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ASSESSING SAFETY CULTURE AMONG PILOTS IN SAUDI AIRLINES: A QUANTITATIVE STUDY APPROACH

by

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A dissertation submitted in partial fulfillment of the requirements
for the degree of Doctor of Philosophy
in the Department of Industrial Engineering and Management System
in the College of Engineering and Computer Science
at the University of Central Florida
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Major Professor: Waldemar Karwowski

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ABSTRACT

In high- risk industries, such as aviation, safety is a key for organization survivor. Most accidents involve human losses and bring substantial cost to organizations. Accidents can devastate the reputation and profitability of any organization. In aviation, more than 80% of aircraft accidents are related to human errors. Safety culture has substantial impact on the success of any organization. Employees' performance and behaviors are influenced by their perception of safety culture within their organization. In the aviation industry, pilots are considered the last resort to prevent accidents or mishaps in the air or ground. The focus on pilots' perception of safety culture is vital to understand how the airline can influence pilots' behaviors in the flight deck, and provide opportunities to minimize risk or unsafe behavior in the future.

The present study examined the effect of safety culture on safety performance among pilots of Saudi Airlines. Safety performance was measured by pilot attitude toward violations and pilot error behavior. The study further analyzed the mediating role of pilot commitment to the airline between safety culture and measures of safety performance. The study used a quantitative approach using survey questionnaire to collect the data. A total of 247 commercial airline pilots, captain and first officer, flying at Saudi Airlines voluntarily participated in the study. Confirmatory factor analysis was conducted to validate each latent construct. The study used structural equation modeling (SEM) to analyze the relationship between all variables in the study using AMOS 22 software.

The study results revealed that safety culture had a direct effect on pilot attitude toward violations and indirect effect on pilot error behavior. Moreover, safety culture had strong effect on enhancing pilot commitment to the airline. The mediating role of pilot commitment to the airline was not significant, and could not mediate the relationship between safety culture and measures of safety performance.

The present research contributed to the current state of knowledge about the significant role of safety culture as a main predictor of safety performance in civil aviation. The present study contributes to aviation psychology by analyzing the effect of safety culture as a predictor for improving pilot commitment to the airline. In addition, this research analyzed the effect of safety culture on pilot attitude toward violations and pilot error behavior. Study findings can be used by airline management to better identify causes of unsafe behavior inside the cockpit. The outcomes of this research emphasize the role of management in shaping and affecting employees' behaviors and attitudes.

I dedicate this work to my parents, my wife, and fellow pilots in Saudi Airlines

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LIST OF ABBREVIATION/ ACRONYMS

CASS	Commercial Aviation Safety Survey
CFA	Confirmatory Factor Analysis
EFA	Exploratory Factor Analysis
FAA	Federal Aviation Administration
FMAQ	Flight Management Attitude Questionnaire
HFACS	Human Factor Analysis and Classification System
ICAO	International Civil Aviation Organization
NTSB	National Transportation Safety Board
OCQ	Organizational Commitment Questionnaire
OSCQ	Organizational Safety Culture Questionnaire
SEM	Structural Equation Modeling
SMS	Safety Management System
TPB	Theory of Planned Behavior

CHAPTER 1: INTRODUCTION

1.1 Background

In high- risk industries, such as aviation, safety is a key factor for organization survival. Most accidents involve human losses and bring substantial cost on organizations. Accidents can devastate the reputation and profitability of any organization (Patankar, Brown, Sabin, & Bigda-Peyton, 2012). In aviation, more than 80% of aircraft accidents are related to human errors (O'Hare, Wiggins, Batt, & Morrison, 1994; Shappell S. & Wiegmann D., 2000).

In the past recent years, aircraft accident causations have been developed through different stages to narrow down root causes of system failure. The first stage was known as the technical period where most blames were due to mechanical malfunctions or reliability of equipment (Wiegmann & Shappell, 2001a). On the second stage, human errors were identified as the probable causes of system breakdown. The third stage is known as the sociotechnical period where human interactions with equipments were the main focus of accidents investigation (Wiegmann, Zhang, von Thaden, Sharma, & Gibbons, 2004). Many training programs have evolved to improve human performance such as Crew Resource Management, Line Operations Safety Audits, and threat and error management (Klinect, Wilhelm, & Helmreich, 1999). Finally, a new era of accident investigation have evolved recent years. The fourth stage is known as organizational culture. In this stage, investigators look at the organization as a major influence or factor that contributed to the cause of the accident instead of blaming only the operators.

Organization with common goals and beliefs such as airlines share common culture characteristics. Different beliefs and values of business success and safety create diverse cultural characteristics between each airline. Research and experience show that senior management has a great influence on promoting a strong organizational safety culture. The success of safety culture to deliver business safety success depends upon management leadership (Schein, 2004; Taylor, 2010; Wu, Chen, & Li, 2008). When the whole organization is committed to shared safety beliefs, a good safety culture is observed within an organization.

Management should evaluate safety culture within their organization before they can pursue any types of improvements in safety culture. It is very hard to measure safety culture because it materializes from individual and organization beliefs. Good culture is formed by a set of common characteristics (Taylor, 2010). The use of quantitative and qualitative assessment can indirectly measure organizational safety culture through the review of common safety culture characteristics within an organization (O'Connor, O'Dea, Kennedy, & Buttrey, 2011; Patankar, Bigda-Peyton, Brown, Sabin, & Bigda-Peyton, 2012; Taylor, 2010; Wiegmann, Hui Zhang, Thaden, Sharma, & Gibbons, 2004).

1.2 Statement of the Problem

The study of safety culture in the aviation industry is still growing. According to the International Civil Aviation Organization (ICAO), each member states have to implement Safety Management System (SMS) (Lu, Young, Schreckengast, & Chen, 2011). ICAO has identified organizational safety culture as an important element that has to be further supported and enhanced through SMS. With the Federal Aviation Administration (FAA) moving toward the regulation of SMS, there is much concern to assess safety culture within the aviation industry (von Thaden & Gibbons, 2008). Assessing safety culture in the airline is an essential step to recognize areas of safety improvements and opportunities for organization's future success. The need to understand how safety culture within an airline can influence pilots behind flight control is vital to minimize risk and assure safe operations.

Organizational factors have played significant role in accident causation. Organizations with positive safety culture have higher communication between employees, high level of assertiveness, and higher level of trust between employees and management (Kelly & Patankar, 2004). In an aviation organization, safety culture highly influences pilot and mechanics (Kelly & Patankar, 2004). Saudi Airlines is one of the major airlines in the Middle East which operates to more than 80 destinations across Asia, Africa, Europe, and North America. There is a necessity to assess safety culture especially among pilots in Saudi Airlines to identify opportunities for improvements and to ensure safe operation. In order to develop a proactive approach to safety culture, a comprehensive safety culture study using survey has to be implemented (Gibbons, von Thaden, & Wiegmann, 2006).

As discussed above, there is a lack of research regarding the effect of safety culture on pilot commitment to the airline and how can their attachment to the airlines affect their performance inside the cockpit. Therefore, the main purpose of this research is to assess safety culture among pilots of Saudi Airlines to identify areas of safety culture improvements. In addition, the effects of current safety culture on pilot commitment to the airline and safety performance are assessed.

1.3 Research Objectives

Organizational culture has contributed to the causes of many accidents in the aviation industry. Analyzing organizational factors have been ignored in aircraft accidents investigation in the past. Focusing on pilot error rather than what have influence the actions of the crew have been the approach method throughout past investigations (von Thaden, Wiegmann, & Shappell, 2006). The main objective of this research is to provide an opportunity to enhance and build a strong safety culture in Saudi Airlines that will improve pilots' performance in the cockpit and overall safety in the airline. The purpose of this research is to develop a model that evaluates current safety culture among pilot in Saudi Airlines. The model identifies the effects of the prevailing safety culture on pilot commitment to the airline and safety performance.

This research investigates the effect of safety culture on safety performance in terms of pilot error behaviors and attitude toward violations. Furthermore, the research analyze whether pilot commitment to the airline mediate the relationship between safety culture and safety performance. This quantitative study determines whether correlations exist between safety culture, pilot commitment to the airline, and safety performance.

1.4 Hypothesis

The hypotheses of this research are proposed to test the relationship between various latent variables. Safety culture is measured by four main factors including organizational commitment, operational personnel, informal safety system, and formal safety system (Gibbons et al., 2006). The research is focused on measuring the effect of safety culture on pilot commitment to the airline and safety performance. Previous literatures indicated that organizational culture has significant effects on employees commitment (Fogarty, 2004; Park, Kang, & Son, 2012; Sheridan, 1992). Hence, the relationship between safety culture and pilot commitment to the airline are investigated. The first hypothesis propose that safety culture of the airline has a significant influence on pilot commitment to the airline.

H_1: safety culture has a significant influence on pilot commitment to the airline.

Management and organizational factors have great influences on the behavior of the crew to commit an error or violation (Shappell S. & Wiegmann D., 2000). In addition, the perception of safety culture influences employees' behavior to commit an error (Fogarty & Shaw, 2010). Therefore, the second and third hypotheses propose a significant influence of safety culture on pilot error behavior and own attitude toward violations.

H_2: safety culture has a significant influence on pilot error behaviors.

H_3: safety culture has a significant influence on pilots own attitude toward violations.

The fourth and fifth hypotheses relates to the effect of employees' commitment as a mediator between safety culture and safety performance. Safety performance is measured through pilot error behavior and own attitude toward violations. Employees' commitment to their organization have played a major role to enhance safety (Block, Sabin, & Patankar, 2007). The fourth hypothesis investigates the effect of pilot commitment to the airline as a mediator between safety culture and pilot error behavior. The fifth hypothesis investigates the effect of pilot commitment to the airline as a mediator between safety culture and pilot own attitude toward violation

H_4: pilot commitment to the airline mediates the relationship between safety culture and pilot error behaviors.

H_5: pilot commitment to the airline mediates the relationship between safety culture and pilot own attitude toward violations.

1.5 Research Contribution

There is a growing concern in recent literature to measure safety culture in the airlines. This research has a significant implication to the body of knowledge in the role of safety culture as a predictor of safety performance. A comprehensive literature review is presented in this research to explain human factors involvement in aircraft accidents, organizational culture role in accident causation, safety culture and its assessment in aviation, and finally measuring employees' commitment to the airline. The outcomes of the research emphasizes the role of management in shaping and affecting employees' behavior and attitude (Fogarty & Shaw, 2010; Neal & Griffin, 2006). Participants of the research are current airlines pilots flying in a major commercial airline, Saudi Airlines. The aim of the research is to assess current safety culture in Saudi Airlines among pilots. The study further investigates to what extent does safety culture affects pilot commitment to the airline and safety performance. The present study contributes to aviation psychology by analyzing the effect of safety culture as a predictor to improve pilot commitment to the airline. Moreover, the study investigates to what extent does safety culture in the airline plays a direct or indirect effect on pilot error behavior and attitude toward violations. In addition, the research aid airline's management by assessing the current safety culture in the airline. The outcomes of this study guide decision makers in the airline to improve pilot commitment to the airline and undertake appropriate actions to minimize pilot error behavior and attitude toward violations.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

A comprehensive literature review is presented to explain human factors roles in aircraft accidents and different stages of accident investigation analysis. Definitions of organizational culture are presented from multiple organizational industries. In addition, the role of organizational factors in accident causation is highlighted to indicate the significant of implementing a strong safety culture in the airlines. Next, the definition of safety culture is discussed among different industries, and various approaches to assess safety culture in aviation are discussed. Finally, the role of employees' commitment to enhance safety is illustrated from airlines' experience perspective and types of employees' commitment is discussed.

2.2 Human Errors in Aviation

The nature of human error was identified two thousand years ago when Roman orator Cicero pointed out "it is in the nature of man to err" (Hawkins, 1987). Understanding why human make mistakes has been a major concern of numerous studies and researches in the past decades. Human errors in aviation played a major role in accident causation. Studies have shown that 70%-80% of aircraft accidents were related to human errors (O'Hare et al., 1994; Shappell S. & Wiegmann D., 2000).

The philosophies to identify the root causes of accidents causation in high-risk industries have developed through different stages over the past several years. Weigmann et al (2004) explained four different stages of developments in the process of determining accidents causation. The first stage is referred to the *technical period* where most of accidents were related to technical failures, system reliability, and poor design. Modern technologies and industrial revolutions have played significant role to diminish accidents due to technical failures. The second stage is the *period of human error* where human failures in the system contributed to the cause of many accidents in different field of high-risk industries including aviation. The Three-Mile Island nuclear power plant accident in the U.S in 1979, withdraw the attentions of investigator from technical aspects to human errors' involvements in system breakdown (Rochlin & Vonmeier, 1994). In the aviation context, the Tenerife disaster in 1977, involving two state of the art airliners, Pan Am and KLM, considered a prototype accident that brought substantial considerations to human performance in aviation. Human errors involved in this accident have contributed to the loss of 583 lives and massive financial losses (Hawkins, 1987; Weick, 1990). The third stage is the *sociotechnical period* where human interactions with machine were further analyzed in depth and considered a probable cause of errors and accidents. Recently, a new approach has been implemented known as *organizational culture*. In this period, investigation evaluate enduring characteristics within an organization as root causes of accident causation (Wiegmann, Zhang, et al., 2004).

Organizational influences on human- related accidents have been recognized since 1974 by Bird's domino theory (Wiegmann & Shappell, 2001b). The theory explained how accidents are caused by consequences of events in logical order. A series of five dominos aligned together with safety or management as the initiating one. Whenever there is a deficiency, it will fall and influence the second part of the dominos, basic causes such as personal and job related factors. The third domino is operator errors and working conditions which are affected by the two previous falling dominos. Accident, personal, and property damages will be the consequences of orderly falling parts of the dominos system as the fourth and fifth pieces of the puzzle (Shappell & Wiegmann, 1997; Wiegmann & Shappell, 2001b). The domino theory indicated how organization can adversely influence human performance and be the main cause of an accident or incident.

The Swiss Cheese model developed by Reason (1990) described two types of failures within an organization; active failure and latent failures. Active failure located at the end of the model caused by employees with direct contact with the system such as pilots in flight deck or maintenance personal on job duty. Latent failures which are embedded characteristics within an organization such as poor communication, vague policy or inadequate training located at the other far end of the system influencing unsafe acts. An airlines scheduling policy that pushes pilots to their maximum duty time could be an example of a latent factor that could affect crew performance who are within direct contact of the flight control on an airplane (Yemelyanov, 2007). Two major factors distinguish the difference between active and latent failures. Time is the first factor that differentiates between the two failures. Active failures have an immediate effect on organization and can be observed whereas latent failure are hidden within organizational structure and take more time to have a negative impact. The second factor is the location of each failure. Active failures are located at the workplace where interaction between the operator and the system or environment. Alternatively, latent failures are concealed within management policies, decisions, training etc. (Reason, 1990).

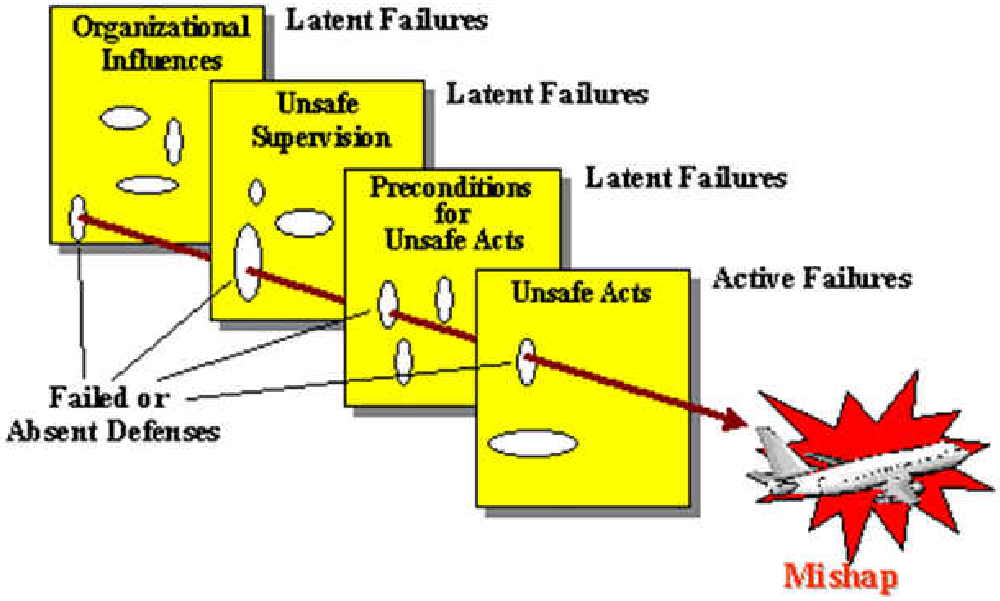

Figure 1 Reason's Swiss cheese Model (1990)

The Swiss Cheese model described four human failures before an accident or incident could happen. Three of these failures are latent failures that influence the occurrence of an active failure which directly can cause a mishap. The first failure takes place at the organizational level when organizations fail to provide adequate training facilities or push their pilots to their maximum duty time to earn more profits. The second failure is due to unsafe supervision. When a below average pilot passes his simulator training and line training on an actual aircraft, lack of supervision could be the cause of future active failure. The last latent failure is preconditions for unsafe acts, such as poor communication between flight crewmembers and flying into adverse weather conditions. All three latent failures influence the unsafe act by pilots who are considered the last line of defense before an accident or incident could take place.

Reason's Swiss Cheese model recognized human failures at different stages, but did not really defines what kind of human errors causing the hole in each stage (Shappell S. & Wiegmann D., 2000). Shappell and Wiegmann (2000) built on Reason's model and developed the Human Factor Analysis and Classification System (HFACS) in an effort to identify the holes in the cheese. The HFACS used the same levels of failures which the Swiss Cheese model used to describe human failures: Unsafe Acts, Precondition for Unsafe Acts, Unsafe Supervision, and Organizational Influences. The HFACS described in details what cause human failures at each stage. The unsafe acts by the operator, leading to an accident or incident, are classified into two categories: errors and violations. Errors were further classified into three types: decision errors, skill-based errors, and perceptual errors (Rasmussen, 1982; Reason, 1990)

Shappell and Wiegmann (2000) described decision errors as "the intentional behavior that proceeds as intended, yet the plan proves inadequate or inappropriate for the situation". Diverting to an inadequate airport during abnormal conditions could be a result of a decision error made by the pilot.

Skilled based errors are basically referred to pilots' skills to fly the aircraft which include but not limited to physical skills, dividing attention, proper scanning, following checklist items, and following proper procedures. Many aircraft accidents have been tied to skilled based errors especially which involve technique errors (Li, Chen, & Wu, 2000; Shappell S. & Wiegmann D., 2000).

Perceptual errors involve misinterpretation by flight crew to aircraft performance or information that could lead them into undesirable states or flight conditions. Controlled Flight

Into Terrain (CFIT) can be an example of perceptual error where flight crew fail to recognize their flight path into terrain or water (Shappell S. & Wiegmann D., 2000).

Shappell and Wiegmann (2000) described violation in the aviation domain as "a willful disregard for the rules and regulations that govern safe flight". Violation could be a result of routine or exceptional violation. Routine violations referred to violation that becomes a normal habit by the person or operator and tolerated by governing authority (Reason, 1997). These violations can be an example of exceeding assigned airspeed or failure to properly brief approach procedures. Exceptional violations on the other hand, are those actions which fully disregard authority and considered extreme (Reason, 1997; Shappell S. & Wiegmann D., 2000).

The HFACS placed organizational influences at the top of the model as the initiating factor that influence human failures at the supervisory and operator levels. The most common organizational influences are resource management, organizational climate, and organizational process. Resource management referred to management decisions regarding available resources for their employee such as onboard equipment, training facilities, safety equipment etc… There is always a debate on the management level on how much they should spend on safety equipment and training. During fiscal austerity, most organizations tend to cut expenses on safety and training to minimize cost (Shappell S. & Wiegmann D., 2000).

Organizational climate can be a reflection of company polices and culture. Company's policies are those decisions by upper management regarding hiring and firing, upgrades promotions, minimum flying hours and overtime, sick leave and emergency leave, accident investigation, and use of drugs and alcohol. Airlines strict adherence to some policies while loosen up on others depending on their culture “the way things really get done around here” (Shappell S. & Wiegmann D., 2000). Figure 2 illustrates the HFACS with organizational influences as the initiating factors that influences human errors.

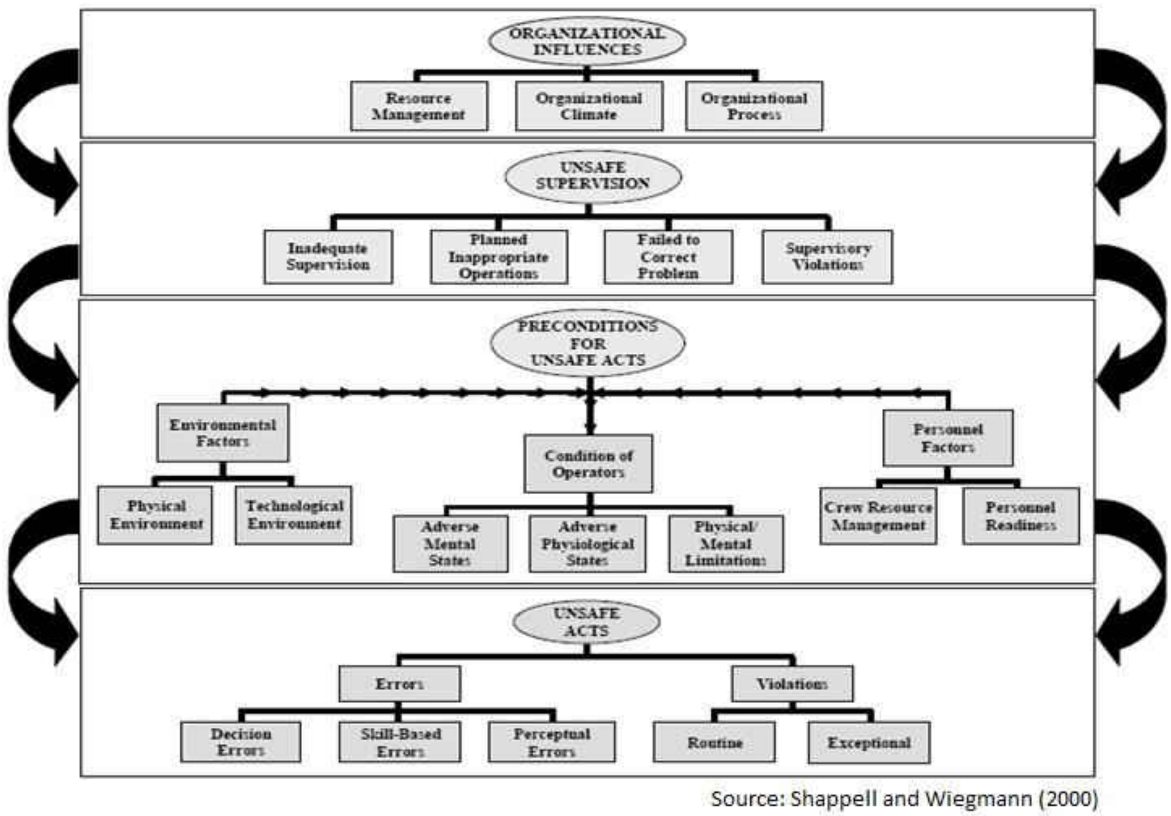

Figure 2 The Human Factor Analysis and Classification System. Shappell and Wiegmann, 2000

Li et al (2000) investigated the relationship between human errors and accidents over a twenty years period in the Chinese Air Force from a Crew Resource Management perspective. Building on Rasmussen (1974), the study identified six different human errors related to cockpit safety: skilled-based level, rule-based level, knowledge based level, communication based level, judgment-based level, and leadership- based level. Study results indicated that most of the accidents were caused by skilled and ruled based errors. Errors on the rule-based level may involve flight crew to believe that it is safe to deviate from standard operating procedures. The study recommended strong management involvement to strictly enforce the adherence to standard operating procedures which have caused many accidents. In addition, providing sufficient pre-training program was also suggested for the air force management to improve pilot's skills and proficiencies to minimize accidents in the future (Li et al., 2000). Study recommendations emphasize the vital role of management to improve safety and human performance to minimize human errors inside the cockpit.

Fogarty and Show (2010) used the Theory of Planned Behavior (TPB) developed by Ajzen to analyze the relationship between climate and violation behavior in aircraft maintenance. Study measured the relationship between six factors influencing employees' behavior to violate: perception of management attitude to safety, own attitude to violation, intention to violate, group norms, workplace pressure, and violation. Analysis revealed the significant role of management attitudes and group norms as a main predictor of violation behavior (Fogarty & Shaw, 2010).

Fogarty (2004) used the Maintenance Environment Survey to determine the influence of safety climate on morale, psychological health, turnover intention, and error in the aviation maintenance environment. Pathway analysis indicated that organizational factors, safety climate, had a direct effect on morale and indirect effect on error behavior (Fogarty, 2004).

2.3 Organizational Culture

Culture was a common term to describe different nationalities rather than organization. The term organizational culture became largely known after the publishing of two books; *corporate culture* and *In search of Excellence* in 1982 (Reason, 1997). There is not a specific definition of organizational culture, but Uttal (1983) definition has been described by Reason (1997) as the one "that capture most of the essentials with the minimum of fuss"

> *"Shared values (what is important) and beliefs (how things work) that interact with an organization's structures and control system to produce behavioral norms (the way we do things around here)".*

Another definition by the UK's Health and Safety commission in 1993 described organizational culture as

> *"The safety culture of an organization is the product if individual and groups' values, attitudes, competencies, and patterns of behavior that determine the commitment to, and the style and proficiency of, an organization's health and safety programmes. Organization with a positive safety culture are characterized by communications founded on mutual trust, by shared perceptions of the importance of safety, and by confidence in the efficacy of preventive measure"*

Helmreich and Merritt (1998) defined organizational culture as "the values, beliefs, assumptions, rituals, symbols and behaviors that define a group, especially in relation to other groups or organization".

Edgar. H. Schein, investigated corporate culture and organizational culture in U.S business, and defined organizational culture as

> "*Organizational culture, is the pattern of basic assumptions that a given group has invented, discovered, or developed in learning to cope with its problems of external adaptation and internal integration—a pattern of assumptions that has worked well enough to be considered valid and, therefore, to be taught to new members as the correct way to perceive, think, and feel in relation to those problems"*

Organizational culture arises from shared beliefs. These beliefs have strong influences on employees' behavior and are hidden beneath different layers (Schein, 2004) . Taylor (2010) described the work by Schein as "generic culture model ". The layered generic model which drives human performance and behavior includes beliefs, espoused values, attitudes, and artefacet (Taylor, 2010). Beliefs start from basic assumptions and common experience of organizational survival. It is very essential to analyze employees' perceptions and beliefs about safety in their organization. The connection between beliefs and behaviors will help to understand organizational safety culture in the organization and the motivation behind employees' behaviors (Taylor, 2010)

There are two different layers of culture in any organization. The outer layer is the surface structure which appears in observable behaviors and tangible items such as uniform¸ logos, and company manuals or procedure. The inner layer of culture consists of beliefs, values, and underlying assumption which influence employee's behavior (Helmreich & Merritt, 1998).

Patankar and Sabin developed the safety culture pyramid which described the linkage between four stacked layers as they influence the behaviors and performance of an individual in an organization. The model placed behaviors or safety performance at the tip of the pyramid. The next layer that influenced safety performance is safety climate which is the attitude and opinions of the employees in regard to safety in the organization. Safety strategies which include organizational mission, leadership, strategies, norms, history, and legend and heroes followed next. On the bottom of the pyramid come safety values which are the underlying values and unquestioned assumption (Patankar, Brown, et al., 2012). Figure 3 illustrates the safety culture pyramid developed by Patankar and Sabin.

