behavior, even if it did not result in an accident.

GMCS3. Coworkers in my workgroup ensure everyone uses the appropriate safety equipment for the job (e.g., hearing protection, gloves, and fall protection).

GMCS4. Coworkers in my workgroup expect other workers to behave safely.

Sub-dimension: work pressure

GWP1. I am encouraged to work faster, rather than by the rules whenever workload builds up.

GWP2. I feel rushed to complete a task if I am behind schedule.

GWP3. Punishment for missing a schedule of event (e.g., delaying an aircraft) is more severe than punishment for working unsafely.

Sub-dimension: safety briefings

GSB1. Recent safety-related events (e.g., injuries and accidents) are incorporated into safety briefings.

GSB2. Personal experiences are used to help strengthen safety briefings.

GSB3. Safety briefings are engaging enough to keep members of my workgroup interested.

B.1 Paper 2 Questionnaire Scale Items

Respondents were asked to indicate on a scale from 1-7 the extent to which they agreed or disagreed with the following scale items. The scale anchors were: 1 (strongly disagree), 2 (disagree), 3 (slightly disagree), 4 (neither agree nor disagree), 5 (slightly agree), 6 (agree), and 7 (strongly agree).

Organization-level safety climate (OSC)

Sub-dimension: management commitment to safety

OMC1. Top management in my organization (squadron-level leadership) places safety over mission accomplishment.

OMC2. Top management in my organization (squadron-level leadership) does not mind if an aircraft is delayed if it is due to safety.

OMC3. Top management in my organization (squadron-level leadership) is strict about working safely even if work falls behind schedule.

Sub-dimension: safety policies and procedures

OSP1. Current safety rules are easy to understand.

OSP2. Current safety rules help keep me safe (e.g., double hearing protection, use of spotters).

OSP3. Current safety procedures reflect how the job is actually performed.

Sub-dimension: safety training

OST1. My organization provides thorough training on every piece of equipment we use.

OST2. My organization provides thorough training on every vehicle we use.

OST3. Training is received in a timely manner when new procedures are introduced.

OST4. My organization provides realistic training that prepares us for the high-stress environment we operate in.

OST5. Training is received at regular intervals to refresh and update knowledge.

OST6. There is an effective training program for all new employees.

Sub-dimension: vehicles and equipment

OVE1. The vehicles we are provided are in good working order.

OVE2. We are provided the appropriate vehicles to get the job done in the safest manner.

OVE3. The vehicles we are provided are maintained to the highest safety standards.

Group-level safety climate (GSC)

Sub-dimension: management commitment and coworker support

My work-shift supervisor:

GMCS1. My work-shift supervisor (e.g., shift foreman, shift lead for flight or section if in an AMS) enforces safety rules and procedures (use of spotters, chocking vehicles, seat belt use, etc.).

GMCS2. My work-shift supervisor (e.g., shift foreman, shift lead for flight or section if in an AMS) quickly corrects any unsafe behavior, even if it did not result in an accident.

GMCS3. Coworkers in my workgroup ensure everyone uses the appropriate safety equipment for the job (e.g., hearing protection, gloves, and fall protection).

GMCS4. Coworkers in my workgroup expect other workers to behave safely.

Sub-dimension: work pressure

GWP1. I am encouraged to work faster, rather than by the rules whenever workload builds up.

GWP2. I feel rushed to complete a task if I am behind schedule.

GWP3. Punishment for missing a schedule of event (e.g., delaying an aircraft) is more severe than punishment for working unsafely.

Sub-dimension: safety briefings

GSB1. Recent safety-related events (e.g., injuries and accidents) are incorporated into safety briefings.

GSB2. Personal experiences are used to help strengthen safety briefings.

GSB3. Safety briefings are engaging enough to keep members of my workgroup interested.

Organizational citizenship behaviors (OCBs)

Sub-dimension: helping behavior

HB1. I help out members of my workgroup if they fall behind in their work.

HB2. I willingly share my expertise with other members of my workgroup.

HB3. I try to act like a peacemaker when other members of my workgroup have disagreements.

HB4. I take steps to try to prevent problems with other members of my workgroup.

HB5. I willingly give my time to help members of my workgroup who have work-related problems.

HB6. I "touch base" with other members of my workgroup before initiating actions that might affect them.

HB7. I encourage other members of my workgroup when they are feeling down.

Sub-dimension: civic virtue

CV1. I provide constructive suggestions about how my workgroup can improve its effectiveness.

CV2. I am willing to risk disapproval to express my beliefs about what's best for my workgroup.

CV3. I attend and actively participate in team meetings.

Sub-dimension: sportsmanship

OCBS1. I always focus on what is wrong with our situation, rather than what is right.

OCBS2. I spend a lot of time complaining about trivial matters.

OSBS3. I always find fault with what other members of my workgroup are doing.

Individual operational performance

IP1. I adequately complete assigned duties.

IP2. I fulfill responsibilities specified in my job description.

IP3. I perform tasks that are expected of me.

IP4. I meet formal performance requirements of the job.

IP5. I engage in activities that will directly affect my performance evaluations.

Impression management

SD1. I sometimes tell lies if I have to.

SD2. I never cover up my mistakes.

SD3. There have been occasions when I have taken advantage of someone.

SD4. I sometimes try to get even rather than forgive and forget.

SD5. I have said something bad about a friend behind his/her back.

SD6. When I hear people talking privately, I avoid listening.

SD7. I never take things that don't belong to me.

SD8. I don't gossip about other people's business.