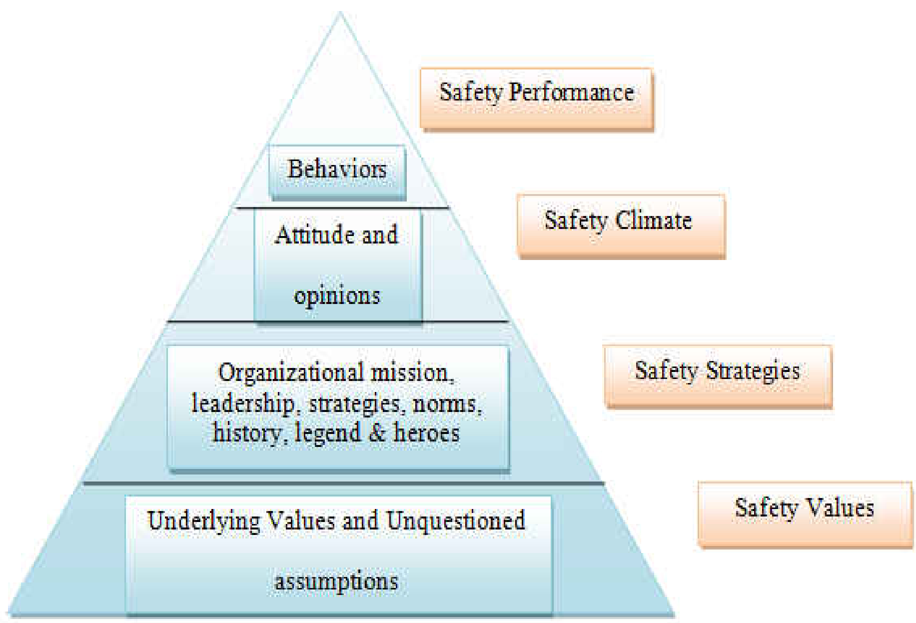

Figure 3 The Safety Culture Pyramid. Patankar and Sabin, 2010

The safety culture pyramid illustrates the relationship between the underlying values of the organization and employees' behavior which affect safety performance. It can aid investigators to analyze contributing factors of the accident and understand how these factors contributed to unsafe behaviors. Neal et al (2000) developed a model to explain the influence of organizational climate and safety climate on individual safety behavior. The study provides a link between the organizational environment and specific individual behaviors related to safety such as compliance and participation. Study revealed that organizational climate has a significant impact on safety climate. The study used safety knowledge and safety motivation as a determinate of safety performance. Findings suggested that safety climate plays a major role as a predictor of safety performance (A. Neal, Griffin, & Hart, 2000) which support the conceptual model of safety culture pyramid.

Organizational culture has contributed to the causes of many accidents in the aviation industry. Analyzing organizational factors have been ignored in aircraft accidents investigation in the past. Focusing on pilot error rather than what have influence the actions of the crew have been the approach methods throughout past investigations (von Thaden, Wiegmann, et al., 2006).

Von Thaden et al (2006) analyzed aircraft accidents related to human errors for a period of ten years from 1990-2000. Accidents involved scheduled and unscheduled major and regional airlines operating under Federal Aviation Regulation (FAR) 121 and 135 respectively. Out of the 1322 accidents, 781 accidents related to human factors according to the analysis of the HFACS designed by Wiegmann, & Shappell (2000). Further analysis revealed to sixty accidents related to pilot error which include 70 organizational factors contributing to the accidents. After careful review of the National Transportation Safety Board (NTSB) reports and clustering the 70 organizational factors, the study was able to identify10 categories related to organizational factors that contributed to the causes of accidents. The ten categories are procedures, training, surveillance, standards, information, supervision, pressure, documentation, substantiation, and facilities (von Thaden, Wiegmann, et al., 2006).

Results of the study revealed that inadequate procedures and directives play significant roles as organizational factors causing pilots' errors and aircraft accidents in both large and small airlines. In addition, organizational factors affecting small airlines appear in training, supervisions, and surveillance whereas lack of information sharing, communication, and documentations are most common in large commercial airlines (von Thaden, Wiegmann, et al., 2006). The study showed how organizational factors played vital roles into accidents causations in the airlines industry. The necessity to understand how these factors can influence crew performance inside the cockpit is very important to improve airlines' safety.

2.4 Safety Culture

Safety culture is a sub facet of organizational culture which can affect member's attitude and behaviors (Cooper Ph.D., 2000). The term safety culture was first mentioned after the investigation of the nuclear power plant accident in Chernobyl Ukraine in 1986 (Cox & Flin, 1998; Flin, Mearns, O'Connor, & Bryden, 2000; K. Mearns, Flin, Gordan, & Fleming, 1998; Kj Mearns & Flin, 1999; Taylor, 2010; Wiegmann, Zhang, et al., 2004). More than 30 people lost their lives instantly and contaminations spread approximately 400 square mile across east Europe threatening surrounding countries and causing significant damages. (Taylor, 2010; Wiegmann, Zhang, et al., 2004).

It was imperative to analyze and determine the root causes of the accident due to extreme political and social pressure in Europe. Investigators of the accident adopted a deeper analysis approach to determine the root causes of the accident by investigating causes beyond mechanical or engineering failures. This approach led to the observation of individual's performance managing, designing, constructing or operating in high- risk industry. The investigation of employees' behavior in the workplace and factors that influence their beliefs and attitude toward safe operations become imminent (Pidgeon, 1998; Wiegmann, Hui Zhang, et al., 2004).

The International Atomic Energy Agency and the Organization for Economic Cooperation and Development have determined "poor safety culture" as a contributing factor to the Chernobyl accident (Wiegmann, Zhang, et al., 2004). Since then, accident investigators considered organization safety culture as a contributing factor. Organizational safety culture contributed to many accidents, for instance the King's Cross underground fire in London and the Piper Alpha oil Platform explosion in the North Sea (Cox & Flin, 1998; Pidgeon, 1998; Taylor, 2010; Wiegmann, Zhang, et al., 2004).

In the aviation industry, the crash of Continental Express Flight 2574 on September 11, 1991 killing 14 people considered a turning point for safety culture in the aviation industry (Meshkati, 1997, as cited from Wiegmann et al 2004). The aircraft experienced in-flight structural breakup and crashed near Eagle Lakes, Texas. The NTSB included in the probable cause of the accident "The failure of Continental Express management to establish corporate culture which encouraged and enforced adherence to approved maintenance and quality assurance procedures" (NTSB/Aircraft Accident Report-92/04, 1992, p. 54, as cited in

Wiegmann et al., 2004). This was the first time investigators considered the term corporate culture or safety culture in the aviation industry. The term become a major subject at the U.S National Summit on Transportation Safety sponsored by the NTSB in 1997 (Wiegmann, Zhang, et al., 2004).

Wiegmann et al (2004) analyzed previous literatures that have defined safety culture in various high-risk industries. He indicated that safety culture reflects to the enduring characteristics of an organization while dealing with critical safety issues. Study analysis defined seven common features of safety culture which include" *(1) safety culture is a concept defined at the group level or higher that refers to the shared values among the entire group or organization member. (2) Safety culture is concerned with formal safety issues in an organization and closely related to, but not restricted to, the management and supervisory systems. (3) Safety culture emphasized the contribution from everyone at every level of an organization. (4) The safety culture of an organization has an impact on its members' behavior at work. (5) Safety culture is usually reflected in the contingency between reward system and safety performance. (6) Safety culture is reflected in an organization's willingness to develop and learn from errors, incidents, and accidents. (7) Safety culture is relatively enduring, stable, and resistant to change".*

In addition, safety culture has been defined in variety of way across safety literatures and different industries. The Confederation of British Industry defined safety culture as "the way we do things around here". Turner (1989) defined safety culture as "a set of attitudes, beliefs or norms". "A constructed system of meaning through which the hazards of the world are understood" (Pidgeon, 1998). Patankar and Sabin (2010) defined safety culture as "a dynamically-balanced, adaptable state resulting from the configuration of values, leadership strategies, and attitudes that collectively impact safety performance at the individual, group, and enterprise level". They further simplified the definition of safety culture to "why we do what we do".

The Health and Safety Executive reviewed safety culture and safety climate literature to develop a safety culture inspection toolkit. The study designed a framework based on Cooper (2000) to differentiate between three interrelated aspects of safety culture. Psychological aspects, which refers to" how people feel" about safety and safety management in all level of the organization and often described as safety climate. Behavioral aspects of safety culture describe employees' behavior, action, and activity related to safety within their organization. These aspects describe "what people do" in their organization in regard to safety and often can be described as organizational factor. The last aspect of safety culture is the situational aspects which describe company's policies, manuals, operating procedures, management system, and communication flow. These aspects explain "what the organization has" and can be described as corporate factors (Health and Safety Executive, 2005). In addition, Guldenmund (2000) reviewed 16 definitions of safety culture and safety climate and indicated that attitude is part of culture and perceptions are more associated with climate (Guldenmund, 2000).

Numerous organizational characteristics have been proposed in previous literature to measure safety culture in an organization and serve as indicators of positive safety culture. Weigmann et al (2004) analyzed previous reports and literatures that have defined organizational indicators of safety culture and proposed five global components or indicators of safety culture.

These indicators are organizational commitment, management involvement, employee empowerment, reward system, and reporting system (Wiegmann, Hui Zhang, et al., 2004). Another study in the U.K by Her Majesty's Railway Inspectorate suggested five indicators that influence safety culture including leadership, two-way communication, employee involvement, learning culture, attitude toward blame (Health and Safety Executive, 2005)

2.5 Assessment of Safety Culture in Aviation

The assessments of safety culture in aviation have been implemented among pilots, mechanics, air traffic controllers, and other employees in the airline. The use of safety climate questionnaire, the measurable facet of safety culture, has been commonly used to measure organizational safety culture. The analysis of safety culture has been diverse across literatures to investigate different types of effects on individual behaviors and safety outcomes.

O'Connor, O'Dea, Kennedy, and Buttrey (2011) reviewed previous researches that have evaluated an assessed safety climate within commercial and military aviation field. A total of 23 studies have been reviewed and categorized by their focus areas of assessment. Researches were focused on different groups within the aviation domain such as pilots, cabin crew, ground handlers, air traffic control, maintenance, and employees from other departments.

Results indicated that previous researches have construct validity in which factors identified were consistent with theory and measured what it was supposed to measure. There is still not an agreed common set of factors to measure safety culture or safety climate across literatures. They further included "in the absence of evidence supporting a link between safety climate and other measures of performance it will be difficult to convince the aviation industry of the utility of the survey as an accident prevention tool". The need to evaluate the effect of prevailing safety culture on human performance measures is vital to appreciate the significance of assessing safety culture.

Lin (2012) analyzed the relationship between safety mission statement and safety behavior in the airline industry. The study used three intervening variables; organizational identification, organizational culture, and safety culture to survey and model the process of brokering knowledge from management to worker on assignment, pilots. Path analysis was used to identify the direct and indirect effects between safety mission statement, organizational identification, organizational culture, and safety culture and safety behavior.

Pearson correlation analysis indicated that there were high correlations between the five factors and especially between safety mission statement and organizational identification, organizational culture and safety culture, organizational identification and organizational culture, and safety culture and safety behavior (Lin, 2012). The study have also indicated that there is a positive influence of safety culture on safety behavior which emphasis the role of safety culture influence on crew performance and overall safety of the airlines.

Kelly and Patankar (2004) used the Organizational Safety Culture Questionnaire (OSCQ) to evaluate current safety culture at two aviation organizations. The OSCQ was based on Patankar (2003), which utilized questions from Cockpit Management Attitude Questionnaire by Helmreich and Merritt, Maintenance Resource Management/ Technical Operation Questionnaire, and Command Safety Assessment Questionnaire. In addition, the OSCQ added few questions to measure organizational attachments and perception of professionalism between flight operation and maintenance personnel. The 50 questions survey was distributed among mechanics, pilots, and other employees within the two organizations. Results from each professional group were compared between the two organizations. The outcome of the study revealed that safety culture highly influences pilot and mechanics. Different attitudes and opinions regarding safety between the two organizations reflect different organization culture (Kelly & Patankar, 2004).

Gill and Shergill (2004) developed and tested a safety assessment questionnaire in a flight training facility in New Zealand. The safety assessment questionnaire addresses the organization approach to safety management, safety management system, and safety culture. The 52 questions included in the survey were divided evenly into two main sets; "organization's approach to safety management" and "safety management system, and safety culture in organization". The organization approach to safety management questionnaire was designed to capture employees' perception regarding the role of their organization and management to ensure safety. The safety management system and safety culture questionnaire sought employees' perceptions on the prevailing safety attitude and beliefs and how safety was managed within their organization.

Four factors were extracted that addressed the organization approach to safety management including positive safety practices, safety education, implementation of safety policies and procedures, and individual's safety responsibilities.

The other section of the questionnaire included 26 questions designed to discover respondents' view in regard to safety management system and safety culture in their organizations. Four factors were extracted including respondents' views about the ways their organizations manage safety, regulator's role, Luck and safety, and safety management, training, and decision- making. Study results indicated that employees believed their organizations were not giving much importance to safety management system and safety culture.

Wang and sun (2012) developed a new safety culture evaluation index based on the Integrated Safety Culture Model. The index was designed to analyze safety culture from two levels of intrinsic and extrinsic level. Safety culture was divided into seven safety sub-culture which includes safety priority culture, standardizing culture, flexible culture, learning culture, teamwork culture, reporting culture, and just culture. The new model illustrates the relationship between safety sub-culture and all of the safety culture dimensions. The new evaluation index enable researcher to evaluate safety culture from two prospective levels, intrinsic and extrinsic.

Evans, Glendon, and Creed (2007) developed a measurement tool to evaluate the level of perceived safety climate especially for pilots. The study identified six broad safety climate themes from previous researches and consultations with experts in the aviation field. The six themes include management commitment to safety, communication, rules and procedures, shifts and schedules, safety training, equipment and maintenance.

A survey including 30 questions addressing the six themes was developed and distributed to 5000 commercial pilots registered with the Civil Aviation Safety Authority in Australia. An Exploratory Factor Analysis (EFA) was performed to identify significant factors. Analyses revealed three significant factors and yielded 18 questions in the final survey. The main three factors are: management commitment and communication, safety training, and equipment and maintenance. A Confirmatory Factor Analysis was performed on the remaining sample. The purpose of the CFA was to test the validity of the proposed structure by the EFA. Results showed adequate fit to the three factor model which suggested its use in future research (Evans, Glendon, & Creed, 2007)

Weigmann, von Thaden, Mitchell, Sharma, & Zhang, (2003) developed and validated the Commercial Aviation Safety Survey (CASS) to evaluate safety culture within the commercial aviation industry. The survey was designed after reviewing previous studies and researches on organizational culture and organizational climate from 1974 to 2001. Out of 107 studies, thirty surveys only discussed safety culture and safety climate while other studies focused on organizational culture without safety or discuss organizational safety without considering culture. Five components of safety culture were identified after reviewing previous research which includes Organizational Commitment, Management Involvement, Employee Empowerment, Reward System, and Reporting System (Weigmann, von Thaden, Mitchell, Sharma, & Zhang, 2003).

The initial survey included 86 questions and was distributed to a regional airlines operating under Federal Aviation Regulation Part 135. A total of 93 pilots and 15 management/supervisory personnel participated in the survey. All five safety culture components had adequate standard reliability. Employees had a positive perception about safety culture in their airline where the mean score was above the neutral point for all five dimensions (von Thaden, Wiegmann, Mitchell, Sharma, & Zhang, 2003). Further analysis suggested changing the Reward System scale to Accountability because performing a safe behavior is an internal component of a pilot's job not a manner where he/she should be rewarded for. It is more appropriate to evaluate safe behavior of pilots inside the cockpit under accountability and consistency rather than reward or recognition. There was a high correlation between Organizational Commitment to safety and Management Involvement. Both seemed to measure the same construct which may create duplicate answers in the survey.

Gibbons, von Thaden, and Wiegmann (2006) revised the CASS to include 84 items. The survey was distributed to 1725 pilots and managers of a large U.S airline. Out of the 1725 surveys, 503 were returned for further analysis. The original 5-factor model did not fit as hypothesized. Exploratory Factor Analyses was performed to determine misalignment of the data within the model. Results and comments from participants suggested a conceptual revision of the model and survey. The new version of the CASS includes 4 main factors and 12 subfactors. The revised CASS had four dimensions including Organizational Commitment (Safety Values, Safety Fundamentals, Beyond Compliance), Operations Personnel (Chief Pilots, Dispatchers, Instructors/Trainers), Formal Safety System (Reporting System, Response and Feedback, Safety Personnel), and Informal Safety System (Accountability, Pilot Authority, and Professionalism). The revised survey included 55 items evaluating the safety culture within airline's flight operation. Figure 4 illustrates the revised four factors CASS (Gibbons et al., 2006). The new revised model demonstrated substantial improvement over the original model in which provides and addresses more in-depth information about safety culture in the airline.

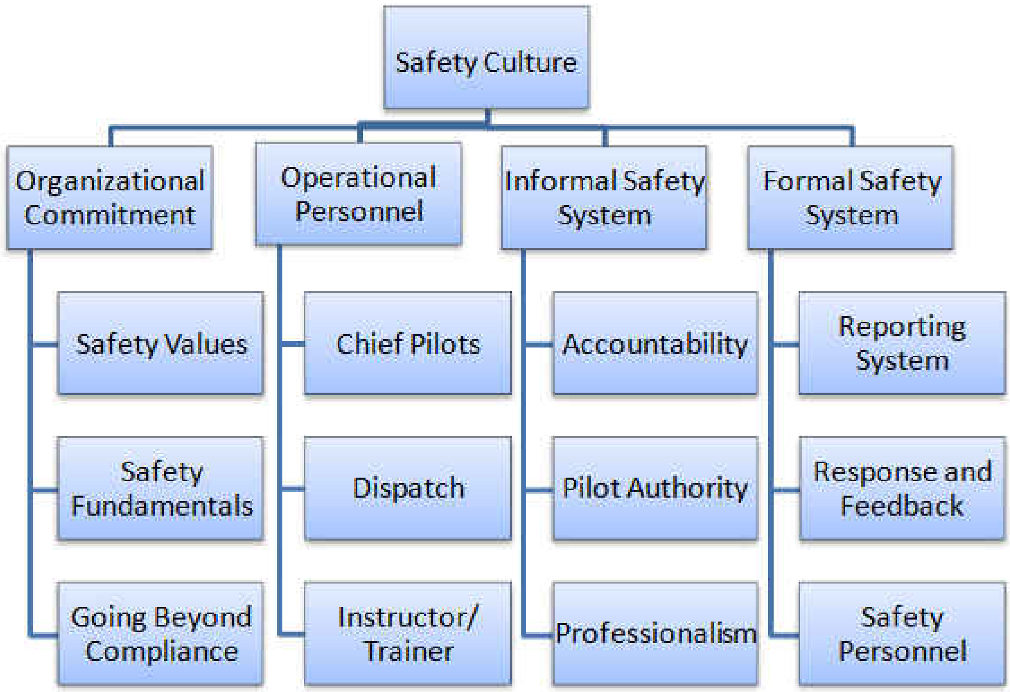

Figure 4 Revised version of the CASS. Gibbons, von Thaden, and Wiegmann, 2006

von Thaden et al. (2006) applied the CASS in the Chinese commercial aviation to validate the four-factor model in different aviation culture. Two Chinese airlines participated in the CASS, airline (A) and airline (B). A total of 630 surveys were distributed between the two airlines, 430 to airline (A) and 200 to airline (B). A confirmatory factor analysis was used to determine if the four factors model fit in the Chinese context. The mean score of each of the four factors of safety culture was calculated and compared between airline (A) and (B). In addition, the mean score of each subfactor was compared between the two airlines.

The four factors model revealed important insight about each airline's safety culture. For example, airlines (A) informal safety program had a mean score of 3.77 on the 7-point scale which indicates slight disappointment of employee attitudes regarding the informal safety program. Further analysis of each subfactor indicated that the mean value of accountability, pilot authority, and professionalism is 3.10, 3.74, and 4.49 respectively. A clear weakness in the accountability measure was observed. This could be related to the airline's culture of having favoritism to some pilots or management reaction toward pilots when an incident happens (von Thaden, Li, Feng, Li, & Lei, 2006). Results of the study indicated that both airlines' pilots have a negative perception of management and a positive perception about their professionalism, instructors, and trainees.

von Thaden, Kessel, & Ruengvisesh (2008) used the CASS to evaluate the safety culture within a major European airline's flight operation. The study involved regular line pilots and upper management pilots. The Cronbach's alpha coefficient was used to measure the reliability of the survey among European airline pilots. Adequate reliability was observed among all four factors of safety culture with an alpha value of 0.97. Pilots showed exceptionally positive perception of safety culture in instructor/ trainers, operation control, maintenance, flight attendants, safety personnel, and safety behaviors. Negative indicators of safety culture were observed in safety value of leadership, going beyond compliance, ground handling operations, reporting system, and accountability. The study showed that the airline has positive and effective safety culture with few negative indicators (von Thaden, Kessel, & Ruengvisesh, 2008)

Since the airline has an exceptionally high level of safety records, study results suggested a high relationship between pilots' motivation and safety attitudes which could result in an incident or accident (von Thaden et al., 2008). The outcomes of the study indicated the significant need to evaluate safety culture in an airline to ensure a free accident environment.

2.6 Employees' Commitment

Motivation and commitment are keys to organizational success. Making employees feel they are very important part of the company have significant influences on their performance. Delta airlines managed to survive during fiscal disparity such as deregulation, 9/11, bankruptcy, merger, and competing with low cost operators. The secret behind Delta's success is the Employee Involvement program at Delta which motivates people and brings the best of them. Delta have managed to run this program since airlines deregulation and name it "the spirit if Delta" (Kaufman, Jan2013 Supplement). Employees at Delta feel attached to their organization and perform more than what they are expected of them. Delta employees showed a perfect example when three flight attendants started a fund raiser for the airline to purchase the first Boeing 767 in the company. Employees along with retiree and community partner managed to secure $30 million as a gift for the airline (Kaufman, Jan2013 Supplement; Walton, 1985). This was a clear message to other airlines and organization that if you take care of your employees, they will take care of you.

Organizational commitment explain the relationship between employees and their organization (Commeiras & Fournier, 2001). While most of the airlines in the U.S were undergoing through financial crisis, Southwest airlines continued to make profit and have high customer satisfaction (D'Aurizio, 2008). A former employee of Southwest airlines summarized nine loyalty lessons that have contributed to the success of the company: hire attitude- train skill, immerse everyone in the culture immediately, keep employee learning, people give as good as they get, find the kid in everyone, do more with less, love employee in tough times, do what's right, and nurture the corporate family (Grubbs-West, 2005. As cited from D'Aurizio, 2008). These loyalty lessons between the employees and the company have significantly contributed to high customers satisfaction and translate into millions of dollars in revenue (Hallowell, 1996).

There are two dimensions of organizational commitment suggested by researchers in the field: the affective dimension and the calculative dimension. The affective dimension reflects a "strong belief in and acceptance of the organizational goals and values, willingness to exert considerable effort on behalf of the organization, and a strong desire to maintain membership in the organization" (Moday et al. 1982, as cited from Commeiras & Fournier, 2001). On the other hand, calculative dimension reflects employees' decision to stay or leave the company based on time spend on the job, resources devoted to the company, and cost of changing the job (Commeiras & Fournier, 2001).

The organizational commitment questionnaire (OCQ) by Porter, L.M., Richard M. Steers, Richard T. Mowday and Paul V. Boulianl (1974) has been extensively used in researches and literatures to measure employees' commitment and the degree of their attachments to the organization (Commeiras & Fournier, 2001). The survey has two versions: 15 item questions and 9 item questions. Commeiras and Fournier (2001) investigated both versions of the survey to determine the most effective way of measuring organization commitment. Recommendations were to use the 9-item version instead of the 15-item because it had a better fit and provided detailed insights about affective commitment. In this research, the OCQ is used to measure pilot commitment to the airlines to identify the extent of their attachment to the airline.

Chen (2006) investigated the effect of organizational commitment, job satisfaction, and individual factors on flight attendant turnover in Taiwanese airlines. The study used the OCQ to measure flight attendant commitment to the airline. Analysis showed that job satisfaction and organizational commitment have a negative impact on turnover intentions (Chen, 2006). This emphasizes the responsibility of management to provide an atmosphere that will improve job satisfaction and employees 'commitment. In addition, Block, et al. (2007) identified two main factors affecting flight crew safety: organizational affiliation and proactive management.

Organization focusing on improving safety within their organization should consider changing the work environment to motivate people instead of taking a punitive approach toward those who fail to comply with standard work procedure (Neal & Griffin, 2006). Motivation has a great effect on safety by influencing the behavior of people in the workplace. Pilots carry on their duties under certain sets of rules and procedures during flights. In addition, pilots are subject to different kind of stresses from passengers, air traffic control, weather, and frequent takeoffs and landings. In aviation, pilot commitment to the airline should be hypothesized to have great influences on safety because it will affect the behavior of pilots operating behind flight control.

CHAPTER 3: METHODS AND PROCEDURES

3.1 Introduction

The focus of this research was to assess safety culture among pilots of Saudi Airlines. The research investigated whether the prevailing safety culture had an effect on pilot commitment to the airline and safety performance. In addition, the research investigated whether pilot commitment to the airline mediates the relationship between safety culture and safety performance. Measuring safety performance was based on pilot behavior to make error and own attitude toward violations. Therefore, the research was focused on answering the following questions:

Q_1: What is the influence of safety culture on pilot commitment to Saudi Airlines?

Q_2: What is the effect of current safety culture on pilot error behavior?

Q_3: What is the effect of current safety culture on pilot own attitude toward violations?

$Q_{4:}$ Does pilot commitment to Saudi Airlines mediates the relationship between safety culture and pilot error behavior?

$Q_{5:}$ Does pilot commitment to Saudi Airlines mediates the relationship between safety culture and pilot own attitude toward violations?

A proposed model evaluating the relationships between safety culture, pilot commitment to the airline, pilot error behavior, and pilot own attitude toward violations was constructed. Figure 5 illustrated the proposed model of safety culture- safety performance. Each variable in the study was measured by using survey questionnaires which had been used and validated in previous researches. Structural Equation Modeling (SEM) was used to analyze the relationships between these factors.

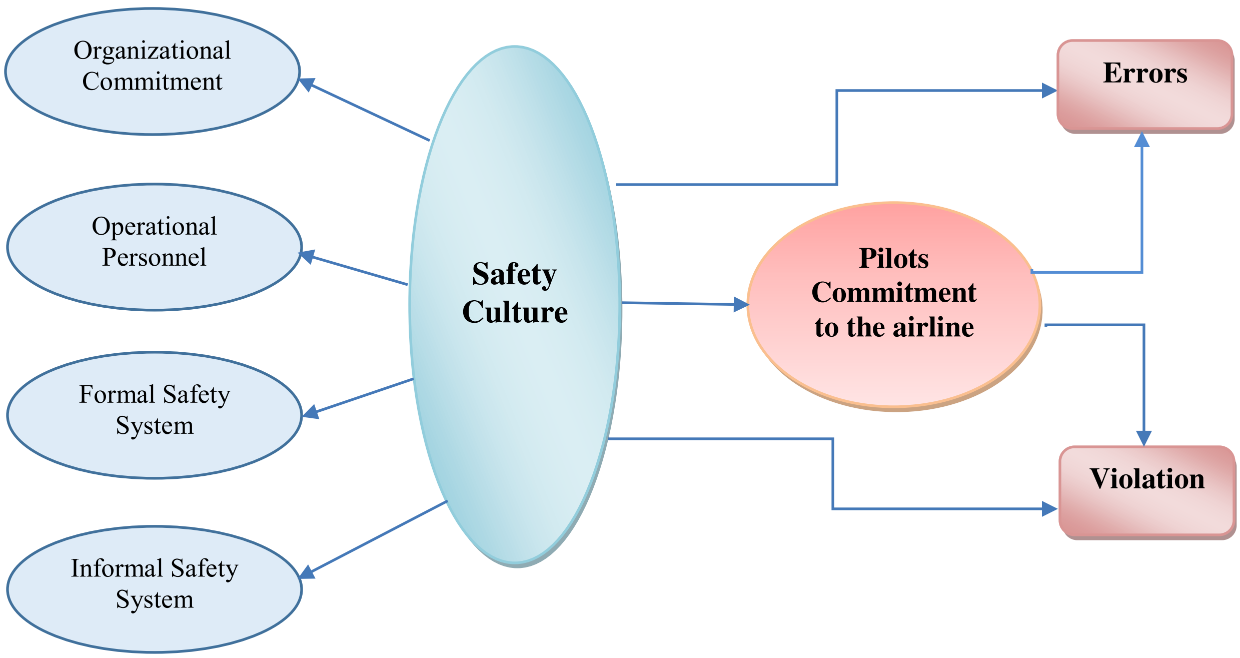

Figure 5 Proposed model of Safety Culture- Safety Performance

3.2 Survey Instrument

Survey instrument has been extensively used to assess safety culture in various industries such as manufacturing, transportation, construction, nuclear power, and chemical (Gibbons et al., 2006). It is the most practical way to collect data from employees in terms of time and cost. The study used four surveys to measure safety culture, pilot commitment to the airline, pilot error behavior, and pilot own attitude toward violations. Demographic information such as crew position, current aircraft flying, flying experience with Saudi Airlines, and flying experience other than Saudi Airlines were inquired at the beginning of the survey. An internal consistency estimate of reliability Cronbach's alpha was measured for each factor to determine the reliability of each scale. Cronbach's alpha indirectly indicates the degree to which a set of items relates to a latent construct. A minimum value of 0.70 or above was required to ensure adequate reliability.

Safety culture was measured using the CASS developed by Gibbons et al. (2006). The survey included 55 questions addressed on a 7-point Likert scale ranging from 1 (strongly disagree), 4 (neither agree nor disagree), to 7 (strongly agree). The survey measured various aspects of safety culture in the airline. The CASS consists of four main factors measuring safety culture including Organizational Commitment, Operational Personnel, Informal Safety System, and Formal Safety System.

The second survey was the OCQ developed by Porter et al. (1974). The survey had been used extensively in previous researches to measure the level of attachment of employees to their organization. The short version suggested by Commeiras and Fournier (2001) was used to measure pilot commitment to the airline. Nine questions measure the affective dimension of pilot commitment to the airline on a 7-point Likert scale ranging from 1 (strongly disagree), 4 (neither agree nor disagree), to 7 (strongly agree). Two questions were dropped because they were not applicable in Saudi Airlines. The remaining seven questions were used to measure pilot commitment to Saudi Airlines.

Pilots own attitude toward violations was measured by Fogarty (2010) own attitude to violations scale. The scale has nine questions addressing employees' attitude to commit violation on a 5-point Likert scale. Due to similarities between some questions in the survey, two questions were deleted to avoid replications. Therefore, seven questions were suggested to measure pilot's own attitude toward violation. In addition, minor changes to some of the terms in the survey were made to ensure clarity to participating pilots.

The fourth survey measured pilot error behavior by using Fogarty (2004) error scale questionnaire. The survey includes three questions addressing maintenance personnel errors behavior within an airline. The questions are general and can be applied to airline pilots. The researcher added one question: "I am more likely to make judgment errors in abnormal or emergency situations" from the Flight Management Attitude Questionnaire (FMAQ) developed by Helmreich, R. L., Merritt, A. C., Sherman, P. J., Gregorich, S. E., & Wiener, E. L. (1993) (Sherman, Helmreich, & Merritt, 1997) . All four questions were addressed on a 5-point Likert scale.

3.3 Study Variables

Study variables in the research were factors measuring safety culture, pilot commitment to the airline, pilot error behavior, and pilots own attitude to violation. The CASS was used to assess safety culture. It consisted of four main factors evaluating safety culture in the airline. These factors are latent variables including Organizational Commitment, Operational Personnel, Informal Safety System, and Formal Safety System. Safety culture was the exogenous variable affecting pilot commitment to the airline, pilot error behavior, and pilot own attitude toward violation. Pilot commitment to the airline was the mediating variable between safety culture and pilot error behavior and own attitude toward violation. In addition, demographic variables such as crew position and flying experience offered extra classifications to the analysis. A definition of each study variables is presented in table 1 which consist of exogenous variables, mediating variables, endogenous variables, and demographic variables.

Seven latent variables were evaluated in the study. Safety culture was the exogenous variable which has four dimensions including organizational commitment, operational personnel, formal safety system, and informal safety system. Pilot commitment to the airline was the mediating variable between safety culture and the two measures of safety performance. The endogenous variables were the two measures of safety performance which include pilot error behavior and pilot own attitude toward violations. Each latent variable is discussed in details in the following section.

3.3.1 Organizational Commitment

Organizational commitment to safety refers to how the airline values safety on its daily practices. The organizational commitment factor consists of fourteen questions addressing how the airline value safety as a main core, safety fundamentals practices, and the airline efforts into going beyond safety compliance.

Safety value was measured by five questions which define how management or leadership regards safety in the organization. The questions focus on observing management's attitudes and values expressed in words and actions regarding safety (von Thaden & Gibbons, 2008). For example: "Management expects pilots to push for on-time performance, even if it means compromising safety."

Safety fundamental was measured by five questions which describe airline's willingness to invest money to improve safety. This includes equipping aircrafts with up to date technologies, updating manuals, and ensuring adequate maintenance procedures are performed. For example: "my airline is committed to equipping aircraft with up to date technology."

Going beyond compliance was measured by four questions which discuss management's commitment to meeting or exceeding safety requirements. This includes, implementing higher than regulatory minimum such takeoff-landing visibilities and cross- wind landing. Moreover, Management considerations to pilot schedule and violations of regulation are discussed. For example: "management goes above and beyond regulatory minimums when it comes to issues of flight safety."

3.3.2 Operational Personnel

The operational personnel reflect pilots' relationship with middle management, supervisors and other operational personnel. Pilot's interactions with chief pilot, dispatch, and instructor/ trainers were discussed. These interactions refer to the degree to which middle management, supervisors or trainers, and dispatch are committed to safety.

Five questions addressed the relationship between pilots and chief pilots who interact with pilots regularly. In Saudi Airlines, the chief pilot position is referred to as the general manager (GM) flying. The GM flying does not interact with pilots as much as equipment managers and supervisors do. Therefore, the term chief pilot in the CASS was replaced by equipment manager/ supervisors to avoid confusion or ambiguity among participating pilots. These questions discuss how equipment manager/ supervisors understand risk involved in flight operation and their willingness to discuss safety issues with pilots. For example: "Equipment managers/ supervisors do not hesitate to contact line pilots to proactively discuss safety issues."

Four questions measured flight dispatcher professionalism and commitment to safety. Questions explain how dispatcher emphasizes important information about weather and safety issues related to the safety of flight. Moreover, questions investigate whether dispatcher is more concern with safety issues or cancelling the flight. For example: "Dispatch would rather take a chance with safety than cancel a flight."

Pilots interact with instructor pilots (IPs) regularly during recurrent training and proficiency check once every six months. Four questions measured IPs understanding with risk associated with flight operation, level of safety emphasized, and IPs commitment to safety. Example: "Instructors prepare pilots for various safety situations even uncommon or unlikely ones."

3.3.3 Informal Safety System

The informal safety system factor addressed the level of accountability among pilots in Saudi Airlines, level of pilot authority, and professionalism among fellow pilots. The accountability dimension referred to the ways in which pilots are treated based on their safe or unsafe behavior. Four questions discussed the fairness of treatment among pilots in the airlines which include favoritism to certain pilots, consistently applying standard accountability measures, fair treatment when pilot make a mistake, and management reaction toward pilot when an accident or incident happen. Example: "When pilots make a mistake or do something wrong, they dealt with fairly by the airline."

Five questions measured pilots' authority in the airlines and to what extent they can make changes regarding safety issues. Example: "Pilots are actively involved in identifying and resolving safety concerns."

Professionalism among fellow pilots measured pilot's perceptions of other pilots regarding airline safety. Five questions concentrated on pilot's view of the airline's safety record, attitude toward unprofessional pilots or pilots with unsafe behaviors, level of authority inside the cockpit, and whether operational pressure compromises safety. Example: "Decisions made by senior pilots are difficult to change."

3.3.4 Formal Safety System

The effectiveness of the airline's reporting system is very important to address safety concerns. Having a punitive approach can devastate the usefulness of the reporting system in the airline and cause fear among pilots to report safety issues (Patankar, Brown, et al., 2012). The formal safety system factor evaluated the effectiveness of the reporting system in Saudi Airlines, report and feedback, and safety personnel authority.

Five questions rated the usefulness of using the reporting system in the airline, their willingness to report unsafe behavior of other pilots, reporting near misses or close calls even if there is no damage involve, and their willingness to report unsafe situations caused by their own. Example: "The safety reporting system is convenient and easy to use."

Response and feedback are part of the reporting system. Pilots rated management response and feedback to safety issues raised by their own. The time that management takes to respond to safety concerns is vital to ensure effective communication and provide a continuous improvement culture in the airline. Four questions addressed the effectiveness of the response and feedback system in the airline regarding safety concerns. Example: “When a pilot reports a safety problem, it is corrected in a timely manner.”

Safety personnel include people who are responsible for safety in the airline such as vice president of safety or safety managers. Five questions evaluated the level of safety personnel authority and effectiveness to promote safety practices in the airline. Example:” Personnel responsible for safety have the power to make changes.”

3.3.5 Pilot Commitment to the Airline

Pilot commitment to the airline explained pilot loyalty to Saudi Airlines and their willingness to put extra efforts to improve the airline. Pilot commitment to the airline was the mediating variable between safety culture and the two measures of safety performance. Pilot commitment to the airline was hypothesized to mediate the relationship between safety culture and pilot error behavior and own attitude toward violations. The influence of the prevailing safety culture on pilot commitment was hypothesized to be significantly positive. The 9- item version of the OCQ proposed by Commeiras and Fournier (2001) was used to measure pilot commitment to Saudi Airlines. Example: “I am willing to put in a great deal of effort beyond that normally expected in order to help this organization be successful.” Two questions were eliminated because they were no applicable to use in Saudi Airlines. The remaining seven questions were used to evaluate pilot commitment to the airline.

3.3.6 Own Attitude to Violations

Safety performance was measured by pilots own attitude toward violations and pilot error behavior. Seven questions addressed pilot own attitude toward violation. Questions evaluated pilot attitudes toward shortcuts, adherence to company procedures, and reporting violations. Example: “I will say something if my peers the other pilot takes shortcuts.”

3.3.7 Pilot Error Behavior

Pilot error behavior was the second variable in the study to evaluate safety performance. Four questions measured pilots’ errors behavior while on duty. Questions articulated around errors frequency and workload factors affecting errors. Example: “I make errors in my job from time to time.”

Table 1 Study Variables and Explanations

Study Variables	Dimensions	Explanations
Safety Culture *(Exogenous Variables)*	Organizational Commitment	Leadership attitude and values regarding safety, words and actions
		The compliance with regulated aspects of safety such as manuals
		Priority is given to safety in the allocation of company resources
	Operational Personnel	The relationship between pilots and middle management such as chief pilot, dispatch, a and instructor trainer
	Informal Safety System	Consistency and appropriateness with which individual are held accountable for unsafe behavior
		Pilot involvement and empowerment in safety decision making
		Peer culture for safety, pilot professionalism
	Formal Safety System	Accessibility, familiarity, and actual use of airline reporting system
		The timeline and appropriateness of management response to reported safety information and dissemination of safety information
		The perceived effectiveness of and respect for persons in formal safety roles
Pilot Commitment *(Mediating Variables)*		A strong belief and acceptance of the airline's goals and values, and a strong desire to maintain membership in the airline
Crew Performance *(Endogenous Variables)*	Violation	Pilots own attitude to violation
	Error	Pilots' error behaviors
(demographic Variables)	Crew Position	Captain -First Officer- Trainee- Second Officer
	Aircraft	Boeing 747,777 - Airbus 330,320 - MD11- E 170
	Flying Exp	Pilots' flying experience in Saudi Airlines Only

3.4 Procedures

Management approval to conduct the study was the first step before any data can be collected. A cover letter explaining the purpose of the study and participants' confidentiality was provided. Participation was voluntary and anonymous to ensure accurate response of participants.

To maximize the number of participants in the study, three distribution methods were implemented. The first one through company emails where pilots receive all company information and updated bulletins. The email included a brief introduction of the purpose of the study and a direct link to the survey. The email method was the easiest and most efficient because pilots are frequently flying and can check their emails on their phones or computers during layovers or days off at any time. The second method was through pilots' mail boxes in the flight operation. Pilots check their mailboxes regularly before each flight to collect company's bulletins, flying revisions, and personal mails. Participants had to return the survey to the researcher mailbox in flight operation. The third method was through fellow pilots in the airline where they encouraged others to participate and assured accuracy of response.

3.4.1 Institutional Review Board (IRB)

The nature of the study involved current pilots flying at Saudi Airlines. It was essential to obtain an Institutional Review Board (IRB) approval before distributing the survey. An informed consent as well as an invitation to participate in the study was provided on the first page of the survey. Participation in the survey was voluntary, and all participants had the right to discontinue the survey at any time.

The study assured confidentiality of all information and did not involve any risk to participating pilots. The survey did not include any personal information such as name or payroll number. Demographic information such as crew position, current aircraft flying, and flying experience with Saudi Airlines were used. The researcher was responsible for keeping all information confidential and secures the data safely.

3.5 Sampling

The population of the study consisted of current airline pilots flying at Saudi Airlines. Flying crew includes captains and first officers. The study targeted all pilots flying in the airlines including line pilots, supervisors, fleet managers, and pilots holding higher managerial positions in several departments in the airlines. The total email list which was provided to the researchers included 850 pilots. Saudi Airlines currently has a total of 106 aircrafts including Boeing 747-400, 777-200, 777-300, Airbus 330, 321, 320, and Embraer 170 .

Permission from top management to conduct the study was granted to process the survey through company emails. To ensure high participations among pilots, the survey was distributed via company emails, pilot mailbox, and personal face to face. Fellow pilots were assigned to distribute the survey among other pilots to increase the number of participants and assure accuracy of response. Being a pilot in Saudi Airlines for more than eight years, the researcher did not have any difficulties to collect the data from fellow pilots in the airline.

3.5.1 Sample size

In any empirical study, the sample size plays a significant role to make inferences about a certain population group. As a general rule, the larger the sample, the better conclusion can be drawn about the population (Leedy, P.D & Ormrod, J. E, 2010). Various rules have been suggested to determine adequate sample size in covariance model. In order to reduce biases to an acceptable level, a minimum sample of 200 is needed in any SEM estimation (Boomsma & Hoogland, 2001; Kline, 2010). Another method to determine the required sample size is based on the number of variables being analyzed ranging from two subject per variables to twenty subjects per variable (Stevens, 2002).

The required sample size in this research was based on Boomsma and Hoogland (2001) which requires a minimum sample size of 200. With current target population of 850, a response rate of 23% was sufficient to meet the minimum sample size of 200.

3.6 Statistical Analysis

Statistical analysis in this research included descriptive statistics, confirmatory factor analysis, structure equation modeling, and test of hypotheses. A description of each analysis is detailed in the following section.

3.6.1 Descriptive Statistic

Frequency tables for all control variables were used to illustrate number and percentage of participating captain and first officers, current aircraft flying, flying experience with Saudi Airlines, and flying experience other than Saudi Airlines. In addition, data were analyzed for multicollinearity problem. In social research, multicollinearity is a common problem where two variables have high intercorrelation and tend to measure the same thing. A correlation of 0.85 or higher can signal multicollinearity problem (Kline, 1998a). Since data in the research are ordinal, Spearman's correlation matrix were used to detect multicollinearity for each latent variable (Schumacker & Lomax, 2010).

3.6.2 Confirmatory Factor Analysis

Confirmatory factor analysis (CFA) is an extension of factor analysis which test whether a set of items defines a construct (Schumacker & Lomax, 2010). A Confirmatory Factor Analysis was conducted to validate the measurement model of each latent construct. The CFA evaluates the construct validity of the proposed model to determines whether it is intended to measure what it is supposed to measure (Kline, 1998b). The CFA was performed using AMOS 22 software.

Goodness of fit indices are used to determine how well the model fit the collected data. A single fit index is not enough to support the fitness of the model to a given data set (Vandenberg & Scarpello, 1990). On the other hand reporting all fit indices is not recommended (Hooper, Coughlan, & Mullen, 2008). The study used four fit indexes to determine the fitness of the proposed model. The first index is the chi-square statistic which tests the closeness of fit between the model examined and a perfect fit or saturated model. It indicates the goodness of fit of the model to the data (Hu & Bentler, 1999). A low value of the chi-square indicates a better fit of the model to the data. However, the chi-square index is sensitive to sample size and can result in an inflated chi-square statistics. Previous researches recommended a ratio of chi-square to degrees of freedom of between two and three represents an acceptable fit.

The second and third fit indices are the comparative fit index (CFI) and the Tucker-Lewis index (TLI). The CFI compares the hypothesized model with a null model and considered to be reasonably robust against violation of assumption. A value above 0.95 is considered good whereas a value between 0.90 and 0.95 is acceptable. The TLI is used to compare a single model or alternative models to a null model and is less sensitive to sample size. A value of more than 0.95 indicates a good fit while a value between 0.90 and 0.95 is acceptable. In addition, a value of less than 0.90 requires a restructure of the model (Hu & Bentler, 1999).

The fourth fit index is the root mean square error of approximation (RMSEA) which account for model complexity. The lower the value, the less manipulation of the fit exists. A value of less than 0.05 considered a good fit while a value between 0.05 and 0.08 indicate an adequate fit. A model of 0.10 or more considered poor fit to the data (Evans et al., 2007).

3.6.3 Structural Equation Modeling

The main purpose of SEM is to determine the extent to which hypothesized model is supported by sample data. Structural equation modeling (SEM) determines the effects and relationships between variables in the proposed model. SEM determines the extent to which the theoretical model shown on figure 5 is supported by data collected from the relevant sample. After validating the measurement model, factor score of each construct was imputed using AMOS 22 software. A composite structural model was build based on factor score of each construct to test the relationship between safety culture, pilot commitment, pilot error behavior, and own attitude toward violation. Safety culture was the only independent variable in the model. Pilot commitment to the airline was the mediating variable between safety culture and the two measures of safety performance pilot error behavior and own attitude toward violation. The dependent variables in the study were pilot error behavior and pilot own attitude toward violations.

CHAPTER 4: FINDINGS

This chapter describes the four types of statistical analysis used in the research to analyze the data. A descriptive statistic was conducted by creating frequency tables of the control variables. Data with incomplete responses were eliminated and only completed responses were used for the analysis. A Spearman's rho correlation matrixes for each latent variable were performed to detect multicollinearity problem.

This research used structural equation modeling to analyze the effect of safety culture on safety performance and the mediating role of pilot commitment to the airlines. The first step in a structural equation modeling is to validate the measurement model (Hu & Bentler, 1999). A confirmatory factor analysis was conducted for each latent variable to validate each construct. After validating each latent construct in the study, a confirmatory factor analysis for the measurement model including all variables in the research was conducted. The internal consistency of each measurement model was evaluated by Cronbach's alpha.

After validating the measurement model, a composite structural model was developed including all exogenous and endogenous variables to analyze the relationships between safety culture, pilot commitment to the airline, pilot error behavior, and own attitude toward violation. The original structural model was revised to improve model fit and eliminate weak relationships. The process of revising the original model is described in the following section. Finally, hypothesis testing was conducted based on structural equation modeling results.

4.1 Descriptive statistics

The population of the study was pilots from Saudi Airlines both captains and first officers. The most efficient way to reach pilots was through email due to the nature of their job and being outside home base most of the time. A web- based survey was distributed among all pilots in the airline using www.SurveyMonkey.com. The survey was distributed to 850 pilots in the airline. A total of 374 pilots participated in the survey. A total of 247 pilots have completed the entire survey which represent 29% response rate and were used for analysis.

4.1.1 Control Variables

Control variables were demographic information retrieved from participating pilots to provide more insight into the research. Four demographic information were collected from participating pilots; crew position, current aircraft flying, years of flying experience with Saudi Airlines, and previous flying experience other than Saudi Airlines.

The first demographic information was crew position. A total of 151 captains (61%) and 96 first officers (39%) completed the survey. Captains were more enthusiastic than first officer to participate in the survey.

Pilots flying different types of aircraft in Saudi Airlines have participated in the survey. The majority of pilots who participated in the research were pilot flying Boeing 777, 116 pilots (47%). The second most pilots who participated were pilots flying Airbus 320, 60 pilots (24.3%). The high percentages of participating pilots flying Boeing 777 and Airbus 320 were expected because both aircrafts have the highest population of pilots in Saudi Airlines. On the other hand, the least participants were MD 90 and Boeing 747-200 pilots. One pilot from MD-90 and 3 pilots from Boeing 747-200 participated at (0.4%) and (1.2%) respectively. Pilots flying Boeing 747-400 were 22, (8.9%). Pilots flying 747-800 were 13, (5.3%). Pilots flying Airbus A330 were 21 pilots (8.5%). Pilots flying Embraer 170 were 20 pilots (8.1%). Table 2 illustrates number and percentages of pilots who participated in the survey based on their current aircraft flying. The total number of participating pilots based on their current aircraft flying is more than 247 because pilots who fly Boeing 747-400 are also qualified to fly Boeing 747-800, and some of them selected both aircraft when completing the survey.

Table 2 Participant current aircraft flying

Current Aircraft Flying		
Answer Options	Response Percent	Response Count
B747-200	1.2%	3
B747-400	8.9%	22
B747-8	5.3%	13
B777	47.0%	116
A320	24.3%	60
A330	8.5%	21
MD11	2.0%	5
MD 90	0.4%	1
EMB 170	8.1%	20

The survey was targeting all generation of pilots in the airline. Different strategies to maximize the response rate were utilized such as follow up emails, personal distribution, and management support to encourage pilots to participate in the research. Pilots with diverse flying experience with Saudi Airlines participated almost equally. Participants with flying experience 5-10 years were 41 pilots (16.6%). Participants with flying experience 15-20 years were the same 41 pilots (16.6%). Participants with flying experience 10-15 years were 38 (15.4%). Participants with flying experience 20-25 years were 23 pilots (9.3%). Participants with flying experience 25-30 years were 31 pilots (12.6%). Participants with flying experience 30-35 were 26 pilots (10.5%). The least number of participants were pilots who have more than 35 years of flying experience where only 15 pilots participated (5.9%). Table 3 shows a summary of participating pilots flying experience with Saudi Airlines.

Table 3 Participant flying experience with Saudi Airlines

Flying experience with Saudi Airlines		
Answer Options	Response Percent	Response Count
0-5 years	13.4%	33
5-10 years	16.6%	41
10-15 years	15.4%	38
15-20 years	16.6%	41
20-25 years	9.3%	23
25-30 years	12.6%	31
30-35 years	10.5%	26
over 35 years	6.1%	15

The fourth demographic information addressed if pilots have previous flying experience other than Saudi Airlines. Participants with previous flying experience other than Saudi Airlines were very low because Saudi Airlines is the flag carrier for the Kingdom of Saudi Arabia since the airline establishment in 1945. Table 4 illustrates the number and percentages of pilot with different flying experience other than Saudi Airlines. The majority of participants were Saudi national 192 pilots who did not have any previous flying experience other than Saudi Airlines (80.4%). The majority of pilots who had previous flying experience other than Saudi Airlines were 41 pilots who flew with previous commercial airliner (17.9%). Pilots with previous charter flying experience were 8 (3.4%) and pilots with previous military flying experience were 5 only (2.1%). Among all participants, there were no pilots who had previous navy flying experience.

Table 4 Previous flying experience other than Saudi Airlines

Previous flying experience other than Saudi Airlines		
Answer Options	Response Percent	Response Count
Commercial Airlines	17.3%	41
Military	2.1%	5
Navy	0.0%	0
Charter airlines	3.4%	8
Only Saudi Airlines	81.0%	192

4.1.2 Multicollinearity check

Multicollinearity is a common phenomenon in social research where two variables have high inter-correlation and tend to measure the same thing. Multicollinearity can affect the outcomes of statistical analysis and draw inaccurate results. Since data in the research are ordinal, Spearman's rho correlation best describes the correlations between all indicators (Schumacker & Lomax, 2010). A Spearman's rho correlation matrix was conducted for each latent variable in the research to check for multicollinearity problem. A correlation of 0.80 was used as a cutoff to signal a multicollinearity problem in the data. A Spearman's correlation matrix was conducted for all four dimensions of safety culture including organizational commitment, operational personnel, formal safety system, and informal safety system. In addition, Spearman's correlation matrix was conducted for pilot commitment to the airline, pilot error behavior, and pilot attitude toward violations to check for multicollinearity problem.

4.1.2.1 Organizational commitment

Organizational commitment is the first dimension of safety culture which measures how Saudi Airlines is committed to safety practices. Organizational commitment included fourteen indicators addressing safety value (SV), safety fundamentals (SF), and going beyond compliance (GB). A Spearman's rho correlation matrix was conducted for all fourteen variables of the organizational commitment. The correlation matrix is shown on Appendix C. Most correlations between organizational commitment indicators were statistically significant at the 0.05 level. SV5 did not have a significant correlation with most of the indicators and was suggested to be eliminated during the next step in confirmatory factor analysis. The highest correlation was 0.632 between SV2 and SV3, which was below the cutoff value of 0.80. Therefore, there was no multicollinearity problem among all indicators of the organizational commitment.

4.1.2.2 Operational Personnel

Operational personnel is the second dimension of safety culture which measures how operational personnel in Saudi Airline's flight operation value safety and respond to pilot's concern regarding safety issues. Thirteen indicators evaluated three operational personnel groups including aircraft supervisors (SUP), flight dispatch (DIS), and instructor pilots (IP). A Spearman's rho correlation matrix was conducted to check for multicollinearity problem between all thirteen indicators. Appendix C shows Spearman's rho correlation matrix for operational personnel. Most correlations were statistically significant at the 0.05 level. SUP5 did not have a significant correlation with most of the indicators and was suggested to be eliminated during the next step in confirmatory factor analysis. The highest correlation was 0.604 between IP1 and IP2, which was below the cutoff value of 0.80. The Spearman's rho correlation matrix indicated there was no multicollinearity problem between all indicators of operational personnel.

4.1.2.3 Formal Safety System

The formal safety systems assess the effectiveness of the reporting system in Saudi Airlines. Fourteen indicators evaluated pilots' opinion about the reporting system (RS), report and feedback (RF), and safety personnel involvement (SP). A Spearman's rho correlation matrix was conducted for all fourteen indicators to check for multicollinearity problem. Appendix C shows the result of the Spearman's rho correlation matrix. All correlations were statistically significant at the 0.05 level. RS4 did not have a significant correlation with most of the indicators and was suggested to be eliminated during the next step in confirmatory factor analysis. The highest correlation was between RF2 and RF3 and had a value of 0.617. The highest correlation among the formal safety system was below 0.80 which indicates there was no multicollinearity problem between all indicators.

4.1.2.4 Informal Safety System

The informal safety system is the fourth dimensions of safety culture and consists of fourteen indicators. The focus of this dimension was to measure the level of accountability between pilots in Saudi Airlines (AC), Pilot authority to implement safety practices (PA), and fellow pilots' professionalism (PR). A Spearman's rho correlation matrix was conducted for the fourteen indicators to check for multicollinearity problem. Appendix C shows the Spearman's rho correlation matrix for the informal safety system. Most of pilot authority indicators (PA) did not have significant correlations with other indicators and were suggested for further investigation during confirmatory factor analysis. The highest correlation was 0.47 between AC2 and AC3, which indicated there was no multicollinearity problem between all indicators.

4.1.2.5 Pilot Commitment to the airline

Pilot commitment to the airline is the mediating variable between safety culture and safety performance. Seven indicators evaluated the level of pilot commitment to Saudi Airlines (PC). A Spearman's rho correlation matrix was conducted to check for multicollinearity problem. Appendix C shows the Spearman's rho correlation matrix for the seven indicators of pilot commitment. All correlations were statistically significant at the 0.05 level. The highest correlation was 0.632 between PC2 and PC4. The Spearman's rho correlation matrix indicates there was no multicollinearity problem between all indicators of pilot commitment.

4.1.2.6 Pilot Error Behavior

Pilot error behavior consists of four indicators to measure pilot error behavior during flight (ER). A Spearman's rho correlation matrix was conducted to check for multicollinearity problem. Appendix C shows Spearman's rho correlation matrix for all indicators of pilot error behavior. All correlations were statistically significant at the 0.05 level. The highest correlation was 0.538 between ER1 and ER3 which indicates there was no multicollinearity problem between all indicators of pilot error behavior.

4.1.2.7 Pilot Attitude toward Violations

Pilot attitude toward violations consists of seven indicators (VO). Pilots were evaluated based on their attitude toward taking shortcuts, pending procedures, and reporting violations. A Spearman's rho correlation matrix was conducted to check for multicollinearity problem. Appendix C shows Spearman's rho correlation matrix for all indicators of pilot attitude toward violations. All correlations were statistically significant at the 0.05 level. VO3 did not have a significant correlation with most indicators and was suggested to be eliminated during the next step in confirmatory factor analysis. The highest correlation was 0.757 between VO1 and VO2, which was below the cutoff value of 0.80. The Spearman's rho correlation matrix indicates there was no multicollinearity problem between all indicators of pilot attitude toward violations.

4.2 Confirmatory Factor Analysis

The first step toward a structural equation modeling was to verify the validity and reliability of the measurement model. The CFA indicates whether the proposed measurement model is intended to measure what is supposed to measure (Kline, 1998b). A confirmatory factor analysis was conducted to verify the reliability and validity of each measurement model.

The first step into confirmatory factor analysis was model specification (Hu & Bentler, 1999; Schumacker & Lomax, 2010). Each latent variable consisted of several indicators which represented a construct. The relationship between each observed variables and its corresponding latent variable is the factor loading which represent how much the observed variable is related to its latent variable. All latent variables in the study were first order factor, where indicators directly relate to the factor, except safety culture. Safety culture was conceptualized by four dimensions and was analyzed as a second order factor. A figure of each specified theoretical model was illustrated to identify indicators of each factor.

The second step into confirmatory factor analysis was to make sure the specified model was identified. AMOS 22 software determined whether each parameter in the specified model could be estimated from the covariance matrix. The study used maximum likelihood estimation (ML) with standardized solution to report statistical estimates.

The third step into confirmatory factor analysis was to test the measurement model and evaluate goodness of fit statistic. AMOS 22 software was used to test each measurement model and generated goodness of fit statistics. The goodness of fit determined whether the specified model was supported by the sample data. The fitness of each measurement model was evaluated based on four fit indices chi-square statistic, comparative fit index (CFI), Tucker-Lewis index (TLI), and root mean square error of approximation (RMSEA).