C.1 Paper 3 Questionnaire Scale Items

Respondents were asked to indicate on a scale from 1-7 the extent to which they agreed or disagreed with the following scale items. The scale anchors were: 1 (strongly

disagree), 2 (disagree), 3 (slightly disagree), 4 (neither agree nor disagree), 5 (slightly agree), 6 (agree), and 7 (strongly agree).

Organization-level safety climate (OSC)

Sub-dimension: management commitment to safety

OMC1. Top management in my organization (squadron-level leadership) places safety over mission accomplishment.

OMC2. Top management in my organization (squadron-level leadership) does not mind if an aircraft is delayed if it is due to safety.

OMC3. Top management in my organization (squadron-level leadership) is strict about working safely even if work falls behind schedule.

Sub-dimension: safety policies and procedures

OSP1. Current safety rules are easy to understand.

OSP2. Current safety rules help keep me safe (e.g., double hearing protection, use of spotters).

OSP3. Current safety procedures reflect how the job is actually performed.

Sub-dimension: safety training

OST1. My organization provides thorough training on every piece of equipment we use.

OST2. My organization provides thorough training on every vehicle we use.

OST3. Training is received in a timely manner when new procedures are introduced.

OST4. My organization provides realistic training that prepares us for the high-stress environment we operate in.

OST5. Training is received at regular intervals to refresh and update knowledge.

OST6. There is an effective training program for all new employees.

Sub-dimension: vehicles and equipment

OVE1. The vehicles we are provided are in good working order.

OVE2. We are provided the appropriate vehicles to get the job done in the safest manner.

OVE3. The vehicles we are provided are maintained to the highest safety standards.

Group-level safety climate (GSC)

Sub-dimension: management commitment and coworker support

My work-shift supervisor:

GMCS1. My work-shift supervisor (e.g., shift foreman, shift lead for flight or section if in an AMS) enforces safety rules and procedures (use of spotters, chocking vehicles, seat belt use, etc.).

GMCS2. My work-shift supervisor (e.g., shift foreman, shift lead for flight or section if in an AMS) quickly corrects any unsafe behavior, even if it did not result in an accident.

GMCS3. Coworkers in my workgroup ensure everyone uses the appropriate safety equipment for the job (e.g., hearing protection, gloves, and fall protection).

GMCS4. Coworkers in my workgroup expect other workers to behave safely.

Sub-dimension: work pressure

GWP1. I am encouraged to work faster, rather than by the rules whenever workload builds up.

GWP2. I feel rushed to complete a task if I am behind schedule.

GWP3. Punishment for missing a schedule of event (e.g., delaying an aircraft) is more severe than punishment for working unsafely.

Sub-dimension: safety briefings

GSB1. Recent safety-related events (e.g., injuries and accidents) are incorporated into safety briefings.

GSB2. Personal experiences are used to help strengthen safety briefings.

GSB3. Safety briefings are engaging enough to keep members of my workgroup interested.

Joint Management System

Sub-dimension: process focus

JMSPF1. The jobs I perform are well defined.

JMSPF2. The jobs I perform can only be done one right way.

JMSPF3. I am given standardized process instructions (e.g., checklists and technical orders) for the jobs I perform.

JMSPF4. Before a new job is started, the best way to do it is defined.

Sub-dimension: Monitoring, hazard control, and communication

JMSHC1. We continuously monitor our production system (defined as vehicles, equipment, machines, division of labor, workflow, and information flow) to ensure that safety risks are reduced or eliminated.

JMSHC2. We have a system in place to identify risks in all jobs.

JMSHC3. Identified risks have been documented.

JMSHC4. The identified risks have been prioritized.

JMSHC5. Strategies have been created to reduce or eliminate all identified risks.

JMSHC6. Management frequently communicates to workers how the organization is meeting safety goals.

JMSHC7. Management frequently communicates to workers how the organization is making safety improvements.

JMSHC8. Management frequently communicates to workers about the key safety priorities of the organization.

Operational performance

OP1. I adequately complete assigned duties.

OP2. I fulfill responsibilities specified in my job description.

OP3. I perform tasks that are expected of me.

OP4. I meet formal performance requirements of the job.

OP5. I engage in activities that will directly affect my performance evaluations.

Safety Behaviors

SB1. I ignore safety regulations to get the job done.

SB2. I take chances to get the job done.

SB3. I bend the rules to achieve a target.

SB4. I get the job done better by ignoring some rules.

SB5. I take shortcuts which involve little or no risk.

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14. ABSTRACT Safety is of critical importance in many industries, and the US Air Force is no exception. Since 2005, the US Air Force has experienced more than 119 on-duty air and ground fatalities as well as 520 off-duty ground fatalities. One of the more dangerous environments in the U.S. Air Force and the civilian industry is air transportation operations where the fatal injury rate is higher than the national average. However, peer-reviewed safety research focusing on air transportation operations is practically non-existent, both in the military and civilian context. Therefore, safety research that helps us better understand how to shape safety behaviors and predict or prevent mishaps must be undertaken. Furthermore, the relationship between safety and operational outcomes is not fully understood, and research efforts to gain a better understanding of the inherent safety-operations tradeoff are long overdue. To address these concerns, this dissertation 1) develops and validates an air transportation operations-specific safety climate scale capable of capturing organization and group-level safety climate, 2) investigates safety climate's relationship with organizational citizenship behaviors and individual operational performance, and 3) examines the role a joint management system plays in translating safety climate into simultaneous increases in safety behaviors and individual operational performance.					
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