The final step into confirmatory factor analysis was to consider modifications to the specified model which had poor model fit. Model modifications included three steps to improve the fitness of the generic model. The first step was to ensure all factors loading on each latent construct were statistically significant and had a critical ratio of $\pm$ 1.96 or higher (Schumacker & Lomax, 2010). Indicators which were not statistically significant were eliminated to improve model fit. The second step was to review the modification indices which provide the expected value that chi square statistics would decrease if the covariance between errors terms were to be included in the model. AMOS 22 generated modification indices for each generic model which were used to improve model fit. A covariance path between errors terms were included in each model based on modification indices to improve model fit. Finally, the standardized residual matrix were examined to identify which covariance terms or correlation were not well accounted for by the model. Indicators with large residuals were deleted because they were not accounted for by the model.

The final step into validating the measurement model was to calculate the internal consistency of the latent construct. Cronbach's alpha score was calculated for each measurement model to ensure the reliability of each instrument. The recommended level of Cranach's alpha was 0.70 or higher to ensure adequate level of reliability.

A CFA was conducted for all exogenous and endogenous variables using maximum likelihood estimation to measure the validity and reliability of each latent construct. Safety culture was the exogenous variable which has four dimensions organizational commitment, operational personnel, formal safety system, and informal safety system. A CFA was conducted for each dimension of safety culture to validate the reliability of each construct. The endogenous variables in the study included pilot commitment to the airline, pilot error behavior, and pilot attitude toward violations. A CFA was conducted for each endogenous variable to validate the reliability of each construct.

4.2.1 Exogenous Variables

Safety culture was the exogenous variable in the study. Safety culture was conceptualized by four main factors; organizational commitment, operational personal, formal safety system, and informal safety system. A CFA was conducted to validate the measurement model of each factor among pilots in Saudi Airlines.

4.2.1.1 Organizational Commitment

Organizational commitment consists of fourteen indicators addressing how management value safety in the airline (SV), safety fundamentals practices (SF), and the organizational role into going beyond safety compliance (GB). Participants' agreement and disagreement were measured on a 7 point Likert scale ranging from strongly disagrees to strongly agree. Five indicators addressed safety values, five indicators addressed safety fundamentals, and four indicators addressed going beyond safety compliance. A confirmatory factor analysis was conducted to validate the measurement model of organizational commitment.

The first step in a confirmatory factor analysis was to evaluate factor loading and critical ratio of each indicator representing organizational commitment. The significance of the regression weight of each indicator was determined by its corresponding critical ratio. Figure 6 shows the initial measurement model of the organizational commitment. All factor loading had critical ratio higher than 1.96 and were statistically significant at the 0.05 level except (SV5) which had a critical ratio of (- 0.442). In order to improve the fitness of the measurement model, SV5 was removed. After removing SV5, all indicators had a critical ratio of more than 1.96 and were statistically significant at the 0.05 level.

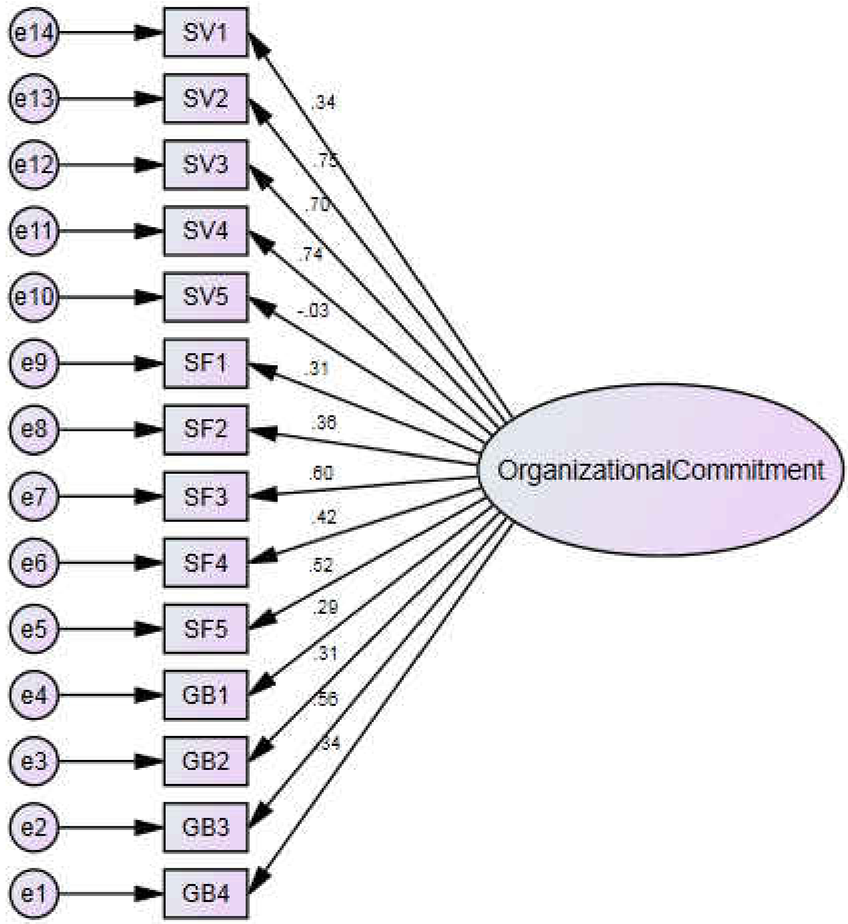

Figure 6 Initial Measurement model for Organizational Commitment

The standardized regression weight which is known as factor loading indicates how much the observed variable is related to the latent construct. Items with weak loading, less than 0.5, were removed from the measurement model unless the researcher feels it is significant to the research and do not affect the fitness of the model. Three indicators representing safety fundamentals SF1, SF2, and SF4 were removed from the initial model because they had low factor loading of 0.31, 0.36, and 0.42 respectively. In addition, one indicator representing going beyond compliance GB2 was removed due to its low factor loading of 0.31.

After deleting items with low factor loading, an evaluation of the model fit was conducted. The organizational commitment measurement model was still not within an acceptable limit. In order to improve model fit, freeing parameters based on their modification indices was used by AMOS 22 software to improve model fit. When parameters were allowed to be free, the chi- square decreased by at least the value of the index (Schumacker & Lomax, 2010). Based on the modification indices generated by AMOS 22, large error terms were correlated to improve model fit. Figure 7 illustrate the revised organizational commitment measurement model.

The revised measurement model of organizational commitment consisted of nine indicators. Factor loading of each indicator ranged from 0.26 to 0.80. Two pairs of errors were correlated to improve model fit. All nine regression coefficients were significant at the 0.05 level. Table 5 illustrates parameters estimates of the generic and revised organizational commitment measurement model. Items such as SV1, SF5, GB1, and GB4 had factor loading of less than 0.5, but were not removed because they revealed significant information about the organizational commitment in the airlines and did not affect the validity of the measurement model. The possibility of deleting these indicators will be further investigated during a confirmatory factor analysis of safety culture-safety performance model where all variables of the study will be included.

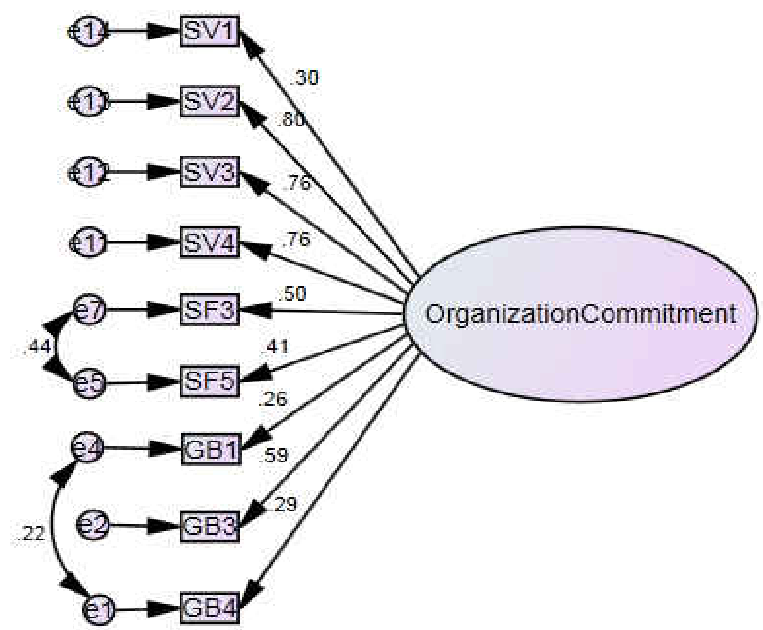

Figure 7 Revised Measurment Model for Organizational Commitement

Table 5 Parameter estimates for Organizational Commitment measurement model

Indicator			Generic Model				Revised Model			
			Estimate	S.E.	C.R.	P	Estimate	S.E.	C.R.	P
GB4	<---	OC	1				1			
GB3	<---	OC	2.083	0.45	4.629	***	2.541	0.628	4.044	***
GB2	<---	OC	0.947	0.271	3.491	***		Deleted		
GB1	<---	OC	0.918	0.271	3.39	***	0.939	0.288	3.263	0.001
SF5	<---	OC	1.86	0.413	4.504	***	1.699	0.47	3.616	***
SF4	<---	OC	1.645	0.4	4.117	***		Deleted		
SF3	<---	OC	2.169	0.459	4.729	***	2.092	0.54	3.876	***
SF2	<---	OC	1.109	0.288	3.852	***		Deleted		
SF1	<---	OC	0.68	0.195	3.495	***		Deleted		
SV5	<---	OC	-0.099	0.224	-0.442	0.659		Deleted		
SV4	<---	OC	2.984	0.6	4.976	***	3.552	0.839	4.235	***
SV3	<---	OC	2.813	0.572	4.914	***	3.572	0.843	4.238	***
SV2	<---	OC	2.878	0.577	4.987	***	3.578	0.839	4.263	***
SV1	<---	OC	1.109	0.301	3.683	***	1.176	0.37	3.18	0.001

The final step into validating the revised measurement model was to evaluate model fit indices. The research used four fit indices as described in the methodology section to determine the fitness of the model. Table 6 shows fit indices for generic and revised measurement model. The chi-square, comparative fit index (CFI), Tucker-Lewis index (TLI), and root mean square error of approximation (RMSEA) were evaluated to determine the fitness of the measurement model.

Table 6 Goodness of Fit indices for Organizational Commitment

Index	Fit Criteria	Generic Model	Revised Model
Chi- Square statistic (X^2)	Low	290.007	45.236
Degrees of Freedom (df)	>= 0	77	25
Chi- Square statistic/df	<= 4	3.766	1.809
Tucker-Lewis index (TLI)	> 0.90	0.683	0.948
Comparative fit index (CFI)	> 0.90	0.732	0.964
Goodness of fit index (GFI)	>0.90	0.828	0.96
Root mean square error of approx (RMSEA)	< 0.05-0.08	0.106	0.057
Probability (p- close)	> 0.05	0	0.3

Table 6 shows the goodness of fit indices for both the generic and revised model. The revised model showed a substantial improvement in model fit. The revised model had a considerably lower (χ^2) statistic which indicates a significant improvement in model fit. In addition, the generic model did not meet fit criteria on TLI, CFI, GFI, and RMSEA. The revised model had better goodness of fit indices.

To measure the internal consistency of the organizational commitment construct, Cronbach's alpha was calculated. The Cronbach's alpha for the organizational commitment construct was 0.797 which was above the recommended level of 0.70 indicating a reliable measurement construct.

4.2.1.2 Operational Personnel

The operational personnel factor included thirteen indicators addressing operational personnel commitment to safety such as aircraft manager/ supervisor (SUP), dispatch (DIS), and instructor pilots (IP). Participants' agreement and disagreement were measured by a 7 point Likert scale ranging from strongly disagrees to strongly agree. The proposed measurement model included five questions about manager/ supervisor, four questions about dispatch, and four questions about instructor pilots. Figure 8 shows the initial measurement model of the operational personnel factor. A confirmatory factor analysis was conducted to validate the measurement model of operational personnel.

All factor loading had a critical ratio higher than 1.96 and were statistically significant at the 0.05 level except SUP5, which was excluded from the measurement model. After removing SUP 5, all low factors loading were identified and investigated. Five items were eliminated due to low factor loading; SUP2, DIS1, DIS2, DIS4, and IP3. The remaining seven indicators had adequate factor loading ranging from 0.39 to 0.70 and were statistically significant at the 0.05 level. SUP1, SUP3, SUP4, and DIS3 had factors loading of less than 0.5, but were not eliminated because they revealed important information to the study. Indicators with low factor loading will be further investigated during the confirmatory factor analysis of safety culture-safety performance model.

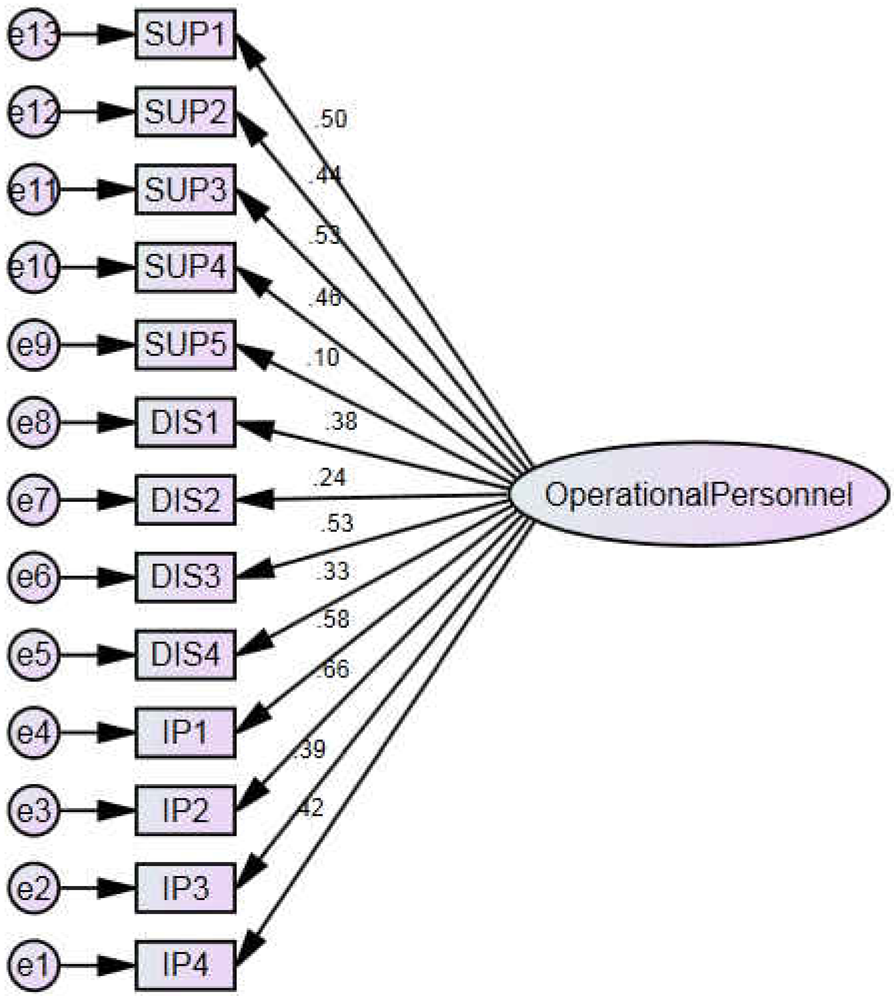

Figure 8 Initial Measurement model for Operational Personnel

After deleting items with low factor loading, the measurement model was evaluated for overall fit. The operational personnel measurement model had adequate fit indices criteria. In order to improve model fit even further, modification indices generated by AMOS 22 were reviewed. Modification indices suggested three pairs of correlation between errors terms between (IP1- IP2), (SUP1- SUP3), and (SUP1-SUP4) to improve model fit. After correlating errors terms, the model fit had further improvement. Figure 9 illustrate the revised operational personnel measurement model.

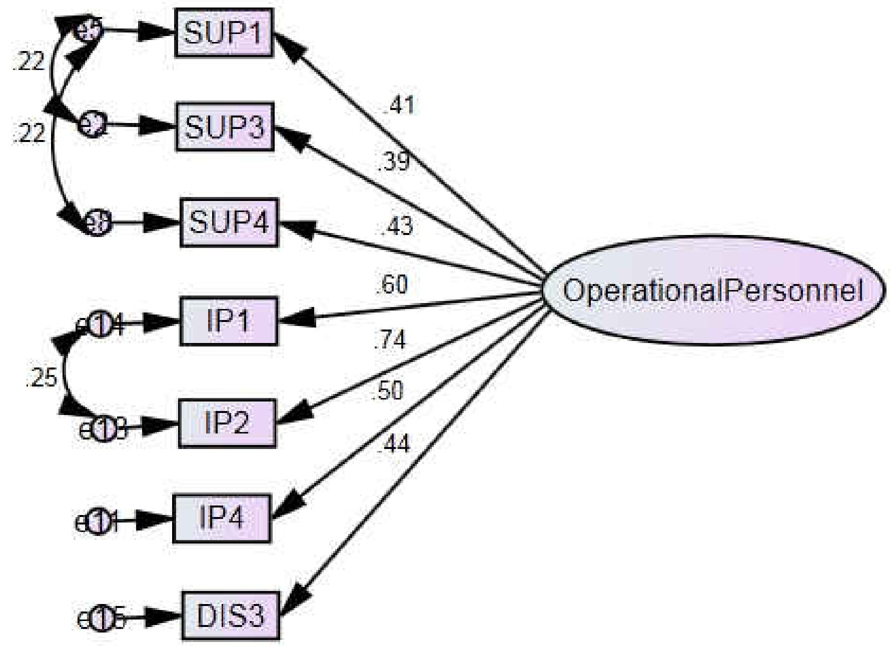

Figure 9 Revised Measurement model for Operational Personnel

Figure 9 shows the revised measurement model for operational personnel. Factors loading ranged from 0.39 to 0.74. All critical ratios were statistically significant at the 0.05 level. Table 7 shows parameters of estimate for generic and revised operational personnel measurement model.

Table 7 Parameter estimates for Operational Personnel measurement model

			Generic Model				Revised Model			
Indicator			Estimate	S.E.	C.R.	P	Estimate	S.E.	C.R.	P
IP4	<---	OPSPRS	1				1			***
IP3	<---	OPSPRS	1.03	0.24	4.286	***	Deleted			
IP2	<---	OPSPRS	1.453	0.263	5.517	***	1.359	0.253	5.377	***
IP1	<---	OPSPRS	1.197	0.228	5.241	***	1.047	0.214	4.88	***
DIS4	<---	OPSPRS	1.059	0.275	3.847	***	Deleted			
DIS3	<---	OPSPRS	1.48	0.292	5.067	***	1.033	0.217	4.755	***
DIS2	<---	OPSPRS	0.707	0.233	3.033	0.002	Deleted			
DIS1	<---	OPSPRS	1.223	0.289	4.237	***	Deleted			
SUP5	<---	OPSPRS	0.279	0.214	1.299	0.194	Deleted			
SUP4	<---	OPSPRS	1.396	0.298	4.682	***	1.095	0.237	4.614	***
SUP3	<---	OPSPRS	1.755	0.349	5.031	***	1.097	0.252	4.354	***
SUP2	<---	OPSPRS	1.409	0.307	4.59	***	Deleted			
SUP1	<---	OPSPRS	1.693	0.346	4.901	***	1.159	0.262	4.424	***

The revised measurement model revealed significant improvement in model fit. Table 8 compares the fitness of generic and revised model which indicated a significant improvement in the revised measurement model.

Table 8 Goodness of Fit indices for Operational Personnel

Index	Fit Criteria	Generic Model	Revised Model
Chi- Square statistic (X^2)	Low	273.071	19.434
Degrees of Freedom (df)	>= 0	65	11
Chi- Square statistic/df	<= 4	4.201	1.767
Tucker-Lewis index (TLI)	> 0.90	0.565	0.945
Comparative fit index (CFI)	> 0.90	0.638	0.971
Goodness of fit index (GFI)	>0.90	0.846	0.978
Root mean square error of approx (RMSEA)	< 0.05-0.08	0.114	0.056
Probability (p- close)	> 0.05	0	0.362

The generic model was not within acceptable fit criteria, and the (χ^2) was 273.071. The revised model has a substantial improvement in model fit and had adequate fit criteria. The (χ^2) decreased by 253.6 which indicated a significant improvement. All fit indices of the revised model were within acceptable limit. The seven indicators of operational personnel revealed a better model fit.

The internal consistency of the operational personnel construct was evaluated by calculating Cronbach's alpha. The seven indicators of operational personnel construct had a Cronbach's alpha of 0.709 which was above the recommended level of 0.70. The operational personnel measurement model had a reliable construct.

4.2.1.3 Formal Safety System

Formal safety system measures the reliability and efficiency of Saudi Airlines reporting system, feedback, and safety personal. The formal safety system factor consisted of fourteen indicators addressed on a 7 point Likert scale. Five questions perceived pilots' attitude toward reporting system in the airline (RS), four questions about report and feedback (RF), and five questions about safety personnel in the airline (SP). Figure 10 show the initial measurement model for formal safety system. A confirmatory factor analysis was conducted to validate the measurement model of formal safety system.

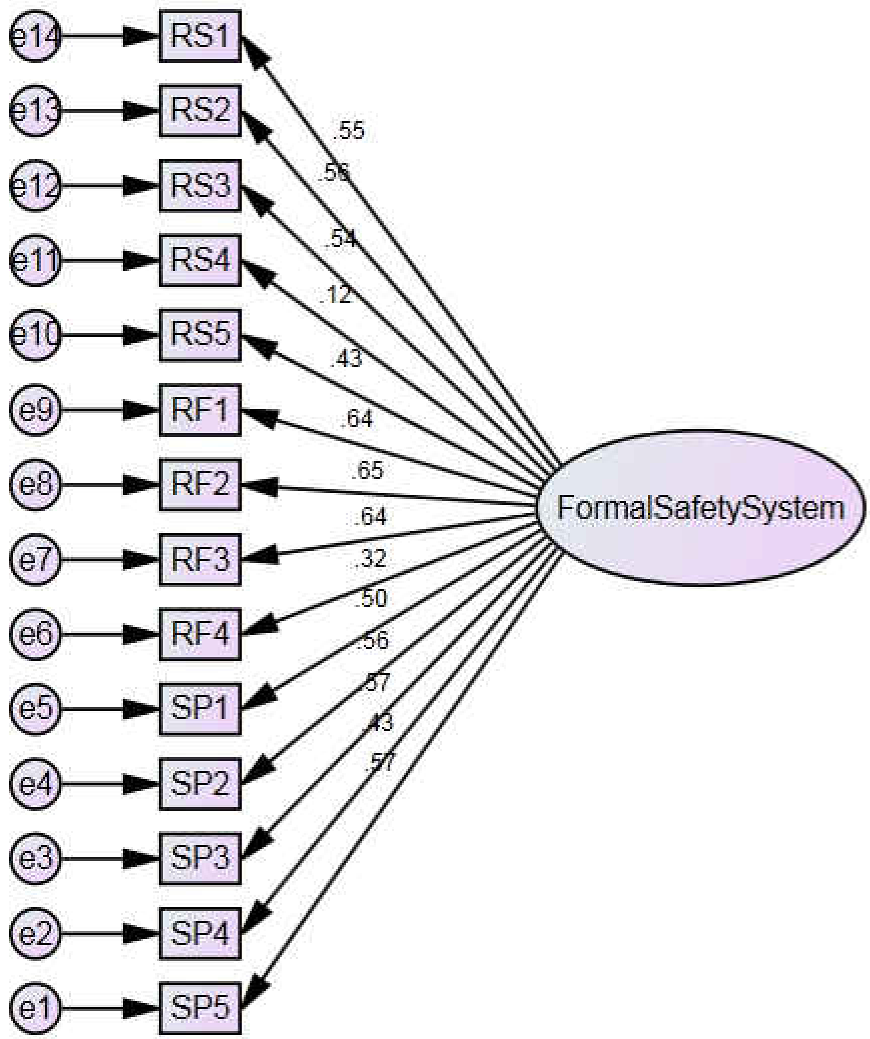

Figure 10 Initial Measurement model for Formal Safety System

All factor loading had a critical ratio higher than 1.96 except RS4 which was deleted from the measurement model. After deleting RS4, all factors were statistically significant at the 0.05 level. Three more indicators were deleted from the measurement model because they had a low factor loading RS5, SP4, and RF4.

After deleting the four indicators, an evaluation for formal safety system measurement model fit was conducted. The formal safety system measurement model was still not within acceptable level of model fit indices criteria. An evaluation for modification indices was reviewed to improve model fit. The modification indices suggested four pairs of correlations between errors terms which include (RS1-RS2), (SP1-SP2), (RF1-RF2), and (RF2-RF3). The covariance between the four errors terms improved model fit to an adequate acceptable limit. Figure 11 illustrate the revised formal safety system measurement model.

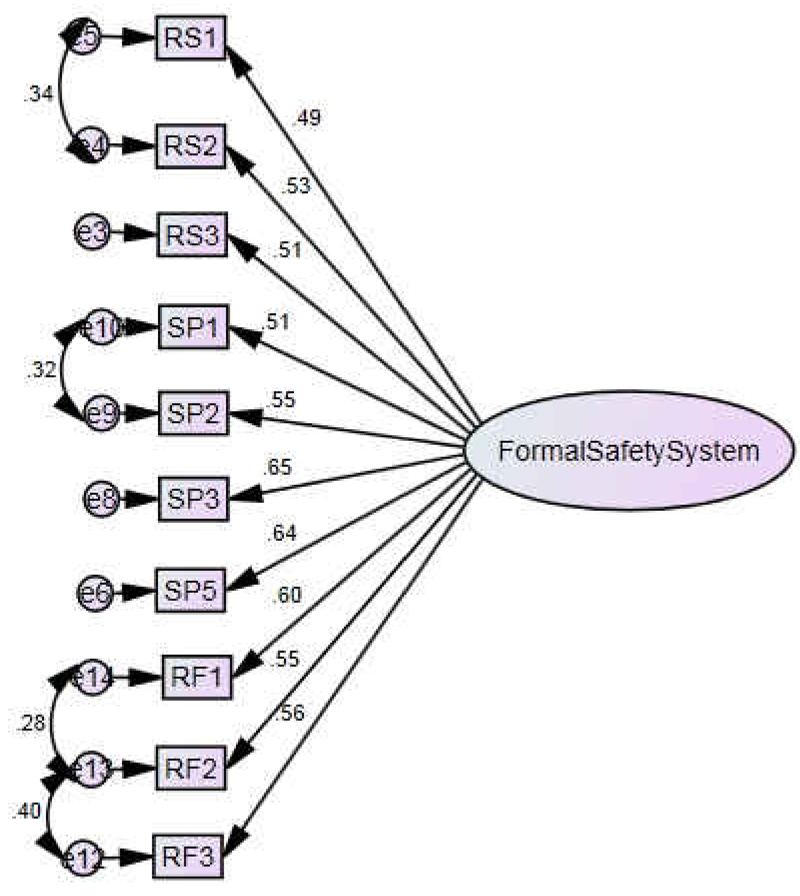

Figure 11 Revised Measurement model for Formal Safety System

The revised measurement model for formal safety system consisted of ten indicators. Factor loading ranged from 0.48 to 0.68. Four pairs of covariance between errors terms were added to improve model fit as shown on figure 11. All critical ratios were statistically significant at the 0.05 level. Table 9 shows the parameters of estimate for the generic and revised formal safety system measurement model.

Table 9 Parameter estimates for the Formal Safety System measurement model

Indicator			Generic Model				Revised Model			
			Estimate	S.E.	C.R.	P	Estimate	S.E.	C.R.	P
SP5	<---	FSS	1				1			
SP4	<---	FSS	0.873	0.156	5.603	***	Deleted			
SP3	<---	FSS	1.276	0.183	6.959	***	1.283	0.161	7.976	***
SP2	<---	FSS	1.368	0.199	6.866	***	1.188	0.17	6.992	***
SP1	<---	FSS	1.077	0.17	6.346	***	0.969	0.147	6.575	***
RF4	<---	FSS	0.661	0.153	4.317	***	Deleted			
RF3	<---	FSS	1.434	0.19	7.558	***	1.104	0.155	7.127	***
RF2	<---	FSS	1.467	0.192	7.627	***	1.087	0.156	6.973	***
RF1	<---	FSS	1.607	0.213	7.535	***	1.328	0.177	7.506	***
RS5	<---	FSS	0.965	0.172	5.599	***	Deleted			
RS4	<---	FSS	0.291	0.175	1.667	0.096	Deleted			
RS3	<---	FSS	1.333	0.197	6.749	***	1.092	0.166	6.565	***
RS2	<---	FSS	1.38	0.2	6.918	***	1.136	0.168	6.75	***
RS1	<---	FSS	1.164	0.172	6.782	***	0.92	0.145	6.363	***

The revised measurement model revealed significant improvement in model fit. Table 10 compares the fitness of the generic and revised model which indicates a significant improvement in the revised measurement model.

Table 10 Goodness of Fit indices for Formal Safety System

Index	Fit Criteria	Generic Model	Revised Model
Chi- Square statistic (X^2)	Low	305.013	71.111
Degrees of Freedom (df)	>= 0	77	31
Chi- Square statistic/df	<= 4	3.961	2.294
Tucker-Lewis index (TLI)	> 0.90	0.698	0.918
Comparative fit index (CFI)	> 0.90	0.744	0.943
Goodness of fit index (GFI)	>0.90	0.845	0.943
Root mean square error of approx (RMSEA)	< 0.05-0.08	0.11	0.073
Probability (p- close)	> 0.05	0	0.048

Table 10 compared the formal safety system generic and revised model. The revised model had a significant improvement in model fit. The (χ^2) decreased by 234.9 which indicated a significant improvement. In addition, most of the fit criteria of the generic model had poor fit. The revised model had adequate fit where all fit criteria were within acceptable limit.

To measure the internal consistency of the revised measurement model, a Cronbach's alpha was calculated. The Cronbach's alpha was 0.832 which was higher than the acceptable limit of 0.70. The revised measurement model for formal safety system had a reliable measurement construct.

4.2.1.4 Informal Safety System

The proposed measurement model for informal safety system consisted of fourteen indicators. The informal safety system factor evaluated pilot perceptions regarding the level of accountability in Saudi Airlines (AC), pilot authority (PA), and level of professionalism among fellow pilots (PR). Four questions addressed accountability, five questions addressed pilot authority, and five questions addressed professionalism. Questions were addressed on a 7 point Likert scale ranging from strongly disagrees to strongly agree. Figure 12 shows the initial measurement model for the informal safety system. A confirmatory factor analysis was conducted to validate the measurement model of informal safety system.

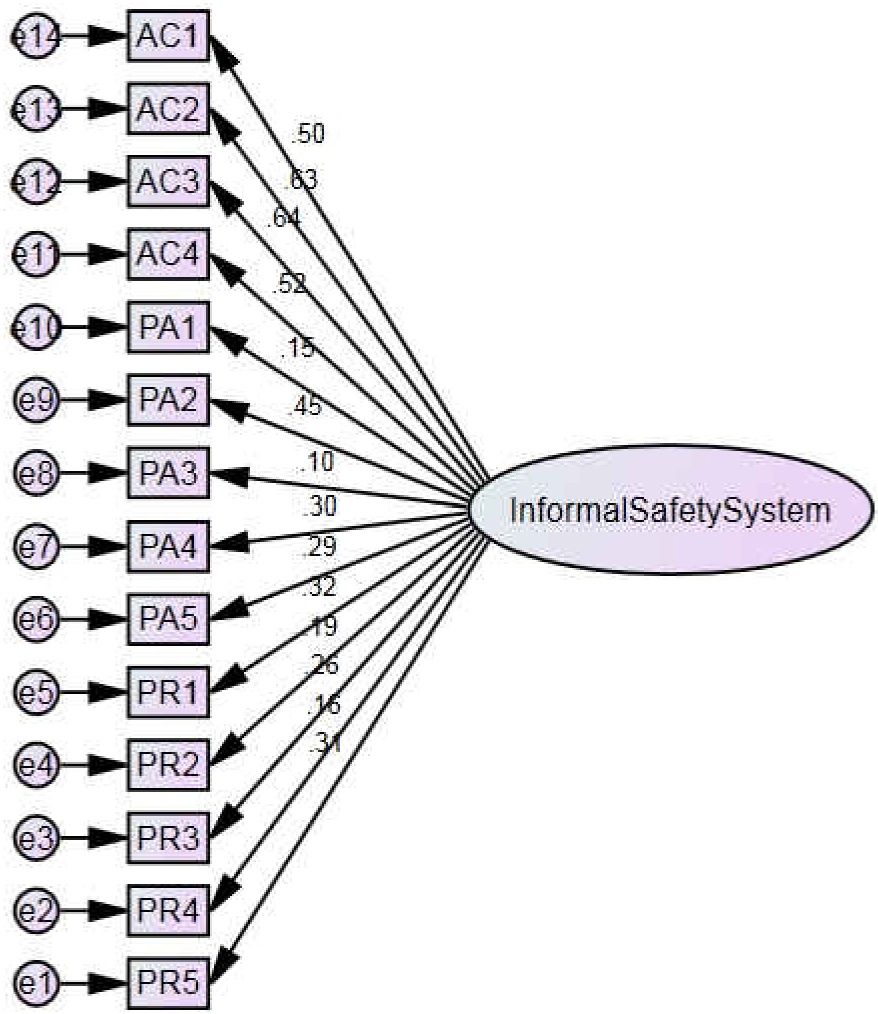

Figure 12 Initial Measurement model for Informal Safety System

All factors loading had a critical ratio of higher than 1.96 except PA1, PA3, and PR4 which were deleted from the measurement model. After deleting PA1, PA3, and PR4, all factors loading were statistically significant at the 0.05 level. Factors with low loading were further investigated to improve model fit. PA5, PR2, and PR3 had low factor loading and were deleted from the measurement model. Three pairs of covariance between errors terms were added to improve model fit as shown on figure 13. After deleting indicators with low factor loading, the fitness of the measurement model was evaluated. The revised informal safety system measurement model had adequate fit where all fit criteria were within an acceptable limit. Figure 13 shows the revised measurement model for the informal safety system.

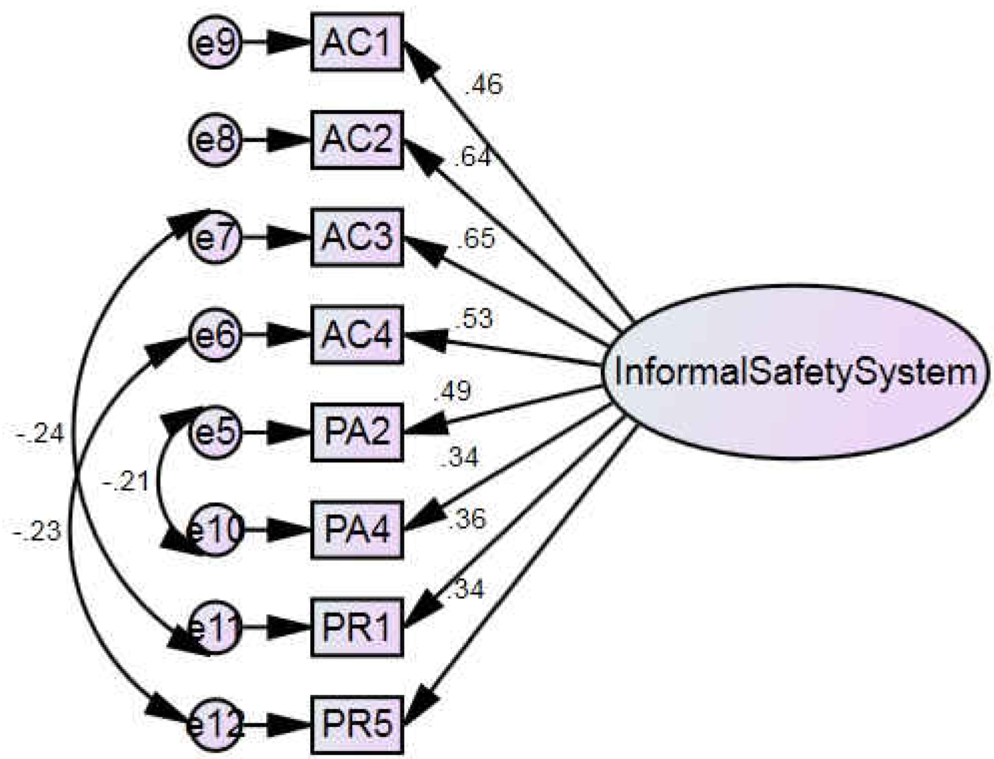

Figure 13 Revised Measurement model for Informal Safety System

The revised measurement model for the informal safety system consisted of eight indicators. Factor loading ranged from 0.34 to 0.65. All critical ratios were statistically significant at the 0.05 level. The eight indicators measurement model had better fit than the generic model. Table 11 shows the parameters of estimate for generic and revised informal safety system measurement model.

Table 11 Parameter estimates for the Informal Safety System measurement model

			Generic Model				Revised Model			
	Indicator		Estimate	S.E.	C.R.	P	Estimate	S.E.	C.R.	P
PR5	<---	ISS	1				1			
PR4	<---	ISS	0.548	0.283	1.935	0.053		Deleted		
PR3	<---	ISS	0.833	0.297	2.803	0.005		Deleted		
PR2	<---	ISS	0.519	0.234	2.211	0.027		Deleted		
PR1	<---	ISS	1.066	0.336	3.17	0.002	1.063	0.31	3.428	***
PA5	<---	ISS	1.218	0.407	2.996	0.003		Deleted		
PA4	<---	ISS	1.253	0.41	3.06	0.002	1.27	0.373	3.406	***
PA3	<---	ISS	0.347	0.279	1.242	0.214		Deleted		
PA2	<---	ISS	1.695	0.462	3.664	***	1.658	0.411	4.036	***
PA1	<---	ISS	0.592	0.328	1.806	0.071		Deleted		
AC4	<---	ISS	1.802	0.47	3.831	***	1.677	0.435	3.853	***
AC3	<---	ISS	2.47	0.613	4.026	***	2.284	0.523	4.365	***
AC2	<---	ISS	2.164	0.539	4.016	***	1.989	0.453	4.388	***
AC1	<---	ISS	1.513	0.399	3.79	***	1.258	0.317	3.964	***

The revised measurement model had a significant improvement in model fit. Table 12 illustrates model fit criteria for generic and revised model. The (χ^2) had decreased by 152 and significant improvement in all fit indices was observed. The revised model had adequate fit criteria to measure the informal safety system construct.

Table 12 Goodness of Fit indices for Informal Safety System

Index	Fit Criteria	Generic Model	Revised Model
Chi- Square statistic (X^2)	Low	181.952	29.925
Degrees of Freedom (df)	>= 0	77	17
Chi- Square statistic/df	<= 4	2.363	1.76
Tucker-Lewis index (TLI)	> 0.90	0.65	0.915
Comparative fit index (CFI)	> 0.90	0.704	0.949
Goodness of fit index (GFI)	>0.90	0.904	0.971
Root mean square error of approx (RMSEA)	< 0.05-0.08	0.074	0.056
Probability (p- close)	> 0.05	0.003	0.355

The internal consistency of the informal safety system construct was evaluated by measuring the Cronbach's alpha. The Cronbach's alpha was 0.675 just below the recommended level of 0.70. The lower reliability of 0.67 was still adequate for research purposes (Nunnally, 1978).

4.2.2 Endogenous Variables

The endogenous variables in the research include pilot commitment to the airline, pilot error behaviors, and pilot attitude toward violations. Pilot commitment to the airline was the mediating variables between safety culture and safety performance which was measured by pilot error behavior and pilot attitude toward violations. A confirmatory factor analysis was conducted for each factor to validate the reliability of each construct.

4.2.2.1 Pilot Commitment to the airline

Pilot commitment to the airline is the mediating factor in the research model. The research hypothesized pilot commitment to mediate the relationship between safety culture and safety performance. The level of pilot commitment to the airline was measured by seven indicators addressed on a 7 point Likert-scale. Figure 14 shows the initial measurement model for pilot commitment. A confirmatory factor analysis was conducted to validate the measurement model of pilot commitment to the airline.

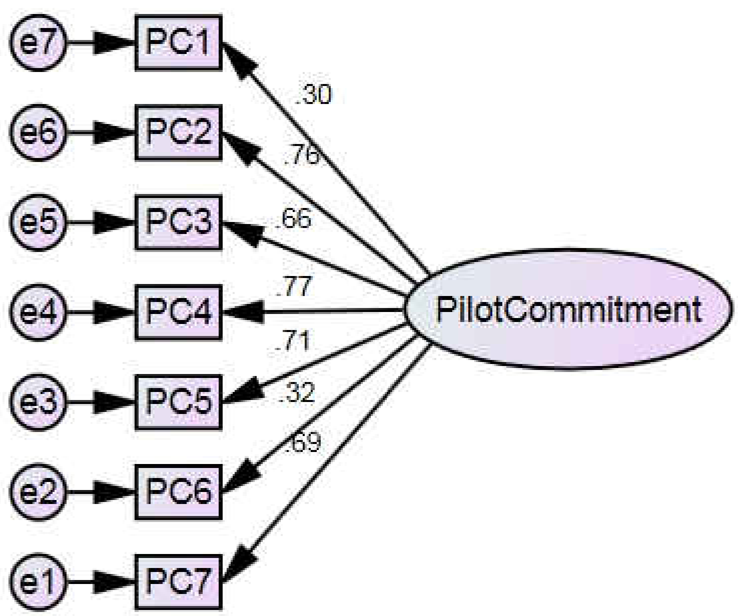

Figure 14 Initial Measurement model for Pilot Commitment to the airline

All factors loading had a critical ratio of higher than 1.96 and were statistically significant at 0.05 level. Two indicators, PC1 and PC6, were eliminated because they had low factor loading. After deleting PC1 and PC6, all indicators had strong factor loading and were statistically significant at 0.05 level. Factor loading ranged from 0.61 to 0.79. Figure 15 show the revised measurement model of pilot commitment to the airline.

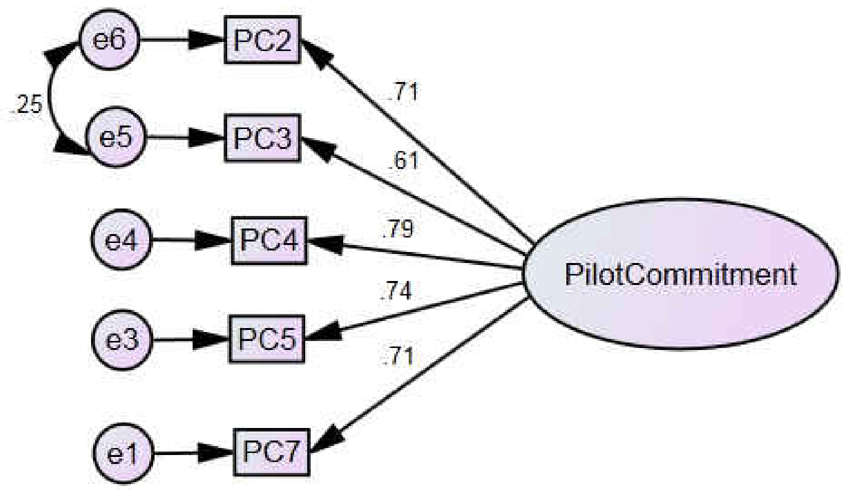

Figure 15 Revised Measurement model for Pilot Commitment to the airline

The revised measurement model of pilot commitment to the airline had five indicators. All critical ratios were statistically significant at the 0.05 level. Table 13 shows the parameter estimates for the generic and revised pilot commitment to the airline measurement model.

Table 13 Parameters estimate for the Pilot Commitment to the airline measurement model

			Generic Model				Revised Model			
Indicator			Estimate	S.E.	C.R.	P	Estimate	S.E.	C.R.	P
PC7	<---	PC	1				1			
PC6	<---	PC	0.304	0.066	4.632	***	Deleted			
PC5	<---	PC	0.988	0.102	9.703	***	1.007	0.1	10.058	***
PC4	<---	PC	1.039	0.1	10.4	***	1.036	0.099	10.519	***
PC3	<---	PC	0.93	0.102	9.144	***	0.835	0.1	8.338	***
PC2	<---	PC	0.934	0.09	10.329	***	0.846	0.088	9.64	***
PC1	<---	PC	0.285	0.067	4.291	***	Deleted			

Table 14 compares model fit between generic and revised measurement model. The revised model showed improvement in model fit indices and had better fit. The internal consistency Cronbach's alpha was 0.841 which was higher than the recommended level of 0.70.

Table 14 Goodness of Fit indices for Pilot Commitment

Index	Fit Criteria	Generic Model	Revised Model
Chi- Square statistic (X^2)	Low	49.345	2.744
Degrees of Freedom (df)	>= 0	14	4
Chi- Square statistic/df	<= 4	3.525	0.686
Tucker-Lewis index (TLI)	> 0.90	0.898	1.007
Comparative fit index (CFI)	> 0.90	0.932	1
Goodness of fit index (GFI)	>0.90	0.944	0.996
Root mean square error of approx (RMSEA)	< 0.05-0.08	0.101	0
Probability (p- close)	> 0.05	0.003	0.814

4.2.2.2 Attitude toward Violations

Safety performance was measured in the study by attitude toward violations and pilot error behavior. The attitude toward violations factor expressed pilots' attitude toward violations behavior, following standard procedures, and reporting violations. The factor consisted of seven indicators addressed on a 5 point Likert scale ranging from strongly disagrees to strongly agree (VO). Figure 16 shows the initial measurement model for the attitude toward violations. A confirmatory factor analysis was conducted to validate the measurement model of pilot attitude toward violations.

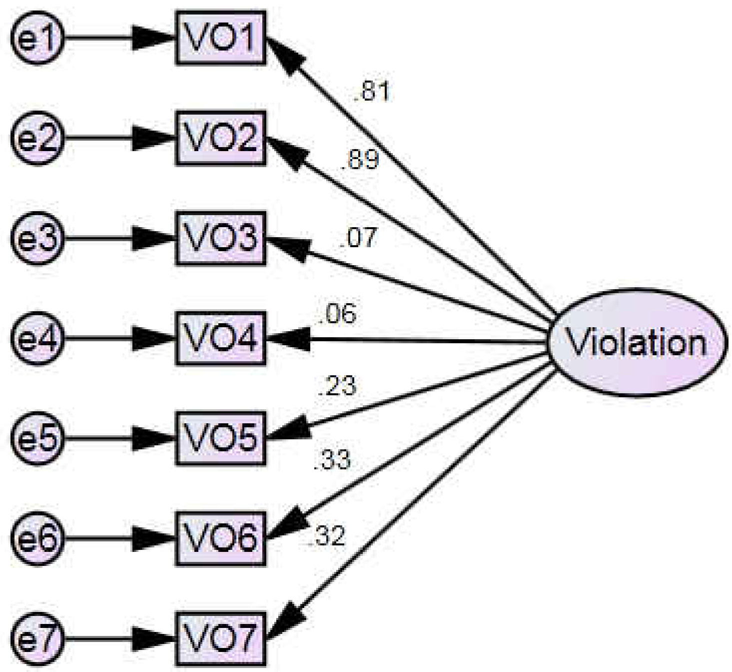

Figure 16 Initial Measurement model for Attitude toward Violations

All factors loading had a critical ratio of higher than 1.96 and were statistically significant at the 0.05 level except VO3 and VO4, which were deleted from the measurement model. After deleting VO3 and VO4, all factors loading were statistically significant at the 0.05 level. VO5 was deleted because it had weak factor loading of 0.23. Modification indices suggested one pair of covariance between (VO6- VO7) to improve model fit. The remaining four indicators had factor loadings ranging from 0.26 to 0.95. VO6 and VO7 had factor loading of 0.29 and 0.26 respectively, but were not deleted because they revealed important information about reporting violations. VO6 and VO7 will be further investigated during the confirmatory factor analysis of safety culture-safety performance model. The revised measurement model had a good fit, and all factors were statistically significant at the 0.05 level. Figure 17 show the revised measurement model for attitude toward violations.

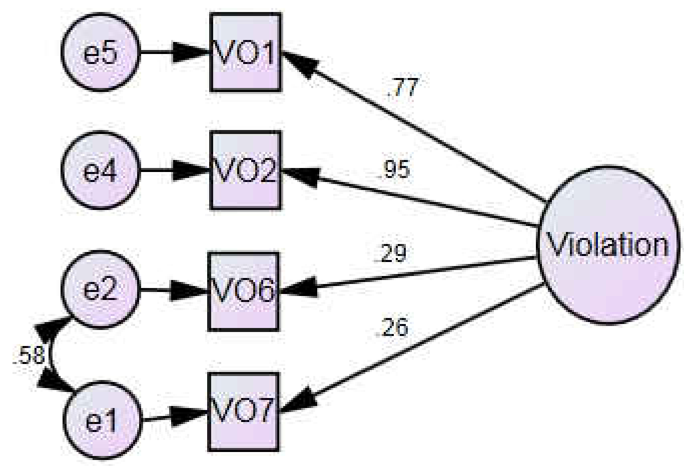

Figure 17 Revised measurement model for Attitude toward Violations

The revised measurement model had four indicators where all critical ratios were statistically significant at 0.05 level. Table 15 shows parameter estimates for generic and revised attitude toward violations measurement model.

Table 15 Paramter estimate for the Attitude toward Violation measurement model

			Generic Model				Revised Model			
	Indicator		Estimate	S.E.	C.R.	P	Estimate	S.E.	C.R.	P
VO1	<---	Violation	1				1			
VO2	<---	Violation	1.054	0.126	8.373	***	1.186	0.221	5.368	***
VO3	<---	Violation	0.109	0.107	1.018	0.309		Deleted		
VO4	<---	Violation	0.085	0.103	0.82	0.412		Deleted		
VO5	<---	Violation	0.272	0.083	3.281	0.001		Deleted		
VO6	<---	Violation	0.287	0.06	4.814	***	0.264	0.061	4.331	***
VO7	<---	Violation	0.285	0.062	4.598	***	0.25	0.063	3.955	***

The revised model had substantial model fit improvements. The four indicators model appeared to have a better fit. Table 16 compare model fit indices between generic and revised model. The internal consistency Cronbach's alpha for attitude toward violations model was 0.709 which was higher than the acceptable recommended level of 0.70.

Table 16 Goodness of Fit indices for Attitude toward Violation

Index	Fit Criteria	Generic Model	Revised Model
Chi- Square statistic (X^2)	Low	171.1	0.253
Degrees of Freedom (df)	>= 0	14	1
Chi- Square statistic/df	<= 4	12.2	0.253
Tucker-Lewis index (TLI)	> 0.90	0.389	1.014
Comparative fit index (CFI)	> 0.90	0.592	1
Goodness of fit index (GFI)	>0.90	0.848	0.999
Root mean square error of approx (RMSEA)	< 0.05-0.08	0.214	0
Probability (p- close)	> 0.05	0	0.71

4.2.2.3 Pilot Error Behaviors

The second factor measuring safety performance in the study was pilot error behaviors. Pilot error behaviors during different scenario in flight were perceived by four indicators (ER). Questions were presented on a 5 point Likert scale ranging from strongly disagrees to strongly agree. Figure 18 show the initial measurement model for pilot error behaviors. A confirmatory factor analysis was conducted to validate the measurement model for pilot error behaviors.

All critical ratios were higher than 1.96 and statistically significant at the 0.05 level. The model had adequate fit criteria. The four factor loadings ranged from 0.42 to 0.83. Table 17 shows parameter estimates for the measurement model.

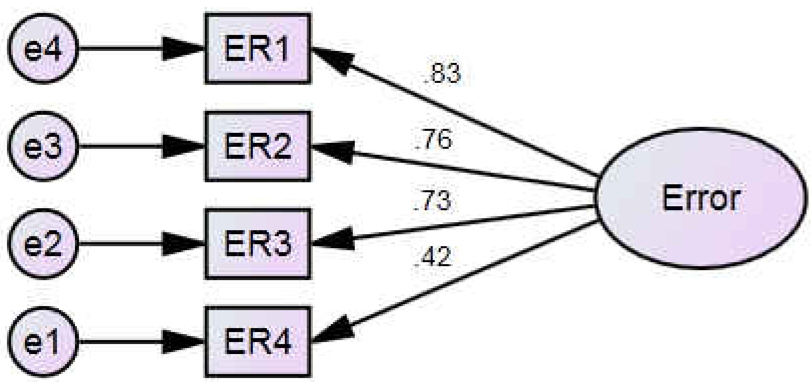

Figure 18 Pilot Error Behaviors measurment model

Table 17 Paramter estimate for Pilot Error Behavior measurement model

			Generic Model			
Indicator			Estimate	S.E.	C.R.	P
ER4	<---	Error	1			
ER3	<---	Error	2.106	0.35	6.012	***
ER2	<---	Error	2.228	0.366	6.079	***
ER1	<---	Error	2.342	0.38	6.158	***

The generic model had adequate fit criteria and all indicators were statistically significant at 0.05 level. Table 18 shows fit indices for pilot error behaviors measurement model.

Table 18 Goodness of Fit indices for Pilot Error Behavior

Index	Fit Criteria	Generic Model
Chi- Square statistic (X^2)	Low	5.692
Degrees of Freedom (df)	>= 0	2
Chi- Square statistic/df	<= 4	2.846
Tucker-Lewis index (TLI)	> 0.90	0.963
Comparative fit index (CFI)	> 0.90	0.988
Goodness of fit index (GFI)	>0.90	0.989
Root mean square error of approx (RMSEA)	< 0.05-0.08	0.087
Probability (p- close)	> 0.05	0.17

All fit indices were within an acceptable limit except the RMSEA which was slightly higher than the acceptable limit of 0.08 but still considered tolerable. A value greater than 0.10 considered a poor fit (Hooper et al., 2008). Finally, the internal consistency Cronbach’s alpha was calculated for pilot error behavior. The Cronbach’s alpha was 0.784 which was higher than the acceptable limit of 0.70.

4.2.3 Validating Safety Culture- Safety Performance Hypothesized Model

It was imperative to validate each measurement construct in the study before conducting a confirmatory factor analysis for the hypothesized research model (Hooper et al., 2008). After validating the measurement model of each construct in the study, a confirmatory factor analysis was conducted to validate the safety culture- safety performance model. The hypothesized model included all variables in the study. Safety culture was conceptualized as a second order factor including four dimensions organizational commitment, operational personnel, formal safety system, and informal safety system. Pilot commitment to the airline, pilot own attitude toward violations, and pilot error behaviors were all included in the hypothesized measurement model along with safety culture as shown in figure 19.

A confirmatory factor analysis was conducted to validate the safety culture- safety performance measurement model for the study. All factor loadings had a critical ratio of higher than 1.96 and were statistically significant at the 0.05 level. The initial hypothesized model did not have adequate fit criteria based on CFI and TLI where (CFI=0.806, TLI=0.792). Contrarily the chi square (χ^2/df) and RMSEA were within acceptable fit criteria where (χ^2/df) = 1.77, and RMSEA = 0.056 (P_{CLOSE}= 0.010). In order to improve model fit, several modifications steps were performed. Indicators with low factor loadings less than 0.50 were removed to improve model fit except VO6 which was not removed because the suggested minimum number of indicators to represent each factor is three (Kline, 1998a). SV1, SF5, GB1, GB4, SUP4, IP1, IP2, IP4, PA4, AC1, PA2, PR1, PR5, VO7, and ER4 were all eliminated from the hypothesized measurement model. After deleting all indictors with low factor loadings, the model fit had some improvement but still not within acceptable fit criteria (χ^2/df = 1.86, CFI= 0.867, TLI= 0.853, RMSEA= 0.059, P_{CLOSE}= 0.007).

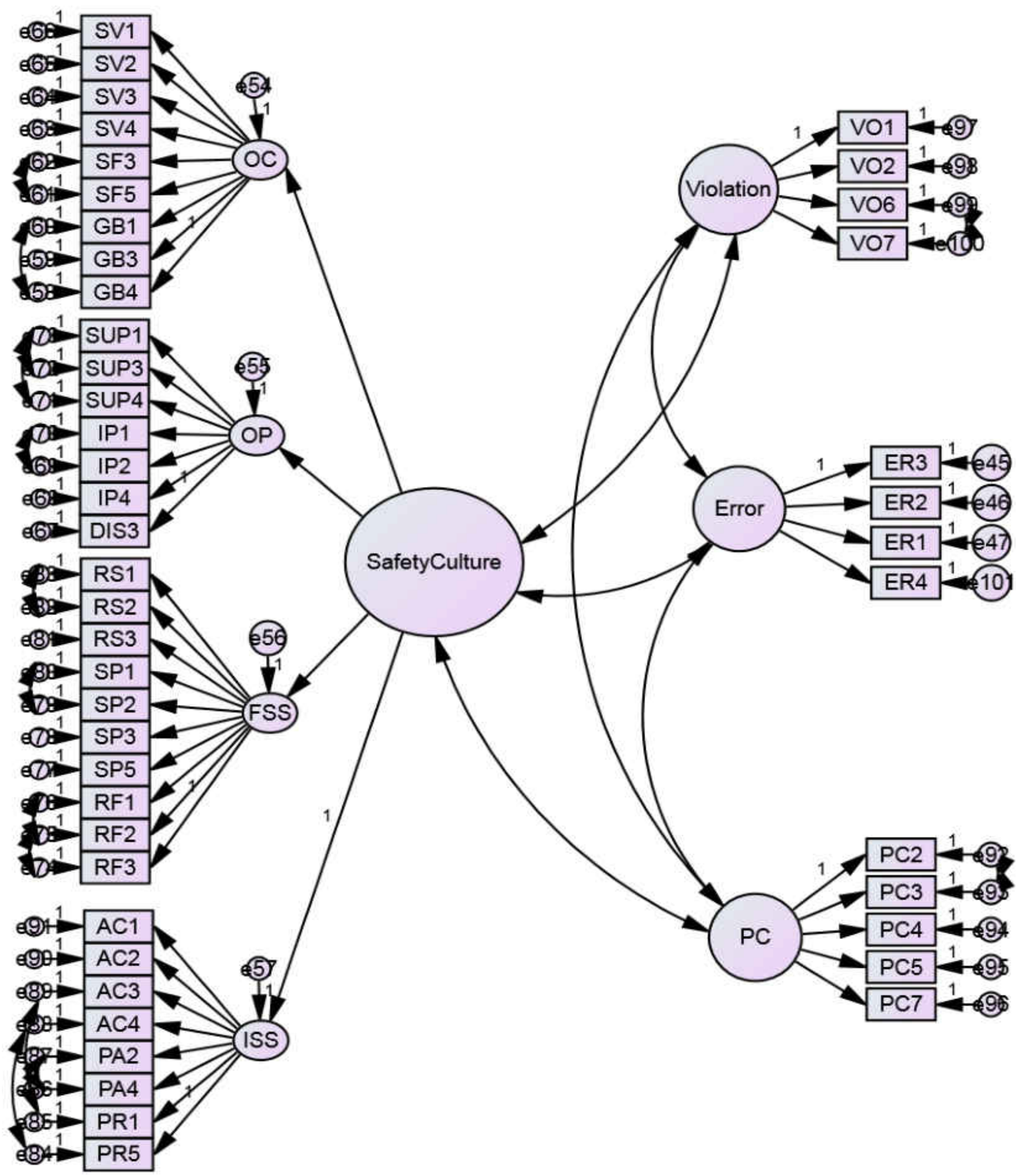

Figure 19 Hypothesized Safety Culture- Safety Performance Measurement model

The next step into model modification was to examine the standardized residual matrix to identify which original covariance terms or correlations are not well accounted for by the model. Standardized residuals value more than 1.96 or 2.58 signals a relationship that is not well accounted for by the model (Schumacker & Lomax, 2010). Five indicators were eliminated because most of their covariance terms or correlations were not accounted for by the model SF3, RS3, SP1, RF1, and PC3. The revised measurement model is shown on figure 20.

The revised measurement model for the research had acceptable fit criteria (χ^2/df = 1.654, CFI= 0.914, TLI= 0.902, RMSEA= 0.052, P_{CLOSE}= 0.364). Table 19 shows the fit criteria of the initial and revised research measurement model. The revised measurement model showed substantial improvements in model fit. The Chi square statistics decreased by 1284 which showed a significant improvement in model fit. All fit criteria of the revised measurement model were within acceptable fit criteria. The correlation and internal consistency Cronbach's alpha of each variable are shown on table 20. The Cronbach's alpha of each variables were within acceptable limit for the research, safety culture = 0.871, pilot commitment to the airline= 0.823, pilot attitude toward violations= 0.691, and pilot error behavior = 0.816.

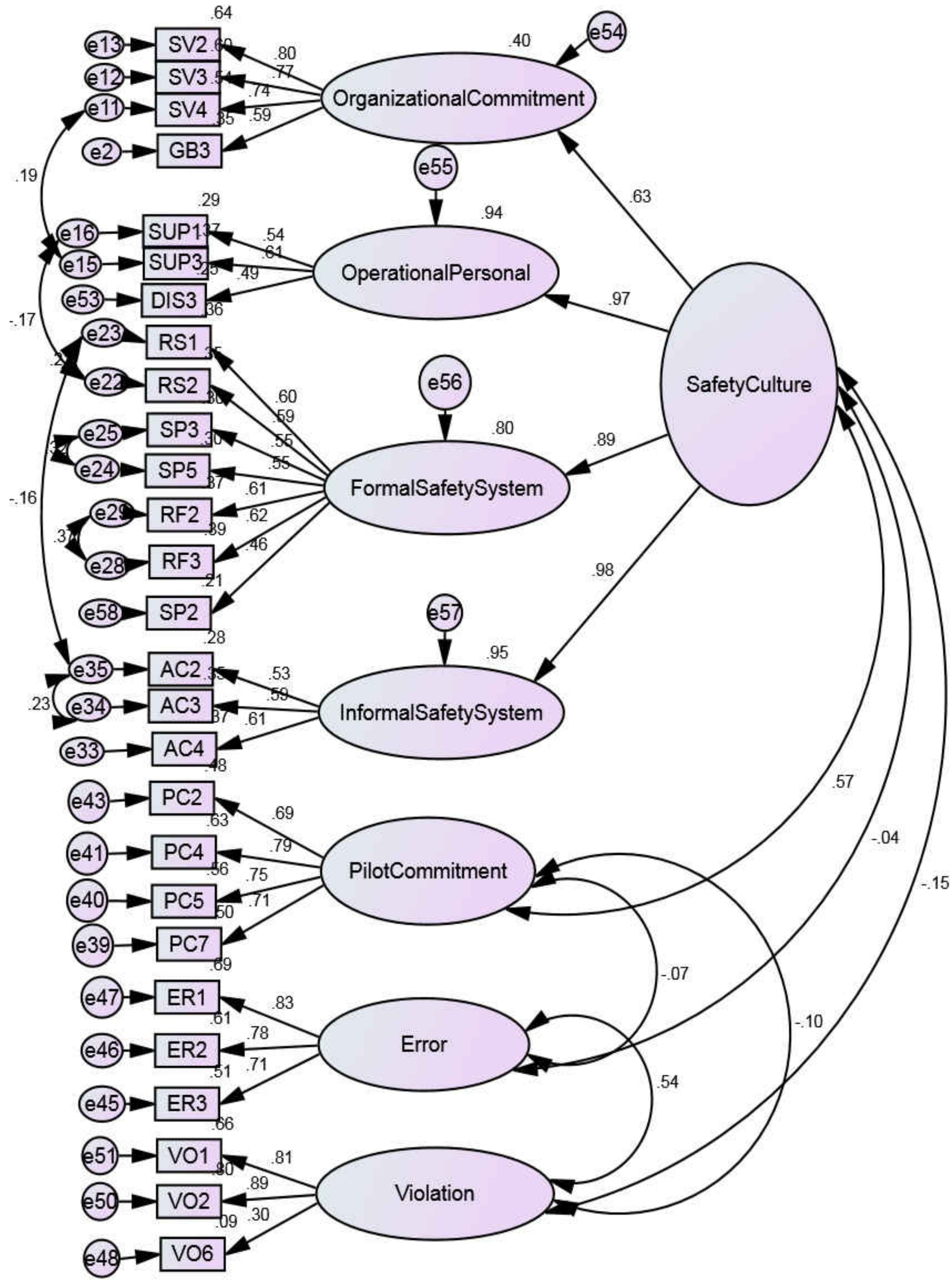

Figure 20 The revised Safety Culture- Safety Performance measurement model

Table 19 Goodness of fit indices for Safety Culture-Safety Performance Measurement model

Index	Fit Criteria	Generic Model	Revised Model
Chi- Square statistic (X^2)	Low	1792.46	507.91
Degrees of Freedom (df)	>= 0	1010	307
Chi- Square statistic/df	<= 4	1.77	1.654
Tucker-Lewis index (TLI)	> 0.90	0.792	0.902
Comparative fit index (CFI)	> 0.90	0.806	0.914
Goodness of fit index (GFI)	>0.90	0.758	0.872
Root mean square error of approx (RMSEA)	< 0.05-0.08	0.056	0.052
Probability (p- close)	> 0.05	0.01	0.364

Table 20 shows the correlation between all variables in the study. Most correlations were statistically significant at 0.05 level. Safety culture had a positive significant correlation with pilot commitment to the airline (r= 0.56, p=0.01). Safety culture had a significant negative correlation with pilot attitude toward violation (r= -0.15, p=0.05). Safety culture did not have a significant correlation with pilot error behavior (r= -0.04, p>0.05). Pilot commitment to the airline had a significant correlation with pilot attitude toward violations (r= -0.10, p=0.05). Pilot commitment to the airline did not have a significant correlation with pilot error behavior (r= -0.075, p>0.05). Finally, pilot attitude toward violations had a significant positive correlation with pilot error behavior (r= 0.54, p=0.01).

Table 20 Descriptive statistics, Cronbach's (α), and correlations among latent constructs

	M	SD	1	2	3	4
1. Safety Culture	3.85	0.956	**<0.871>**			
2. Pilot Commitment	4.961	1.19	0.566**	**<0.823>**		
3. Attitude to violations	2.024	0.59	-0.149*	-0.10*	**<0.691>**	
4. Errors behavior	3.44	0.955	-0.04	-0.075	0.541**	**<0.816>**

Cronbach's alpha values are shown in brackets

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

4.3 Structural Equation Modeling

After validating the research measurement model, a structural model was built to test the hypothesis of the research. The study used path analysis with observed variables to test the relationship and hypothesis in the study. Composite variables (observed variables) were imputed to provide scale score of each construct in the study by using AMOS 22. Composite variables had several advantages over latent hyper structural model and provide better model fit (Landis, Beal, & Tesluk, 2000). The structural model included all exogenous and endogenous variables in the study. The exogenous variable in the study was safety culture influencing pilot commitment to the airline, pilot error behaviors, and pilot attitude toward violations. The endogenous variables in the study included pilot commitment to the airline, pilots' attitude toward violations, and pilot error behaviors. In addition, the study hypothesized pilot commitment to the airline to mediate the relationship between safety culture and pilot attitude toward violations and pilot error behaviors.

The generic structural model was build based on theoretical framework to test the hypothesis of the study by connecting the exogenous variable, safety culture, to the endogenous variables, pilot commitment to the airline, pilot attitude toward violations, and pilot error behaviors. Control variables such as crew position and flying experience with Saudi Airlines were included in the structural model to provide more insight to the study. The standardized path coefficients were calculated for each relationship in the model. Figure 21 show the generic structural model for the effect of safety culture on safety performance.

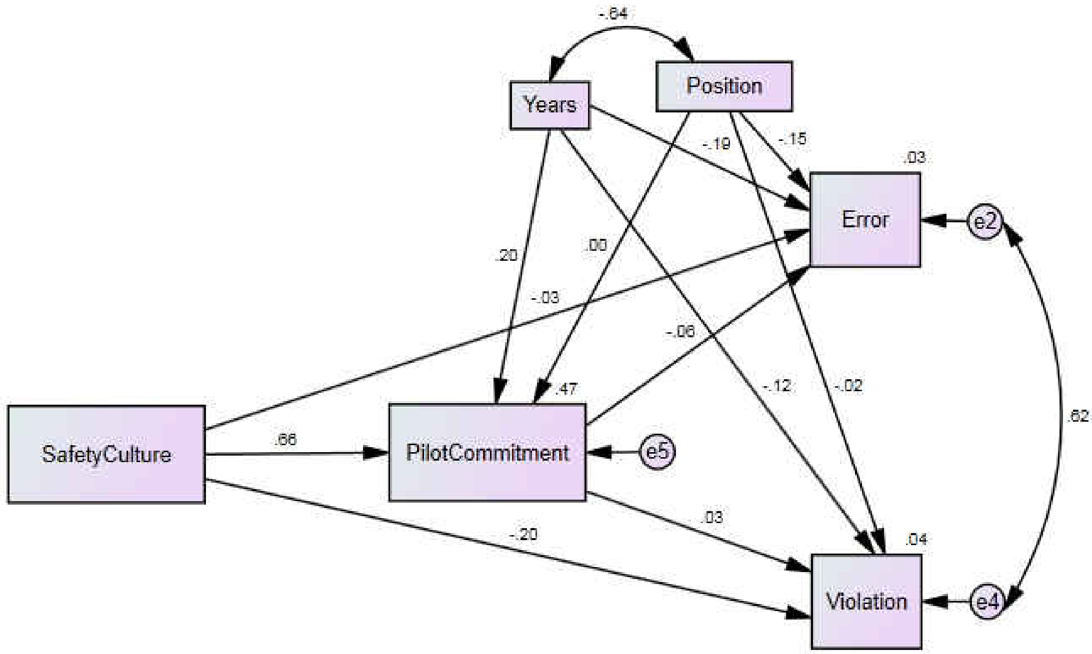

Figure 21 Generic Structural model for Safety Culture-Safety Performance

The generic structural model for safety culture effect on safety performance was evaluated based on goodness of fit statistics. The study used four fit indices to evaluate the fitness of the structural model based on the sample data. The four fit indices are chi-square statistic, comparative fit index (CFI), Tucker-Lewis index (TLI), and root mean square error of approximation (RMSEA). The first step into validating the structural model was to identify regression paths which were not statistically significant at the 0.05 level. Standardized paths coefficients which were not statistically significant were removed from the model one at the time to improve model fit. The second step was to evaluate modification indices to check the value that chi-square (χ^2) would decrease if correlations between errors terms can be included in the model.

The initial structural model for safety culture- safety performance had adequate fit criteria (χ^2/df = 1.931, CFI= 0.995, TLI = 0.966, RMSEA= 0.062, P_{close}= 0.312). Regression paths from crew position and years of experience to pilot attitude toward violations were not statistically significant at the 0.05 level and were removed from the model. In addition, the regression path from crew position to pilot commitment to the airline was not statistically significant at 0.05 level and was removed from the model. The high correlation between pilot attitude toward violations and pilot error behavior suggested a regression path between the two variables. The revised structural model for safety culture- safety performance included a path from pilot attitude toward violations to pilot error behavior as shown on figure 22.

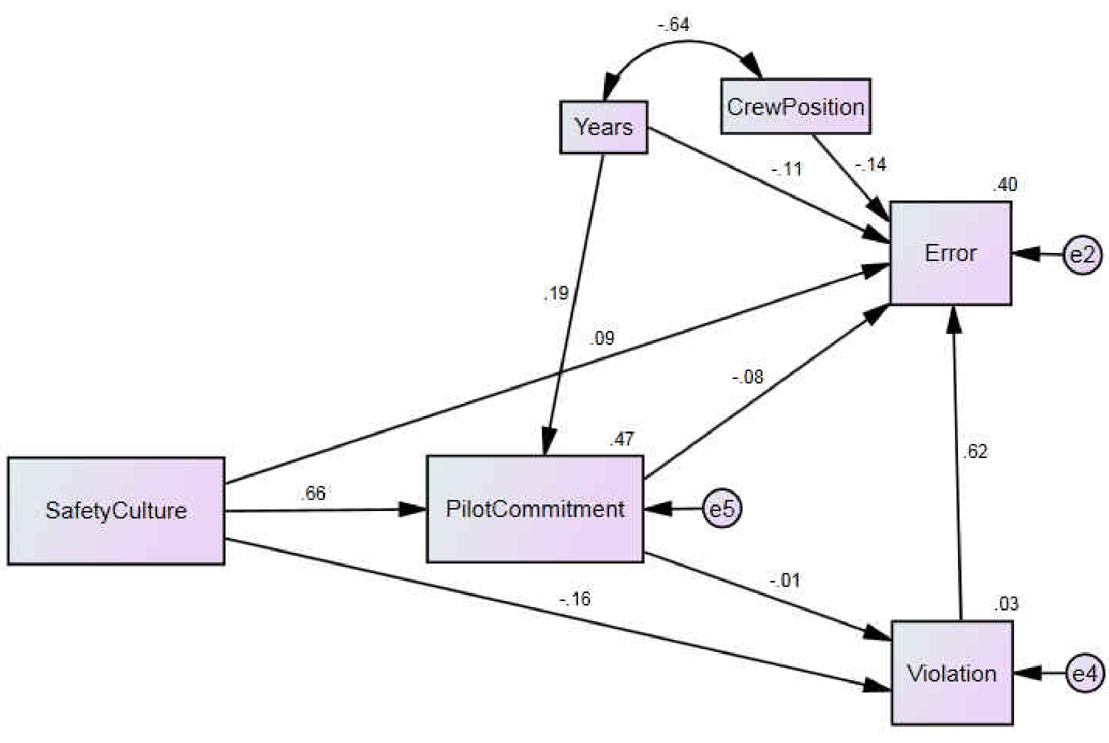

Figure 22 The revised structural model for the effect of safety culture on safety performance

The revised structural model for safety culture- safety performance had a better fit criteria than the generic model (χ^2/df = 1.323, CFI= 0.996, TLI = 0.988, RMSEA= 0.036, P_{close}= 0.555). Table 21 shows a comparison of model fit criteria between the generic and revised structural model. The revised structural model of safety culture-safety performance was used to test research hypotheses and analyze the relationship between safety culture, pilot commitment to the airline, pilot attitude toward violations, and pilot error behaviors among pilots of Saudi Airlines.

Table 21 Goodness of fit indices for safety culture- safety performance structural model

Index	Fit Criteria	Generic Model	Revised Model
Chi- Square statistic (X^2)	Low	3.863	6.616
Degrees of Freedom (df)	>= 0	2	5
Chi- Square statistic/df	<= 4	1.931	1.323
Tucker-Lewis index (TLI)	> 0.90	0.966	0.988
Comparative fit index (CFI)	> 0.90	0.995	0.996
Goodness of fit index (GFI)	>0.90	0.995	0.991
Root mean square error of approx (RMSEA)	< 0.05-0.08	0.062	0.036
Probability (p- close)	> 0.05	0.312	0.555

The revised structural model showed that safety culture had a significant positive effect on pilot commitment to the airline (β=0.66, p<0.001). This indicates the importance of safety culture as a main predictor to enhance pilot commitment to Saudi Airlines. In addition, safety culture had a significant negative effect on pilot attitude toward violations (β= -0.165, p=0.048). This relationship indicated the significant role of safety culture to minimize pilot attitude toward violations. As pilots in Saudi Airlines have positive perceptions about safety culture, they are less likely to have attitudes toward violations. On the other hand, safety culture did not have a significant direct effect on pilot error behaviors (β=0.095, p>0.05). This finding implied that pilot error behaviors cannot be predicted directly from safety culture in Saudi Airlines. Pilot commitment to the airline was the mediating variable between safety culture and pilot attitude toward violations and pilot error behaviors. Pilot commitment to the airline did not have a statistically significant effect on neither pilot attitude toward violations (β= -0.010, p>0.05) nor pilot error behaviors (β= -0.080, p>0.05). Therefore, pilot commitment to the airline could not mediate the relationship between safety culture and the two measures of safety performance. The research continued to test the mediation effect of pilot commitment for calculation purposes only. A mediation test was performed using bootstrapping to evaluate the effect of pilot commitment to the airline as a mediator variable between safety culture and safety performance measures. Safety culture had a significant negative direct effect on pilot attitude toward violations (β= -0.165, p=0.048). Table 22 shows a comparison of parameter estimates between generic and revised safety culture -safety performance structural model.

The mediating effect of pilot commitment to the airline between safety culture and pilot error behaviors was tested at first. The direct effect of safety culture on pilot error behavior was not statistically significant at the 0.05 level where (β= 0.095, p>0.05). The indirect effect of safety culture on pilot error behavior through the mediating effect of pilot commitment to the airline was not statistically significant at the 0.05 level (β= -0.057, p>0.05). Therefore, pilot commitment to the airline did not mediate the relationship between safety culture and pilot error behavior. The indirect effect of safety culture on pilot attitude toward violations through the mediating effect of pilot commitment to the airline was not statistically significant (β= -0.007, p>0.05). This indicated that pilot commitment to the airline could not mediate the relationship between safety culture and pilot attitude toward violations.

The revised safety culture-safety performance structural model included a direct path from pilot attitude toward violations to pilot error behaviors. The revised model hypothesized pilot attitude toward violations to mediate the relationship between safety culture and pilot error behaviors. The mediating effect of pilot attitude toward violations between safety culture and pilot error behaviors was tested. Since the direct effect of safety culture on pilot error behaviors was not significant, the indirect effect through pilot attitude toward violation was calculated. The indirect effect of safety culture on pilot error behavior was statistically significant ($\beta = -0.107$, $p=0.002$). The result showed that safety culture had an indirect effect on pilot error behaviors mediated by pilot attitude toward violations. In addition, another test of mediation was performed to test the mediating effect of pilot attitude toward violation between pilot commitment to the airline and pilot error behavior. Since pilot commitment to the airline did not have a significant direct effect on pilot error behaviors, the indirect effect was calculated through the mediating effect of pilot attitude toward violations. The indirect effect of pilot commitment to the airline on pilot error behavior was not statistically significant ($\beta = -0.006$, $p>0.05$). The result showed that pilot commitment to the airline does not have neither direct nor indirect effect on pilot error behavior. Table 23 shows the direct, indirect, and total effect of all variables in the model.

The effect of the two control variables in the study crew position and years of experience at Saudi Airlines were calculated. Crew position and years of experience did not have a significant effect on pilot attitude toward violations. Crew positions included captains and first officers. The coding in the data for captains was 1 and 2 for first officers. Crew position had a significant effect on pilot error behavior ($\beta = -0.138$, $p=0.032$). The negative sign of the path coefficient implied that first officer in Saudi Airlines has less behavioral tendency to make errors. Years of flying experience with Saudi Airlines was recorded as a scale from one to eight. Years of flying experience with Saudi Airlines had a significant effect on pilot commitment to the airline (β= 0.193, $p<0.001$). As pilots spend more times flying with Saudi Airlines they become more loyal to the airline.

Table 22 Parameter estimates of the revised structural model of safety culture -safety performance

			Gemeric model				*Revised model*			
			Estimate	S.E.	C.R.	P	Estimate	S.E.	C.R.	P
PilotCommitment	<---	SafetyCulture	0.811	0.057	14.22	***	0.811	0.057	14.212	***
PilotCommitment	<---	Years	0.095	0.029	3.239	0.001	0.094	0.023	4.157	***
PilotCommitment	<---	CrewPosition	0.008	0.127	0.066	0.947	Deleted			
Error	<---	CrewPosition	-0.225	0.122	-1.853	0.064	-0.204	0.096	-2.138	0.032
Violation	<---	SafetyCulture	-0.039	0.017	-2.334	0.02	-0.032	0.016	-1.975	0.048
Error	<---	SafetyCulture	-0.024	0.074	-0.324	0.746	0.082	0.058	1.41	0.159
Error	<---	PilotCommitment	-0.045	0.061	-0.738	0.46	-0.056	0.048	-1.178	0.239
Error	<---	Years	-0.064	0.029	-2.223	0.026	-0.038	0.022	-1.685	0.092
Violation	<---	PilotCommitment	0.004	0.014	0.305	0.76	-0.002	0.013	-0.118	0.906
Violation	<---	Years	-0.009	0.006	-1.455	0.146	Deleted			
Violation	<---	CrewPosition	-0.008	0.027	-0.277	0.782	Deleted			
Error	<---	violation	No regression path				2.738	0.221	12.381	***

Table 23 Direct, Indirect, and Total effects

Independent variable		Dependent variable	
		Pilot Errors	Pilot attitude toward violation
Safety Culture	Direct effect	0.095	-0.165
	Indirect effect	-0.16	-0.007
	Total effect	-0.065	-0.172
Pilot commitment	Direct effect	-0.08	-0.01
	Indirect effect	-0.006	–
	Total effect	-0.086	-0.01
Crew position	Direct effect	-0.138	–
	Indirect effect	–	–
	Total effect	-0.138	–
Years of experince	Direct effect	-0.111	–
	Indirect effect	-0.017	-0.002
	Total effect	-0.128	-0.002

4.4 Hypothesis Testing

The final step of the statistical analysis was hypothesis testing. The revised structural model of safety culture- safety performance was used to test research hypotheses. The study included five hypotheses which were tested using the revised structural model in AMOS 22. Bootstrapping was used to test the mediating effect of pilot commitment to the airline and pilot attitude toward violations in the model. The study had five hypotheses as followed:

H_1: safety culture has a significant influence on pilot commitment to the airline.

H_2: safety culture has a significant influence on pilot error behaviors.

H_3: safety culture has a significant influence on pilot own attitude toward violations.

H_4: pilot commitment to the airline mediates the relationship between safety culture and pilot error behaviors.

H_5: pilot commitment to the airline mediates the relationship between safety culture and pilot own attitude toward violations.

The first hypothesis was supported. Safety culture had a significant positive effect on pilot commitment to the airline (β=0.66, p<0.001). As it was predicted, safety culture plays a significant role to enhance pilot commitment to Saudi Airlines. The second hypothesis was not supported. Safety culture did not have a significant effect on pilot error behaviors (β=0.095, p>0.05). The direct effect of safety culture on pilot error behaviors was not significant which implied that a mediating effect could better explain how the level of safety culture in the airline can affect pilot error behaviors. The third hypothesis was supported. Safety culture had a significant negative direct effect on pilot attitude toward violations (β= -0.165, p=0.048). The negative relationship indicated that as pilots in Saudi Airlines have a positive perception about safety culture, the less likely they are to have an attitude toward violations. Hypothesis four was not supported. Pilot commitment to the airline did not mediate the relationship between safety culture and pilot error behaviors. In order for a mediation to take place, the mediator variable should have a significant effect on the dependent variable. The direct effect of pilot commitment to the airline on pilot error was not statistically significant (β= -0.080, p>0.05). Therefore, pilot commitment to the airline could not mediate the relationship between safety culture and pilot error behaviors. The fifth hypothesis was not supported. Pilot commitment to the airline could not mediate the relationship between safety culture and pilot attitude toward violations. Pilot commitment to the airline did not have a significant effect on pilot attitude toward violations (β= -0.010, p>0.05). Therefore, pilot commitment to the airline could not be used as a mediator between safety culture and pilot attitude toward violations. The failure of pilot commitment to the airline to mediate both safety performance measures among pilots is not an unexpected result. Professional culture plays a significant role into pilot performance inside the cockpit. Pilots take pride of their job and want to do it right (Helmreich & Merritt, 1998). In addition, pilot unlike other employees are part of the operating system and if the system fail they fail with it in an accident or incident which might cost them their job or life. Therefore, pilot commitment to the airline did not mediate the relationship between safety culture and safety performance.

CHAPTER 5: DISCUSSION, IMPLICATION, CONCLUSION, LIMITATION, AND FUTURE RESEARCH

The main focus of the research was to analyze the effect of safety culture on safety performance among pilots in Saudi Airlines. The study also investigated the mediating role of pilot commitment to the airline between safety culture and measures of safety performance. The following section includes a discussion of study results and compares it to previous research in the aviation field. The implication of the study, conclusions, limitation, and recommended areas for future research will be discussed.

5.1 Discussion

The role of safety culture as a main predictor of pilot commitment to the airline was analyzed in the first hypothesis. Safety culture was conceptualized by four main factors organizational commitment to safety, operational personal, formal reporting system, and informal reporting system. Study results showed that safety culture had a significant positive effect on pilot commitment to the airline (β=0.66, p<0.001). This finding underlines the role of safety culture as a main predictor of pilot commitment to the airline. Moreover, the result emphasizes the role of airline management to enhance pilot commitment to the airline by involving them into safety practices, respond to their safety concern, giving them authority to make necessary decisions regarding safety issues, and most importantly being committed to appraising safety practices. Fogarty (2004) analyzed the effect of safety climate on morale, psychological health, turnover intentions, and error among aviation maintenance engineers in Australian Army. Morale was measured by employees' commitment to their organization and job satisfaction. Results showed that safety climate had a positive significant effect on morale (Fogarty, 2004). Another study by Park, Kang, and Son (2012) analyzed the effect of safety climate on individual attitude among military maintenance personnel in Korea. Individual attitude was measured by employees' commitment to the organization and job satisfactions. Result showed that safety climate had a significant positive effect on individual attitude. Both studies showed parallel results and supported the findings of the present study in regard to the effect of safety culture on pilot commitment to the airline.

The second findings in the study relate to the direct effect of safety culture on pilot error behaviors. Safety culture did not have a significant direct effect on pilot error behaviors ($\beta=0.095$, $p>0.05$). Pilots' perception about safety culture in Saudi Airlines is not enough to influence error behaviors. The same study by Fogarty (2004), which was mentioned in the previous paragraph, examined the effect of safety climate on maintenance personnel error behaviors. The study showed that safety climate is not enough to directly predict error behaviors. In addition, the study showed that a mediating variable such as fatigue or stress can better explain the influence of safety climate on error behaviors. The present study examined the mediating role of pilot attitude toward violations between safety culture and pilot error behaviors. Safety culture had a significant indirect effect on errors behaviors through pilot attitude toward violations ($\beta= -0.107$, $p=0.002$). Chen and Chen (2014) analyzed the effect of safety management system, morality leadership, and self-efficacy on pilots' safety behavior. Pilots' safety behavior was measured by safety compliance and safety participation. Commercial airline pilots from five major Taiwanese airlines participated in the study. Results showed that safety management practices have a significant effect on pilot safety behaviors such as safety compliance and safety participation. This implies that safety culture can affect pilots' positive behaviors but not necessarily has a direct effect on error behaviors. Another important fact that could support the result of the present study regarding the insignificant direct effect of safety culture on pilot error behavior is that pilots, unlike other employees their lives depends on their performance in the workplace, the cockpit. Pilots are part of the system; if the system fails they will go down with it. Therefore, even if they have negative perceptions about safety culture in the airline, they still have to perform at their best in the workplace to protect their lives.

The third hypotheses of the research examined the effect of safety culture on pilot attitude toward violations. Findings showed that safety culture had a significant direct effect on pilot attitude toward violations (β= -0.165, p=0.048). As pilots in Saudi Airlines have positive perceptions about safety culture their attitude toward violations decreases. The revised measurement model for pilot attitude toward violations measured how pilot would react toward a violation caused by their colleague or supervisor and their attitude toward reporting violations. Fogarty and Shaw (2010) examined the effect of management attitude to safety on attitude toward violations among air force maintenance personnel. The study showed that perceptions of management attitude to safety had a significant direct effect into shaping employees own attitude toward violations. This finding supports the result of the current research where pilots' perceptions about safety culture in Saudi Airlines had a direct effect on pilot own attitude toward violations.

The mediating role of pilot commitment to the airline between safety culture and pilot own attitude toward violations and pilot error behaviors was not significant. Pilot commitment to the airline did not have a significant effect on pilot error behaviors or pilot attitude toward violations. Fogarty (2004) measured morale by employees' commitment and job satisfactions and examined the effect of morale on errors behaviors among aircraft maintenance personnel. Results showed that morale did not have a significant effect on error behaviors. Park, Kang, and Son (2012) measured employees' individual attitude by organization commitment and job satisfaction. The study examined the effect of individual attitude on error behaviors among aircraft maintenance personnel. There was no significant effect from individual attitude to errors behavior. The present study hypothesized pilot commitment to mediate the relationship between safety culture and pilot error behaviors and pilot attitude toward violations. Both hypotheses were not supported because pilot commitment to the airline did not have a significant effect on pilot error behaviors and attitude toward violations. The present study further examined the role of pilot attitude toward violations to mediate the effect of safety culture and error behaviors. Result showed that pilot attitude toward violations mediates the effect of safety culture on errors behavior (β= -0.107, p=0.002). Fogarty (2004) suggested the use of individual health or fatigue as a mediator between safety climate and error behaviors. The present study showed that safety culture had a direct and indirect effect on safety performance through the effect on pilot attitude toward violations and pilot error behaviors. Professional culture among airline pilots could explain the insignificant effect of pilot commitment to the airline on pilot error behaviors and pilot attitude toward violations. Pilots have pride in their job and highly motivated to perform it well. From my personal experience as a pilot in Saudi Airlines, the level of commitment to the airline has no effect on pilot performance inside the cockpit. Pilots who criticizes airline management still perform at their best during flight.

5.2 Implication

The present research has a number of implications for both research and Saudi Airlines. First, the study showed that safety culture had a significant effect on pilot commitment to the airline. This finding signifies the need to evaluate and improve safety culture in civil aviation. Saudi Airlines should focus on evaluating and improving current safety culture which will in return improve pilot loyalty to the airline. In order to improve pilot commitment to the airline, the airline should have a high level of commitment to safety, engage pilots to make decisions about safety, and enhance the reporting system. The present study confirmed the role of safety culture as a main predictor to improve employees' commitment to their organization especially among pilots in the airline.

Second, the present study shows how safety culture plays a significant role into shaping pilot safety behavior in civil aviation. Safety culture had a direct effect on pilot own attitude toward violations and indirect effect on pilot error behaviors. These results highlight the responsibility of airline management to minimize unsafe behaviors and enhance safety practices. These findings emphasize the necessity to review safety reports, incidents, and previous accidents to identify which organizational factors contributed directly or indirectly to influence unsafe behaviors. Airline management should not immediately blame pilots for unsafe actions, but rather should investigate what factors influenced their behavior to commit an error or violation.

Pilot commitment to the airline did not have a significant influence on pilot attitude toward violations or pilot error behaviors. This indicates that pilots' behavior inside the cockpit is not influenced by their attachment to the airline. Fogarty (2004) indicated that morale is not enough to explain the indirect effect of negative perception about management on error behaviors. Saudi Airlines should encourage the reporting of unsafe behaviors and consistently analyze whether it may relate to pilot commitment to the airline or not.

A consistent evaluation of safety culture is necessary to monitor improvement and evaluate corrective actions. Furthermore, the need to evaluate which type of culture exists within the airline is essential to identify which action should be taken. Patankar and Sabin (2010) identified four dominant states of safety culture along the accountability scale: secretive culture, blame culture, reporting culture, and just a culture. Saudi Airlines should pay more attention to the dimensions of safety culture which include organizational commitment, operational personnel, formal safety system, and informal safety system. These dimensions shape the safety culture within the airline. An evaluation of each dimension is essential to identify which areas need further improvement.

5.3 Conclusion

As the number of aircraft flying globally increase, the threat of having an aircraft accident would increase. Organizational factors have played a significant role into accident causation in high-risk industries including civil aviation. Organizational factors have influenced employees' behavior in the workplace. The focus on safety culture in the airline is crucial to ensure the safety of travel.

The present study assessed safety culture among pilots of Saudi Airlines. The study examined the effect of safety culture on pilot commitment to the airline, and the effect of safety culture on safety performance. The two measures of safety performance were pilot error behaviors and attitude toward violations. The study further examined the mediating role of pilot commitment to the airline between safety culture and the two measures of safety performance. A total of 247 pilots, captain and first officers, voluntarily participated in the survey which represented 29% response rate. A confirmatory factor analysis was used to validate each construct in the study. Structural equation modeling was used to test the hypotheses of the research. Findings revealed the essential role of safety culture as a main predictor of employees' commitment to the airline. Moreover, safety culture plays a significant role into shaping pilots attitudes and behaviors inside the cockpit. Study findings showed that safety culture, crew position, and years of flying experience at Saudi Airlines accounted for 47% of the variance in pilot commitment to the airline, 40% of the variance in pilot error behavior, and 3% of the variance in pilot attitude toward violations.

The result of the study emphasizes the role of organizational factors into shaping employees' behavior. Moreover, the present study showed the significant role of safety culture to enhance employees' commitment to their organization. Airline management should pay more attention to the dimensions of safety culture and try to identify how they can improve the safety culture in the airline.

5.4 Study limitations

The collected data in the study were based on voluntary participation of pilots in Saudi Airlines to a survey questionnaire. The evaluation of safety culture, level of commitment to the airline, attitude toward violations and errors behavior was based on pilots' perceptions and self-reported behavior. Safety culture was evaluated based on pilots' perceptions of management commitment to safety, operational personnel commitment to safety, current reporting system in the airline, and level of accountability. Participants could have been bias toward what they think was right and not what they actually believed. Moreover, pilots who have negative attitudes toward management might have been biased toward criticizing management in all aspects. Pilot error behaviors and attitude toward violations were based on pilots' self-reported behavior. Some pilots especially with low experience in the airline do not want to report their unsafe behaviors to avoid possible negative repercussion. Therefore, the data in the research were based on true and honest opinion of participating pilots.

5.5 Future research

The present study examined the effect of safety culture on safety performance in terms of pilot error behaviors and attitude toward violations. Safety culture was conceptualized by four dimensions including organizational commitment, operational personnel, formal safety system, and informal safety system. Study findings showed that safety culture had a direct effect on pilot attitude toward violations and an indirect effect on pilot error behaviors. Future research should concentrate on the four dimensions of safety culture to examine which one has the most influence on safety performance. In addition, the human factor analysis and classification system (HFACS) categorized unsafe acts into errors and violations (Wiegmann & Shappell, 2001a). Errors were classified into skill based errors, decision errors, and perceptual errors. Violations were classified into routine and exceptional. Future research should investigate the effect of safety culture on different types of errors and violations to identify which unsafe acts are highly influenced by safety culture.

APPENDIX A: SURVEY INSTRUMENT

Assessing Safety Culture among Pilots in Saudi Airlines

1. Crew Position

- [ ] Captain
- [ ] First Officer
- [ ] Flight Engineer

2. Current Aircraft Flying

- [ ] B747-300
- [ ] B777
- [ ] MD11
- [ ] B747-400
- [ ] A320
- [ ] MD 90
- [ ] B747-800
- [ ] A330
- [ ] EMB 170

3. Flying experience with Saudi Airlines

- [ ] 0-5 years
- [ ] 15-20 years
- [ ] 30-35 years
- [ ] 5-10 years
- [ ] 20-25 years
- [ ] over 35 years
- [ ] 10-15 years
- [ ] 25-30 years

4. Previous flying experience other than Saudi Airlines

- [ ] Commercial Airlines
- [ ] Military
- [ ] Navy
- [ ] Charter airlines
- [ ] Not applicable

Page 1

Assessing Safety Culture among Pilots in Saudi Airlines

These items refer to the value that your airline's upper management places on safety

*** 1. Safety is a core value in my airline.**

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

*** 2. Managment is more concerned with making money than being safe.**

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Some what agree	Agree	Strongly agree
○	○	○	○	○	○	○

*** 3. Management expects pilots to push for on-time performance, even if it means compromising safety.**

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

*** 4. Managment does not show much concern for safety until there is an accident or incident**

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

*** 5. Management does not cut corners where safety is concerned**

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

Assessing Safety Culture among Pilots in Saudi Airlines

These items refer to your airline's typical practices related to safety in various areas

*** 1. Checklist and procedures are easy to understand.**

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

*** 2. My airline's manuals are kept up to date.**

Strongly diagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

*** 3. My airline is willing to invest money and effort to improve safety.**

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

*** 4. My airline is committed to equipping aircraft with up-to- date technology.**

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

*** 5. My airline ensures that maintenance on aircraft is adequately performed and that aircraft are safe to operate.**

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

Assessing Safety Culture among Pilots in Saudi Airlines

These items refer to upper management's commitment to meeting or exceeding safety requirements

*** 1. Management goes above and beyond regulatory minimums when it comes to issues of flight safety.**

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

*** 2. Management schedule pilots as much as legally possible, with little concern for pilots' sleep schedule or fatigue.**

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

*** 3. Management tries to get around safety requirements whenever they get a chance.**

Strongly disagree	Disagree	Somewhat diagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

*** 4. Management views regulation violation very seriously, even when they don't result in any serious damage.**

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

Assessing Safety Culture among Pilots in Saudi Airlines

These items refer to equipment managers/supervisors with whom you interact regularly

*** 1. Equipment managers/ supervisors do not hesitate to contact line pilots to proactively discuss safety issues.**

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

*** 2. Equipment managers/supervisors are unavailable when line pilots need help.**

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Stongly agree
○	○	○	○	○	○	○

*** 3. As long as there is no accident or incident, equipment managers/ supervisors don't care how flight operation performed.**

Stronly disagree	Disagree	Somewhat disagree	Neither agree not disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

*** 4. Equipment managers/supervisors have a clear understanding of risks associated with flight operation.**

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

*** 5. Pilots often report safety concerns to their equipment managers/ supervisors rather than safety department.**

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

Assessing Safety Culture among Pilots in Saudi Airlines

These items refer to your airline's dispatch procedures

*** 1. Dispatch consistently emphasizes information or details (e.g weather requirements, NOTAMs) that affect flight safety.**

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

*** 2. Dispatch inappropriately uses the MEL (e.g use it when it is better to fix equipment)**

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

*** 3. Dispatch is responsive to pilots' concerns about safety.**

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

*** 4. Dispatch would rather take a chance with safety than cancel a flight.**

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

Assessing Safety Culture among Pilots in Saudi Airlines

These items refer to you airline's line and simulator instructors

*** 1. Instructor Pilots at the simulator have a clear understanding of risks associated with flight operation**

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

*** 2. Safety is consistently emphasized during training at my airline.**

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

*** 3. Instructor pilots teach shortcuts and ways to get around safety requirements.**

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

*** 4. Instructor Pilots prepare pilots for various safety situation even uncommon or unlikely ones.**

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

Assessing Safety Culture among Pilots in Saudi Airlines

Please rate your airline's official system for reporting safety issues and concerns

*** 1. The safety reporting system is convenient and easy to use.**

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

*** 2. Pilots can report safety discrepancies without fear of negative repercussions.**

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

*** 3. Pilots are willing to report information regarding marginal performance or unsafe actions of other pilots.**

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

*** 4. Pilots do not bother reporting near misses or close calls since these events do not cause any real damage.**

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

*** 5. Pilots are willing to file reports about unsafe situations, even if the situation was caused by their own actions.**

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

Assessing Safety Culture among Pilots in Saudi Airlines

These items refer to the response pilots receive from your airline's official safety system

*** 1. Safety issues raised by pilots are communicated regularly to all other pilots in this airline.**

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

*** 2. When a pilot reports a safety problem, it is corrected in a timely manner**

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

*** 3. Pilots are satisfied with the way this airlines deals with safety reports.**

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

*** 4. My airline only keeps track of major safety problems and overlooks routine ones.**

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

Assessing Safety Culture among Pilots in Saudi Airlines

These items refer to the person or people in your airline who are formally designated as responsible for safety

*** 1. Person responsible for safety hold a high status in the airline.**

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

*** 2. Person responsible for safety have the power to make changes.**

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

*** 3. Person responsible for safety have a clear understanding of the risks involved in flying the line.**

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

*** 4. Safety personnel have little or no authority compared to operational personnel.**

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

*** 5. Safety personnel demonstrate a consistent commitment to safety.**

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

Assessing Safety Culture among Pilots in Saudi Airlines

These items refer to the ways in which pilots are treated based on their safe or unsafe behavior at your airline

*** 1. Airline management shows favoritism to certain pilots.**

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

*** 2. Standards of accountability are consistently applied to all pilots in this organization.**

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

*** 3. When pilots make a mistake or do something wrong, they are dealt with fairly by the airline.**

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

*** 4. When an accident or incident happens, management immediately blames the pilot.**

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

Assessing Safety Culture among Pilots in Saudi Airlines

These items refer to the extent to which pilots have the authority to provide input and make decisions regarding safety

***1. Pilots are rarely asked for input when airline procedures are developed or changed.**

Strongly disagree	Disagree	Somewhat disagree	Neither agree not disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

***2. Pilots are actively involved in identifying and resolving safety concerns.**

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

***3. Pilots who call in sick or fatigued are investigated by aircraft supervisors or other management personnel**

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

***4. Pilots have little real authority to make decisions that affect the safety of normal flight operation.**

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

***5. Management rarely questions a pilot's decision to delay a flight for safety issue.**

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

Assessing Safety Culture among Pilots in Saudi Airlines

These items refer to the attitudes you perceive among fellow pilots in regard to safety

*** 1. Pilots view the airline's safety record as their own and take pride in it**

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

*** 2. Pilots who don't fly safely quickly develop a negative reputation among other pilots.**

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

*** 3. Pilots with less seniority are willing to speak up regarding flight safety issues.**

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

*** 4. Decisions made by senior pilots are difficult to challenge.**

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

*** 5. Pilots don't cut corners or compromise safety regardless of the operational pressures to do so.**

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

Assessing Safety Culture among Pilots in Saudi Airlines

Please express your own attitude to the following questions

***1. I make errors in my job from time to time.**

Strongly disagree ◯ | Disagree ◯ | Neither agree nor disagree ◯ | Agree ◯ | Strongly agree ◯

***2. Workload pressures have at times affected the quality of my work.**

Strongly disagree ◯ | Disagree ◯ | Neither agree nor disagree ◯ | Agree ◯ | Strongly agree ◯

***3. I have made errors that have been detected by other pilots.**

Strongly disagree ◯ | Disagree ◯ | Neither agree nor disagree ◯ | Agree ◯ | Strongly agree ◯

***4. I am more likely to make judgment errors in abnormal or emergency situations.**

Strongly disagree ◯ | Disagree ◯ | Neither agree nor disagree ◯ | Agree ◯ | Strongly agree ◯

***5. I will say something if my peers the other pilots take shortcuts.**

Strongly disagree ◯ | Disagree ◯ | Neither agree nor disagree ◯ | Agree ◯ | Strongly agree ◯

***6. I will say something if my supervisor takes shortcuts**

Strongly disagree ◯ | Disagree ◯ | Neither agree nor disagree ◯ | Agree ◯ | Strongly agree ◯

***7. There are better ways of performing a task than those described in Flight Operating Policy Manual**

Strongly disagree ◯ | Disagree ◯ | Neither agree nor disagree ◯ | Agree ◯ | Strongly agree ◯

***8. Bending a procedure is not the same as breaking it.**

Strongly disagree ◯ | Disagree ◯ | Neither agree nor disagree ◯ | Agree ◯ | Strongly agree ◯

***9. Shortcuts, in order to get a task done, are still violations of procedures**

Strongly disagree ◯ | Disagree ◯ | Neither agree nor disagree ◯ | Agree ◯ | Strongly agree ◯

***10. Reporting mistakes helps other learn from them.**

Strongly disagree ◯ | Disagree ◯ | Neither agree nor disagree ◯ | Agree ◯ | Strongly agree ◯

***11. Personnel should be encouraged to report their mistakes.**

Strongly disagree ◯ | Disagree ◯ | Neither agree nor disagree ◯ | Agree ◯ | Strongly agree ◯

Assessing Safety Culture among Pilots in Saudi Airlines

Please express you attitude toward the airline

***1. I am willing to put in a great deal of effort beyond that normally expected in order to help this airline be successful**

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

***2. I talk up this organization to my friends as a great organization to work for.**

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

***3. I find that my values and the airline's value are very similar.**

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

***4. I am proud to tell others that I am part of this airline.**

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

***5. This airline really inspires the best in me in the way of job performance.**

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

***6. I really care about the fate of this airline.**

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

***7. For me, this is the best of all airlines for which to work.**

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
○	○	○	○	○	○	○

APPENDIX B: IRB APPROVAL

University of Central Florida

University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

Approval of Exempt Human Research

From: **UCF Institutional Review Board #1**
FWA00000351, IRB00001138

To: **Mohammad Alsowayigh**

Date: **June 06, 2013**

Dear Researcher:

On 6/6/2013, the IRB approved the following activity as human participant research that is exempt from regulation:

Type of Review:	Exempt Determination
Project Title:	Assessing Safety Culture among Pilots in Saudi Airlines: A Quantitative Study Approach
Investigator:	Mohammad Alsowayigh
IRB Number:	SBE-13-09428
Funding Agency:	
Grant Title:	
Research ID:	N/A

This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are made and there are questions about whether these changes affect the exempt status of the human research, please contact the IRB. When you have completed your research, please submit a Study Closure request in iRIS so that IRB records will be accurate.

In the conduct of this research, you are responsible to follow the requirements of the Investigator Manual.

On behalf of Sophia Dziegielewski, Ph.D., L.C.S.W., UCF IRB Chair, this letter is signed by:

Signature applied by Joanne Muratori on 06/06/2013 12:31:07 PM EDT

Joanne Muratori

IRB Coordinator

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APPENDIX C: SPEARMAN'S CORRELATION MATRIX

Correlations: Organizational Commitment

			SV1	SV2	SV3	SV4	SV5	SF1	SF2	SF3	SF4	SF5	GB1	GB2	GB3	GB4
Spearman's rho	SV1	Correlation Coefficient	1.000	.212**	.224**	.272**	.110	.111	.223**	.287**	.083	.231**	.228**	.111	.243**	.143*
		Sig. (2-tailed)	.	.001	.000	.000	.084	.083	.000	.000	.193	.000	.000	.083	.000	.024
		N	247	247	247	247	247	247	247	247	247	247	247	247	247	247
	SV2	Correlation Coefficient	.212**	1.000	.632**	.575**	.026	.190**	.133*	.386**	.270**	.290**	.205**	.312**	.462**	.266**
		Sig. (2-tailed)	.001	.	.000	.000	.679	.003	.036	.000	.000	.000	.001	.000	.000	.000
		N	247	247	247	247	247	247	247	247	247	247	247	247	247	247
	SV3	Correlation Coefficient	.224**	.632**	1.000	.590**	-.006	.229**	.216**	.344**	.150*	.255**	.099	.264**	.412**	.186**
		Sig. (2-tailed)	.000	.000	.	.000	.920	.000	.001	.000	.018	.000	.121	.000	.000	.003
		N	247	247	247	247	247	247	247	247	247	247	247	247	247	247
	SV4	Correlation Coefficient	.272**	.575**	.590**	1.000	-.056	.228**	.218**	.438**	.272**	.330**	.212**	.347**	.460**	.246**
		Sig. (2-tailed)	.000	.000	.000	.	.379	.000	.001	.000	.000	.000	.001	.000	.000	.000

	N	247	247	247	247	247	247	247	247	247	247	247	247	247	247
SV5	Correlation Coefficient	.110	.026	-.006	-.056	1.000	-.080	.035	.098	-.102	.005	.100	.006	.079	.026
	Sig. (2-tailed)	.084	.679	.920	.379	.	.209	.581	.126	.110	.940	.118	.924	.215	.684
	N	247	247	247	247	247	247	247	247	247	247	247	247	247	247
SF1	Correlation Coefficient	.111	.190**	.229**	.228**	-.080	1.000	.382**	.236**	.243**	.295**	.037	.071	.054	.212**
	Sig. (2-tailed)	.083	.003	.000	.000	.209	.	.000	.000	.000	.000	.566	.265	.394	.001
	N	247	247	247	247	247	247	247	247	247	247	247	247	247	247
SF2	Correlation Coefficient	.223**	.133*	.216**	.218**	.035	.382**	1.000	.428**	.233**	.282**	.120	.064	.073	.254**
	Sig. (2-tailed)	.000	.036	.001	.001	.581	.000	.	.000	.000	.000	.060	.318	.254	.000
	N	247	247	247	247	247	247	247	247	247	247	247	247	247	247
SF3	Correlation Coefficient	.287**	.386**	.344**	.438**	.098	.236**	.428**	1.000	.417**	.542**	.324**	.165**	.261**	.251**
	Sig. (2-tailed)	.000	.000	.000	.000	.126	.000	.000	.	.000	.000	.000	.010	.000	.000
	N	247	247	247	247	247	247	247	247	247	247	247	247	247	247

SF4	Correlation Coefficient	.083	.270**	.150*	.272**	-.102	.243**	.233**	.417**	1.000	.416**	.143*	.201**	.176**	.215**
	Sig. (2-tailed)	.193	.000	.018	.000	.110	.000	.000	.000	.	.000	.025	.001	.005	.001
	N	247	247	247	247	247	247	247	247	247	247	247	247	247	247
SF5	Correlation Coefficient	.231**	.290**	.255**	.330**	.005	.295**	.282**	.542**	.416**	1.000	.216**	.096	.217**	.257**
	Sig. (2-tailed)	.000	.000	.000	.000	.940	.000	.000	.000	.000	.	.001	.132	.001	.000
	N	247	247	247	247	247	247	247	247	247	247	247	247	247	247
GB1	Correlation Coefficient	.228**	.205**	.099	.212**	.100	.037	.120	.324**	.143*	.216**	1.000	-.024	.096	.305**
	Sig. (2-tailed)	.000	.001	.121	.001	.118	.566	.060	.000	.025	.001	.	.710	.133	.000
	N	247	247	247	247	247	247	247	247	247	247	247	247	247	247
GB2	Correlation Coefficient	.111	.312**	.264**	.347**	.006	.071	.064	.165**	.201**	.096	-.024	1.000	.438**	.072
	Sig. (2-tailed)	.083	.000	.000	.000	.924	.265	.318	.010	.001	.132	.710	.	.000	.257
	N	247	247	247	247	247	247	247	247	247	247	247	247	247	247
GB3	Correlation Coefficient	.243**	.462**	.412**	.460**	.079	.054	.073	.261**	.176**	.217**	.096	.438**	1.000	.070

		Sig. (2-tailed)	.000	.000	.000	.000	.215	.394	.254	.000	.005	.001	.133	.000	.	.274
		N	247	247	247	247	247	247	247	247	247	247	247	247	247	247
	GB4	Correlation Coefficient	.143*	.266**	.186**	.246**	.026	.212**	.254**	.251**	.215**	.257**	.305**	.072	.070	1.000
		Sig. (2-tailed)	.024	.000	.003	.000	.684	.001	.000	.000	.001	.000	.000	.257	.274	.
		N	247	247	247	247	247	247	247	247	247	247	247	247	247	247

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

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

Correlations: Operational Personnel

			SUP1	SUP2	SUP3	SUP4	SUP5	DIS1	DIS2	DIS3	DIS4	IP1	IP2	IP3	IP4
Spearman's rho	SUP 1	Correlation Coefficient	1.000	.221**	.330**	.362**	.174**	.277**	.141*	.310**	.110	.224**	.228**	.094	.236**
		Sig. (2-tailed)	.	.000	.000	.000	.006	.000	.027	.000	.084	.000	.000	.140	.000
		N	247	247	247	247	247	247	247	247	247	247	247	247	247
	SUP 2	Correlation Coefficient	.221**	1.000	.477**	.206**	.121	.157*	.131*	.181**	.254**	.205**	.163*	.219**	.148*
		Sig. (2-tailed)	.000	.	.000	.001	.058	.014	.039	.004	.000	.001	.010	.001	.020
		N	247	247	247	247	247	247	247	247	247	247	247	247	247
	SUP 3	Correlation Coefficient	.330**	.477**	1.000	.127*	-.055	.089	.187**	.202**	.270**	.211**	.284**	.327**	.132*
		Sig. (2-tailed)	.000	.000	.	.046	.386	.164	.003	.001	.000	.001	.000	.000	.039
		N	247	247	247	247	247	247	247	247	247	247	247	247	247
	SUP 4	Correlation Coefficient	.362**	.206**	.127*	1.000	.181**	.148*	.120	.213**	.091	.324**	.299**	.094	.147*
		Sig. (2-tailed)	.000	.001	.046	.	.004	.020	.060	.001	.154	.000	.000	.139	.021
		N	247	247	247	247	247	247	247	247	247	247	247	247	247

SUP5	Correlation Coefficient	.174**	.121	-.055	.181**	1.000	.067	-.083	-.001	-.118	.092	.137*	.012	.082
	Sig. (2-tailed)	.006	.058	.386	.004	.	.296	.194	.981	.064	.149	.031	.857	.197
	N	247	247	247	247	247	247	247	247	247	247	247	247	247
DIS1	Correlation Coefficient	.277**	.157*	.089	.148*	.067	1.000	.172**	.540**	.217**	.084	.101	.002	.039
	Sig. (2-tailed)	.000	.014	.164	.020	.296	.	.007	.000	.001	.190	.114	.969	.546
	N	247	247	247	247	247	247	247	247	247	247	247	247	247
DIS2	Correlation Coefficient	.141*	.131*	.187**	.120	-.083	.172**	1.000	.170**	.173**	-.012	.131*	.057	-.038
	Sig. (2-tailed)	.027	.039	.003	.060	.194	.007	.	.008	.006	.855	.040	.372	.552
	N	247	247	247	247	247	247	247	247	247	247	247	247	247
DIS3	Correlation Coefficient	.310**	.181**	.202**	.213**	-.001	.540**	.170**	1.000	.357**	.198**	.245**	.125*	.156*
	Sig. (2-tailed)	.000	.004	.001	.001	.981	.000	.008	.	.000	.002	.000	.049	.014
	N	247	247	247	247	247	247	247	247	247	247	247	247	247
DIS4	Correlation Coefficient	.110	.254**	.270**	.091	-.118	.217**	.173**	.357**	1.000	.044	.090	.151*	.061

	Sig. (2-tailed)	.084	.000	.000	.154	.064	.001	.006	.000	.	.491	.160	.017	.339
	N	247	247	247	247	247	247	247	247	247	247	247	247	247
IP1	Correlation Coefficient	.224**	.205**	.211**	.324**	.092	.084	-.012	.198**	.044	1.000	.604**	.368**	.440**
	Sig. (2-tailed)	.000	.001	.001	.000	.149	.190	.855	.002	.491	.	.000	.000	.000
	N	247	247	247	247	247	247	247	247	247	247	247	247	247
IP2	Correlation Coefficient	.228**	.163*	.284**	.299**	.137*	.101	.131*	.245**	.090	.604**	1.000	.416**	.497**
	Sig. (2-tailed)	.000	.010	.000	.000	.031	.114	.040	.000	.160	.000	.	.000	.000
	N	247	247	247	247	247	247	247	247	247	247	247	247	247
IP3	Correlation Coefficient	.094	.219**	.327**	.094	.012	.002	.057	.125*	.151*	.368**	.416**	1.000	.304**
	Sig. (2-tailed)	.140	.001	.000	.139	.857	.969	.372	.049	.017	.000	.000	.	.000
	N	247	247	247	247	247	247	247	247	247	247	247	247	247
IP4	Correlation Coefficient	.236**	.148*	.132*	.147*	.082	.039	-.038	.156*	.061	.440**	.497**	.304**	1.000
	Sig. (2-tailed)	.000	.020	.039	.021	.197	.546	.552	.014	.339	.000	.000	.000	.
	N	247	247	247	247	247	247	247	247	247	247	247	247	247

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

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

Correlations: Formal Safety System

			RS1	RS2	RS3	RS4	RS5	RF1	RF2	RF3	RF4	SP1	SP2	SP3	SP4	SP5
Spearman's rho	RS1	Correlation Coefficient	1.000	.504**	.279**	.044	.201**	.274**	.334**	.405**	.146*	.152*	.190**	.276**	.164**	.246**
		Sig. (2-tailed)	.	.000	.000	.492	.001	.000	.000	.000	.022	.017	.003	.000	.010	.000
		N	247	247	247	247	247	247	247	247	247	247	247	247	247	247
	RS2	Correlation Coefficient	.504**	1.000	.390**	.067	.267**	.290**	.324**	.317**	.257**	.195**	.216**	.320**	.210**	.313**
		Sig. (2-tailed)	.000	.	.000	.293	.000	.000	.000	.000	.000	.002	.001	.000	.001	.000
		N	247	247	247	247	247	247	247	247	247	247	247	247	247	247
	RS3	Correlation Coefficient	.279**	.390**	1.000	.142*	.528**	.394**	.293**	.260**	.157*	.235**	.263**	.243**	.262**	.245**
		Sig. (2-tailed)	.000	.000	.	.026	.000	.000	.000	.000	.014	.000	.000	.000	.000	.000
		N	247	247	247	247	247	247	247	247	247	247	247	247	247	247
	RS4	Correlation Coefficient	.044	.067	.142*	1.000	.183**	.050	-.024	.042	.159*	.048	.069	.034	.079	.067
		Sig. (2-tailed)	.492	.293	.026	.	.004	.435	.704	.514	.013	.457	.277	.597	.218	.294
		N	247	247	247	247	247	247	247	247	247	247	247	247	247	247

RS5	Correlation Coefficient	.201**	.267**	.528**	.183**	1.000	.278**	.164**	.250**	.093	.161*	.198**	.179**	.171**	.179**
	Sig. (2-tailed)	.001	.000	.000	.004	.	.000	.010	.000	.145	.011	.002	.005	.007	.005
	N	247	247	247	247	247	247	247	247	247	247	247	247	247	247
RF1	Correlation Coefficient	.274**	.290**	.394**	.050	.278**	1.000	.536**	.416**	.200**	.291**	.347**	.297**	.254**	.349**
	Sig. (2-tailed)	.000	.000	.000	.435	.000	.	.000	.000	.002	.000	.000	.000	.000	.000
	N	247	247	247	247	247	247	247	247	247	247	247	247	247	247
RF2	Correlation Coefficient	.334**	.324**	.293**	-.024	.164**	.536**	1.000	.617**	.229**	.241**	.274**	.269**	.273**	.292**
	Sig. (2-tailed)	.000	.000	.000	.704	.010	.000	.	.000	.000	.000	.000	.000	.000	.000
	N	247	247	247	247	247	247	247	247	247	247	247	247	247	247
RF3	Correlation Coefficient	.405**	.317**	.260**	.042	.250**	.416**	.617**	1.000	.196**	.195**	.315**	.290**	.342**	.282**
	Sig. (2-tailed)	.000	.000	.000	.514	.000	.000	.000	.	.002	.002	.000	.000	.000	.000
	N	247	247	247	247	247	247	247	247	247	247	247	247	247	247
RF4	Correlation Coefficient	.146*	.257**	.157*	.159*	.093	.200**	.229**	.196**	1.000	.020	.145*	.194**	.201**	.183**

	Sig. (2-tailed)	.022	.000	.014	.013	.145	.002	.000	.002	.	.749	.023	.002	.001	.004
	N	247	247	247	247	247	247	247	247	247	247	247	247	247	247
SP1	Correlation Coefficient	.152*	.195**	.235**	.048	.161*	.291**	.241**	.195**	.020	1.000	.524**	.403**	.276**	.413**
	Sig. (2-tailed)	.017	.002	.000	.457	.011	.000	.000	.002	.749	.	.000	.000	.000	.000
	N	247	247	247	247	247	247	247	247	247	247	247	247	247	247
SP2	Correlation Coefficient	.190**	.216**	.263**	.069	.198**	.347**	.274**	.315**	.145*	.524**	1.000	.396**	.368**	.361**
	Sig. (2-tailed)	.003	.001	.000	.277	.002	.000	.000	.000	.023	.000	.	.000	.000	.000
	N	247	247	247	247	247	247	247	247	247	247	247	247	247	247
SP3	Correlation Coefficient	.276**	.320**	.243**	.034	.179**	.297**	.269**	.290**	.194**	.403**	.396**	1.000	.041	.561**
	Sig. (2-tailed)	.000	.000	.000	.597	.005	.000	.000	.000	.002	.000	.000	.	.520	.000
	N	247	247	247	247	247	247	247	247	247	247	247	247	247	247
SP4	Correlation Coefficient	.164**	.210**	.262**	.079	.171**	.254**	.273**	.342**	.201**	.276**	.368**	.041	1.000	.048
	Sig. (2-tailed)	.010	.001	.000	.218	.007	.000	.000	.000	.001	.000	.000	.520	.	.449
	N	247	247	247	247	247	247	247	247	247	247	247	247	247	247

SP5	Correlation Coefficient	.246**	.313**	.245**	.067	.179**	.349**	.292**	.282**	.183**	.413**	.361**	.561**	.048	1.000
	Sig. (2-tailed)	.000	.000	.000	.294	.005	.000	.000	.000	.004	.000	.000	.000	.449	.
	N	247	247	247	247	247	247	247	247	247	247	247	247	247	247

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

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

Correlations: Informal Safety System

			AC1	AC2	AC3	AC4	PA1	PA2	PA3	PA4	PA5	PR1	PR2	PR3	PR4	PR5
Spearman's rho	AC1	Correlation Coefficient	1.000	.374**	.328**	.383**	.185**	.290**	.187**	.185**	.170**	.096	.021	.162*	.197**	.122
		Sig. (2-tailed)	.	.000	.000	.000	.003	.000	.003	.003	.007	.132	.742	.011	.002	.056
		N	247	247	247	247	247	247	247	247	247	247	247	247	247	247
	AC2	Correlation Coefficient	.374**	1.000	.470**	.294**	.068	.328**	.066	.124	.193**	.207**	-.020	.100	.094	.264**
		Sig. (2-tailed)	.000	.	.000	.000	.287	.000	.303	.051	.002	.001	.754	.118	.141	.000
		N	247	247	247	247	247	247	247	247	247	247	247	247	247	247
	AC3	Correlation Coefficient	.328**	.470**	1.000	.391**	.140*	.352**	.103	.200**	.232**	.057	.056	.205**	.027	.128*
		Sig. (2-tailed)	.000	.000	.	.000	.028	.000	.108	.002	.000	.370	.382	.001	.667	.044
		N	247	247	247	247	247	247	247	247	247	247	247	247	247	247
	AC4	Correlation Coefficient	.383**	.294**	.391**	1.000	.158*	.202**	.233**	.281**	.052	.116	.084	.017	.237**	-.004
		Sig. (2-tailed)	.000	.000	.000	.	.013	.001	.000	.000	.414	.069	.186	.791	.000	.948
		N	247	247	247	247	247	247	247	247	247	247	247	247	247	247

PA1	Correlation Coefficient	.185**	.068	.140*	.158*	1.000	.116	.162*	.038	.045	.090	-.056	.101	.184**	.005
	Sig. (2-tailed)	.003	.287	.028	.013	.	.069	.011	.555	.485	.160	.383	.114	.004	.942
	N	247	247	247	247	247	247	247	247	247	247	247	247	247	247
PA2	Correlation Coefficient	.290**	.328**	.352**	.202**	.116	1.000	.120	-.012	.101	.215**	.026	.171**	-.042	.205**
	Sig. (2-tailed)	.000	.000	.000	.001	.069	.	.060	.848	.113	.001	.685	.007	.506	.001
	N	247	247	247	247	247	247	247	247	247	247	247	247	247	247
PA3	Correlation Coefficient	.187**	.066	.103	.233**	.162*	.120	1.000	.067	-.042	.030	.025	.078	.021	.016
	Sig. (2-tailed)	.003	.303	.108	.000	.011	.060	.	.297	.515	.637	.690	.224	.748	.798
	N	247	247	247	247	247	247	247	247	247	247	247	247	247	247
PA4	Correlation Coefficient	.185**	.124	.200**	.281**	.038	-.012	.067	1.000	.022	.140*	.109	.037	.207**	.158*
	Sig. (2-tailed)	.003	.051	.002	.000	.555	.848	.297	.	.732	.027	.089	.563	.001	.013
	N	247	247	247	247	247	247	247	247	247	247	247	247	247	247
PA5	Correlation Coefficient	.170**	.193**	.232**	.052	.045	.101	-.042	.022	1.000	.144*	.062	.160*	-.075	.133*

	Sig. (2-tailed)	.007	.002	.000	.414	.485	.113	.515	.732	.	.024	.331	.012	.242	.036
	N	247	247	247	247	247	247	247	247	247	247	247	247	247	247
PR1	Correlation Coefficient	.096	.207**	.057	.116	.090	.215**	.030	.140*	.144*	1.000	.314**	.255**	.079	.248**
	Sig. (2-tailed)	.132	.001	.370	.069	.160	.001	.637	.027	.024	.	.000	.000	.219	.000
	N	247	247	247	247	247	247	247	247	247	247	247	247	247	247
PR2	Correlation Coefficient	.021	-.020	.056	.084	-.056	.026	.025	.109	.062	.314**	1.000	.205**	-.151*	.157*
	Sig. (2-tailed)	.742	.754	.382	.186	.383	.685	.690	.089	.331	.000	.	.001	.017	.013
	N	247	247	247	247	247	247	247	247	247	247	247	247	247	247
PR3	Correlation Coefficient	.162*	.100	.205**	.017	.101	.171**	.078	.037	.160*	.255**	.205**	1.000	-.062	.231**
	Sig. (2-tailed)	.011	.118	.001	.791	.114	.007	.224	.563	.012	.000	.001	.	.334	.000
	N	247	247	247	247	247	247	247	247	247	247	247	247	247	247
PR4	Correlation Coefficient	.197**	.094	.027	.237**	.184**	-.042	.021	.207**	-.075	.079	-.151*	-.062	1.000	.076
	Sig. (2-tailed)	.002	.141	.667	.000	.004	.506	.748	.001	.242	.219	.017	.334	.	.234
	N	247	247	247	247	247	247	247	247	247	247	247	247	247	247

PR5	Correlation Coefficient	.122	.264**	.128*	-.004	.005	.205**	.016	.158*	.133*	.248**	.157*	.231**	.076	1.000
	Sig. (2-tailed)	.056	.000	.044	.948	.942	.001	.798	.013	.036	.000	.013	.000	.234	.
	N	247	247	247	247	247	247	247	247	247	247	247	247	247	247

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

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

Correlations: Pilot Commitment to the airline

			PC1	PC2	PC3	PC4	PC5	PC6	PC7
Spearman's rho	PC1	Correlation Coefficient	1.000	.395**	.302**	.316**	.135*	.334**	.164**
		Sig. (2-tailed)	.	.000	.000	.000	.034	.000	.010
		N	247	247	247	247	247	247	247
	PC2	Correlation Coefficient	.395**	1.000	.599**	.632**	.506**	.350**	.488**
		Sig. (2-tailed)	.000	.	.000	.000	.000	.000	.000
		N	247	247	247	247	247	247	247
	PC3	Correlation Coefficient	.302**	.599**	1.000	.496**	.500**	.216**	.487**
		Sig. (2-tailed)	.000	.000	.	.000	.000	.001	.000
		N	247	247	247	247	247	247	247
	PC4	Correlation Coefficient	.316**	.632**	.496**	1.000	.584**	.365**	.593**
		Sig. (2-tailed)	.000	.000	.000	.	.000	.000	.000
		N	247	247	247	247	247	247	247
	PC5	Correlation Coefficient	.135*	.506**	.500**	.584**	1.000	.159*	.526**
		Sig. (2-tailed)	.034	.000	.000	.000	.	.012	.000

		N	247	247	247	247	247	247	247
	PC6	Correlation Coefficient	.334**	.350**	.216**	.365**	.159*	1.000	.287**
		Sig. (2-tailed)	.000	.000	.001	.000	.012	.	.000
		N	247	247	247	247	247	247	247
	PC7	Correlation Coefficient	.164**	.488**	.487**	.593**	.526**	.287**	1.000
		Sig. (2-tailed)	.010	.000	.000	.000	.000	.000	.
		N	247	247	247	247	247	247	247

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

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

Correlations: Pilot Error Behavior

			ER1	ER2	ER3	ER4
Spearman's rho	ER1	Correlation Coefficient	1.000	.458**	.538**	.267**
		Sig. (2-tailed)	.	.000	.000	.000
		N	247	247	247	247
	ER2	Correlation Coefficient	.458**	1.000	.358**	.326**
		Sig. (2-tailed)	.000	.	.000	.000
		N	247	247	247	247
	ER3	Correlation Coefficient	.538**	.358**	1.000	.321**
		Sig. (2-tailed)	.000	.000	.	.000
		N	247	247	247	247
	ER4	Correlation Coefficient	.267**	.326**	.321**	1.000
		Sig. (2-tailed)	.000	.000	.000	.
		N	247	247	247	247

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

Correlations: Pilot attitude toward Violations

			VO1	VO2	VO3	VO4	VO5	VO6	VO7
Spearman's rho	VO1	Correlation Coefficient	1.000	.757**	.057	.083	.228**	.270**	.281**
		Sig. (2-tailed)	.	.000	.371	.193	.000	.000	.000
		N	247	247	247	247	247	247	247
	VO2	Correlation Coefficient	.757**	1.000	.046	.042	.231**	.295**	.292**
		Sig. (2-tailed)	.000	.	.475	.512	.000	.000	.000
		N	247	247	247	247	247	247	247
	VO3	Correlation Coefficient	.057	.046	1.000	.346**	-.039	-.033	-.039
		Sig. (2-tailed)	.371	.475	.	.000	.537	.603	.545
		N	247	247	247	247	247	247	247
	VO4	Correlation Coefficient	.083	.042	.346**	1.000	.241**	.123	.212**
		Sig. (2-tailed)	.193	.512	.000	.	.000	.054	.001
		N	247	247	247	247	247	247	247

	VO5	Correlation Coefficient	.228**	.231**	-.039	.241**	1.000	.211**	.267**
		Sig. (2-tailed)	.000	.000	.537	.000	.	.001	.000
		N	247	247	247	247	247	247	247
	VO6	Correlation Coefficient	.270**	.295**	-.033	.123	.211**	1.000	.651**
		Sig. (2-tailed)	.000	.000	.603	.054	.001	.	.000
		N	247	247	247	247	247	247	247
	VO7	Correlation Coefficient	.281**	.292**	-.039	.212**	.267**	.651**	1.000
		Sig. (2-tailed)	.000	.000	.545	.001	.000	.000	.
		N	247	247	247	247	247	247	247

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

LIST OF REFERENCES

Block, E. E., Sabin, E. J., & Patankar, M. S. (2007). The structure of safety climate for accident free flight crews. *International Journal of Applied Aviation Studies*, *7*(1), 46–59.

Boomsma, A., & Hoogland, J. J. (2001). The Robustness of LISREL Modeling Revisited. *STRUCTURAL EQUATION MODELING: PRESENT AND FUTURE: A FESTSCHRIFT IN HONOR OF KARL JÖRESKOG (PP. 139–168). CHICAGO: SCIENTIFIC SOFTWARE INTERNATIONAL*. Retrieved from http://130.203.133.150/viewdoc/summary?doi=10.1.1.11.684

Chen, C.-F. (2006). Job satisfaction, organizational commitment, and flight attendants' turnover intentions: A note. *Journal of Air Transport Management*, *12*(5), 274–276. doi:10.1016/j.jairtraman.2006.05.001

Commeiras, N., & Fournier, C. (2001). Critical Evaluation of Porter et al.'s Organizational Commitment Questionaire: Implications for Researchers. *Journal of Personal Selling & Sales Management*, *21*(3), 239.

Cooper Ph.D., M. D. (2000). Towards a model of safety culture. *Safety Science*, *36*(2), 111–136. doi:10.1016/S0925-7535(00)00035-7

Cox, S., & Flin, R. (1998). Safety culture: Philosopher's stone or man of straw? *Work & Stress*, *12*(3), 189–201. doi:10.1080/02678379808256861

D'Aurizio, P. (2008). Southwest Airlines: lessons in loyalty. *Nursing Economic$*, *26*(6), 389–392.

Evans, B., Glendon, A. I., & Creed, P. A. (2007). Development and initial validation of an Aviation Safety Climate Scale. *Journal of Safety Research*, *38*(6), 675–682. doi:10.1016/j.jsr.2007.09.005

Flin, R., Mearns, K., O'Connor, P., & Bryden, R. (2000). Measuring safety climate: identifying the common features. *SAFETY SCIENCE*, *34*(1-3), 177–192.

Fogarty, G. J. (2004). The Role of Organizational and Individual Variables in Aircraft Maintenance Performance. *International Journal of Applied Aviation Studies*, *4*(1), 73–90.

Fogarty, G. J., & Shaw, A. (2010). Safety climate and the Theory of Planned Behavior: Towards the prediction of unsafe behavior. *Accident Analysis & Prevention*, *42*(5), 1455–1459. doi:10.1016/j.aap.2009.08.008

Gibbons, A. M., von Thaden, T. L., & Wiegmann, D. A. (2006). Development and Initial Validation of a Survey for Assessing Safety Culture Within Commercial Flight Operations. *The International Journal of Aviation Psychology*, *16*(2), 215–238. doi:10.1207/s15327108ijap1602_6

Guldenmund, F. . (2000). The nature of safety culture: a review of theory and research. *Safety Science*, *34*(1–3), 215–257. doi:10.1016/S0925-7535(00)00014-X

Hallowell, R. (1996). Southwest Airlines: A Case Study Linking Employee Needs Satisfaction and Organizational Capabilities to Competitive Advantage. *Human Resource Management*, *35*(4), 513–534.

Hawkins, F. H. (1987). *Human factors in flight*. Hants, England: Gower Technical Press.

Health and Safety Executive. (2005). *A review of safety culture and safety climate literature for the development of the safety culture inspection toolkit* (Research Report No. 367). Norwich, United Kingdom: Health and safety Executive.

Helmreich, R. L., & Merritt, A. C. (1998). *Culture at work in aviation and medicine : national, organizational and professional influences / Robert L. Helmreich, Ashleigh C. Merritt*. Aldershot ; Brookfield, VT, USA : Ashgate, c1998.

Hooper, D., Coughlan, J., & Mullen, M. R. (2008). Structural Equation Modelling: Guidelines for Determining Model Fit. *Electronic Journal of Business Research Methods*, *6*(1), 53–59.

Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling*, *6*(1), 1–55. doi:10.1080/10705519909540118

Kaufman, B. E. . (Jan2013 Supplement). Keeping the Commitment Model in the Air during Turbulent Times: Employee Involvement at Delta Air Lines. *Industrial Relations*, *52*(S1), 343–377.

KELLY, T., & PATANKAR, M. S. (2004). Comparison of Organizational Safety Cultures at Two Aviation Organizations. In *Proceedings of the First Safety across High-Consequence Industries Conference* (pp. 71–76).

Kline, R. B. (1998a). *Principles and practice of structural equation modeling*. New York, NY US: Guilford Press.

Kline, R. B. (1998b). Software Review: Software Programs for Structural Equation Modeling: Amos, EQS, and LISREL. *Journal of Psychoeducational Assessment*, *16*(4), 343.

Kline, R. B. (2010). *Principles and practice of structural equation modeling [electronic resource] / Rex B. Kline*. New York : Guilford Press, 2010.

Klinect, J. r., Wilhelm, J. a., & Helmreich, R. l. (1999). Threat and Error Management: Data from Line Operations Safety Audits. In *Proceedings of the Tenth International Symposium on Aviation Psychology, Volume 2* (pp. 683–688).

Landis, R. S., Beal, D. J., & Tesluk, P. E. (2000). A Comparison of Approaches to Forming Composite Measures in Structural Equation Models. *Organizational Research Methods*, *3*(2), 186.

Leedy, P.D, & Ormrod, J. E. (2010). *Practical research: Planning and design*. Upper Saddle River, N.J: Merrill Prentice Hall.

Li, W.-C., Chen, H.-C., & Wu, F.-E. (2000). Human errors in the cockpit and accidents prevention strategies from cockpit resources management perspective. In *Digital Avionics Systems Conference, 2000. Proceedings. DASC. The 19th* (Vol. 2, pp. 5D1/1 –5D1/7 vol.2). doi:10.1109/DASC.2000.884885

Lin, Y.-H. (2012). Knowledge brokering for transference to the pilot’s safety behavior. *Management Decision*, *50*(7), 1326–1338. doi:10.1108/00251741211247030

Lu, C., Young, J., Schreckengast, S., & Chen, H. (2011). Safety Culture: The Perception of Taiwan's Aviation Leaders. *International Journal of Applied Aviation Studies*, *11*(1).

Mearns, K., & Flin, R. (1999). Assessing the state of organizational safety - Culture or climate? *CURRENT PSYCHOLOGY*, *18*(1), 5–17.

Mearns, K., Flin, R., Gordan, R., & Fleming, M. (1998). Measuring Safety Climate on Offshore Installations. *Work & Stress*, *12*(3), 238–254.

Neal, A. [b1] (analytic), & Griffin, M. A. [b2] (analytic). (2006). A study of the lagged relationships among safety climate, safety motivation, safety behavior, and accidents at the individual and group levels (English). *J. Appl. Psychol.*, *91*(4), 946–953.

Neal, A., Griffin, M. ., & Hart, P. . (2000). The impact of organizational climate on safety climate and individual behavior. *Safety Science*, *34*(1–3), 99–109. doi:10.1016/S0925-7535(00)00008-4

Nunnally, J. C. (1978). *Psychometric theory / Jum C. Nunnally*. New York : McGraw-Hill, c1978.

O'Connor, P., O'Dea, A., Kennedy, Q., & Buttrey, S. E. (2011). Measuring safety climate in aviation: A review and recommendations for the future. *Safety Science*, *49*(2), 128–138. doi:10.1016/j.ssci.2010.10.001

O'Hare, D., Wiggins, M., Batt, R., & Morrison, D. (1994). Cognitive failure analysis for aircraft accident investigation. *Ergonomics*, *37*(11), 1855–1869. doi:10.1080/00140139408964954

Park, H., Kang, M. J., & Son, S. (2012). Factors affecting quality and performance – a case study of Korean aircraft maintenance unit. *Total Quality Management & Business Excellence*, *23*(2), 197–219. doi:10.1080/14783363.2011.639560

Patankar, M. S., Bigda-Peyton, M. S. P., Jeffrey P. Brown, Edward J. Sabin and Thomas G., Brown, J. P., Sabin, E. J., & Bigda-Peyton, T. G. (2012). *Safety Culture: Building and Sustaining a Cultural Change in Aviation and Healthcare*. Ashgate Publishing, Ltd.

Patankar, M. S., Brown, J. P., Sabin, E. J., & Bigda-Peyton, T. G. (2012). *Safety Culture*. Ashgate Publishing, Ltd.

Pidgeon, N. (1998). Safety culture: key theoretical issues. *Work & Stress*, *12*(3), 202–216.

Rasmussen, J. (1982). Human errors. A taxonomy for describing human malfunction in industrial installations. *Journal of Occupational Accidents*, *4*(2–4), 311–333. doi:10.1016/0376-6349(82)90041-4

Reason, J. T. (1990). *Human error / James Reason*. Cambridge [England] ; New York : Cambridge University Press, 1990.

Reason, J. T. (1997). *Managing the risks of organizational accidents / James Reason*. Aldershot, Hants, England ; Brookfield, Vt., USA : Ashgate, c1997.

Rochlin, G., & Vonmeier, A. (1994). Nuclear-Power Operations - a Cross-Cultural-Perspective. *ANNUAL REVIEW OF ENERGY AND THE ENVIRONMENT*, *19*, 153–187.

Schein, E. H. (2004). *Organizational Culture and Leadership*. Jossey-Bass.

Schumacker, R. E., & Lomax, R. G. (2010). *A beginner's guide to structural equation modeling (3rd ed.)*. New York, NY US: Routledge/Taylor & Francis Group.

Shappell, S. A., & Wiegmann, D. A. (1997). A Human Error Approach to Accident Investigation: The Taxonomy of Unsafe Operations. *The International Journal of Aviation Psychology*, *7*(4), 269–291. doi:10.1207/s15327108ijap0704_2

Shappell S., & Wiegmann D. (2000). The human factors analysis and classification system (HFACS). *Office of Aviation Medicine Technical Report No, DOT/FAA/AM-00/7*.

Sheridan, J. E. (1992). Organizational Culture and Employee Retention. *Academy of Management Journal*, *35*(5), 1036–1056.

Sherman, P. J., Helmreich, R. L., & Merritt, A. (1997). National culture and flight deck automation: Results of a multination survey. *The International Journal of Aviation Psychology*, *7*(4), 311–329.

Stevens, J. (2002). *Applied Multivariate Statistics for the Social Sciences*. L. Erlbaum.

Taylor, J. B. (2010). *Safety culture : assessing and changing the behaviour of organizations / John Bernard Taylor*. Farnham : Gower, 2010.

Vandenberg, R. J., & Scarpello, V. (1990). The matching model: An examination of the processes underlying realistic job previews. *Journal of Applied Psychology*, *75*(1), 60–67. doi:10.1037/0021-9010.75.1.60

Von Thaden, T. L., & Gibbons, A. M. (2008). *The Safety Culture Indicator Scale Measurment System (SCISMS)* (Technical Report No. HFD-08-03/FAA-08-2). University of Illinois Human Factor Division Technical Report.

Von Thaden, T. L., Kessel, J., & Ruengvisesh, D. (2008). Measuring Indicators of Safety Culture in a Major European Airline's Flight Operation Department. In *The Proceeding of the 8th International Symposium of the Australian Aviation Psychology Association*. Novotel Brighton Beach, Sydney, 8-11 April.

Von Thaden, T. L., Li, Y., Feng, L., Li, J., & Lei, D. (2006). *Validating the Commercial Aviation Safety Survey in the Chinese Context* (Technical Report No. HFD-06-09). University of Illinois Human Factor Division Technical Report.

Von Thaden, T. L., Weigmann, D. A., & Shappell, S. A. (2005). Organizational Factors in Commercial Aviation Accidents 1990-2000. *Proceedings of the 13th International Symposium on Aviation Psychology, Dayton, Ohio, USA, April 18-21, 2005. Wright State University, Dayton, Ohio, USA. Available in CD-ROM Format*, 801–805.

Von Thaden, T. L., Wiegmann, D. A., & Shappell, S. A. (2006). Organizational Factors in Commercial Aviation Accidents. *The International Journal of Aviation Psychology*, *16*(3), 239–261. doi:10.1207/s15327108ijap1603_1

von Thaden, Wiegmann, Mitchell, Sharma, & Zhang. (2003). Safety Culture in a Regional Airline: Results From a Commercial Aviation Safety Survey (Vol. 2, pp. 1214–1219). Presented at the PROCEEDINGS OF THE SYMPOSIUM ON AVIATION PSYCHOLOGY, Wright State University.

Walton, R. E. (1985). From control to commitment in the workplace. *Harvard Business Review*, *63*(2), 77–84.

Weick, K. E. (1990). The Vulnerable System: An Analysis of the Tenerife Air Disas. *Journal of Management*, *16*(3), 571.

Weigmann, D. A., von Thaden, T. L., Mitchell, A. A., Sharma, G., & Zhang, H. (2003). *Development and initial validation of a Safety culture survey for commercial aviation* (Technical Report No. AHFD-03-3/FAA-03-1). University of Illinois at Urbana-Champaign.

Wiegmann, D. A., Hui Zhang, Thaden, T. L. von, Sharma, G., & Gibbons, A. M. (2004). Safety Culture: An Integrative Review. *International Journal of Aviation Psychology*, *14*(2), 117–134.

Wiegmann, D. A., & Shappell, S. A. (2001a). A human error analysis of commercial aviation accidents using the Human Factors Analysis and Classification System (HFACS). *FAA Office of Aviation Medicine Reports*, *DOT-FAA-AM-01-3*, 1–13.

Wiegmann, D. A., & Shappell, S. A. (2001b). Human Error Perspectives in Aviation. *The International Journal of Aviation Psychology*, *11*(4), 341–357. doi:10.1207/S15327108IJAP1104_2

Wiegmann, D. A., Zhang, H., von Thaden, T. L., Sharma, G., & Gibbons, A. M. (2004). Safety Culture: An Integrative Review. *The International Journal of Aviation Psychology*, *14*(2), 117–134. doi:10.1207/s15327108ijap1402_1

Wu, T.-C., Chen, C.-H., & Li, C.-C. (2008). A correlation among safety leadership, safety climate and safety performance. *Eine Wechselbeziehung Zwischen Sicherheitsführungsverhalten, Sicherheitsklima Und Sicherheitseffizienz*, (3), 307.

Yemelyanov, A. M. (2007). Modeling operator performance for error analysis. In *IEEE International Conference on Systems, Man and Cybernetics, 2007. ISIC* (pp. 609 –614). doi:10.1109/ICSMC.2007.4414114